electronics

A McGRAW-HILL PUBLICATION

JULY · 1955

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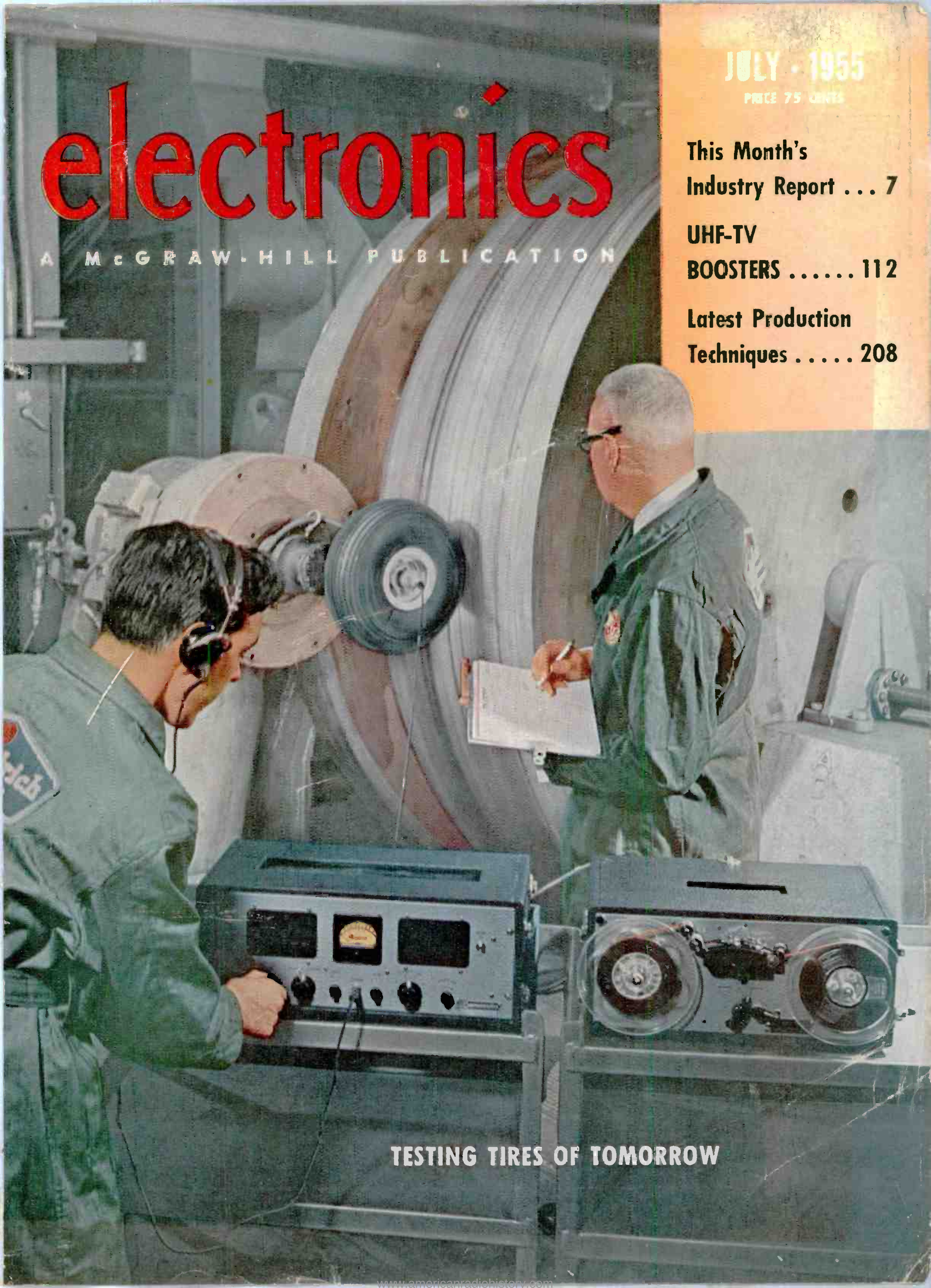


TESTING TIRES OF TOMORROW

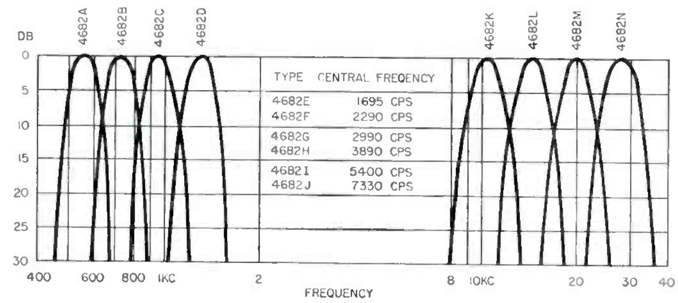
OUR MILLIONTH FILTER SHIPPED THIS YEAR...

FILTERS

FOR EVERY APPLICATION

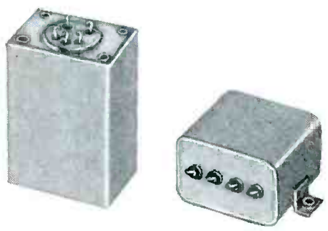
TELEMETERING FILTERS

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

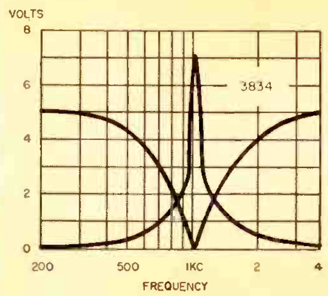


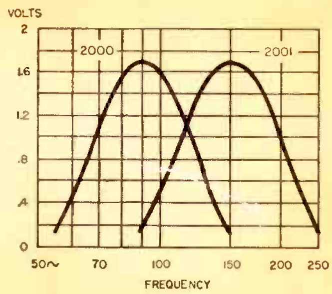
TYPE	CENTRAL FREQENCY
4682E	1695 CPS
4682F	2290 CPS
4682G	2990 CPS
4682H	3890 CPS
4682I	5400 CPS
4682J	7330 CPS

Dimensions:
(4682A) 1½ x 2 x 4″



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





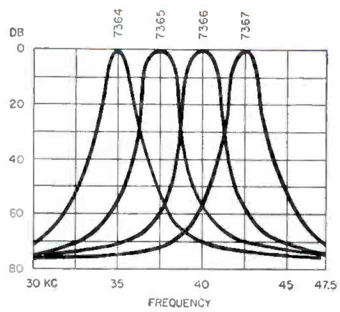
AIRCRAFT FILTERS

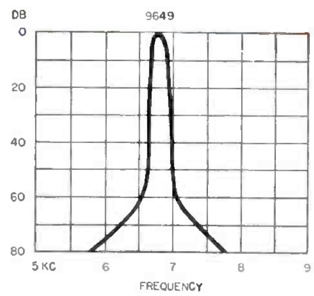
UTC has produced the bulk of filters used in aircraft equipment for over a decade. The curve at the left is that of a miniaturized (1020 cycles) range filter providing high attenuation between voice and range frequencies.

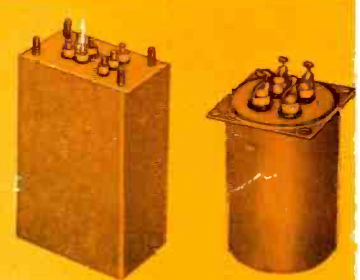
Curves at the right are that of our miniaturized 90 and 150 cycle filters for glide path systems.

CARRIER FILTERS

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



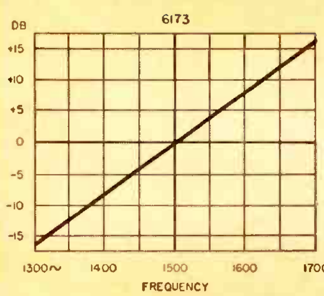


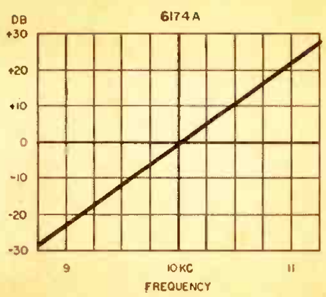


Dimensions:
(7364 series) 1⅝ x 1⅝ x 2⅛″.
(9649) 1½ x 2 x 4″.

DISCRIMINATORS

These high Q discriminators provide exceptional amplification and linearity. Typical characteristics available are illustrated by the low and higher frequency curves shown.





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

For full data on stock UTC transformers, reactors, filters, and high Q coils, write for Catalog A.

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electronics

A McGRAW-HILL PUBLICATION

JULY • 1955

CONTINUED ON NEXT PAGE

contents

continued

SHOP

COMMUNICATIONS—Time spent reading ELECTRONICS has often aided in design work, but in a recent instance it could come under the heading of speeding interoffice correspondence.

Two engineers, a floor apart at one of the larger government laboratories, had problems. One was looking for an application for nonlinear capacitors he had developed. The other required a compact f-m oscillator for use in his project. Both men independently plowed in time on research and design and came up with similar oscillators using a nonlinear capacitor.

Neither knew of the other's work until the upstairs man published an article in ELECTRONICS. When the downstairs man received his issue there wasn't much left for him to do other than trot upstairs to pick up a breadboard model and continue on with other parts of his project.

WORKING COPIES—A reader calls to our attention the fact that in at least one company plant, that of Burroughs new research laboratories at Paoli, Pa., there are very few recent copies of ELECTRONICS on the library shelves. And those few are dog-eared and marked from considerable use.

A check of the library files reveals that ELECTRONICS is taken out by engineers almost twice as many times as a second choice magazine.

COLOSSAL WAVEGUIDE—A subscriber from Maryland stopped in

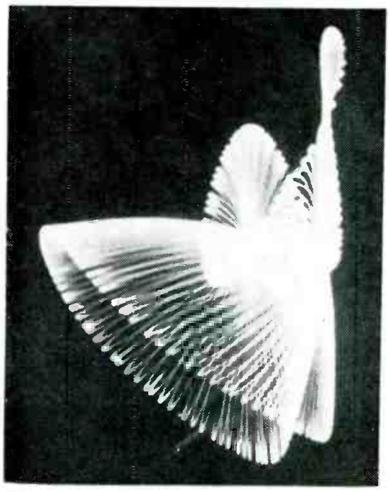
electronics

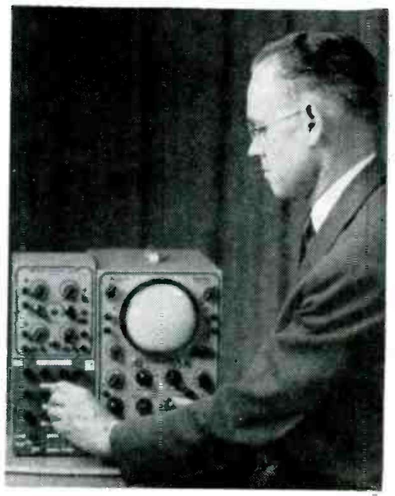
JULY, 1955 Vol. 28, No. 7

Member ABC and ABP

the office the other day to tell us that we don't have to pay $1.20 for a single copy of an old issue. (*Shoptalk*, April, 1955) He very kindly offered to loan us, provided we don't cut or mutilate pages, any issue back to 1941, when he started his subscription. We are truly grateful.

He told us of an interesting project, part of which might be solved by a mile-long waveguide, to handle frequencies on the order of 35 megacycles. But ideas and data on possible construction are not easy to come by. Particularly since the structure should offer low wind resistance.





Whistler's Mother, No. 9, and the originator of Electronic Abstractions, Ben F. Laposky, with some of the equipment he employed

PHOSPHOR ART—The editors chose as their favorite of the scope trace patterns described in Industry Report, p. 24, the pattern illustrated on this page. We think it resembles the famous painting of Whistler's Mother.

Electronic artist Laposky used a modified Heathkit oscilloscope to display all the designs. Various types of oscillators, such as sine wave, sawtooth and square wave generators, were combined, along with phasing networks, amplifiers, modulating circuits and additional magnetic field circuits.

A 5BP11A cathode-ray tube was used for most patterns. Photography was generally by a single-frame 35-mm camera with f/2 lens (and accessory close-up lens), on Linagraph pan and ortho films.

Only light from the phosphor was allowed to reach the negative.

SRO READERS—Many readers of ELECTRONICS may not have noticed the statement that appears in our indicia. (That's the name of the section in fine print at the bottom of this page.) In the second paragraph it points out that "Subscriptions are solicited only from persons engaged in theory, research, design, production, maintenance and use of electronic and industrial control components, parts and end products. Position and company connection must be indicated on subscription orders."

Because subscribers are primarily engineers, almost all requests for tear sheets of an article published ordinarily come from technical personnel of companies in the electronics field. When the article "Electronic Computers for the Businessman" appeared in the June issue we noticed a change in the character of the requests. The majority were still from companies and laboratories very definitely in electronics, but many were from firms that make maps, slaughter cattle, write life insurance, give investment advice, and produce gasoline, to mention a few of the more unusual ones.

We suspect, too, that the warm weather has increased our pass-on readership, over the back fence to friends in other industries.

Thanks for the extra audience even though we can't utilize the box office.

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Model E-6-15A Nobatron

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PRECISELY REGULATED DC **SPECIFY NOBATRON***

accurate • dependable • economical

For more than ten years, Sorensen NOBATRONS have provided regulated, low-voltage, high-current DC in thousands of laboratory and industrial applications. Their users have chosen them for their ±0.2% regulation accuracy, their convenience of use compared with battery installations or other sources, their dependability, their easy maintenance.

Nobatron circuits usually employ only three tubes. They are easily accessible for replacement when required. The characteristics listed below are conservative and tell you why you should specify Nobatron.

Models available (numbers indicate voltage & current) E-6-5A, E-6-15A, E-6-40A, E-6-100A, E-12-5, E-12-15, E-12-50, E-28-5, E-28-10, E-28-30, E-28-70, E-28-150, E-48-15, E-125-10, E-200-5.

ELECTRICAL CHARACTERISTICS

Input	95-130 VAC, 1ϕ, 50-60 cycles. 120/208, 3ϕ, 4-wire wye for the E-28-150. The E-28-70 requires 190/260, 1ϕ power.
Reg. accuracy	±0.2% against line, ±0.2% against load.
Ripple	Varies to 1% RMS max. under worst conditions.
Load range	1/10 to full load.
Output range	Adjustable ±10%; down to 20% at lesser accuracy.
Recovery time	0.2 seconds on all models up to 1 KW rating, increasing to 0.5 seconds at 10 KW.

Note: "A" models output either 6 or 7 volts.

*Reg. U.S. Pat. Off.

Model SR2

NOBATRON-RANGERS Your interests may best be served by an instrument with electrical characteristics similar to the standard Nobatron, but with stepless, continuously adjustable output. If so — find out more about Sorensen's line of Nobatron-RANGERS.

ELECTRICAL CHARACTERISTICS

Input	95-130 VAC, 1ϕ, 50-60 cycles for SR30 and SR100. 190-260 VAC, 1ϕ, 50-60 cycles for the SR2.		
Reg. accuracy	±0.25% at any voltage setting.		
Ripple	1% RMS max.		
Output: Model	SR100	SR30	SR2
VDC	5-135	5-30	100-300
Amps	1-10	3-30	1-10

TUBELESS NOBATRONS Sorensen is aware of the advantages of tubeless circuitry, and manufactures a line of tubeless supplies, also.

ELECTRICAL CHARACTERISTICS

Model	MA65	MA640	MA2850
Input, VAC, 60~	105-125, 1ϕ	105-125, 1ϕ	190-230, 3ϕ, 4-wire, wye
Output, VDC	6, adj. ±10%	4.5-7.7 adj.	23-32 adj.
Load range	0-5 amp.	0-40 amp.	0-50 amp.
Ripple	1% max.	1% max.	3% max.
Reg. accuracy	±1.0% for any combination of line and load.		
Recovery time	0.2 sec.	0.15 sec.	0.5 sec.

Model MA640

Catalogs available describing the complete line of Sorensen instruments. Write for free copies today.

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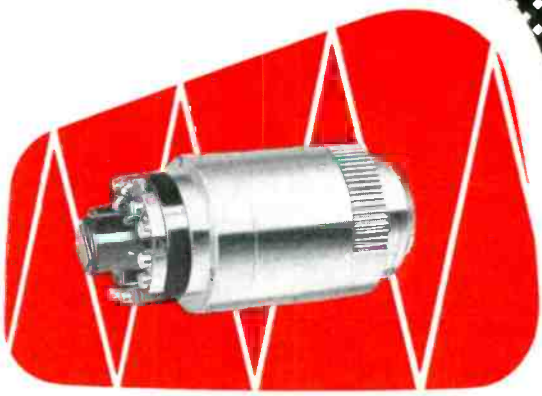
MUIRHEAD MAGSLIPS



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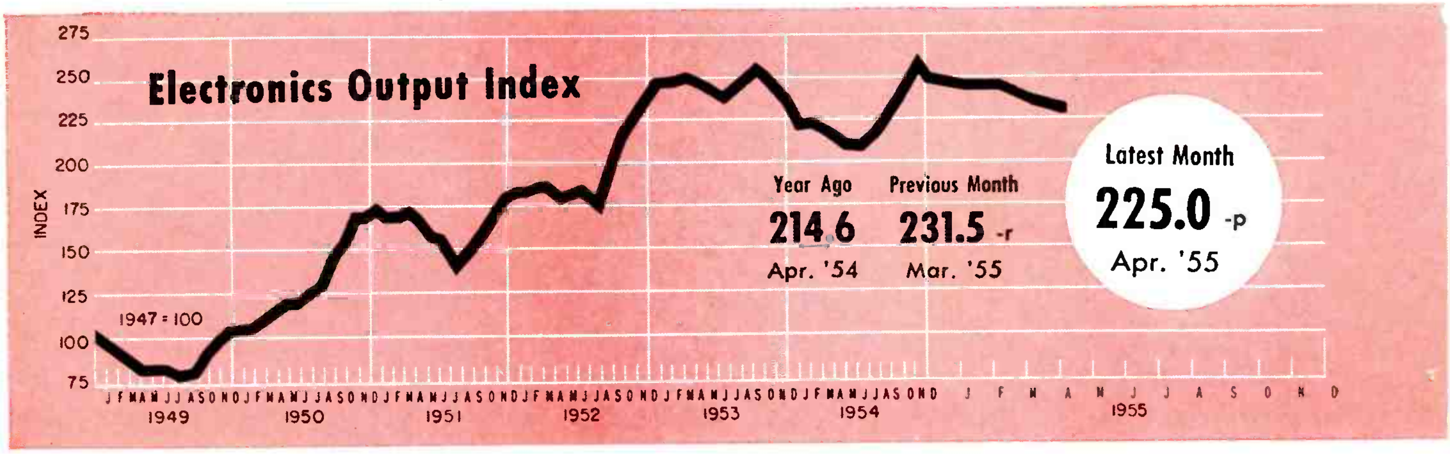


FIGURES OF THE MONTH

	Latest Month	Previous Month	Year Ago
RECEIVER PRODUCTION			
(Source: RETMA)	Apr. '55	Mar. '55	Apr. '54
Television sets, total	583,174	831,156	457,608
With UHF	103,088	115,726	112,833
Color sets	nr	nr	......
Radio sets, total	1,099,775	1,482,274	745,235
With F-M	13,894	23,859	14,008
Home sets	193,431	300,840	165,232
Clock radios	72,602	173,944	73,590
Portable sets	265,866	233,465	175,424
Auto sets	567,876	774,025	330,989
RECEIVER SALES			
(Source: RETMA)	Apr. '55	Mar. '55	Apr. '54
Television sets, units	411,748	669,794	371,720
Radio sets (except auto)	367,841	448,488-r	427,911
RECEIVING TUBE SALES			
(Source: RETMA)	Apr. '55	Mar. '55	Apr. '54
Receiv. tubes, total units	35,426,153	40,859,562	29,640,942
Receiv. tubes, value	$26,779,586	$29,742,529	$21,697,489
Picture tubes, total units	788,317	913,003	727,655
Picture tubes, value	$14,620,075	$17,675,881	$14,994,779
SEMICONDUCTOR SALES			
	Mar. '55	Feb. '55	Mar. '54
Germanium diodes, units / Silicon diodes, units	1,674,762	1,649,126	1,061,010

	Quarterly Figures		
INDUSTRIAL TUBE SALES	Latest Quarter	Previous Quarter	Year Ago
(Source: NEMA)	4th '54	3rd '54	4th '53
Vacuum (non-receiving)	$9,338,181	$8,803,740	$9,467,331
Gas or vapor	$3,498,123	$3,570,586	$4,854,222
Phototubes	nr	nr	$405,000
Magnetrons and velocity modulation tubes	$15,249,651	$13,112,244	$13,073,095
Gaps and T/R boxes	$1,788,780	$1,476,407	$1,707,730

	Latest Month	Previous Month	Year Ago
TV SETS INSTALLED			
(Source: NBC Research Dept.)	May '55	Apr. '55	May '54
Total sets	35,809,000	35,504,000	30,083,000
BROADCAST STATIONS			
(Source: FCC)	May '55	Apr. '55	May '54
TV stations on air	454	453	397
TV stations CPs—not on air	124	121	176
TV stations—new requests	16	18	45
A-M stations on air	2,711	2,717	2,575
A-M stations CPs—not on air	103	98	111
A-M stations—new requests	217	201	158
F-M stations on air	540	539	549
F-M stations CPs—not on air	12	13	18
F-M stations—new requests	4	5	5
COMMUNICATION AUTHORIZATIONS			
(Source: FCC)	Apr. '55	Mar. '55	Apr. '54
Aeronautical	42,045	40,991	42,998
Marine	49,261	49,212	45,132
Police, fire, etc.	17,827	17,599	15,241
Industrial	24,045	23,728	21,029
Land transportation	7,499	7,453	6,829
Amateur	134,720	132,959	120,581
Citizens radio	11,193	10,557	5,664
Disaster	313	313	271
Experimental	600	600	550
Common carrier	1,917	1,860	1,549
EMPLOYMENT AND PAYROLLS			
(Source: Bur. Labor Statistics)	Mar. '55	Feb. '55	Mar. '54
Prod. workers, comm. equip.	355,000-r	358,100-r	362,300
Av. wkly. earnings, comm.	$70.58 -r	$70.40 -r	$67.55
Av. wkly. earnings, radio	$68.68 -r	$68.11 -r	$66.76
Av. wkly. hours, comm.	40.1-r	40.0-r	39.5
Av. wkly. hours, radio	39.7-r	39.6-r	39.5
STOCK PRICE AVERAGES			
(Source: Standard and Poor's)	May '55	Apr. '55	May '54
Radio-tv & electronics	471.4	448.0	305.3
Radio broadcasters	537.0	519.1	322.1

p—provisional; r—revised
nr—not reported

FIGURES OF THE YEAR

TOTALS FOR FIRST FOUR MONTHS

	1955	1954	Percent Change	1954 Total
Television set production	2,771,426	1,904,718	+45.5	7,346,715
Radio set production	4,739,919	3,326,800	+42.5	10,400,530
Television set sales	2,355,740	2,145,147	+ 9.8	7,317,034
Radio set sales (except auto)	1,609,182	1,487,247	+ 8.2	6,430,743
Receiving tube sales	152,762,153	106,026,920	+44.0	385,089,458
Cathode-ray tube sales	3,427,805	2,690,519	+27.4	9,913,504

INDUSTRY REPORT

electronics—July • 1955

New TV Sets Utilize Automatic Production

Admiral and RCA introduce new receivers that make extensive use of etched circuits

TELEVISION receiver manufacturers are moving toward greater use of automatic production techniques and printed circuits. This is evident in the new models recently introduced by Admiral and RCA.

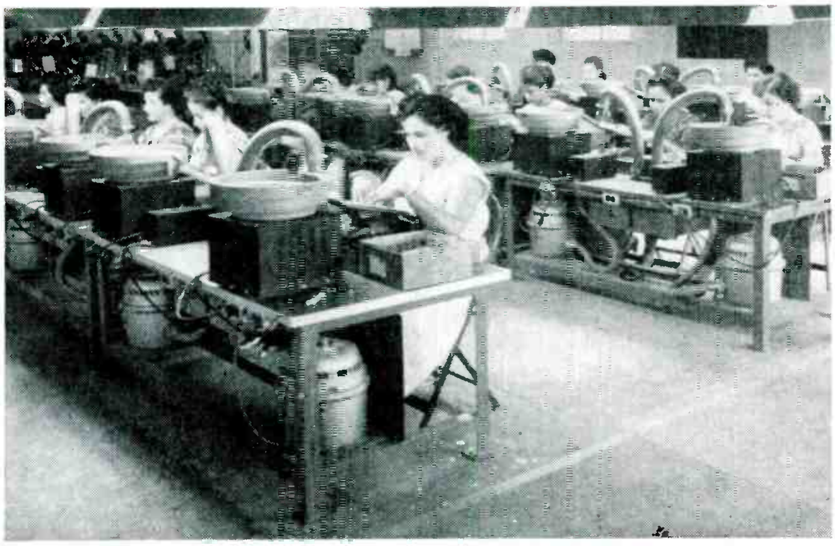
► **Assembly**—Three etched wiring boards assembled by automatic machines and dip-soldered have eliminated 425 hand-soldered connections from Admiral's new tv receivers. This mechanization has, according to the firm, reduced human error in assembly by over 99 percent.

The printed wiring in the new model represents from 75 to 80 percent of all circuitry. A total of 231 electrical components are mounted on the 13-tube printed-circuit sections.

Over 75 percent of these components, including resistors, capacitors, wire jumpers and tube sockets, are inserted by Admiral-designed automatic assembly machines. The firm believes that by the end of 1955 practically every major manufacturer will be using printed circuits in its tv receivers.

► **Boards**—In the new RCA sets five etched wiring boards are utilized. According to the company, tests both in the field and in its labs have proven the advantages of such circuits for greater reliability.

Two firms plan to introduce tv sets next year that incorporate ACF's modules.



PRODUCTION of mica parts increases at one Sylvania Commonwealth plant as . . .

Puerto Rican Boom Hits New Highs

BACK in June, 1953, ELECTRONICS took a long look at expansion plans for Puerto Rico plants. Today, just two years later, many of these plans have come true. Electronics has become the fastest growing new industry in Puerto Rico's flourishing Operation Bootstrap.

At this point what is the score? Here are a few of the key figures, just compiled by the island's New York headquarters.

► **New Plants**—There were then 21 electronic and electrical manufacturers operating on the island. Today, the total is up to 34, with some of the newcomers representing the biggest installations in the field.

► **New Sales**—For the first six months of 1953 total shipments to the continental United States came to $1,589,000. For the first half of 1954 (latest figures) they had more than trebled to $5,511,000.

► **New Profits**—Records of the Electronics Industry Association of Puerto Rico, recently compiled from 19 companies for fiscal 1953-1954, show: Gross profits (sales minus manufacturing costs) were 38 percent of net sales. Net profits after taxes were 28 percent of net sales.

In comparable U. S. figures for the industry, net profits before taxes averaged 20 percent of net sales. Subsidiaries of three major U. S. companies are averaging 30 to 40-percent of net sales.

► **No Income Tax**—Without a vote in the United States Congress, Puerto Rico has never been subject to the Federal income tax (no taxation without representation). In addition, the island government has extended ten years of local income tax exemption to qualified manufacturers from the start of operations. But "runaway" producers, who close existing mainland facilities, do not receive local exemption.

Acceptable branch plants or brand new installations can reinvest 100 cents out of every profit dollar.

▶ **Worker Productivity**—Trained for decades in the highly skilled needlecraft tradition, Puerto Rican labor has shifted rapidly and successfully to the intricacies of electronic manufacture. A recent Economic Development Administration survey shows that Commonwealth workers average 90 percent of U. S. productivity standards after 10.3 months of training, and 89-percent efficiency. But several plants report over 100-percent productivity "due to innate manual dexterity" and "greater enthusiasm for the job."

The island's extensive network of vocational schools graduate more than 6,500 students yearly.

▶ **Materials Available Locally**—With growth has also come integration and more local supplies of equipment for new manufacturers, including steel wire and wire products, screw machine products, construction materials, tool and die work, die-casting, compression and injection-molding of plastics.

Transistors Progress at High Rate

Phonograph preamp and microphone adapter appear. New production method unveiled

SINGLE transistor in a combination equalizer and preamplifier circuit, is incorporated in higher-price models of RCA's high-fidelity phonographs. The stage is fed from a magnetic pickup cartridge and replaces a two-stage conventional equalizer-preamplifier. The circuit is said to be free of hum and microphonics and have less noise than equivalent vacuum-tube circuits.

The three-transistor adapter amplifier shown in the photograph permits using a dynamic microphone and headset in airborne intercom sets designed for carbon microphone and magnetic headsets. The adapter unit is wired into the microphone cable between the dynamic microphone and plug which fits into the existing jack.

Transistorized RCA adapter makes possible substitution of different microphones and headset types

▶ **Other Advances**—New technique in transistor manufacturing is GE's meltback process. This is a modification of the company's rate-growing technique that permits growing germanium or silicon crystals with thinner impurity layers than could be grown using the basic rate growing method.

These thinner layers extend the transistor's high-frequency cutoff as much as five times that of ordinary transistors. In addition improved current and power-amplification characteristics are claimed. Potential applications include tv, radar and other high-frequency circuits.

In the basic rate growing process, thick layers are formed in the crystal by cycling the rate of growth as the crystals are withdrawn from a pool of molten metal. Cooling to room temperature takes 20 minutes.

In the new meltback process, crystals are in the form of a thin wire and they cool in less than a second. Migration of impurities from layer to layer is greatly reduced and the thinner layers permit operation at higher frequencies than the thick layers allowed.

Air Force Backs Electronics Industry

More contracts to come from air-frame manufacturers under weapons system policy

AIR FORCE development and procurement program for electronics, while continuing at a relatively high level as compared with pre-Korea, will be well within the capacity of the industry. This was the forecast of Brig. Gen. Thos. P. Gerrity, USAF, director of procurement and production at material headquarters.

▶ **Program**—It will be a competitive environment, he said, where the Air Force, as a customer, will take full advantage of the competitive situation to obtain top quality products at the lowest price.

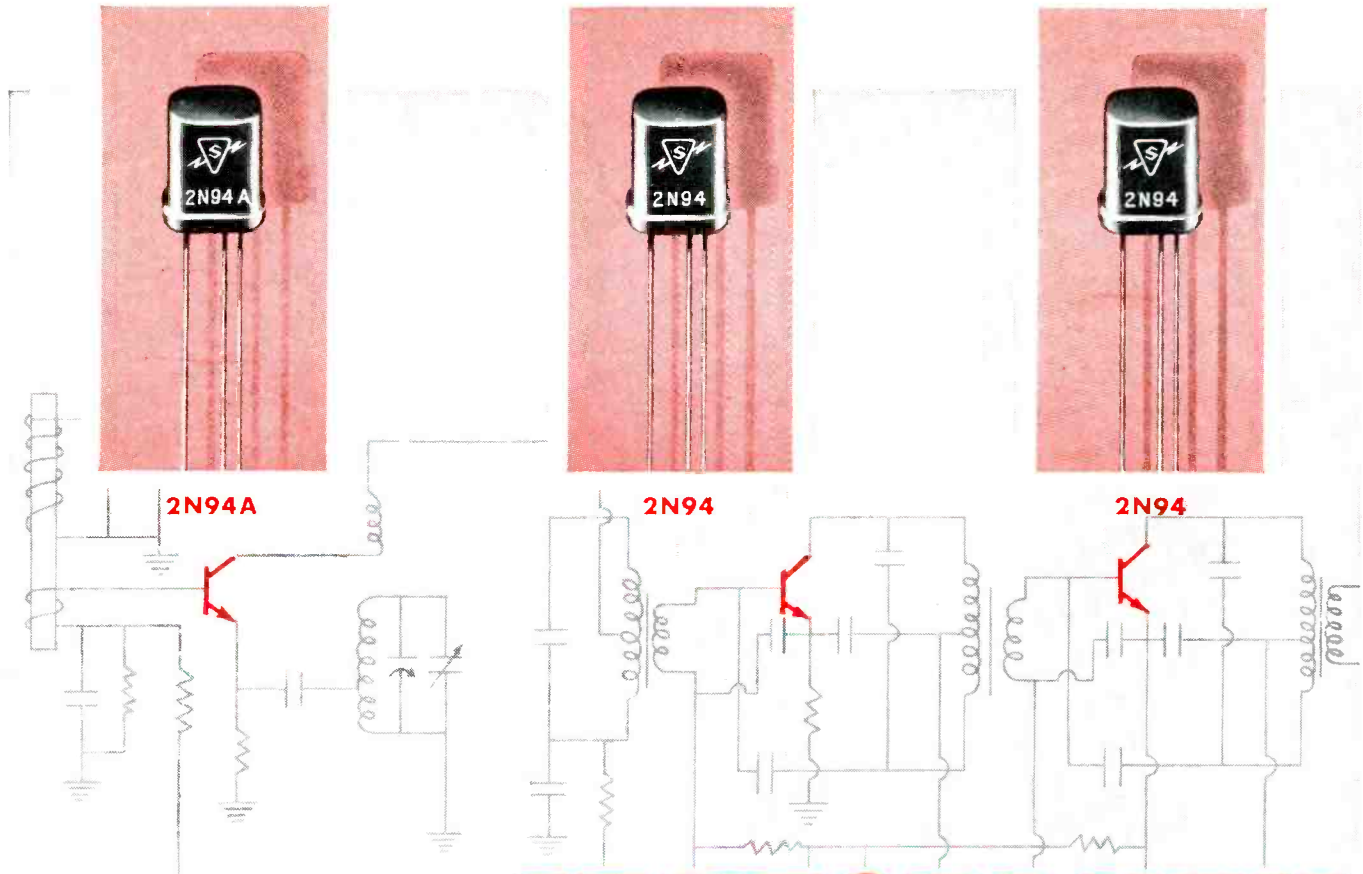
At the same time, he stressed that the Air Force does not encourage or condone entry into development and production of parts or subsystems by other than the industry normally providing such equipment.

A number of manufacturers have feared that the weapon-systems policy will result in the prime contractor establishing control over development and procurement of equipment. Under the weapons system concept, the Air Force makes the prime contractors—the airframe contractor—responsible for the total weapon system meeting performance guarantees.

▶ **Teeth**—Prime contractors with large contracts are expected to establish their own small-business program. Records will be checked by an Air Force administrative contracting office to be certain that small-business concerns are getting subcontract opportunities. During prime contract negotiations, Air Force buyers will call for a fair spread of subcontracting.

A special clause will continue to appear in all Air Force weapon-systems contract stating that the government is not approving any increase by the contractor of his

(Continued on page 10)



UNIFORMITY

...for more gain from stage to stage without preselecting

For your broadcast applications, Sylvania high frequency transistors Type 2N94 and 2N94A offer higher gain without preselection by stage. Production is simplified; performance is more stable; servicing problems are minimized.

Low collector capacitance and ease of neutralization account for this important advantage. In a typical broadcast application, the addition of a single 10 $\mu\mu$f capacitor in the collector circuit of IF and RF stages provides adequate neutralization.

Uniformity is obtained through unique construction techniques permitting close production control.

In computer applications Sylvania Transistors offer quick recovery time for high speed switching and provide higher gains at higher operating currents.

High Frequency Transistors
Type 2N94 (3 mc alpha cutoff)
Type 2N94A (6 mc alpha cutoff)
featuring
- high gain
- high uniformity
- low collector capacity
- ease of neutralization

Low Frequency—High Gain
Type 2N34 (PNP)
Type 2N35 (NPN)
—for low to medium power use. Gains up to 40 db in grounded emitter circuit

High Power—Low Frequency
Type 2N68 (PNP)
Type 2N95 (NPN)
—increased power ratings—to 2.5 watts. Use for high current, low voltage applications (6—24 volt power supplies)
Type 2N101 (PNP)
Type 2N102 (NPN)
Similar to types 2N68 and 2N95 without cooling fins. Power dissipation 1 watt.

For complete information on Sylvania Transistors write to Department G40R.

"Another reason why it pays to specify Sylvania"

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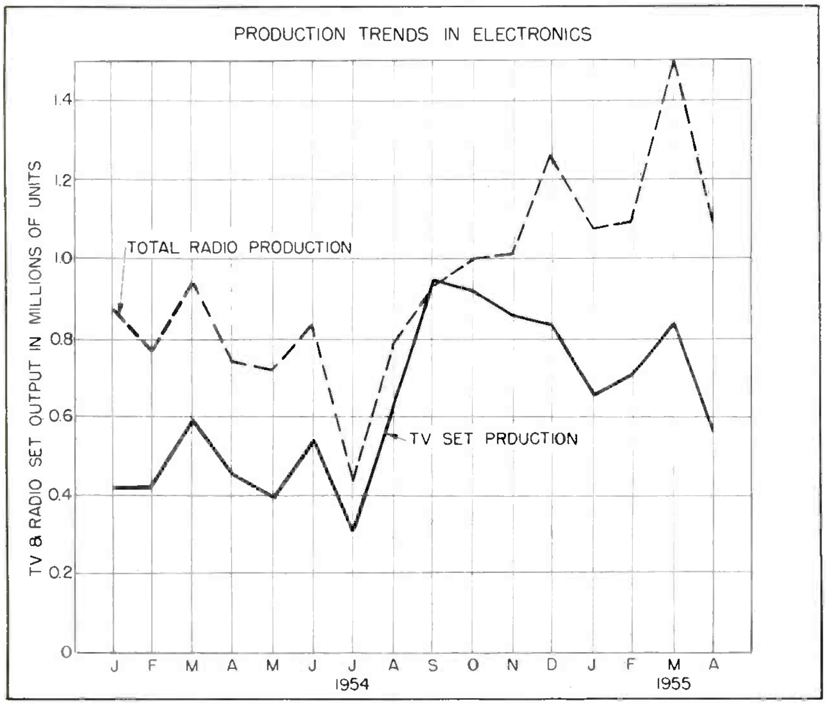
normal manufacturing functions.

▶ **Expansion**—General Gerrity said that Air Force is taking a closer look at requests for facility expansion. It is not the policy to furnish industrial facilities to industry where facilities are available through subcontracting, or where such industries should be privately financed for expansion.

As missiles reach the production phase, steps must be taken, General Gerrity said, to take better advantage of the electronic industry's capacity to produce on an economical basis. Air Force will encourage maximum subcontracting of components normally associated with the electronic equipment industry.



TV And Radio Get Set For Summer

Production of sets slows down as the industry enters the traditional slump period

SEASONAL characteristics of the radio-tv set business are once again becoming apparent as the industry enters the summer months. However, as shown in the chart, the decline in April of this year is much less severe than in 1954.

Factory production of tv receivers declined in April to 583,175 units compared with 831,156 sets for March and 457,608 receivers produced in April of last year, according to RETMA. Total tv output for the first four months of this year was 2.7 million units compared to 1.9 million in '54 and 2.9 million in the '53 period.

April radio production was one million sets compared to 1.4 million in March, 1955 and 745,235 in April, 1954. Total radio production in the first four months of this year was 4.7 million units compared to 3.3 million for the period in '54 and 4.9 million in '53.

▶ **Percent**—For the past four years the month of July has consistently been the period of lowest radio and tv production, mainly because it is the time when most set makers schedule plant vacations. During the month only 2 to 4 percent of annual output is produced compared to 6 to 8 percent in most other months.

On a percentage basis the pattern of tv and radio set production has generally followed an erratic course.

As shown in the table there is some similarity in the volume of set production in the quarters of alternate years:

TV	Quarters 1	2	3	4
1951	41	23	12	24
1952	22	16	22	40
1953	31	22	23	24
1954	20	19	25	36
1955 (Est)	30			
Radio				
1951	36	26	15	23
1952	23	23	21	33
1953	27	24	22	27
1954	24	22	21	33
1955 (Est)	35			

For example, in both 1951 and 1953 first quarter volume was high while in 1952 and 1954 it was relatively low. So far this year, both radio and tv output seem to be beginning to follow the percentage pattern established in 1951 and 1953.

Broadcasters Focus On Color Equipment

Stations wanting to broadcast live color pictures now have greater choice of equipment

LIVE STUDIO color broadcasts at low cost are possible with Du Mont's new Vitascan equipment in which camera and lights are effectively transposed (technical details in *Electrons At Work*).

Suitable only for use in a light-tight studio, the system employs stroboscopic light sources that are illuminated during the time that television scanning is blanked out. Persistence of vision in the human eye gives performers the feeling they have normal lighting.

If a small station is already equipped to broadcast color film, only about $16,000 additional outlay is necessary for live studio color. A station that can now take color network programs but is not equipped to handle color film would pay $33,000.

By contrast, a single color television camera and lights would cost in the neighborhood of $60,000. Du Mont engineers estimate pickup tube cost (using special multiplier phototubes) as 5¢ an hour contrasted to $7 an hour for image orthicons.

(Continued on page 12)

REVERSIBLE
SILICON MIXER DIODES

by Bomac

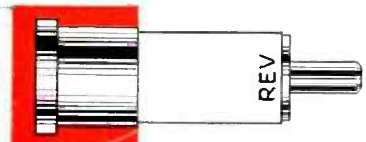
Here's another step forward by Bomac — a *reversible* silicon mixer diode. The 1N415 and 1N416 series are the first silicon diodes to have selective polarity.

Polarity is indicated by the letters REV located at one end of the diode. To change the polarity, just switch the position of the end cap.

With the end cap attached to the contact pin at the unmarked end of the cartridge, the diode will be of normal polarity. With the end cap attached to the end marked REV, the diode will be of reverse polarity. The complete assembly, with either polarity, is electrically the same as its equivalent type of regular silicon diodes.

The Bomac 1N415 and 1N416 series will meet all conditions of JAN 1A specifications.

NORMAL POLARITY



REVERSE POLARITY

1N415 - 1N416 SERIES

Band	Type	Equivalent Type	Frequency (Mc)	Max. Conversion Loss (db)	Noise Ratio (Times)	Max. (VSWR)	IF Imped. (OHMS)	Burnout (erg)
X	1N415B	1N23B	9375	6.5	2.7	—	—	1.0
		1N23BR	9375	6.5	2.7	—	—	1.0
X	1N415C	1N23C	9375	6.0	2.0	1.50	325–475	1.0
		1N23CR	9375	6.0	2.0	1.50	325–475	1.0
X	1N415D	1N23D	9375	5.0	1.7	1.30	350–450	1.0
		1N23DR	9375	5.0	1.7	1.30	350–450	1.0
S	1N416B	1N21B	3060	6.5	2.0	—	—	2.0
		1N21BR	3060	6.5	2.0	—	—	2.0
S	1N416C	1N21C	3060	5.5	1.5	—	—	2.0
		1N21CR	3060	5.5	1.5	—	—	2.0

UNIQUE PACKAGE PROTECTION

For complete protection during shipment and storage Bomac has designed a reusable RF Protective Package* which conforms with MIL-E1B specification. Diodes stored in this package are completely protected no matter how many times they are handled after the original seal is broken.

*PAT. APPLIED FOR

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Magnetic Recording Moves Into New Markets

Tape equipment gains sales in new fields as applications increase rapidly

TOTAL sales of magnetic tape recorders are expected to reach the 285,000 mark this year, surpassing 1954 unit sales by at least 20,000 units. Latest estimates by Minnesota Mining and Mfg. put 1954 unit sales to the home market at 255,000 units. Sales outside the home entertainment field this year are expected to hit the 15,000 mark compared to 10,000 units in 1954. Tape sales are expected to go from 1954's dollar volume of $7.2 million to $8.2 million this year.

Last year about 75 firms were active in various phases of the industry. Today there are over 100 companies in the field.

▶ **Wired Music**—An increasing number of magnetic-tape units are being sold to firms that specialize in providing background music to factories, restaurants, stores, banks and other establishments. Three companies are currently manufacturing long-playing tape reproducer units for the background music field.

▶ **Business**—As yet, the magnetic-tape recorder has not made tremendous headway in the office dictation field but there are signs that this market may soon pick up. There are only a handful of firms that manufacture magnetic-tape recorders designed specifically for dictation use although a number of companies sell home-type tape recorders for this purpose. Latest entry in the dictation recorder field is DeJUR-Amsco which recently announced a new tape machine weighing 11 pounds and retailing for $169.50. It provides push-button control of the tape for recording, listening, fast forward and reverse winding, and stopping.

▶ **Film**—Another market where magnetic recording equipment is beginning to be sold in greater quantity is the home movie equipment field. Most major firms now offer movie projectors equipped for magnetic recording of sound on film. New sales impetus in this field is expected as a result of a new method, developed by Minnesota Mining, of adding magnetic sound track to film. It is done automatically by a magnetic laminator that bonds the track permanently to the film in a dry process using no solvents or liquid magnetic dispersions.

Tape recorder designed for office use has been introduced by DeJUR-Amsco

▶ **Broadcasting**—Magnetic tape equipment has been used to automatically control on-the-air operations of radio stations and is now being applied to the tv field. GE recently demonstrated an experimental system that handled all station breaks, commercials and programs of a tv station's film and side programming equipment through the use of inaudible tone signals recorded on magnetic tape.

Community TV Expects Growth

Wired systems weathered freeze end and hope to outlast satellite transmitters

BORN OF the 1948-52 television freeze, the community antenna system of wired television is still growing despite increased competition and possibility of auxiliary booster transmitters.

At its fourth annual convention in New York's Park Sheraton, National Community Television Association gathered a record crowd and reviewed its problems and accomplishments. There are over 200 active members of the organization. Eighteen exhibitors showed their wares.

▶ **Size of Industry**—Value of existing plants, which comprises mountaintop antennas, coaxial cable lines, wideband amplifiers and other electronic gear, is estimated at $25,000,000. The systems (there are three in competition at Williamsport, Pa.) use up about $10 million worth of new equipment every year. Around 400 systems serve an estimated 320,000 homes and 1,200,000 people.

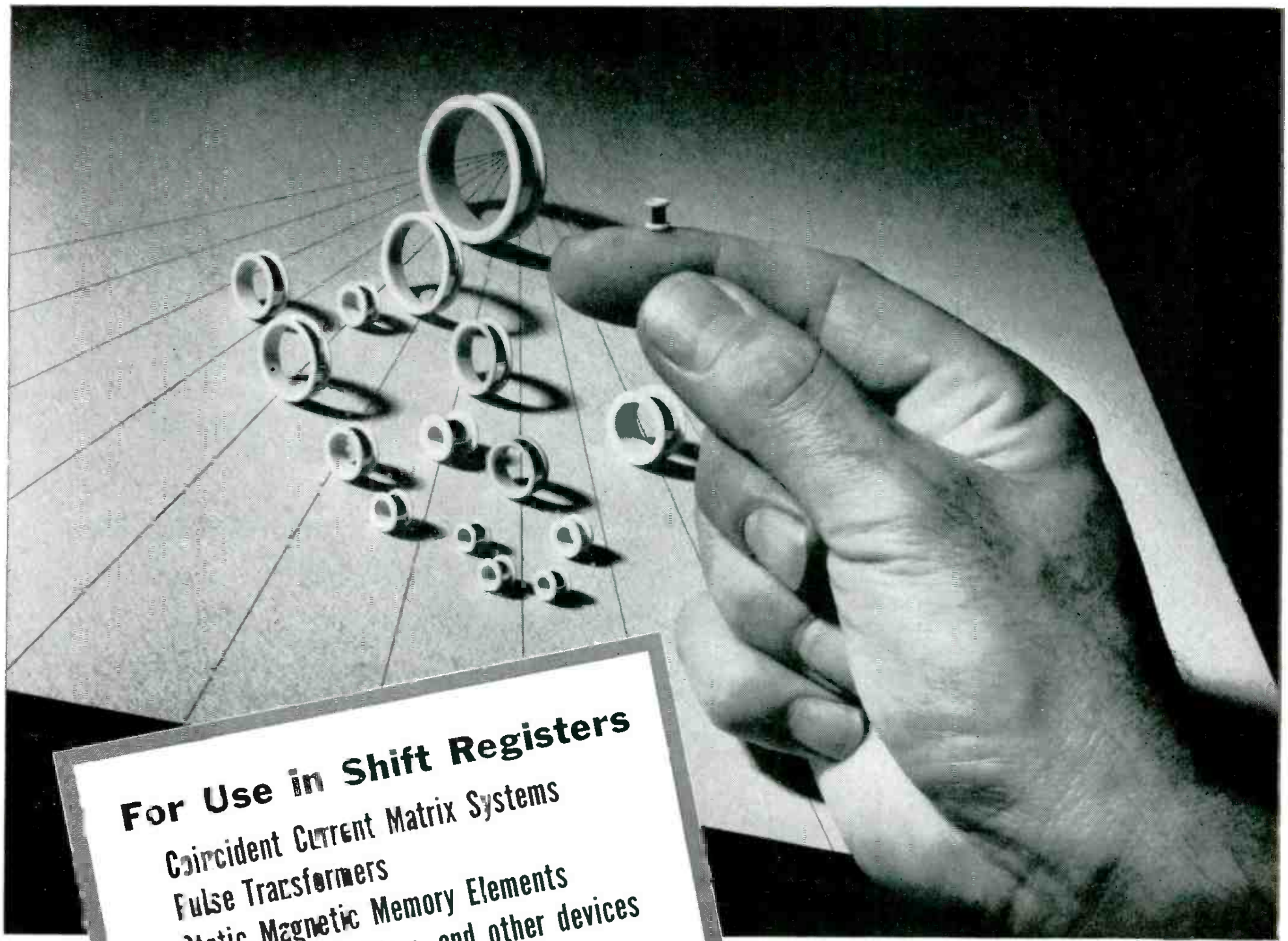
Subscribers per system vary from a few hundred to 6,000 homes. Each installation runs anywhere from $150 down to $50. The monthly service charge seldom exceeds $4.

▶ **Future**—Despite the nationwide competitive tv system possible with current frequency assignments, NCTA believes it has a market potential of at least 1,000 communities. With a system capable of handling seven or eight channels, even in color, many people may continue to prefer getting their tv reception the easy way.

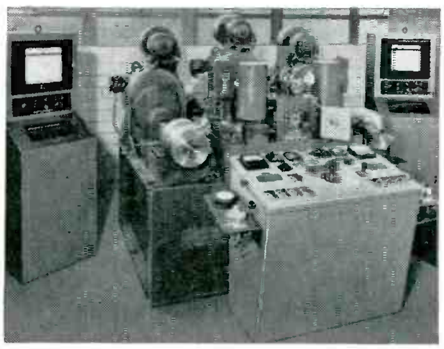
Although some broadcasters are reported as being fundamentally opposed to allowing pickup and distribution of their programs, there seems to be little fear that the systems will collapse for lack of material. Telephone and power poles have usually been available, at a fee, for stringing cables through a town.

The greatest potential threat to the wire systems is installation of satellite transmitters of low power that will pick up a distant, weak signal and beam it down into the valley where residents can obtain the program through the air free.

(Continued on page 14)



specify BOBBIN CORES by ARNOLD



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"TAPE-WOUND BOBBIN CORES FOR COMPUTER APPLICATIONS"

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ADDRESS DEPT. E-57

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Specifically, their desirable properties include quite rectangular hysteresis loops, relatively low coercive values and high saturation densities; plus temperature stability and the ability to shift in a few microseconds from negative remanence to positive saturation, and vice versa, under conditions of pulse excitation.

Arnold Bobbin Cores are available in a wide range of sizes, tape thicknesses, widths and number of wraps to suit the ultimate use of the core. Magnetic materials usually employed are Deltamax, Square Permalloy and Supermalloy, in standard thicknesses of .001", .0005", .00025" and .000125". Special advantages derive from Arnold's position as a fully-integrated producer of wound cores, able to maintain precise control over every production operation . . . melting, rolling, winding, testing, etc.

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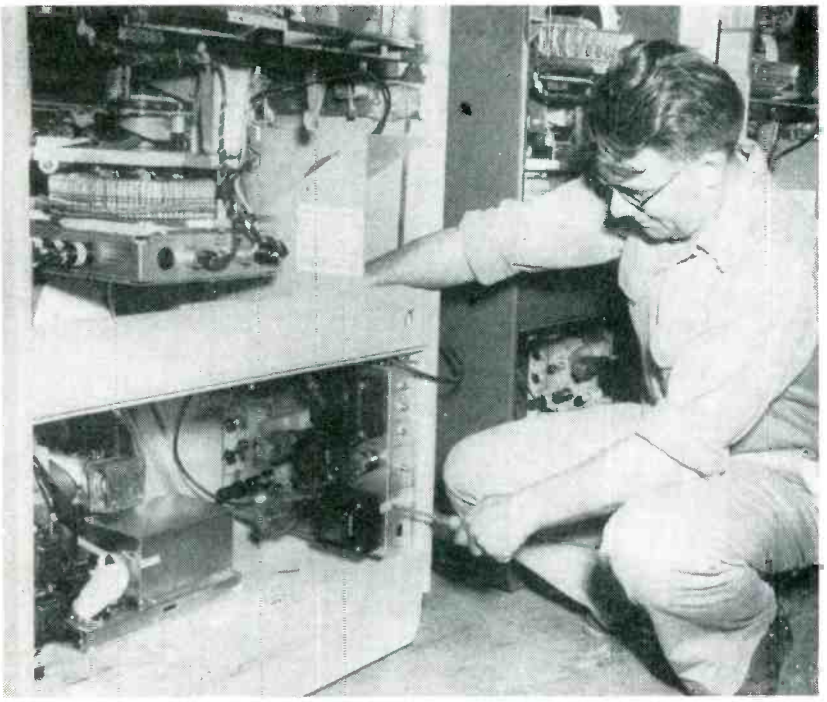


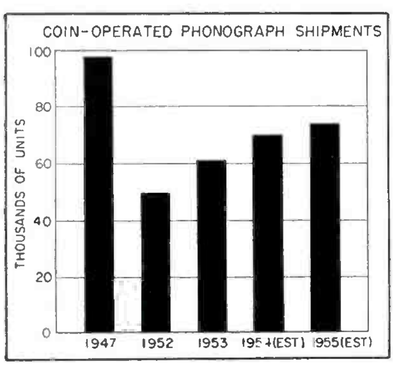
PRODUCTION of coin-operated phonographs at Wurlitzer increases as . . .

Juke Box Business Gains Volume

Other entertainment mediums have made inroads but the business is still growing

SETBACK that the coin-operated phonograph field suffered between 1947 and 1952 is being overcome. According to the Department of Commerce 61,000 units were shipped in 1953. Last year about 70,000 units were shipped. Some major manufacturers see shipments for 1955 going as high as 75,000 units.

Dollarwise this is by no means a small volume in the overall electronic phonograph market. The 61,000 units shipped in 1953 represented a total dollar volume of $37.0 million or nearly 80 percent of the self-contained electronic phonograph business. There were 489,000 units of all other types of self-contained electronic phonographs produced in 1953 but they accounted for a dollar value of only $12.0 million. Value for all phonograph shipments in 1953 according to the Department of Commerce was $60.9 million. Thus, the coin-operated field accounted for over 60 percent of factory dollar value.



► **Market**—An estimated half million coin-operated juke boxes are in use in the U. S. The areas of greatest use follow the population with New York as the top market.

The export market is increasing in importance. There were 21,711 units exported in 1954 compared to 14,189 in 1953. Between 15 and 20 percent of nickelodians are replaced each year.

Big factor that has increased coin-phono sales is the movement to the 10-cent play rather than a nickel.

► **Product**—Average price of a juke box is about $1,000, an increase in the past few years as hi-fi has entered the field. One model now on the market uses five speakers, another three and another a 15-inch speaker.

Models have followed the changes in record speeds and sizes. Now, most of the units produced use the 45-rpm system. A few years ago, the trend was to the installation of remote control units at individual booths. Now it is estimated that only about five percent of the units are so equipped.

Government Probes Mergers In Industry

FTC merger report samples U. S. industry acquisition rate and finds it increasing

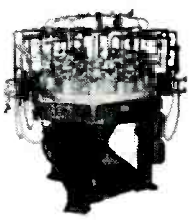
OVER 50 mergers or acquisitions have been consummated or planned by companies in the electronics field, in the first six months of this year. This is nearly equal to the total number of such activities that took place in the industry in all of 1954.

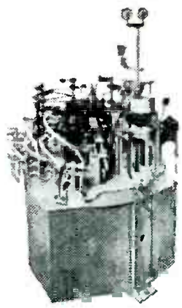
► **Rate**—Increasing merger rate in electronics follows that of industry in general. The recent report by the Federal Trade Commission shows that by the end of 1954 the rate of merger activity in manufacturing and mining had tripled the 1949 level. However the rate was substantially lower than occurred during the latter 1920's. During the period 1948-54, 1,610 formerly independent manufacturing and mining concerns were reported to have disappeared as a result of mergers and acquisitions.

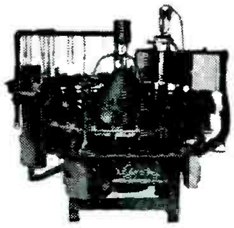
► **Industry**—The FTC Report shows that in the 1948-54 period, 70 firms in the electrical machinery industry classification, which includes electronics, acquired 111 companies, and ranked seventh in number of mergers out of 20 industries covered.

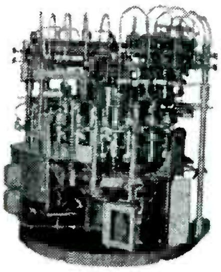
Two firms in the field each acquired five companies. American Machine and Foundry, now heavily engaged in electronics, made 11 acquisitions during the period. Litton

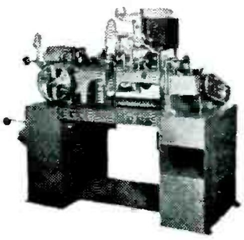
(Continued on page 16)

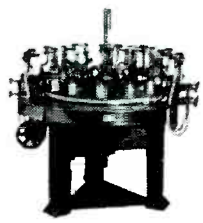

SUB-MINIATURE TUBES


DIODES


POWER TUBES


RADIO RECEIVING TUBES


TRANSISTORS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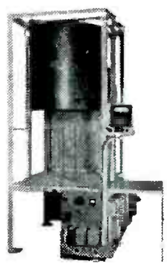
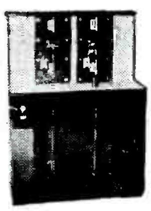
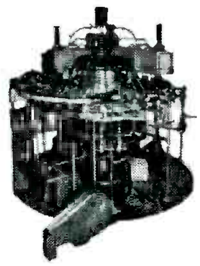
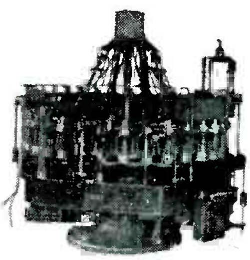
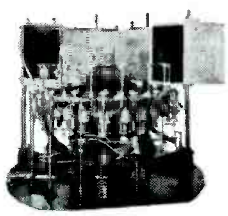
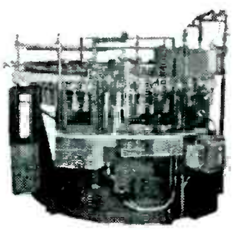

CATHODE RAY TUBES

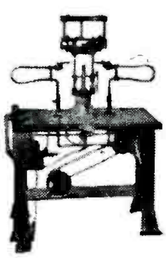

LIGHTHOUSE TUBES

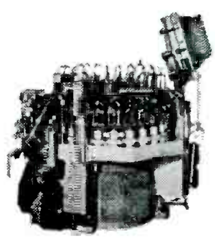

RADIO TUBES

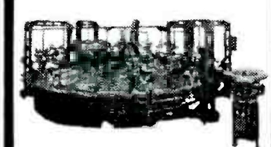

MINIATURE RADIO TUBES


CATHODE RAY TUBES


RADIO RECEIVING TUBES


SINGLE CR TUBE


SUB-MINIATURE


CATHODE RAY TUBES

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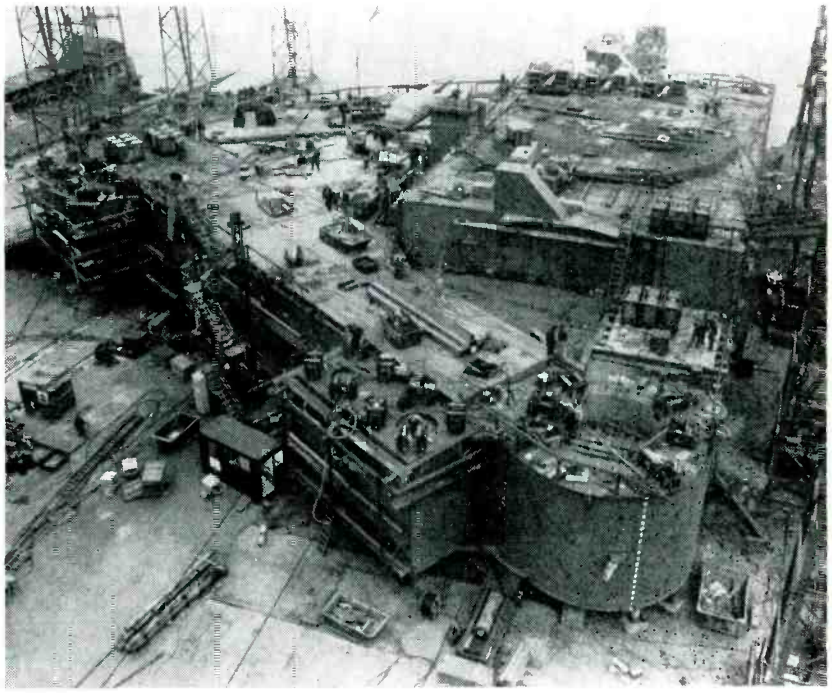
Industries has acquired nine electronic companies in the past 18 months. However for 47 companies in the electrical classification only one acquisition was made.

▶ **Assets**—Companies with assets of under $50 million accounted for 40 percent of the acquisitions in electrical machinery in the 1948-54 period. The report showed that 15.3 percent of the acquiring firms had assets of $50 million and over, 29.7 had assets of $10 to $49 million; 14.4 percent had $5 to 9.9 million; 26.1 had $1 to 4.9 million and 14.4 had under $1 million.

▶ **Reasons**—Advantages expected to be gained by acquiring companies through mergers include: additional capacity to supply a market already supplied, lengthened product lines, product diversification, facilities to produce goods formerly purchased, facilities to process or distribute goods formerly sold and other advantages such as empty plants, patents, tax savings or a valuable corporate shell.

Mergers In Electronics (First six months 1955)

Aerovox, Henry L. Crowley & Co.
Aerovox, Luther Mfg.
Aircraft Radio, Orion Industries
Allied Structural Steel, Electronics Protection
ACF, Engineering & Research Corp.
American Electronics, Berlant
American Electronics, Pierson
Baldwin-Lima, Ruge-de Forest
Budd Company, Continental-Diamond Fibre
Burroughs, Todd Co.
Clarostat, Cambel Industries
Clevite, Technical Instrument
Clevite-Wallace Aviation
Curtiss Wright, Elly Electronics
Daystrom, American Gyro
Daystrom, Heath
Daystrom, Weston Electrical
ECA, W. S. MacDonald
Electronic Specialty, Electromec-Miniature Components-Audio Pacific
Elgin, American Microphone
Elgin, Advance Relay
Fairchild Camera, Freed Electronics
General Dynamics, Stromberg-Carlson
Gudeman, Dilectron
Hall-Scott Motors, Bardwell & McAlister
Hamilton Watch, Hathaway Instrument
Hoffman Electronics, Analyzer Corp.
IRC, Hycor Companies
Ketay Instrument, Norden Laboratories
Ketay, Vari-Ohm
Lavoi Laboratories, Matawan Electronics and Bayshore Electronic Products
Litton Industries, USECO
Litton Industries, Ahrendt
Mack Trucks, White Industries and Radio Sonic
Minneapolis-Honeywell, Dolecam
Mag Electric Products, Mag Electric Networks
Norden-Ketay, Acragage
Panellit, Jordan Electronics
Preco, Electra Motors and California Gear
Sangamo, Gothard Mfg.
TelAutograph, Walsco and Schott
Texas Instruments, Radell Resistor
Topp Industries, Bonner Machine
Remington Rand, Sperry Corp.
Varo, Schuttig



STEEL ISLANDS are prepared for launching as . . .

Radar Platform Installation Starts

FIRST of several offshore radar platforms, nicknamed Texas Towers because they resemble offshore oil-drilling rigs in the Gulf of Mexico, was recently launched by Bethlehem Steel at its Quincy, Mass., shipyard. (ELECTRONICS, Sept. 1954, p. 10.)

The stations will be located along the Atlantic Coast from New York to Newfoundland, 80 to 100 miles at sea, to give warning of unfriendly craft approaching our shores.

Each island will support electronic equipment, provide a helicopter landing base and housing for a crew. The first platform will be delivered to the erectors who must have it in position not later than August 15 because installation cannot be made during the hurricane season. The Air Force handles contracts for the electronic gear.

▶ **Protection**—To support the platform, three legs, approximately 150 feet in length and 10 feet in diameter, will be filled with reinforced concrete. Painting, combined with cathodic protection, will protect the legs from corrosion except at the tidal and spray levels. A 35-foot length of Lukens 10 percent Monel-clad steel, the same thickness as the balance of the columns, will be used to protect these areas.

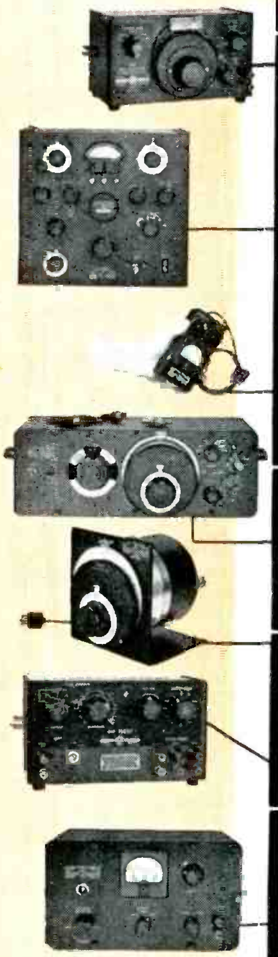
Toll Television Pondered By FCC

PROPONENTS and opponents of paid television programs have filed comments, at the request of the Federal Communications Commission, indicating how they feel about adoption of rules and standards authorizing pay-as-you-see tv.

▶ **Proponents**—Zenith, Skiatron and Telemeter are three systems suggested to distribute paid television entertainment and collect or bill the necessary fees.

Zenith proposes use of a punch card for billing that will also give the subscriber decoder information. Skiatron has developed a printed circuit card that solves the code and is also used to bill the looker. Telemeter would use a coin box that automatically displays the price of the show in progress. A picture advertising the program and a special sound channel appear on the set tuned to the pay channel before the

(Continued on page 20)



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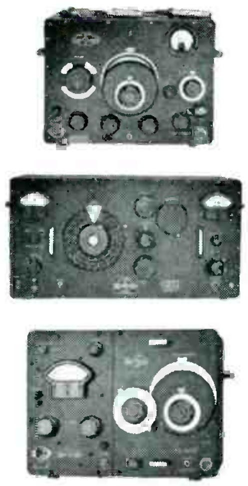
20 Cycles to 2000 Mc

		Frequency Range	Loaded Output/ Open Circuit Volts	Nominal Load Impedance	Harmonic Distortion	Additional Features
Audio and Low Frequency	**1210-B RC Oscillator, $140**	20 cycles – 0.5 Mc (sine or square waves)	80 mw/7v 40 mw/45v 0-30v peak to peak, square waves	600Ω 12,500Ω 2,500Ω	<1.5% <2.5%	Multi-purpose lab signal source — converts to Sweep Oscillator with 1210-P1 Discriminator and 908-P Synchronous-Dial Drive.
	1301-A Low-Distortion Oscillator, $495	20-15,000 cycles (27 fixed frequencies)	18 mw/6.6v 100 mw/30v	600Ω balanced or grounded 5000Ω grounded	<0.1%	Drift not greater than 0.02% per hour after first 10 min. — frequency range extends to 2 cycles with 1301-P1 Extension Unit.
	1302-A Oscillator, $420	10-100,000 cycles	40 mw/10v 20 mw/5v 80 mw/20v	600Ω balanced 300Ω grounded 5000Ω grounded	<0.5% <1%	Output Voltage Constant ±1.0 db.
	1303-A Two-Signal Audio Generator, $1450	(1) 20-20,000 cycles (2) 20,000-40,000 cycles (3) Two signals separately adjustable (4) Two signals with a fixed difference	Normal-10 mw/5v High-1 w/50v	600Ω grounded	<0.2% <1%	Ideal for intermodulation distortion testing — drift less than 7c in first hour, completed in 2 hrs. — output constant within ±0.3 db.
	1304-B Beat-Frequency Oscillator, $555	20-20,000 cycles 20,000-40,000 cycles	1 w/50v	600Ω balanced or grounded	<1%	Converts to Sweep Oscillator with 908-P — high stability, low hum.
	1214-A Unit Oscillator, $66	400, 1000 cycles (2 fixed frequencies)	200 mw/80v	8000Ω grounded or ungrounded	<3%	Has built-in power supply unlike most Unit Instruments.
	1307-A Transistor Oscillator, $88	400, 1000 cycles (2 fixed frequencies)	6 mw/2v	600Ω	<5%	Battery operated, with output meter — small and compact.
	723-C and D Vacuum-Tube Forks, $185	400 or 1000 cycles (2 models)	50 mw/31v max.	50, 500, 5000Ω	<0.5%	Frequency accuracy to ±0.05% — max. drift 0.2% occurs first 30 min.
Medium and High Frequency	**700-A Wide-Range Beat-Frequency Oscillator, $750**	50 cycles — 40 kc 10 kc — 5 Mc	0.1 w/10-15v	3500Ω pot.	<3%	Log. frequency calibration, high voltage, and frequency stability — has incremental frequency control.
	1330-A Bridge Oscillator, $525	400 cycles, 1000 cycles 5 kc — 50 Mc	0.75 w/12v 1 w/10v	50Ω 20-80Ω	<3%	Internal 400- and 1000-cycle modulation — excellent shielding for bridge work.
	1211-A Unit Oscillator, $295	0.5-5 Mc 5-50 Mc	2 w 200 mw	50Ω	Converted to Sweep Oscillators with unique 1750-A Sweep Drive — output regulated with 1263-A Amplitude - Regulating Power Supply (described below).	Compact, inexpensive, well shielded — frequency increments of 0.2% per division.
VHF and UHF	**1215-B Unit Oscillator, $190**	50-250 Mc	80 mw	50Ω		Semi-butterfly tuned circuit with no moving contacts.
	1208-B Unit Oscillator, $190	65-500 Mc	100 mw	50Ω		Very wide range, thorough shielding.
	1209-B Unit Oscillator, $235	250-920 Mc	200 mw	50Ω		Butterfly circuit avoids uhf tuning difficulties — excellent stability.
	1218-A Unit Oscillator, $465	900-2000 Mc	200 mw	50Ω		Audio, pulse, square-wave or frequency modulation from external source.
Special Purpose	**1217-A Unit Pulser, $225**	30 c — 100 kc (12 fixed frequencies)	20v	200Ω positive pulses, 1500Ω negative pulses		Rise time, 0.05μsec — external drive possible over range — square waves at any frequency.
	1213-AB Crystal Oscillator, $130	1-Mc Crystal provides harmonics of 10 kc, 100kc, 1Mc, up to 1000 Mc.	6v at 10 kc, 100 kc 1v at 1 Mc	varies with frequency		Stability, 1 ppm per day — fine frequency adjustment provided.
	1390-A Random Noise Generator, $240	30 cycles — 20 kc 30 cycles — 500 kc 30 cycles — 5 Mc	1v	800Ω grounded	Noise Spectrum	Invaluable audio-test tool — high, uniform spectrum-level over range.

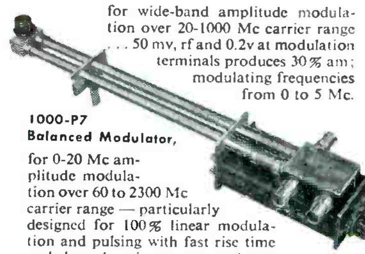
1210-B, 1211-A, 1215-B, 1208-B, 1209-B, 1218-A, 1217-A, 1213-AB Require type 1203-A Unit Power Supply . . . $40.

SIGNAL GENERATORS

		Frequency Range	Output	Characteristics
	1001-A $695	5kc — 50 Mc 8 direct-reading ranges	0.1μv-200 mv; 10Ω jack becomes 50Ω with series unit supplied, 25Ω at end of output cable — 2v at 300Ω from 2nd jack	Incremental dial indicates 0.1% of frequency per division — modulation adjustable 0-80%, indicated on meter, 400c internal or 20-15,000c external am — ±1% calibration, high stability, low drift and negligible leakage and incidental fm.
	805-C $1495	16 kc — 50 Mc 7 direct-reading ranges	Less than 0.1μv to 2 v — 75Ω at panel; 75Ω cable has termination impedance of 37.5, 7.1 and 0.75Ω	Internal and external modulation variable 0 to 100%, indicated on meter — drift less than ±0.1% during 5 hrs. continuous operation — ±1% calibration; frequency increments as small as 0.01% — less than 0.05% incidental fm for full 100% modulation — no leakage or excessive harmonic distortion, no cable errors.
40-2000 Mc with three oscillator sections and one power supply	**1021-AV $595**	40-250 Mc in one band	0.5μv — 1v at 50Ω	Butterfly-tuning circuit has no sliding contacts, no noise, good stability and very low drift — internal 1 kc and external amplitude modulation adjustable from 0 to 50% — incidental fm under 100 ppm over most of range.
	1021-AU $615	250-920 Mc one band		
	1021-AW $845	900-2000 Mc one band	0.5μv — 1v at 50Ω	UHF pencil tube with tuned plate and cathode, remarkably free of noise modulation — ±1% calibration; incremental frequency control for small adjustments — drift under 0.1% per day — 100-10,000 cycles square-wave modulation from external source — stray fields cannot be detected with receiver having 2μv sensitivity.

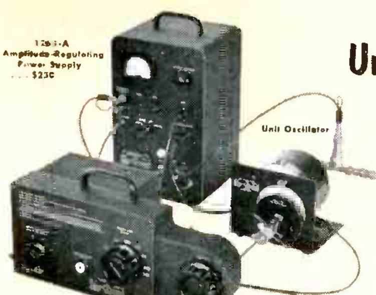


For Modulating Oscillators and Signal Generators Over Wide Ranges with Negligible fm . . .



1000-P6
Crystal-Diode Modulator . . . $40
for wide-band amplitude modulation over 20-1000 Mc carrier range . . . 50 mv, rf and 0.2v at modulation terminals produces 30% am; modulating frequencies from 0 to 5 Mc.

1000-P7
Balanced Modulator,
for 0-20 Mc amplitude modulation over 60 to 2300 Mc carrier range — particularly designed for 100% linear modulation and pulsing with fast rise time and short duration. **$225**



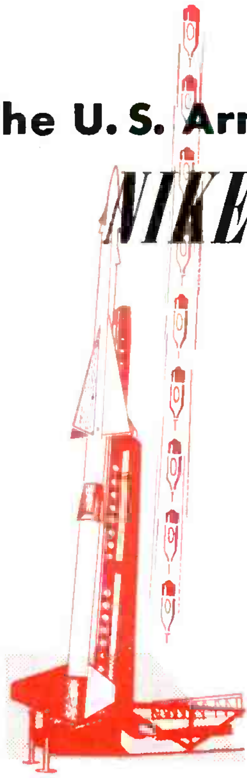
Unique Sweep Drive

Adapts Manually-Operated Equipment To Automatic Sweep

The 1750-A Sweep Drive attaches to knobs, dials or shafts for automatic sweeping of oscillators and other equipment. Sweep Arc, Speed, and Center Frequency are all continuously variable, even while the Sweep is in motion, and large percentage variations in frequency are possible. Speed is adjustable from 0.5 to 5 cps — a CRO sweep voltage proportional to shaft-angular-position is supplied, permitting calibration of CRO horizontal axis — Limit Switch, Universal Coupling System and many other features.

In combination with G-R Unit Oscillators covering the range from 0.5 to 2000 Mc, a versatile and inexpensive system of Sweeping Signal Sources is available. The 1263-A Regulating Power Supply has been developed especially for automatic sweep applications and will hold oscillator output-voltage constant to within 2%, independent of frequency.

1750-A Sweep Drive . . . $400



The U. S. Army Ordnance *NIKE* *thinks itself to a kill with "Brains" that rely on* ... RAYTHEON *Tubes*

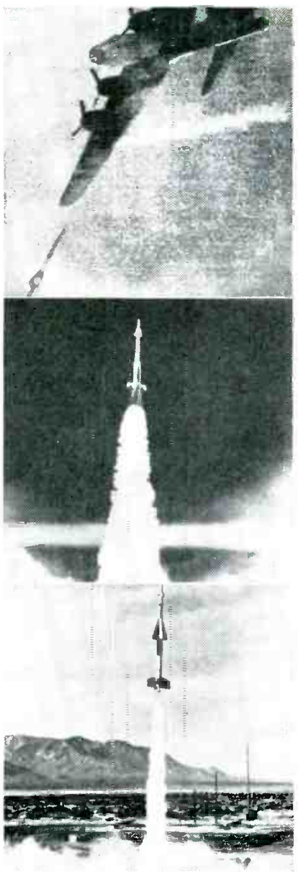
Nike, as graceful as the Greek goddess for which she is named, locates, pursues and destroys hostile aircraft. Nike reaches far beyond conventional anti-aircraft weapons; outmaneuvers fighters or bombers alike — actually thinks her way to the kill.

From bottom to top:

Nike blasts off

Nike reaches full flight speed in seconds

Unerringly, the Nike system's electronic "brain" takes her to the target.



Selection of Western Electric Company as prime contractor for the U. S. Army's Nike guided missile systems was logically based on the necessity for supreme reliability of manufacture and of consequent performance.

Selection of Raytheon Subminiature Tubes by Western Electric was dictated by that same necessity. A number of the subminiature tubes that go into the Nike system's superhuman "brain" are Raytheon Tubes.

No pains were spared, no tests overlooked in securing the very finest, most dependable tubes for the Army's *Nike*. Think, then, of your own tube applications and their needs whether they be for low microphonics, low power, long life, extreme reliability under severe service conditions or a combination of requirements. Will you be satisfied with anything less than the best? Specify Raytheon Quality Subminiature Tubes.

RAYTHEON Flat Press Subminiature Tubes ...the tubes with the SEAL of RELIABILITY

The long, flat press glass to metal seal is a Raytheon development that reduces glass strain, button cracking, lead burning, lead corrosion and lead breakage. Its in-line leads permit easier socketing and easier wiring. It is ideal for printed circuitry.

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RAYTHEON MANUFACTURING COMPANY

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For application information write or call the Home Office or: 9501 Grand Avenue, Franklin Park (Chicago), Illinois, TUxedo 9-5400

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fee is deposited.

▶ **Opposition**—Broadcasters are vocal when they comment on pay-tv. Even the provisions of a bill proposed by Representative Carl Hinshaw of California to designate subscription tv as a nonbroadcast service fail to satisfy most of them.

Jerrold Electronics says that any code can be broken and that pay tv will fall easy prey to bootleggers. The firm proposes a plan to adapt the community antenna technique to paid programs by web of coaxial cables in urban areas.

FIXED STATIONS like the one above are going mobile as . . .

Civil Air Patrol Radio Keeps Up

Number of stations increases as the service expands mobile vhf operations

THERE are now over 10,500 Civil Air Patrol radio stations in the U. S. for a gain since 1953 of more than 3,000 stations.

In 1954 there were 9,188 stations and 7,302 in 1953. The 1953 total represented a drop in CAP stations over 1952 totals, but it was a paper decrease and not a physical reduction in the number of stations. This was due to a new FCC licensing procedure in which only complete stations were included in the total figure rather than individual pieces of equipment as previously.

▶ **Mobile**—Since 1954, the number of mobile transmitters has increased substantially, by almost 1,000 units, to a total of 5,630 stations. The rise has been a result of a drive for greater mobility in line with Air Force policy and a limitation placed on the number of fixed radio stations in the CAP communications system.

Airborne stations now number 515, an increase of over 20 percent since 1954.

Present policy regarding the licensing of fixed h-f stations in CAP limits the total number of stations to two per region, two per group, three per wing and two per squadron. There are 4,451 fixed units.

▶ **Shortages**—According to CAP, the shortage of vhf equipment still exists and remains a serious problem. Of stations now installed, approximately half are vhf.

Multichannel lightweight vhf equipment suitable for installation in CAP aircraft is not available through Air Force sources and commercial types are considered too expensive.

Approximately 80 percent of the equipment has been purchased privately by members of the organization. The remainder comes from donations through the services and corporate and state purchases. There are some 15 states that have appropriated funds for CAP.

▶ **Gear**—A number of electronics manufacturers have been urged to build equipment for CAP use that is light in weight, low in cost and simple to operate and maintain. There has been some success in this regard. According to CAP, The Reisner Corp. has a suitable airborne air/ground vhf set. Other manufacturers such as Gonset, Crico and Lettine are also producing equipment for the program.

Electronics Revives Aladdin's Lamp

HOUSE lamps that can be turned off and on by the touch of a hand will be available this fall as a result of a new electronic lamp control developed by GE.

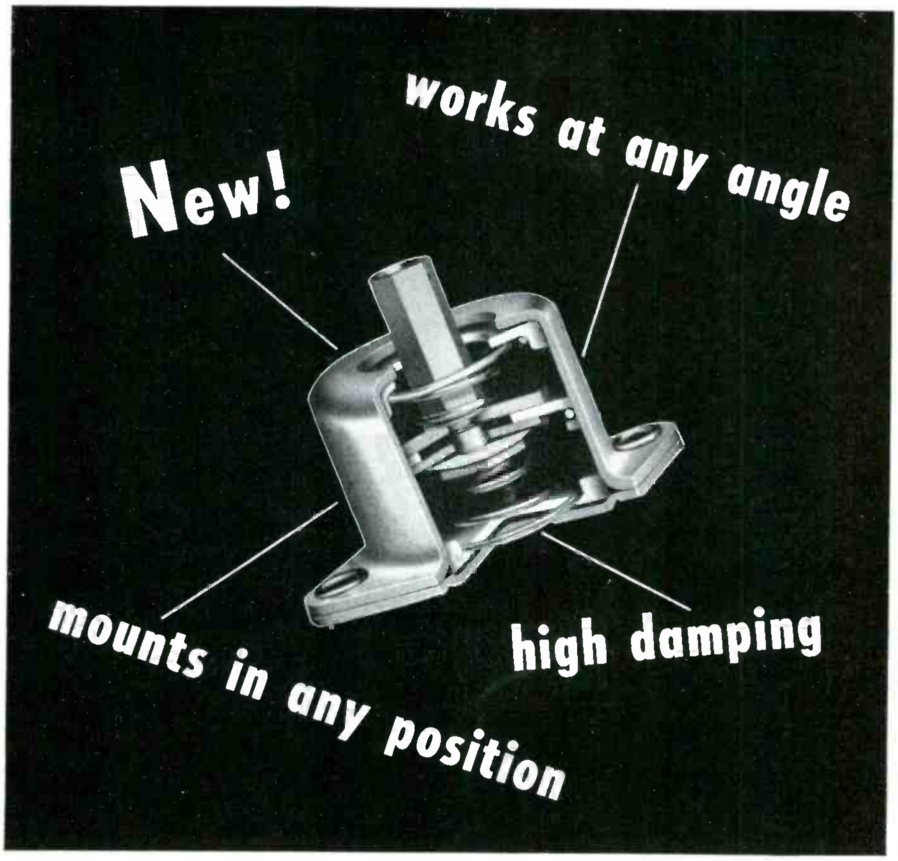
Touchtron, as the device is called,

Electronic lamp control, left, allows lamps to be turned off and on by the touch of a finger, not a push

is an electronic switch that is actuated by a touch of the hand to two closely adjacent metal surfaces. These might be the metal base and a decorative band. The touch triggers a neon triode that operates a specially designed relay to turn the lamp on or off.

The unit draws negligible power from the line and incorporates spe-

(Continued on page 22)



Nothing Less than this ALL-ANGL Mount gives sure protection in JETS and MISSILES

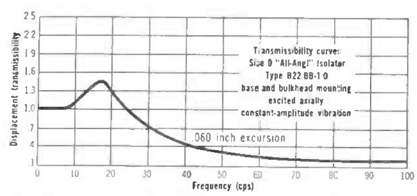
WHY? Because this Barry mount is independent of operating or mounting position. Through every operational maneuver of jets, VTO's, and missiles, the ALL-ANGL gives the same effective shock and vibration protection as in level flight.

These are the vital performance characteristics of the ALL-ANGL Mount:

- Equal stiffness in all directions
- Equal damping in all directions
- Low transmissibility at resonance — less than 3
- Isolation under superimposed steady state accelerations up to 5 g

Maximum load ratings of Size 0 ALL-ANGL mounts now available are 0.5 to 3.0 pounds per mount, in four ranges.

Write today for Data Sheet W5. For specific recommendations, call your nearest Barry Sales Representative.



Typical transmissibility curve for ALL-ANGL mount, both base and bulkhead mounting, excited axially at constant amplitude.

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cial circuits to minimize external interference. It is expected that, initially, lamps using the device will cost about $15 more than ordinary lamps.

Plans Are Set For 1955 WESCON

AUGUST will once again focus attention of the electronics industry on California where the 1955 Western Electronic Show and Convention will take place, August 24-26 in San Francisco. More than 20,000 engineers, scientists and business executives will attend the show. Exhibitors displaying their products will exceed 600.

▶ **Growth**—The show, which began as a regional event, has become of national importance to the electronics industry because of the growth of electronics on the west coast. This expansion is mirrored in the growth of two sponsoring organizations of the show, Region 7 of the IRE and WCEMA, the West Coast Electronic Manufacturers Association.

Although IRE nationally has increased from 37,000 members to 42,000 in the past year for a 12-percent gain, growth of the Seventh Region has been even greater. Examples are Phoenix, which increased 40 percent last year; Los Angeles, which obtained 700 new members during the past year; San Francisco, which has a 17-percent increase and now also has the Palo Alto subsection with 663 members compared to 250 three years ago.

WCEMA, which started with a half-dozen companies is now made up of 186 firms in the electronics manufacturing, research and development fields in the western states.

▶ **Technical**—More than 25 technical sessions are planned. Speakers will discuss audio, antennas and propagation, circuit theory, vehicular communications, broadcasting and tv, telemetering, airborne electronics, information theory, management, electronic devices, computers, microwave theory and component parts.

NEW factory construction indicates . . .

Electronics Growing In France

Radio and tv production increase as the industry expands plants and facilities

THERE are now over 200,000 tv sets in use in France, representing a gain of about 100,000 units since the beginning of the year for one of the largest increases in the history of French tv. It represents retail sales of approximately $28 million.

At the end of 1952 there were 50,000 sets in use in the country and by the end of 1954 this figure had jumped to 125,000. So far this year tv sets are being installed at a rate of 20,000 a month.

French radio is also healthy. There were 8.9 million sets in use on March 31 of this year compared to 8.8 million in 1954 and 8.4 million in '53. Most tv sets in France are made in the country, mainly because the 819-line system is used.

▶ **Industry**—For the entire French electrical and electronics industry, the value of production in 1954 reached an all-time high of $1.3 billion, nearly three times the value of output in 1938, at today's prices. During the same period, employment in the industry has risen from 136,000 in 1938 to 210,000 last year. The total wage bill for the industry in 1954 was $303 million in addition to employer-paid social security charges of more than $100 million.

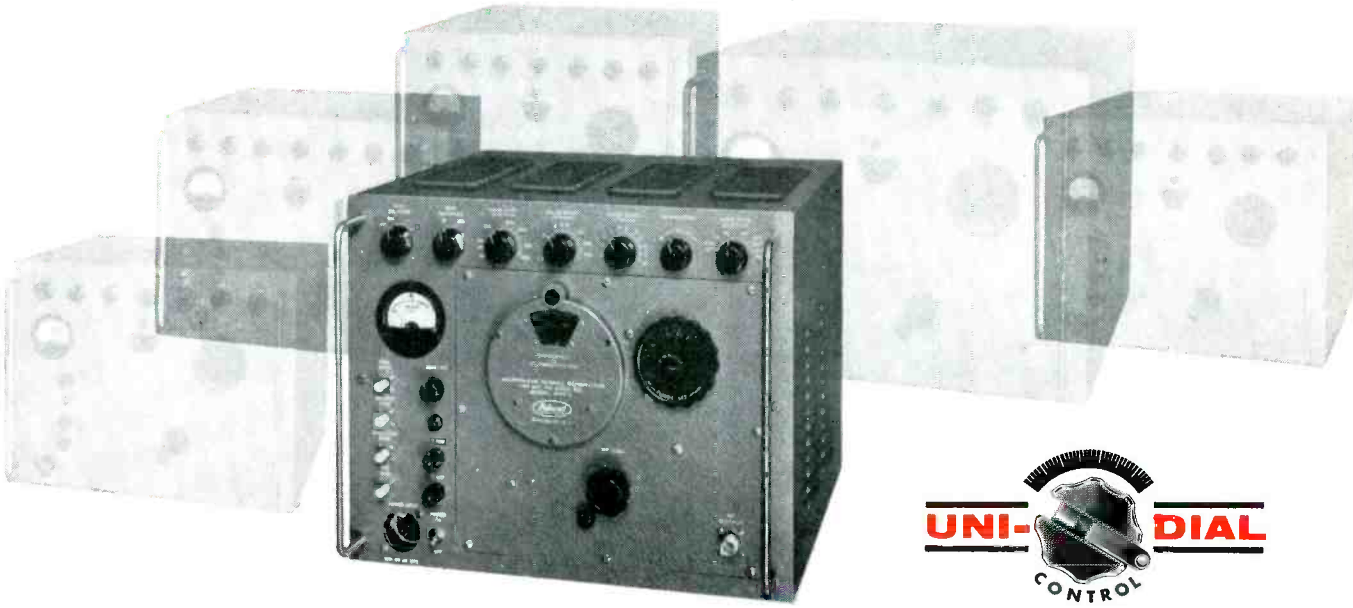
▶ **Character**—The French electrical and electronics equipment industry is made up of 1,600 firms, about 60 percent of them located in the Paris area. Seventy of these companies had gross production in 1954 of more than $2.8 million and together they produced 64 percent of the total output of the industry. Total of 1,175 small firms account for 12 percent of the industry's gross.

▶ **Future**—With the production of tv in France bidding to reach a new high in 1955, the manufacturers there are expanding plants and facilities. Latest expansion is that of the Societé Francaise Radio-Electrique, a branch of the Compagnie Generale de Telegraphie Sans Fil. The firm is building a new 290,000 sq ft tube factory, a model of which is shown.

The new plant will employ 3,000 people in Saint-Egreve, at the foot of Mt. Neron. The factory will be named the Centre Technique et Industrial E. Girardeau, to honor the pioneer in French electronics and founder of the Societé Francaise Radio-Electrique.

(Continued on page 24)

MICROWAVE SIGNAL GENERATORS 950 to 11,500 mc



UNI-DIAL CONTROL

JUST ONE POLARAD MICROWAVE SIGNAL GENERATOR CAN MAKE ALL THESE MEASUREMENTS

- Receiver sensitivity
- Noise figure
- Signal to noise ratio
- Image rejection
- Beacon sensitivity
- Bandwidth
- Standing wave ratio
- Antenna gain and pattern
- Conversion gain or loss
- Attenuation
- Filter characteristics
- Multi-pulsed systems, such as Beacons, DME, Tacan, etc.

Each Polarad Microwave Signal Generator (4 models cover 950-11,500 mc) is equipped with the unusually simple UNI-DIAL control that tracks reflector voltages automatically while tuning continuously. Frequency, accurate to ±1%, is read directly on the single frequency dial. There are no mode charts, no slide rule interpolations necessary.

But, most significant are the **built-in** features that enable use of these rugged instruments for so many applications: internal modulation, pulse and FM; internal square wave modulation; synchronization outputs, delayed and undelayed; provision for multi-pulse modulation input; provision for external modulation and synchronization; variable attenuator calibrated directly in - dbm; engineered ventilation to insure specification performance over long operating periods.

Contact your local Polarad representative or write directly to the factory for the latest detailed specifications.

SPECIFICATIONS (all models unless indicated)

Model #	Frequency Range
MSG-1	950 - 2400 mc
MSG-2	2150 - 4600 mc
MSG-3	4450 - 8000 mc
MSG-4	6950 - 10,800 mc
MSG-4A	6950 - 11,500 mc

Frequency accuracy: ±1%
Power output:
MSG-1 & 2: 1 mw
MSG-3, 4 & 4A: 0.2 mw
Attenuator range: 120 db
Attenuator Accuracy: ± 2 db
Output impedance: 50 ohms nominal

Internal pulse modulation:
Pulse width: 0.5 to 10 microseconds
Delay: 3 to 300 microseconds
Rate: 40 to 4000 pps
Synchronization: internal or external, sine wave or pulse

Internal FM:
Type: Linear sawtooth
Rate: 40 to 4000 cps
Synchronization: Internal or external, sine wave or pulse
Frequency deviation:
MSG-1 & 2: ±2.5 mcs
MSG-3, 4 & 4A: ±6 mcs

Internal square wave modulation:
40 to 4000 pps

External pulse modulation:
Polarity: Positive or negative
Rate: 40 to 4000 pps
Pulse width: 0.5 to 2500 microseconds
Pulse separation (for multiple pulses): 1 to 2500 microseconds

Output synchronizing pulses:
Polarity: Positive, delayed & undelayed
Rate: 40 to 4000 pps
Voltage: Greater than 25 volts
Rise time: Less than 1 microsecond

Price:
MSG-1, 2 ....$1,720.00
MSG-3, 4 ....$2,190.00
MSG-4A $2,450.00

AVAILABLE ON EQUIPMENT LEASE PLAN

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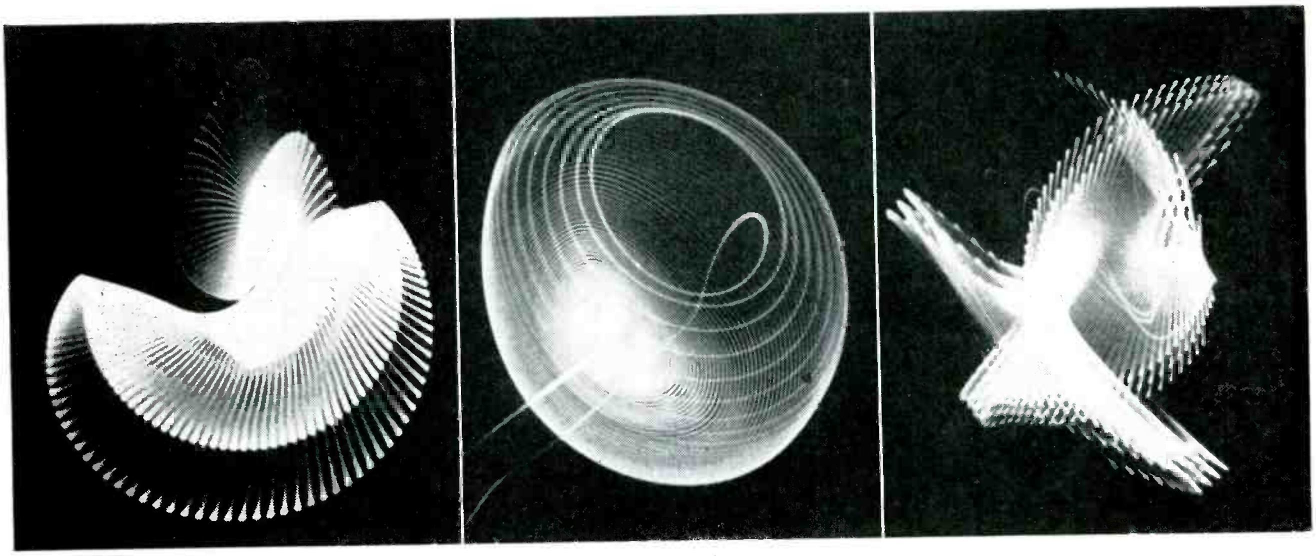


ELECTRONIC ABSTRACTIONS No. 38, 27 and 4 were selected to show . . .

Complex Scope Patterns Form Art Studies

USE of cathode-ray oscillograms in the art and design fields is a new application of electronics that may have a promising future.

Oscilloscope traces which are especially selected or composed for their abstract art values are now called oscillons. Oscillonics may be defined as the art of composing such figures, however presented or applied. Oscillons, whether in black and white or color, may be drawn, but are best recorded by photographs.

▶**Applications**—The designs shown are from a monochrome cathode-ray tube, but future developments of this technique will include use of tricolor tubes and circuits. As abstract motion picture themes moving oscillons can provide a form of entertainment, especially if synchronized with music; likewise if projected on a screen. While primarily created for their own sake as art forms, oscillons may find application in decorative art, as in textiles and ceramics.

These patterns were formed for their esthetic appeal by their originator, Ben F. Laposky, a commercial artist. (See p 3.) They were not intended for any kind of technical application or study.

As various basic waveforms were fed into the oscilloscope circuits, they were controlled and shaped until a pattern with possibilities of good design was created. This was then photographed with a fast camera, as many of the best forms were moving in some way.

Attempts to stop some with synchronizing circuits generally changed the figure or distorted it into something not desired as a good design. Of the almost infinite number of traces the scope may be made to display, only a small number could be used as oscillons.

A traveling exhibit of 50 photographic enlargements of oscillons, titled Electronic Abstractions, an alternative name for the designs, has been circulated by Sanford Museum, of Cherokee, Iowa. This exhibit has been shown in 31 art museums and universities in the United States since 1953. Articles on the development have appeared in mathematical and art journals.

Parts Conference Highlights Research

NEED to accelerate component research to meet increased new demands for specialized and highly reliable devices was a major topic of concern at the sixth annual Electronic Components Conference.

Problems concerned with component research were discussed at the final luncheon session by L. C. Hyland, vice-president of Hughes Aircraft Co. He pointed out that large electronics manufacturers, like Hughes, are finding it necessary to form their own component design departments, because the component industry has been too slow in supplying the specialized products required for their operations.

He also condemned component failure in military electronic systems as "unnecessary, if we design components more carefully, and research them more thoroughly."

One of the reports among the 56 papers presented to the delegates was on the use of tiny electronic devices to stimulate inactive nerve centers of involuntary muscles. The experiments, conducted successfully on dogs, are only in the preliminary stage, but Dr. Ivan A. Getting of Raytheon Manufacturing Co. stressed that application to the human body is possible.

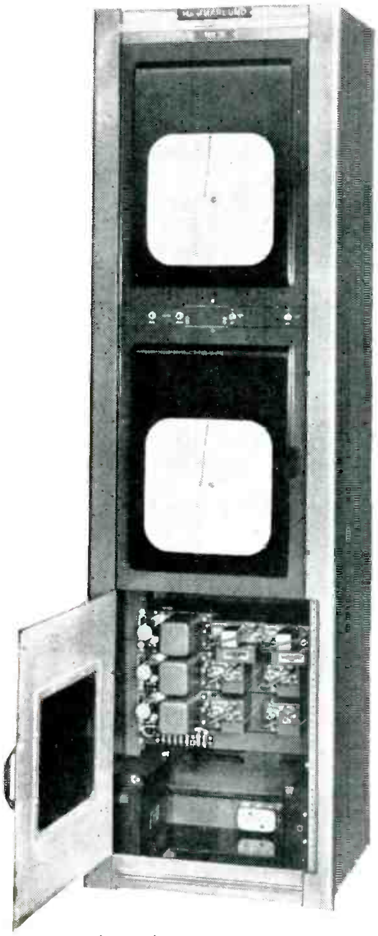
More than 1,200 electronics engineers, chiefly from electronic companies and military installations in the Los Angeles area, attended the sessions which were conducted by chairman Dr. Simon Ramo, of Ramo-Wooldridge Corp.

(Continued on page 26)

Centralized Operations Control...

Remote Supervisory Controls For Industrial & Governmental Use

- *Puts all controls and metering in your central office.*
- *Provides simultaneous and continuous operations.*
- *Uses your present instruments if desired.*
- *Uses just one telephone circuit or radio channel.*
- *Is tested, proven, and safe.*



Central terminal equipment for control of remote operations and display of telemetered information.

Remote terminal equipment. Operates in response to signals received from the central control point to perform ON-OFF and OPEN-CLOSE operations and returns metered data. Local control and indicating meters are also included.

Your present equipment can be integrated into a Centralized Operation Control system. What COC does is modernize it to the extent that all your normal control and telemetering operations can be handled from a single central point over a single telephone circuit. Or, radio or microwave may be used.

Now, valves and switches can be opened and shut, pumps and other machinery can be started and stopped, flow, levels, voltages and most all other quantities can be metered, all from your central control point. And all these functions can be operated continuously and/or simultaneously as desired.

And, you don't have to have an electronics specialist on the job to operate your COC system. Once installed, any capable communications service man, electrician or instruments man can service it.

COC systems are flexible. All units are open-ended for future expansion. An almost unlimited number of functions are possible, but you buy only what you need at the start.

Perhaps the most attractive feature to those who are responsible for controls and remote instrumentation is dependability and safety. COC units loaf most of the time—they are designed with an 8 to 1 safety factor. And there are all the extensive fail-safe and alarm features built in that you will want.

For full information, write to The Hammarlund Manufacturing Company, 460 West 34th Street, New York 1, New York.

Ask for Bulletin. E-7

HAMMARLUND

Since 1910

Financial Roundup

Company profits show up well in first quarter compared to same 1954 period

PROFIT reports by companies in the electronics field show that the first three months of 1955 are, for many firms, far ahead in sales and profits over the same period last year.

Following are the profit reports of 16 firms in the field, for the fiscal periods indicated:

Company	1955 Net Profit	1954
Admiral 3m	$1,238,176	$1,504,044
Amer. Electronics 3m	81,408	67,344
Amer. Cable & Radio 3m	211,446	476,106
AMF 3m	909,000	988,000
British Industries 3m	68,528	17,896
Clevite 3m	1,175,482	941,115
CBS 3m	3,892,677	2,866,365
Cornell-Dubilier 6m	1,036,649	847,953
Curtiss-Wright 3m	6,820,707	3,193,842
Daystrom 12m	1,716,216	1,458,924
Int'l. Resistance 15w	199,457	69,378
W. L. Maxson 6m	594,359	659,412
Motorola 3m	2,153,038	1,644,084
Philco 3m	2,447,000	2,438,000
Raytheon 9m	3,592,000	2,703,000
Weston 3m	213,403	350,781

▶ **Securities**—American Machine & Foundry registered with SEC covering 237,641 shares of its $7 par value common stock to be offered at the rate of one new share for each ten held. Net proceeds will be used to reduce current bank loans.

Jerrold Electronics registered with SEC covering $2.7 million of 6-percent convertible subordinated debentures due in 1975, and 200,000 shares of its 10-cent par value common stock. The debentures are to be offered at 100 percent of principal amount and the common stock at $4 per share. Other stocks and stock purchase warrants are to be offered. A major purpose of the financing is to enable the company to construct, invest in, own and operate a number of community tv systems.

Minshall Organ offered 100,000 shares of common stock, par $1, at $3 per share. Proceeds will be used to liquidate debts, pay expenses of the issue and for retooling and working capital.

American Electronics offered $1.2 million of 5-percent convertible debentures, due in 1967, at 100 percent and accrued interest. Net proceeds will be used to retire short-term bank loans and for general corporate purposes.

FUTURE MEETINGS

JUNE 27–JULY 1: AIEE Summer General Meeting, New Ocean House, Swampscott, Mass.

JULY 5–7: International Symposium on radar, radio and sound wave propagation, Navy Electronics Lab., San Diego, Calif.

AUG. 22–23: Symposium on Electronics and Automatic Production sponsored by Stanford Research Institute and NICB, San Francisco, Calif.

AUG. 24–SEPT. 3: The National Radio Show, Earls Court, London, England. Preview for overseas visitors August 23.

AUG. 24–26: 1955 WESCON, Civic Auditorium and Fairmount Hotel, San Francisco, Calif.

AUG. 26–28: Sixteenth Annual Summer Seminar, Emporium Section IRE, Emporium, Pa.

AUG. 26–SEPT. 4: Great German Radio, Gramophone and TV Exhibition, Dusseldorf, Germany.

SEPT. 12–16: Tenth Annual Instrument Conference & Exhibit, ISA, Shrine Exposition Hall and Auditorium, Los Angeles, Calif.

SEPT. 14–16: 1955 Annual Meeting of the Association for Computing Machinery, University of Penn., Philadelphia, Pa.

SEPT. 17: Symposium on Automation, Cedar Rapids IRE, Cedar Rapids, Iowa

SEPT. 19–20: Sumposium on Electronic Automation, University of Penn., Irvine Auditorium, Philadelphia, Pa.

SEPT. 26–27: RETMA Symposium, Electronics For Automation and Automation For Electronics, Philadelphia.

SEPT. 28–29: Industrial Electronics Conference, AIEE, Rackham Memorial Auditorium, Detroit, Mich.

OCT. 3–5: National Electronics Conference, Hotel Sherman, Chicago, Ill.

OCT. 12–15: 1955 Convention of the Audio Engineering Society concurrent with the Audio Fair, Hotel New Yorker, New York, N. Y.

OCT. 17–19: RETMA Radio Fall Meeting, Hotel Syracuse, Syracuse, N. Y.

OCT. 20–22: Eighth Annual Gaseous Electronics Conference, GE Research Lab., The Knolls, Schenectady, N. Y.

OCT. 24–25: First Annual Technical Meeting, IRE Professional Group On Electron Devices, Shoreham Hotel, Washington, D. C.

OCT. 25–27: International Conference on Electronic Digital Computers and Information Processing, Darmstadt, Germany.

OCT. 28–29: 1955 Symposium of Philadelphia ISA, Penn Sherwood Hotel, Philadelphia, Pa.

OCT. 31–NOV. 1: 1955 East Coast Conference on Aeronautical and Navigational Electronics, IRE, Lord Baltimore Hotel, Baltimore, Md.

Industry Shorts

▶ **Construction** permits for 12 uhf-tv station have been extended by FCC until next January because permittees are delaying construction owing to uncertain economic future.

▶ **Mobile** radio equipment exposed to Yucca Flat atomic experiments is now being used in Phoenix, Ariz., civilian vehicles. Some units had been as close as 4,700 feet from the atomic tower.

▶ **Total** of nearly 36-million tv receivers were shipped to dealers during the nine year period between 1946 and 1954, according to RETMA.

▶ **Texas** tv transmitting tower with a total height of 1,521 feet is under construction. Of a total of 866 tons of steel, solid round legs make up 407 tons. There are only 28 tv towers with a height of 1,000 feet or more in the U. S.

▶ **More** than 100 new Sperry autopilots with various types of landing-approach couplers are slated for four major U.S. airlines.

▶ **Prisms** made from polystyrene containing an array of thin wires may be used to control the direction of radar beams, according to the Radio Research Board in England.

▶ **Hams** that are carried through smoke-filled tunnels in which meat and smoke are oppositely charged, attract as much smoke in four minutes as they would in 12 hours by conventional methods.

KAY

Crystal Controlled TV Picture and Sound Signal Sources at VHF and UHF Frequencies

TRANSMITTERS FOR:
1. **Closed Circuit Community TV**
2. **Studio Monitoring at RF Frequencies**
3. **Low Power Satellite Operation**
4. **Overall Test Signal for COLOR and Black & White TV Receiver.**

KAY
Mega-Pix

The Kay Mega-Pix provides two separate twelve-channel crystal controlled oscillators, frequency multipliers and output amplifiers to develop a crystal controlled RF picture and sound carrier on each TV channel.

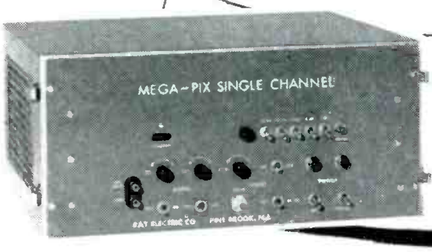
Using the standard video signal (either from a monoscope, color bar generator or TV receiver) the Mega-Pix provides a modulated picture carrier on any of the 12 TV channels. An available FM sound carrier signal is provided on each channel to assist in monitoring at the receiver. See general specifications.

Mega-Pix **UHF CONVERTER:** Converts RF signal from Mega-Pix to any specified UHF channel. $450 f.o.b. factory. Catalog 850-A.

SPECIFICATIONS

- **Output Signal Frequencies:** RF picture and Sound, all channels
- **Accuracy:** 0.01%
- **Video/Audio Carrier Output:** At least 30 mv across 72 ohms
- **Amplitude Control:** Individual level control of carriers; simultaneous control range of 20, 20, 10, 6 and 3db switched—10 db variable.
- **RF Output Impedance:** 72 ohms
- **Video Input Impedance:** 72 ohms
- **Video Input Signal Requirements:** Approx. 1 v, peak-to-peak, black negative
- **Video Bandwidth:** Flat, 5 mc
- **Picture Carrier Modulation:** 0-85+%, adjustable
- **Sound Carrier Deviation:** 0-25 kc, adjustable
- **Sound Modulating Frequency:** 400 cps, or external audio. Pre-emphasis supplied
- **Power Requirements:** 105 to 125 v., 50 to 60 cps, 90 w. *approx.*
- **Catalog No.:** 391-A

Price f.o.b. factory: **$990**



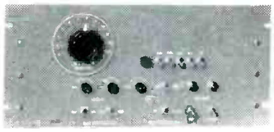
Mega-Pix SINGLE CHANNEL

Same specifications as Mega-Pix, Output *Signal Frequencies:* TV RF Picture and Sound frequencies, choice of any one channel, IF through 13: audio-video carrier output, 250 mv across 72 ohms. Send for catalog 392-A.

$495 *f.o.b. factory*

Ultra-Pix

ULTRA-PIX: UHF crystal controlled TV picture and sound RF signal source. Provides one VHF and three UHF channels for complete TV production line, lab and field test. BASIC SPECIFICATIONS SAME AS MEGA-PIX. Also available with one VHF and one UHF channel with maximum sound picture output of 240 millivolts across 72 ohms. Send for catalog 540-A. *$795 f.o.b factory*



Mega-Pix Jr.

MEGA-PIX, JR.: Same specifications as Mega-Pix, through "Picture Carrier Modulation" Unit employs beat frequency technique to provide TV RF sound and picture carrier frequencies on channels 2 to 13 inclusive. Send for catalog 390-A.

$695 f.o.b. factory

Telefilter

TELEFILTER: Converts the Mega-Pix or similar generator to vestigial side band operation. Used where modulated carrier signal generators are to be operated on adjacent channels. Send for catalog 840-A. *$195 f.o.b. factory*

KAY

ELECTRIC COMPANY

DEPT. E-7

14 MAPLE AVENUE

PINE BROOK, N. J.

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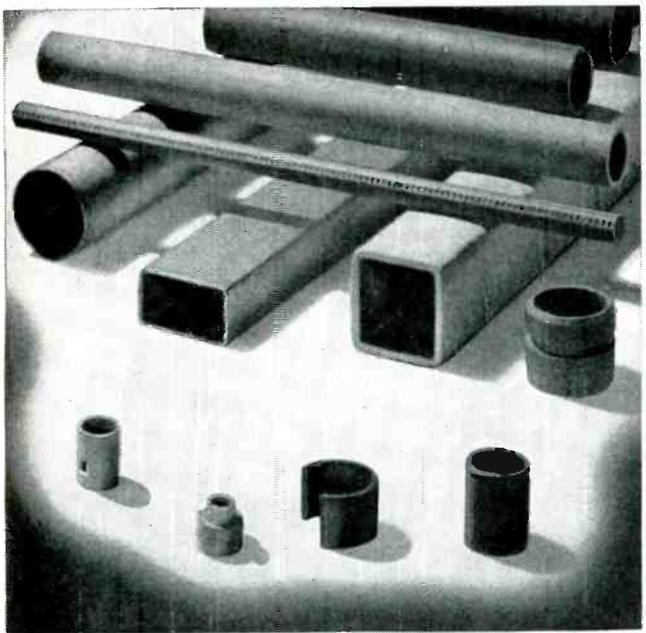


C-D-F SPIRAL TUBING offers many advantages to the cost-conscious design engineer and purchasing agent. It is low-cost, moisture-resistant, high-strength, and easy to fabricate. It has sufficiently low dielectric loss properties and good dielectric strength for many applications.

New C-D-F Plastic Spiral Tubing reduces unit costs, improves products

Using C-D-F's new Spiral Tubing is a way of saving money in buying electronic insulation . . . without lowering the electrical and mechanical characteristics of the part required. This special tubing is a high-strength plastic made from paper or vulcanized fibre that is spirally wound. It is available in two basic forms in various grades: (1) as plain untreated tubing. (2) as impregnated tubing containing various types of thermosetting insulating varnishes.

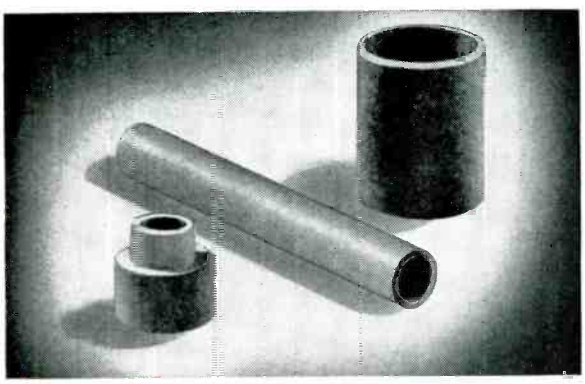
BUY ONLY THE PROPERTIES YOU NEED

Spiral Tubing can be used to replace rolled or molded laminated phenolic tubing in many cases. As the degree of moisture resistance and mechanical strength is established during the manufacturing process, you specify . . . and buy . . . only those properties required for the application. C-D-F also offers complete designing, machining and assembly. You can get finished components, or random length tubing, with fast deliveries. Write for Technical Folder ST-53 and samples, after checking our catalog in Sweet's Design File. Call the C-D-F sales engineer listed there—he can save you time and money immediately with C-D-F Spiral Tubing!

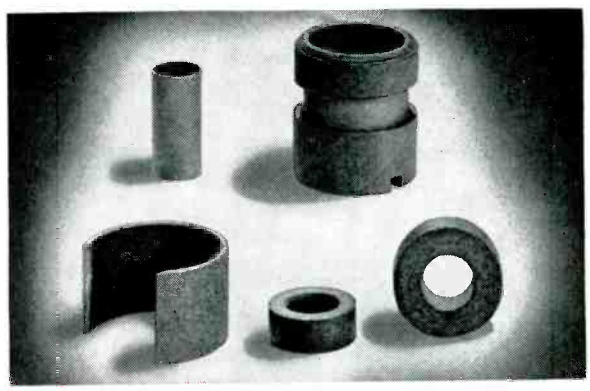
Continental-Diamond Fibre

CONTINENTAL-DIAMOND FIBRE COMPANY

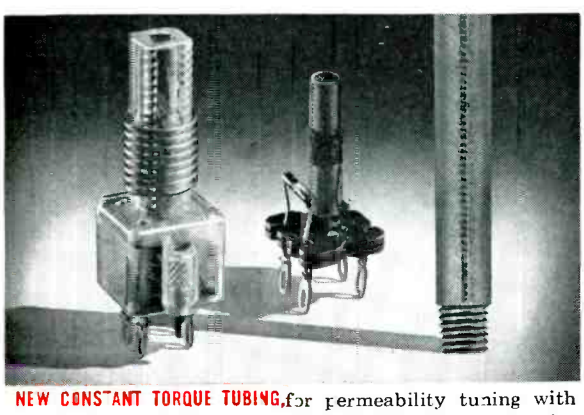
NEWARK 16, DELAWARE



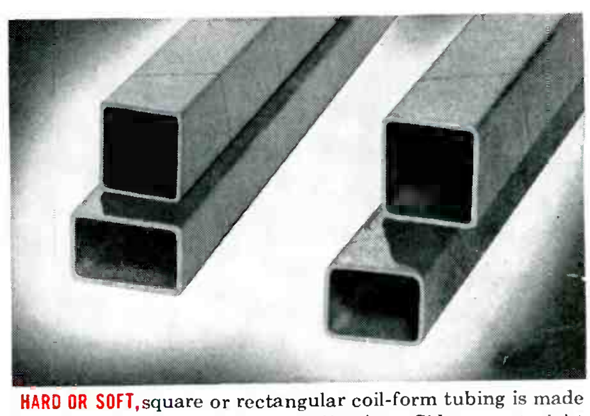
A VERY HARD TUBE is supplied in C-D-F Grade 6A. The parts shown have maximum mechanical strength, lowest water absorption rate under immersion conditions and most stable dielectric loss properties. Fine for bushings and cores.



THIN-WALL SPIRAL TUBING has good concentricity and is tough. Note thin wall construction, cleanness of machining, variety of shapes. C-D-F Spiral Tubing is easily machined, formed, punched. Made in many grades for special applications.



NEW CONSTANT TORQUE TUBING, for permeability tuning with iron cores, features exact internal threading with three point suspension of the core to prevent binding . . . *no* external embossing to lower dielectric strength. Write for samples.



HARD OR SOFT, square or rectangular coil-form tubing is made for solenoid and transformer applications. Sides are straight with minimum gap in paper winding. Supplied in soft, varnished kraft, or hard, rigid tubing.

Industry's first full year performance warranty on all transistors announced by General Electric

MADE POSSIBLE THROUGH PROVED PERFORMANCE IN RIGID LIFE TESTS

NOW, IN ADDITION to the recently announced price reductions, General Electric provides a full year warranty on its complete line of transistors—the first warranty of its kind in the Semiconductor industry.

CONTINUOUS QUALITY checks and life tests in G.E.'s laboratories and plants, *and in the field*, have proved conclusively the performance superiority and longer life of the G-E transistors. In tests requiring operational stability at temperatures up to 85°C for thousands of hours, G-E transistors have surpassed every specification. The full year warranty is your assurance of this performance.

IN THE LAST 12 MONTHS the list of important manufacturers who have swung over to G-E Semiconductor Products in radio, communications, and other electronic equipment has increased at a startling rate. Why not profit by their successful experience? Now is the time to use all of the many advantages offered by General Electric Semiconductors in the production of your equipment. Especially in view of their recent reductions in price and the new Performance Warranty. For additional information, write today to: *General Electric Company, Semiconductor Products, Section X475, Electronics Park, Syracuse, New York.*

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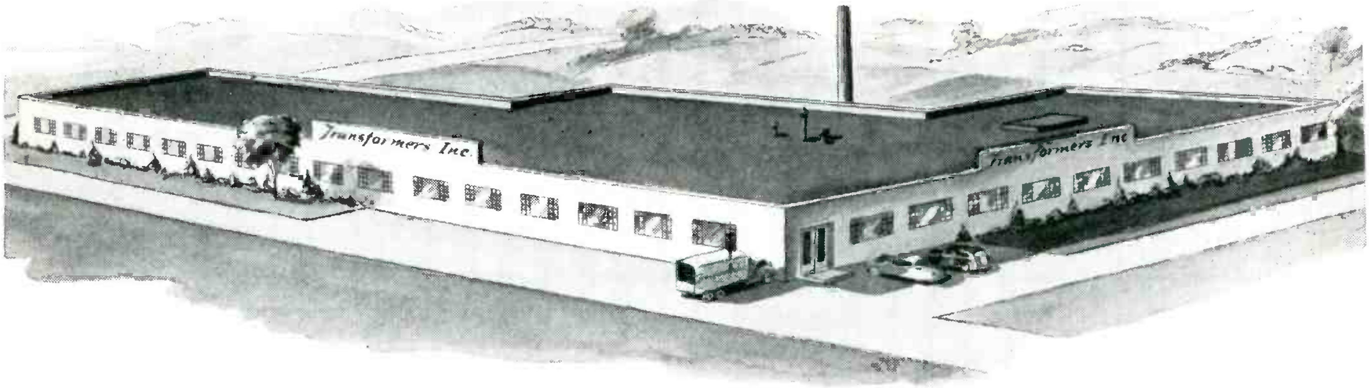

COMPUTER PRECISION TRANSFORMERS

Voltage reference transformers and computer excitation transformers

TRANSFORMER ACCURACY

Voltage ratio $\pm$ .0001% **Phase angle < .001 milliradian**

These accuracies can be obtained for transformers if the load, temperature and frequency vary within small limits.

These conditions unfortunately exist only when a transformer is used for reference. There are, however, many requirements for excitation purposes where a high degree of precision is needed. For these requirements we have been regularly supplying transformers with a voltage ratio accuracy as high as .001% and phase angle error of less than .01 milliradian. When the required accuracy is not better than $\pm$.01% for voltage ratio and .1 milliradian for phase angle error the transformers can be supplied in production quantities at low cost.

Our new plant in Vestal, New York has approximately 20,000 square feet devoted exclusively to the design and manufacture of precision transformers.

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Transformers Inc. meets all requirements for

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- Greater Economy
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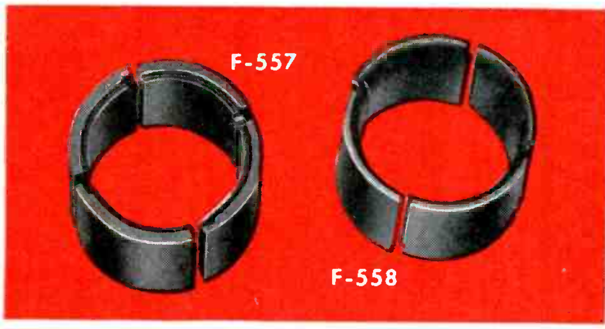
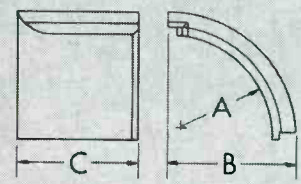
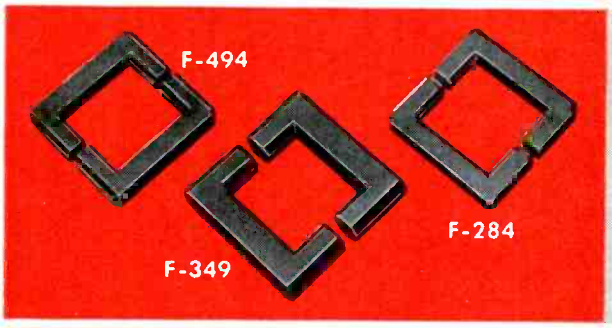


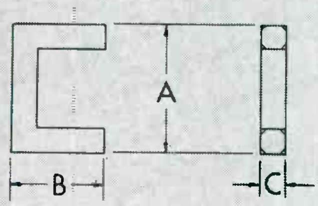


*F-557 conforms to MPA Tentative Standard 18-55T for parts DY-3, DY-4.

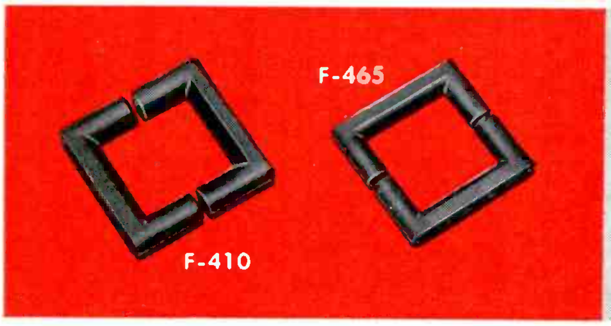
†F-558 conforms to MPA Tentative Standard 18-55T for parts DY-1, DY-2.

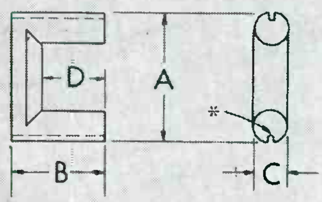
PART NO.	F-557*	F-558†
A	.960″	.950″
B	1.210″	1.215″
C	1.125″ 1.250″	1.250″ 1.375″





PART NO.	F-284	F-349	F-494
A	2.250″	2.500″	2.250″
B	1.057″	1.156″	1.025″
C	.375″	.490″	.375″
X-Sect.	Rect.	Octag.	Rect.





*Longitudinal Screw slots are .156″ deep x .140″ wide.

PART NO.	F-410	F-465
A	2.477″	2.308″
B	1.156″	1.062″
C	.545″	.447″
D	.703″	.687″

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- **SOUND MECHANICAL DESIGNS**
- **HIGH EFFICIENCY**
- **EXCELLENT STABILITY**
- **LIGHTWEIGHT**
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HIGH QUALITY, GENERAL-PURPOSE RELAYS FEATURING COMPACTNESS, DEPENDABILITY AND LONG LIFE!

hermetically sealed or dust-protective enclosures

48 TYPES available from STOCK

Current ratings up to 25 amp, AC or DC

When you want the utmost in relay dependability, investigate the Amrecon line. Amrecon relays are designed, produced, and tested in the new, air-conditioned Ohmite plant.

These ruggedly built relays have the ability to handle power loads usually requiring larger, heavier units. They are built to meet rigorous aircraft relay standards, and are particularly adapted to mobile equipment where severe shock and vibration are encountered.

Amrecon relays are available with screw, plug, or solder-wire terminals; in a variety of contact arrangements; with hermetically sealed or dust-protective enclosures. Order from the 48 stock types, or let Amrecon's engineers help you work out special relay applications.

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ROTARY TAP SWITCHES

For your AC power-switching requirements in the 10 to 100 amp range, Ohmite Tap Switches are the finest units available. They are load-break, non-shorting, single-pole switches of unusually compact design.

Numerous design and construction features provide ruggedness and dependability. Silver-to-silver contacts eliminate contact maintenance. The rotor contact is self-cleaning. The switch shaft is electrically "dead"—insulated by a strong ceramic hub. Furthermore, the positive cam-and-roller mechanism for "slow-break, quick-make" action greatly increases contact life.

Ohmite Tap Switches are available with 2 to 12 taps in the single pole, non-shorting type. Two or three switches can be grouped in tandem to form multi-pole assemblies. They are also available in open-type models for both shorting and non-shorting applications.

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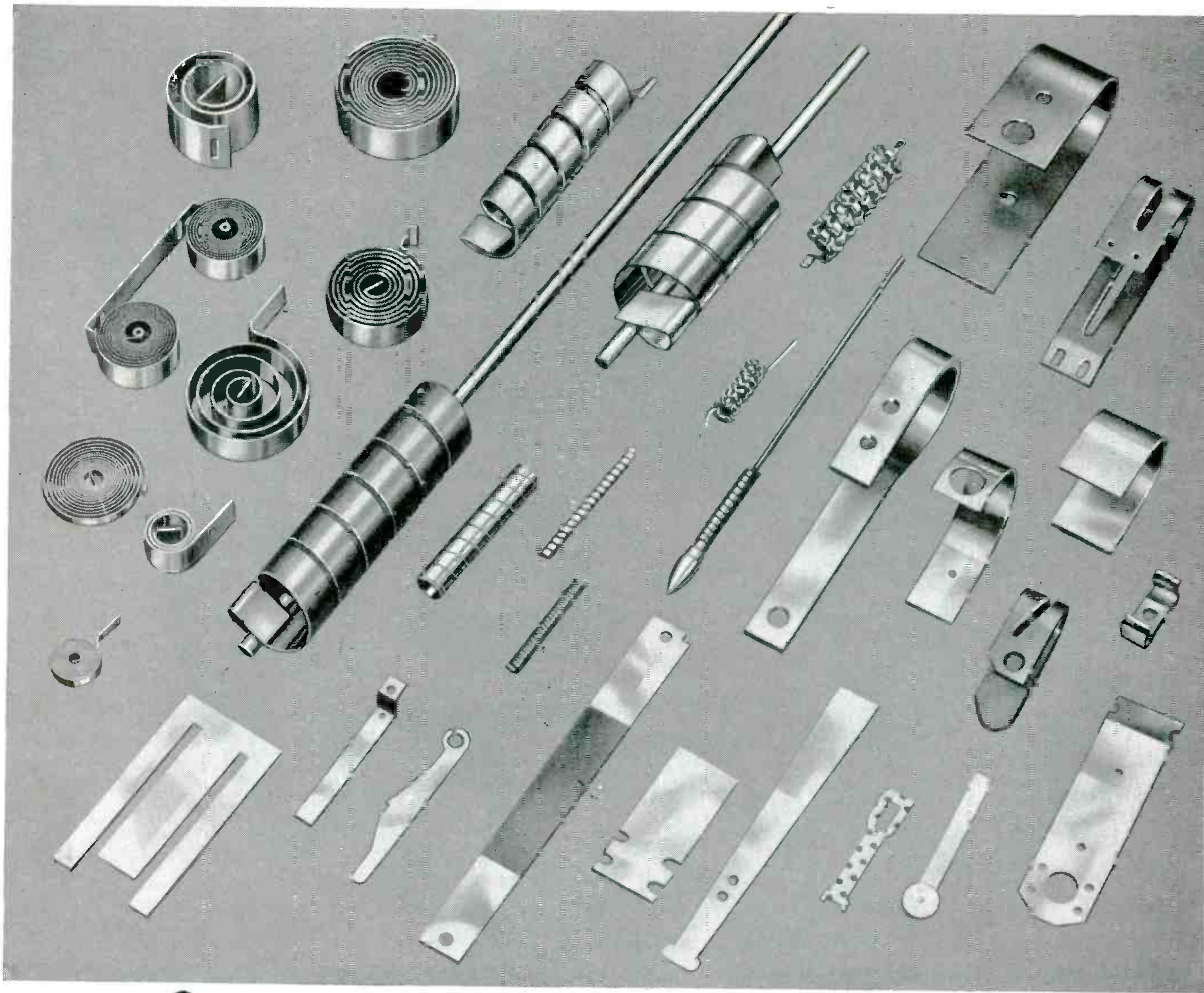
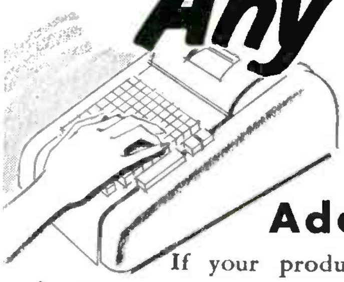


Any way you Figure it...



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Thermostat Metals and Assemblies
Add up to Performance and Economy

If your products require temperature control . . . indication or compensation, General Plate TRUFLEX thermostat metals and fabricated elements and assemblies give you reliable, accurate performance and at the same time *cut your costs.*

Here's why — Advanced General Plate production methods coupled with the best equipment available insure positive consistency in thermal and mechanical performance and maintain close dimensional tolerances. Every lot, whether it is 10 pieces or 10,000, is a duplicate of the original, thus eliminating rejects and costly adjustments in assembly.

General Plate TRUFLEX fabricated elements and assemblies ready for installation in your products are engineered and manufactured to your exact specifications. You get accurate and consistent performance, because every order comes to you a faithful duplicate of the original. Costly fabrication problems . . . needless expense for special calibration equipment . . . and time consuming assembly adjustments are eliminated.

General Plate TRUFLEX thermostat metal and assemblies are made to meet your specific requirements for temperature range, electrical resistance, corrosion resistance, etc. If you prefer to make your own elements, General Plate will produce TRUFLEX thermostat metal strip to your material specifications. Write for TRUFLEX thermostat metal catalog and engineering assistance.

You can profit by using General Plate Composite Metals!

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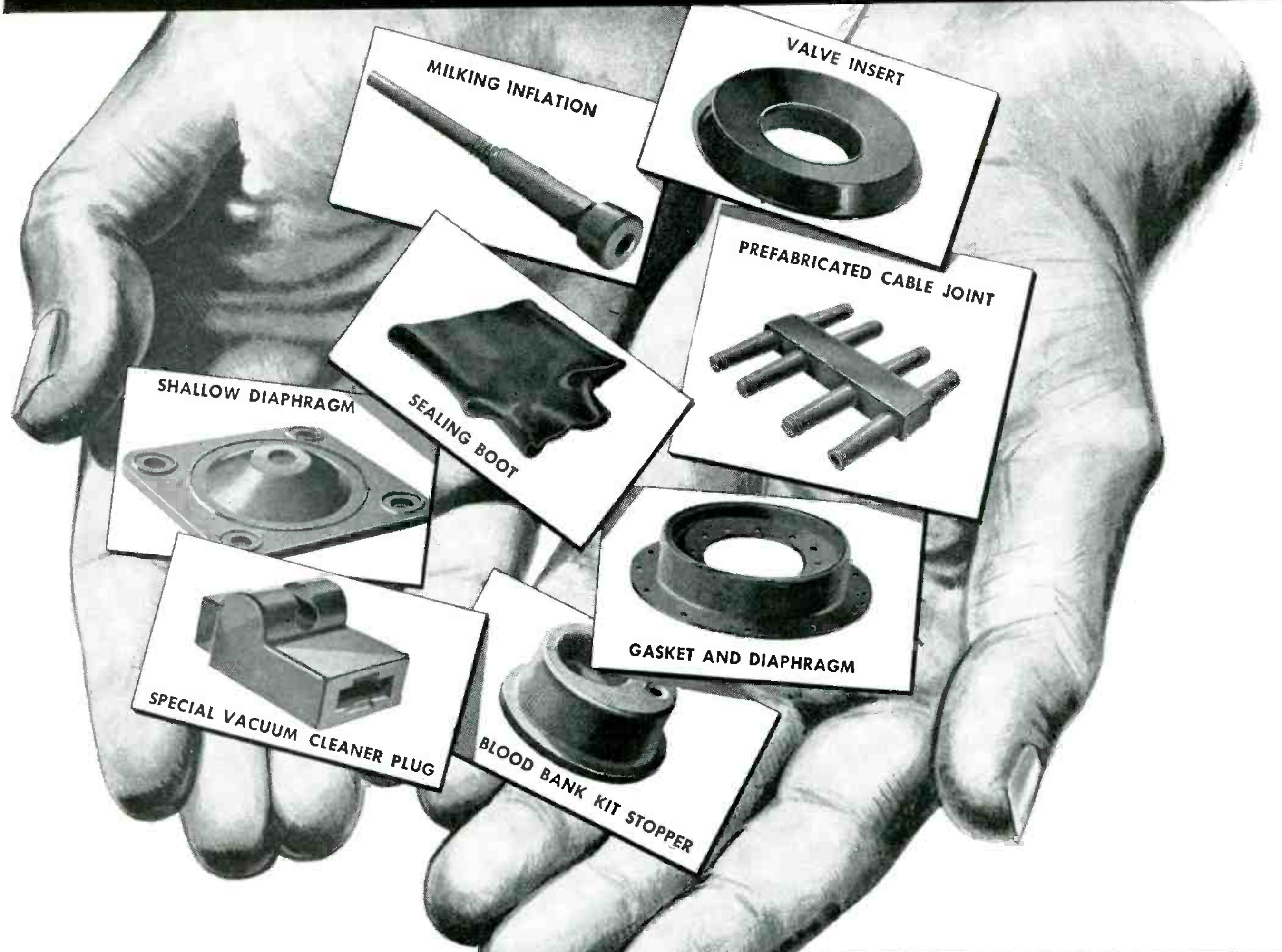

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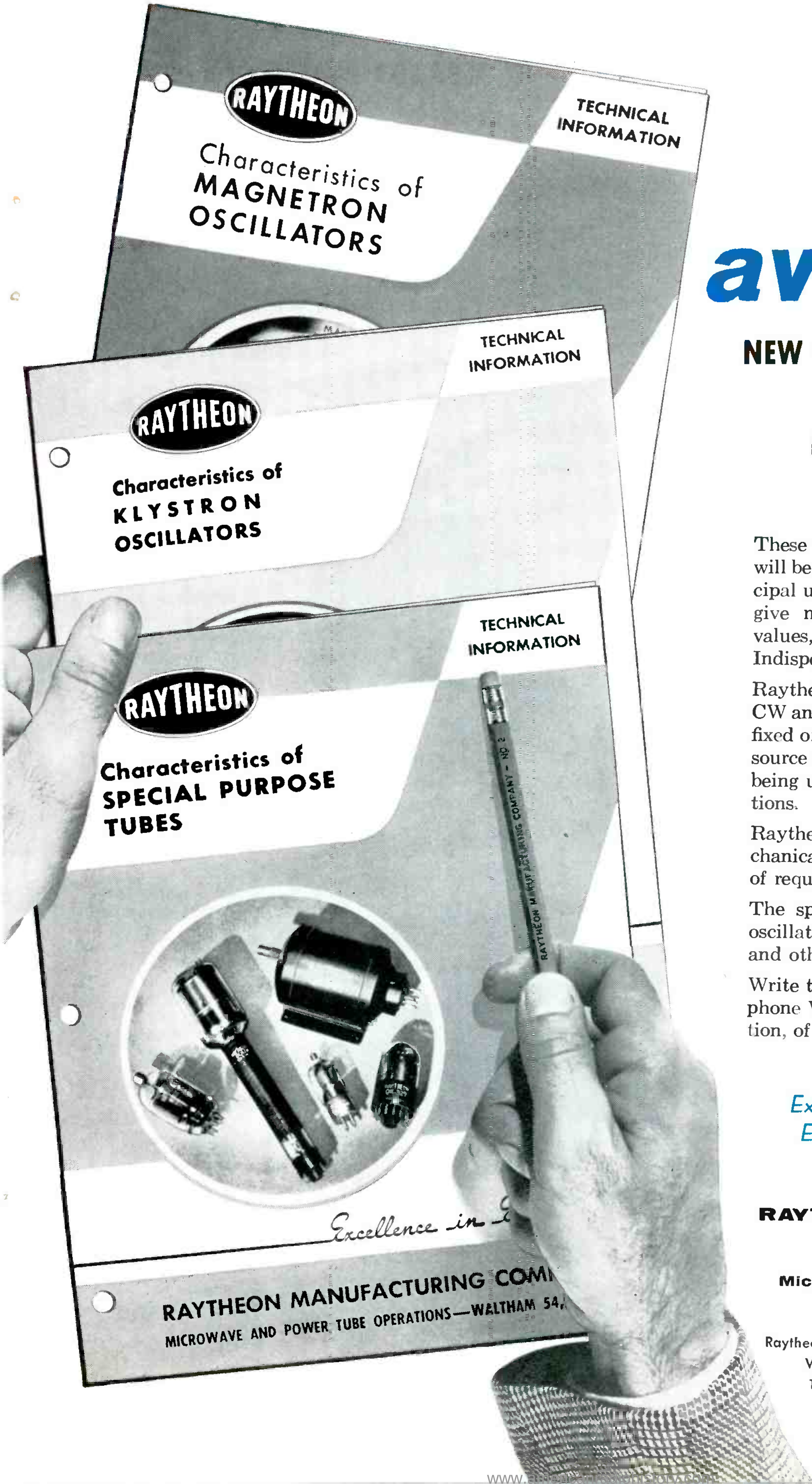

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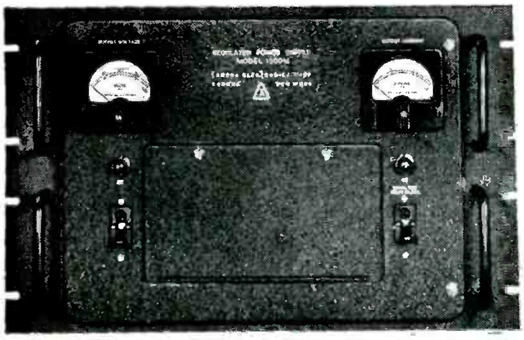

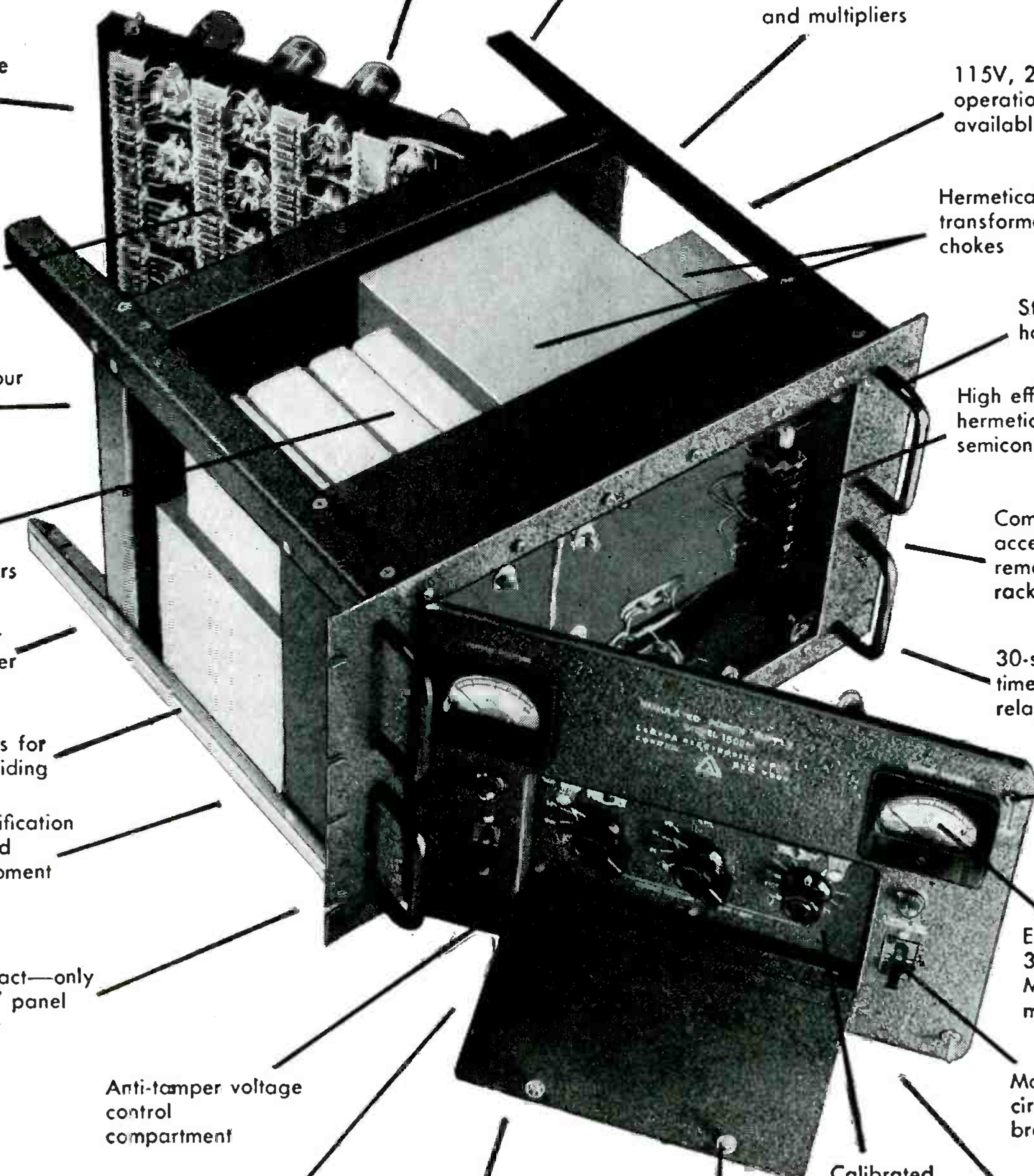

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Precision low temperature coefficient, wirewound reference networks and multipliers

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Quarter-turn fasteners for easy access

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Rated for 24-hour continuous duty

Oil-filled, hermetically sealed capacitors

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Compact—only $12\frac{1}{4}$" panel height

Anti-tamper voltage control compartment

Rated for 1.5 amperes over entire voltage range

Advanced packaging for optimum thermal and mechanical design

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Excellent regulation, low output impedance, low ripple

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POWER SUPPLY SERIES

COMPONENT POWER SUPPLY FOR ORIGINAL EQUIPMENT

CHOICE OF 28 OUTPUT VOLTAGE RANGES, THREE STANDARD A. C. VOLTAGE SOURCES

THREE SERIES: wide range (0-400 VDC); intermediate range (125 volt band); narrow range (50 volt band, centered at 25 volt intervals from 25 VDC to 375 VDC).

MODELS and PRICES*

MODEL[1]	OUTPUT VOLTAGE RANGE[2] at output currents from 0-1.5 amperes	INPUT POWER[3]	**BASE PRICE (U.S. and Canada) F.O.B. Factory Corona, N.Y.
WIDE RANGE MODELS			
WIDE RANGE MODELS: Voltage range is completely covered in 16 continuously variable bands. Each band range is 50 volts (±25 volts).			
1500	0-400 VDC	1530 W	**$695**
INTERMEDIATE RANGE MODELS			
INTERMEDIATE RANGE MODELS: Voltage range is completely covered in 4 continuously variable bands. Each band range is 50 volts (±25 volts).			
1510	0-125 VDC	980 W	**$595**
1511	25-150 VDC	1030 W	**$595**
1512	50-175 VDC	1080 W	**$615**
1513	75-200 VDC	1130 W	**$615**
1514	100-225 VDC	1180 W	**$635**
1515	125-250 VDC	1230 W	**$635**
1516	150-275 VDC	1280 W	**$655**
1517	175-300 VDC	1330 W	**$655**
1518	200-325 VDC	1380 W	**$655**
1519	225-350 VDC	1430 W	**$665**
1520	250-375 VDC	1480 W	**$665**
1521	275-400 VDC	1530 W	**$665**
NARROW RANGE MODELS			
NARROW RANGE MODELS: Voltage range is continuously variable.			
1530	0-50 VDC	830 W	**$555**
1531	25-75 VDC	880 W	**$555**
1532	50-100 VDC	930 W	**$565**
1533	75-125 VDC	980 W	**$565**
1534	100-150 VDC	1030 W	**$565**
1535	125-175 VDC	1080 W	**$585**
1536	150-200 VDC	1130 W	**$585**
1537	175-225 VDC	1180 W	**$605**
1538	200-250 VDC	1230 W	**$605**
1539	225-275 VDC	1280 W	**$625**
1540	250-300 VDC	1330 W	**$625**
1541	275-325 VDC	1380 W	**$625**
1542	300-350 VDC	1430 W	**$635**
1543	325-375 VDC	1480 W	**$635**
1544	350-400 VDC	1530 W	**$635**

[1]Model No. Suffix	Meters (3½")	Input Power Source Single Phase	Surcharge (see chart above for price**)
None	-	105-125 V, 50-60 CPS	None
M	2	105-125 V, 50-60 CPS	Add $30 to base price
S	-	190-225 V, 50-60 CPS	None
M-S	2	190-225 V, 50-60 CPS	Add $30 to base price
T	-	210-250 V, 50-60 CPS	None
M-T	2	210-250 V, 50-60 CPS	Add $30 to base price

[2]Current rating of 0-1.5 amperes applies over entire voltage range except for voltages below 100 VDC where the rating of 0.1-1.5 amperes applies.

[3]*With all outputs loaded to full ratings and input at 125 VAC, 225 VAC or 250 VAC.*

SPECIFICATIONS*

DC OUTPUT VOLTAGE: (regulated for line and load). At output currents from 0-1.5 amperes (see Note 2.) Refer to chart at left for voltage ranges of designated models.
- Regulation (line) ....0.15% or 0.3 volt (whichever is greater). For input variations from 105-125 VAC, 190-225 VAC, or 210-250 VAC.
- Regulation (load) ....0.15% or 0.3 volt (whichever is greater). For load variations from 0 to 1.5A except as modified by Note 2.
- Internal Impedance ......Less than 0.4 ohms.
- Ripple and Noise ....Less than 5 millivolts rms.
- Polarity ....Either positive or negative may be grounded.

AC OUTPUTS
- (unregulated) ....Two outputs, isolated and ungrounded. Each is 6.5 VAC at 15A (at 115 VAC, 208 VAC or 230 VAC input). Allows for drop in connecting leads. May be connected in series for 12.6V (nominal) at 15A, or in parallel for 6.3V (nominal) at 30A.

AC INPUT ....105-125 VAC, 50-60 CPS, single phase, 190-225 VAC, 50-60 CPS, single phase, or 210-250 VAC, 50-60 CPS, single phase. Refer to table at left for input power of designated models.

AMBIENT TEMPERATURE AND DUTY CYCLE ....Continuous duty at full load up to 50°C (122°F) ambient.

OVERLOAD PROTECTION:
- External Overload Protection ....AC and DC magnetic circuit breakers. Trip-Free. Instant manual reset. Front Panel.
- Internal Failure Protection ....Fuses, front panel access.

INPUT AND OUTPUT CONNECTIONS ....Heavy duty barrier terminal block, rear of chassis. 8 foot heavy duty rubber covered line cord with integral molded plug, also supplied.

METERS:
- Output Voltage ....3½" rectangular voltmeter on metered models.
- Output Current ....3½" rectangular ammeter on metered models.

CONTROLS:
- DC Output Controls ....Located in recessed compartment with access door on front panel. Calibrated in volts DC.
  Wide range units: Two band switches and continuously variable vernier-control.
  Intermediate range units: One band switch and continuously variable vernier-control.
  Narrow range units: Continuously variable vernier-control.
- AC and DC Power ....Magnetic circuit breakers, front panel.

VOLTAGE REFERENCE ....A stable 5651 reference tube is used to obtain superior long-time voltage stability.

TIME DELAY RELAY CIRCUIT ....A 30 second time delay circuit is provided to allow tube heaters to come to proper operating temperature before high voltage can be applied.

PHYSICAL DATA:
- Mounting ....Std. 19" rack mounting.
- Size ....12¼" H x 19" W x 16½" D behind front panel.
- Weight ....175 lb. net, 225 lb. ship. wt.
- Panel Finish ....Black ripple enamel (standard). Special finishes available to customer's specifications at moderate surcharge.

*Specifications and prices effective May, 1955, subject to change without notice

A 1.5 AMP POWER SUPPLY FOR EVERY PURPOSE

This new Lambda series gives you the economy of standard production models and the adaptability and precision engineering of custom units. Lambda's advanced electrical design provides rugged, stable operation.

Models in the 1.5 amp series are especially recommended as component power supplies for original equipment; in laboratories; for experimental models and prototypes; for computers; in industrial installations; for transmitters; and for use in the television and radio industries.

λ LAMBDA Electronics Corp.

THE FIRST NAME IN POWER SUPPLIES

103-02 NORTHERN BOULEVARD • CORONA 68, NEW YORK • TWining 8-9400

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"Red - we can't risk a shipping delay. Assembly needs those parts Monday to keep up production!"

"Don't worry - they're coming American. They have the largest cargo capacity of any airline in the business!"

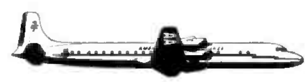
Your best assurance of rapid, reliable deliveries is American Airlines. In addition to the largest capacity, American also leads all other air cargo carriers in:

COVERAGE — with routes to more key retail markets and industrial areas, American provides the most direct one-carrier service.

SCHEDULES — with the most frequent scheduled departures, American keeps terminal time to a minimum and assures prompt forwarding.

EXPERIENCE — first with scheduled airfreight, American Airlines now has the largest, most experienced personnel force.

For complete information about the advantages of shipping American, wire collect to American Airlines, Inc., Cargo Sales Division, 100 Park Avenue, New York 17, New York.



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LOOK ..... TO **Transitron**

SILICON RECTIFIERS AND DIODES

designed for specific applications

SILICON POWER RECTIFIERS

Rated for 125°C operation, Transitron's silicon rectifiers provide high power handling ability and reliability at high temperature. They are specifically designed for magnetic amplifier and power supply applications. Send for Bulletin TE-1321.

Specifications and Ratings at 125°C

HIGH POWER TYPES			MEDIUM POWER TYPES		
TYPE	P.I.V.* (volts)	Idc** (amps)	TYPE	P.I.V.* (volts)	Idc** (amps)
1N411	50	10	1N332	400	0.4
1N412	100	7	1N334	300	0.4
1N413	200	5	1N336	200	0.4
			1N338	100	1.0

* Peak Recurrent Inverse Voltage at full load
** Maximum Average Forward Current at full load

SILICON JUNCTION DIODES

Transitron's silicon junction diodes are characterized by superior forward conductance and reliable operation up to 150°C. They are specifically designed for applications requiring extremely high inverse resistance at high temperatures. Send for Bulletin TE-1322.

TYPE	Forward Current at +1 V (ma)	Inverse Current at Specified Voltage (ua)		Maximum Working Voltage (volts)
		at 25°C	at 125°C	
1N137A	3	.03 at 20V	—	36
1N138A	5	.01 at 10V	—	18
1N137B	20	.03 at 20V	5 at 20V	36
1N138B	40	.01 at 10V	2 at 10V	18
1N350	20	.03 at 60V	5 at 60V	70
1N351	8	.03 at 100V	5 at 100V	120
1N352	5	.05 at 150V	10 at 150V	170
1N353	3	.10 at 200V	20 at 200V	225
1N354	1	.10 at 300V	20 at 300V	325

ACTUAL SIZE

SILICON BONDED DIODES

Transitron's silicon bonded diodes are specifically designed for high frequency and very fast switching applications at high temperatures. They are particularly useful in detector, discriminator and pulse circuitry. Send for Bulletin TE-1308.

TYPE	Forward Current at +1 V (ma)	Inverse Current at Specified Voltage (ua)	Inverse Breakdown Voltage
S4	1	1 at 10V	15
S5	1	.1 at 10V	20
S6	4	.5 at 5V	10
S7	2	1 at 10V	20
S8	1	1 at 10V	10

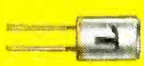
Operating frequency range 0-500 mc. Average Shunt Capacitance 0.8 uufd

ACTUAL SIZE

Transitron's special engineering group is available to assist you with specific applications. Inquiries concerning your particular design problems are invited.

Transitron electronic corporation • melrose 76, massachusetts

Glass Diodes



Silicon Diodes

Germanium Diodes

Transistors

Silicon Rectifiers

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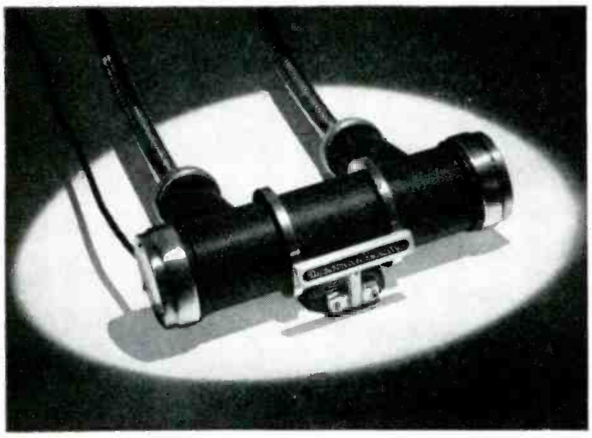
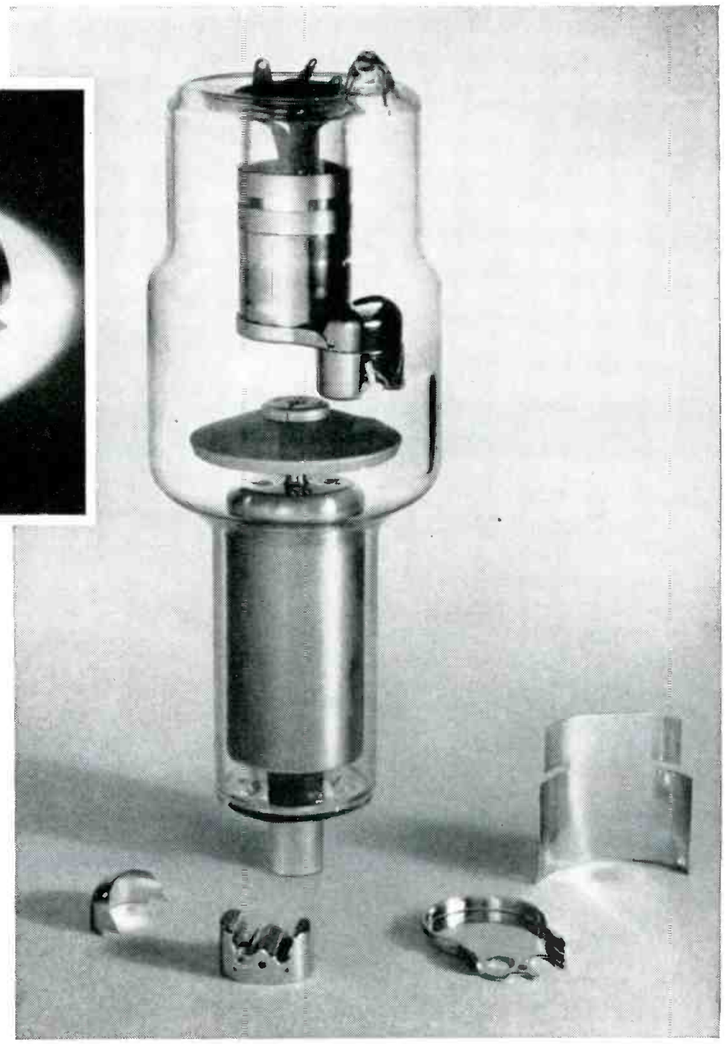


Assembled view of Machlett Dynamax 20-DF rotating anode X-ray tube and mounting.

Why Machlett chooses Nickel for nearly 400 X-ray tube parts



Dynamax 20-DF (Double Focus) — X-ray tube manufactured by Machlett Laboratories Inc. uses pure Nickel for cathode head and parts connected to it. Nickel parts are easy to fabricate, stand rugged service.

Today, free X-ray clinics sometimes take as many as 1200 exposures in a six-hour day.

Until recently, this was an impossible task. Every exposure means that millions of electrons have been focused in an ideal pattern at the nickel cathode head, then slammed against a tungsten target, spinning in a vacuum. The heat at the target is so intense that the target metal would melt or vaporize if the anode were not rotating.

The sharp focus of these tubes, says the manufacturer, depends upon accuracy of the contours and dimensions of the nickel cathode head, as well as on placement of the filament within the focussing slots.

Resistance to high temperatures, and retention of critical dimensions are important reasons why Machlett Laboratories, Springdale, Conn., specified Inco Electronic Grade "A" Nickel for this cathode head . . . and for nearly 400 other X-ray tube parts, too!

Nickel not distorted by high temperature

For Machlett's tube designers know how much Inco Nickel contributes to longer tube life. Nickel's high temperature strength and low vapor pressure are essential in maintaining a vacuum over a wide range of temperatures. Nickel's resistance to oxidation, moderate expansion, and ready fabrication aid in processing and holding the precise tolerances needed for these critical tube parts.

Nickel's very easy to work with too.

In tube production Inco Nickel is readily out-gassed at high temperatures . . . easily *formed* and *welded* into sturdy tube parts, despite intricate design.

When you need metals that perform better longer . . .

When you have a metal problem — a part that should last longer or perform better — think of Inco Nickel and Inco Nickel Alloys. And write Inco's Development & Research Division for helpful information on where *you* may improve a design or end a production difficulty by using these metals.

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N. Y.

INCO TRADE MARK **NICKEL ALLOYS**

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

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PLUG IT IN

Airpax Series 300 choppers are available in three mounting styles. The popular plug-in style, Type 300, fits a 7-pin miniature tube socket. It can be locked in place by a tube shield.

BOLT IT DOWN

For permanent mounting, Airpax supplies you with Type 303. The Series 300 chopper withstands shock and vibration, commending it to such rigid mounting.

OR STRAP IT ON

Or, for mounting parallel to a chassis, Type 302 is available. These choppers, rated for 2,000 hours life, can be soldered advantageously into many equipments.

THIS RUGGED LONG-LIFE CHOPPER CAN TAKE IT!

Airpax Series 300 choppers operate at 400 CPS. The SPDT contacts are rated for 2 MA at 100 V MAX.

For complete specifications write to

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

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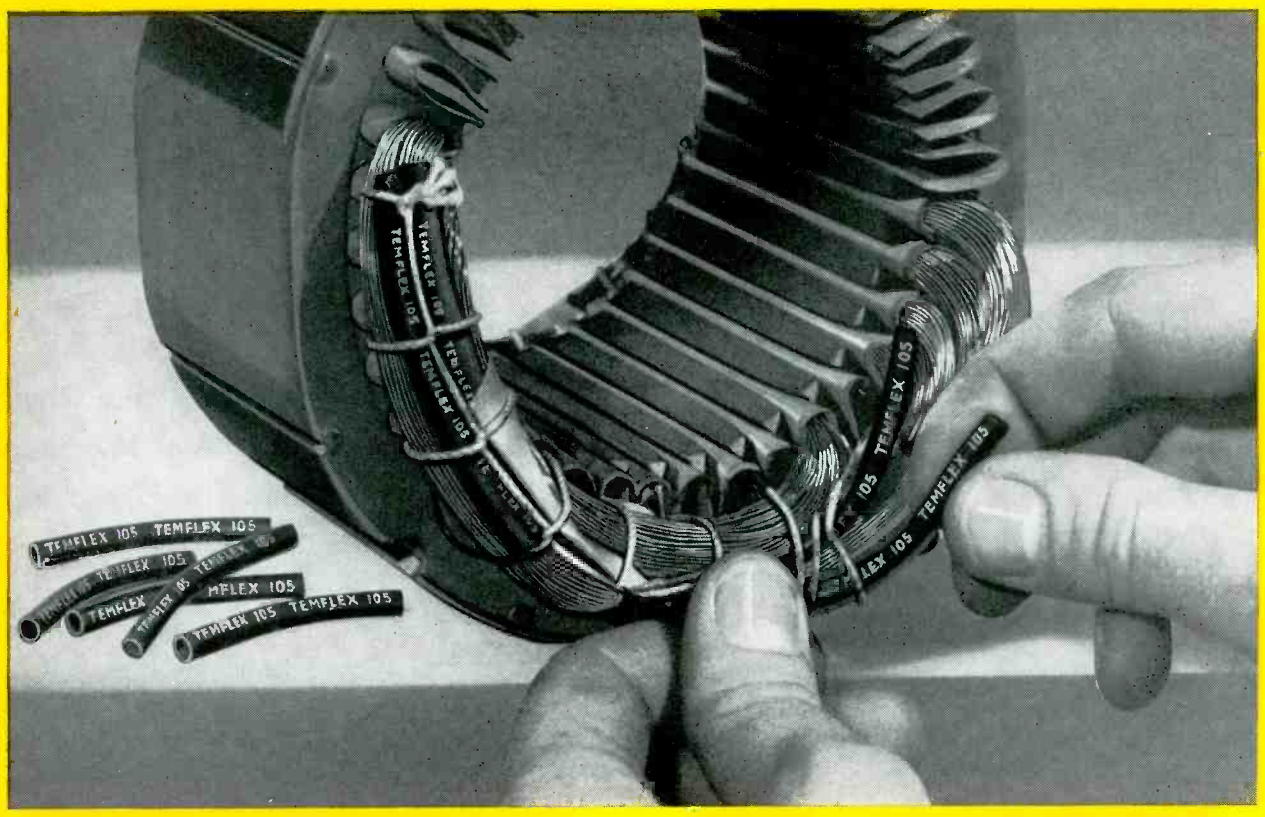
New! Greater Penetration Resistance



Improved Temflex* 105 Plastic Tubing Provides Greater Resistance to "Cut Through"

Looking for a really tough, wear resistant plastic tubing? Then you'll like our new formulation for Temflex 105. Improved heat deformation characteristics and resistance to "cut through" provide substantially higher physical strength . . . an average of 20% over older type plastic tubings as demonstrated in standard penetration tests. In addition, low percentages of shrinkage provide you with lower manufacturing costs. Color stability is better too, even under sustained high temperatures. Yet there is no sacrifice of the remarkable heat aging and electrical properties that make Temflex 105 so popular. Retains flexibility and high dielectric strength after varnishing, baking, exposure to chemicals and prolonged high temperature duty . . . resists mineral and coal tar solvents. And it is UL approved for continuous operation at 105° C. Electrical, electronic and automotive equipment makers cut assembly costs and eliminate soldering by using Temflex 105 to insulate transformer leads, relay leads and other connections. Fits all standard wire sizes. Send for literature and test samples.

1905 1955 GOLDEN ANNIVERSARY IRVINGTON

PLASTICS PRODUCTS

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

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MINNESOTA MINING & MANUFACTURING COMPANY
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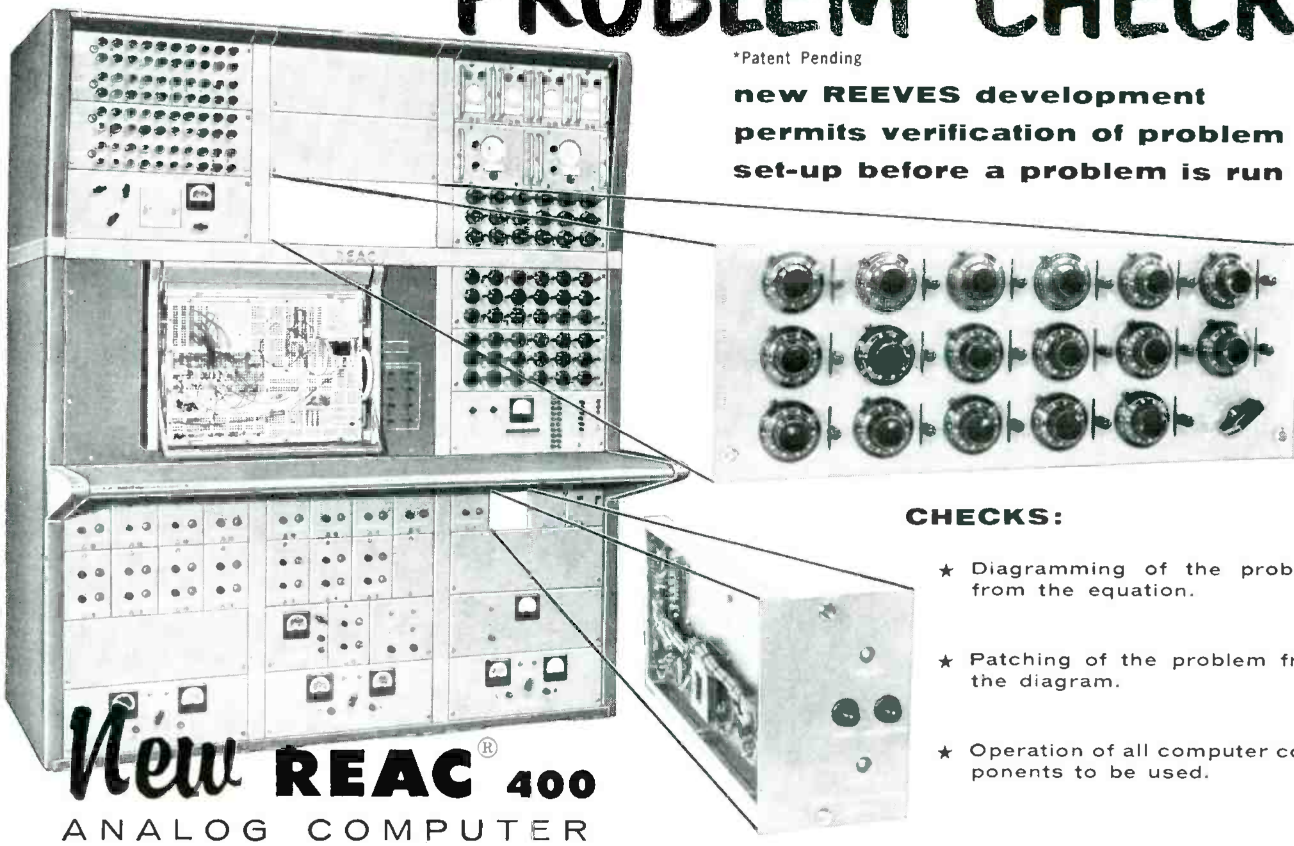
PROBLEM CHECK*

*Patent Pending

new REEVES development permits verification of problem set-up before a problem is run



New REAC® 400
ANALOG COMPUTER

CHECKS:

- ★ Diagramming of the problem from the equation.
- ★ Patching of the problem from the diagram.
- ★ Operation of all computer components to be used.

"Problem Check" is a new method developed by Reeves to verify analog computer circuits **without disturbing the problem set-up.** Checking is done directly from the equation **before** the problem is run, and the operation of every computing element is checked. Further, if the output of any computing element is not correct, the location of the difficulty is indicated, and the trouble can be quickly and easily found. After "Problem Check," runs may be taken on the machine with assurance that the set-up is correct and that the machine is functioning properly.

It's the only economical way...

Prepatch boards are, of course, prepared away from the machine. "Problem Check" means that only an absolute minimum of time is required on the machine to check the problem set-up in its entirety. A great deal of expensive checking and cross-checking while the problem is on the machine is thereby eliminated.

REVIEW THESE OUTSTANDING REAC® 400 FEATURES

***New* HIGH SPEED SERVOS**
Servo multipliers have bandwidth over 50 cps. Velocity 1500 v/sec. Six gang pots; two tapped with front panel plug-in turrets for function generation.

***New* HIGH SPEED RESOLVERS**
Vastly improved dynamic performance . . . 35-cycle bandwidth. Rectangular and Polar operation; Full AGC either mode requires no trimming. Front panel plug-in turrets for function generation.

***New* BUILDING-BLOCK CONSTRUCTION**
Permits assembly of computer elements in any desired combination to do particular job or expand existing installation. Completely adaptable to your specific requirements.

***New* CONVENIENT PATCHBAY**
Available in units of 1632, 3264 or 4896 holes for maximum flexibility. Color-coded mask aids in patching. Patchboard changes possible during operation.

***New* POWERFUL AMPLIFIERS**
New dual amplifier chassis, individually chopper-stabilized. Noise less than 3 mv rms in cabinet. Phase shift 0.075° @ 100 cps. Bandwidth over 10 KC in cabinet.

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REEVES INSTRUMENT CORPORATION
A Subsidiary of Dynamics Corporation of America
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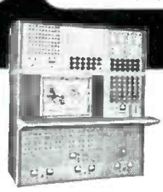
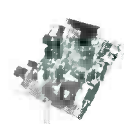


REAC Analog Computers

Precision Floated GYROS

Precision RESOLVERS and PHASE SHIFTERS



SERVO MECHANICAL PARTS

3RV55

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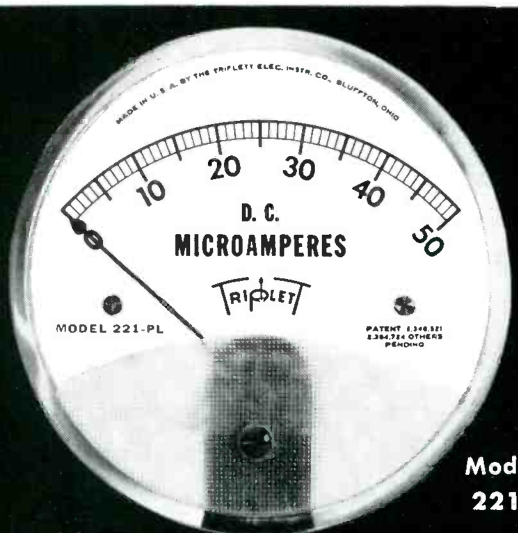
TRIPLETT IS WAY AHEAD IN

PANEL METERS featuring

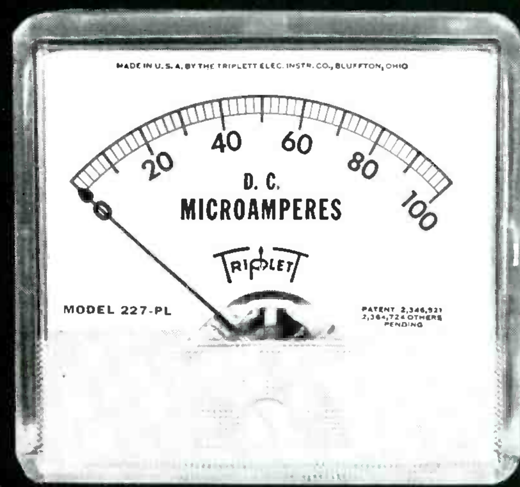
Clear Front Plastic PL Styles with:

1. Much longer scale
2. More light on scale
3. Clear, unbreakable front
4. Regular panel space and mounting
5. Improved panel appearance

Triplett PL meters are now available in 5 styles . . . 2″ and 3″ round, plus 2″, 3″ and 4″ square. Transparent plastic case front projects over the rim of the instrument, offering longer scale length and easier readability. PL meters are available in D.C. Permanent Magnet Moving Coil and A.C. Iron Vane types.



Model 221-PL



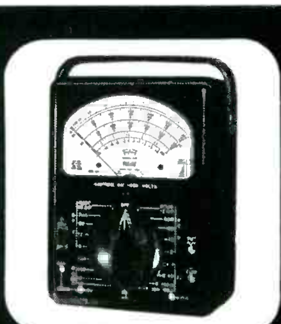
Model 227-PL

TESTING EQUIPMENT

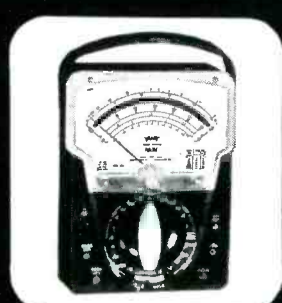
When selecting your next piece of test equipment, look over Triplett's *complete* V-O-M line . . . it will prove Triplett's ability to keep pace with your requirements. Below are examples of the complete V-O-M line. Look to Triplett for leadership.

TRIPLETT

TRIPLETT ELECTRICAL INSTRUMENT CO.
Bluffton, Ohio



MODEL 630. Famous Volt-Ohm-Milliammeter. Many features making this the favorite in a popular V-O-M line.

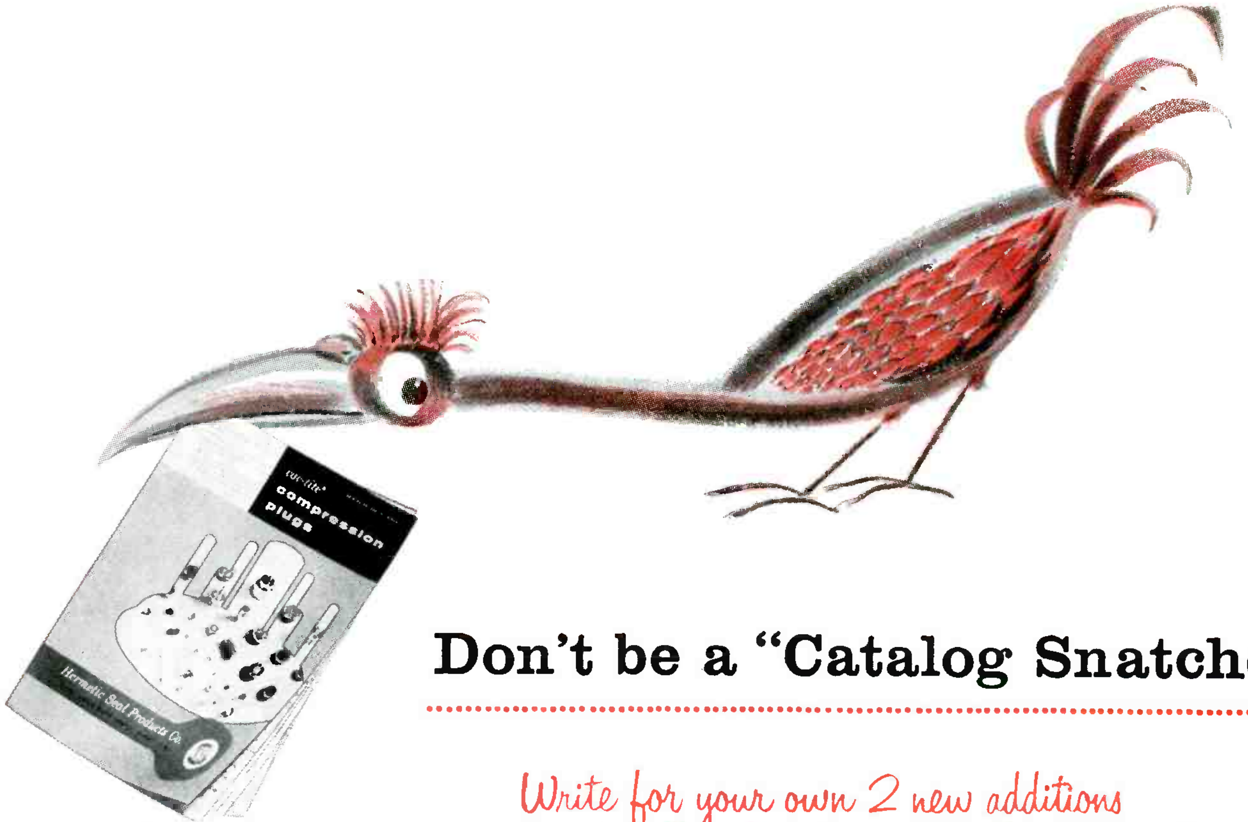


MODEL 630NA. The first V-O-M with all-in-one features. Does everything anybody ever wants. 70 ranges, plus other unique features.

MODEL 631. Combination V-O-M and VTVM. 2-in-1 battery operated combination saves money—will do all your work easier at half the price.

BURTON BROWNE ADVERTISING

TRIPLETT HAS SET THE STANDARD IN INSTRUMENTS FOR OVER HALF A CENTURY



Don't be a "Catalog Snatcher"!

Write for your own 2 new additions to Encyclopedia Hermetica—they're Free!

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On Vac-Tite* Compression Plugs (No. 300)
And Single Terminal Feed-Thru's And Stand-Offs (No. 400)

Hermetic's two new catalogs are so handy as desk-top references that they'll drive any engineer who hasn't requested or received his copies to "Catalog Snatching"!

These two latest additions to Encyclopedia Hermetica, a continuing catalog series that has become industry's most helpful source of design and purchasing data, provide every significant innovation in hermetically sealed plugs, feed-thru's and stand-offs.

You'll find these two new catalogs indispensable and so easy to use that you'll be able to locate and identify the preferred type needed by its Hermetic part number in second's time. You'd better guard them well against the "Catalog Snatcher" because they contain the most complete line of plugs, stand-offs and feed-thru's ever offered!

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

Write **for your copies today! Also, request Vac-Tite* Compression Multi-Headers Catalog No. 200, MS Series.**

Hermetic Seal Products Company

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As promised last November, our size 8 and 22 standard synchros are now in production and available for 3 weeks or less delivery.
In addition, we have added the BuOrd type size 15 transmitter to the line.
Size 15
1.437'' diameter
ACTUAL SIZE
Size 11
1.062'' diameter
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Size 10
.937'' diameter
ACTUAL SIZE
BuOrd Size 15
1.437'' diameter
ACTUAL SIZE
BONUS
Size 22
2.161'' diameter
ACTUAL SIZE
Next
HERE!
Next
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Size 8
.750'' diameter
ACTUAL SIZE
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CLIFTON PRECISION PRODUCTS CO., INC.
CLIFTON HEIGHTS
PENNSYLVANIA

NOW

IRC resistance strips and discs

IRC Resistance Strips and Concentric Disc Resistors offer unusual adaptability to special requirements. They consist of a high grade paper-base phenolic sheet to which IRC resistance material is permanently bonded.

Resistance strips can be used as supplied by IRC, with either side or end termination, or they can be further processed by the user to form particular shapes for individual requirements. Use coupon for detailed data on specifications and characteristics.

TYPICAL APPLICATIONS

IRC RESISTANCE STRIPS

IRC RESISTANCE STRIPS ARE USED EXTENSIVELY IN:

- Strain Gauges
- Servo-Mechanisms
- UHF Attenuators
- Telemetering Equipment
- In conjunction with Wave Guides

IRC CONCENTRIC DISC RESISTORS

THESE ARE PUNCHED FROM RESISTANCE STRIPS AND PREPARED BY IRC FOR USE IN APPLICATIONS SUCH AS:

- Terminating Resistors for line matching stubs.
- Concentric Line Terminations of low power requirements.
- Matching Resistors in measuring equipment—high frequency vacuum tube voltmeters, signal generators, etc.

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

Wherever the Circuit Says

IRC

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

INTERNATIONAL RESISTANCE CO.

Dept. 232, 401 N. Broad St., Philadelphia 8, Pa.

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

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Company____________________

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Operate at temperatures to 125°C without voltage derating

Withstand dielectric test of twice rated voltage

Insulation resistance higher than any other *metallized paper capacitor*

Self healing dielectric

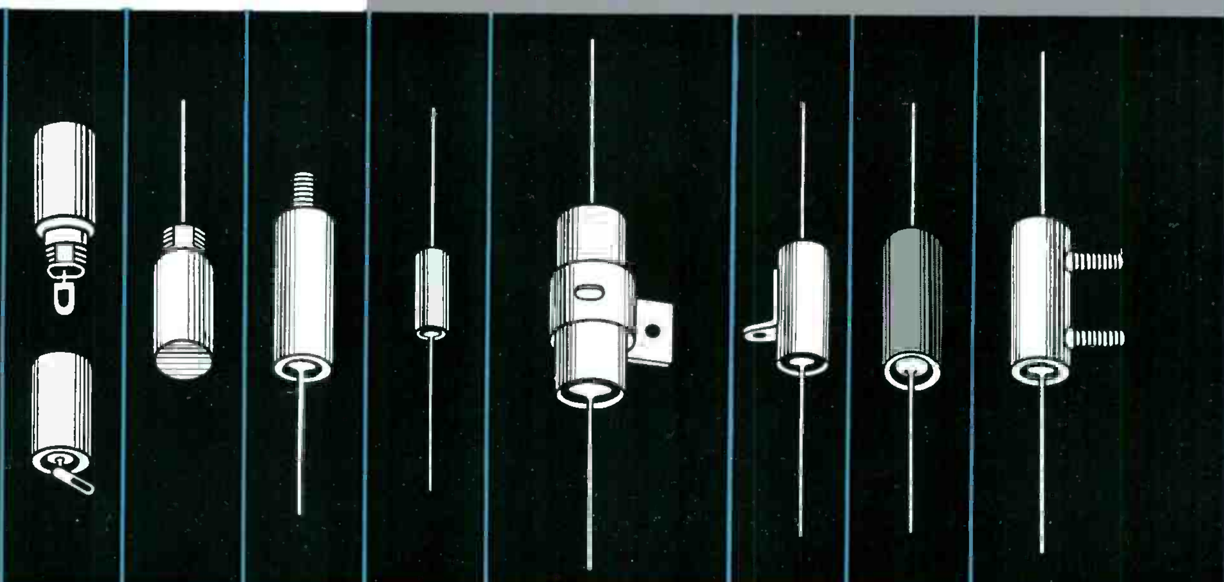
Here are the finest capacitors which the present state of the art can produce.

In the application of stringent quality controls, Sprague has gone so far as to metallize its own paper . . . the only commercial manufacturer to do this. Thus Sprague is the only capacitor manufacturer with *complete* control over the end product. And in no other type of capacitor does quality in manufacture play so important a part in performance.

subminiature, metal-clad

SPRAGUE metallized paper capacitors

A complete range of ratings and sizes, hermetically sealed with glass-to-metal solder-seals in corrosion-resistant cases, is available in numerous mounting and terminal styles. Write for Engineering Bulletin 224 on your letterhead.



SPRAGUE® *world's largest capacitor manufacturer*

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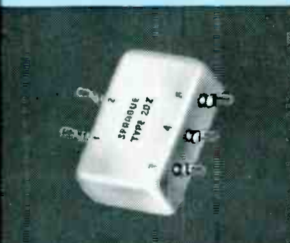
choose from this complete line of

MINIATURE PULSE TRANSFORMERS

Type 10Z
tubular pulse transformer

Type 15Z
miniature bathtub pulse transformer



Type 20Z
drawn-shell bathtub pulse transformer

Type 41Z
plug-in pulse transformer

NOW YOU CAN CHOOSE from eighteen standard pulse transformers in four major construction styles, all in quantity production at Sprague. The standard transformers covered in the table below offer a complete range of characteristics for computer circuits, blocking oscillator circuits, memory array driving circuits, etc.

These hermetically sealed units will meet such stringent military specifications as MIL-T-27, and operate at temperatures up to 85°C. Special designs are available for high acceleration and high ambient temperature operation. In addition, the electrical counterparts of each transformer can be obtained in lower cost housings designed for typical commercial environment requirements.

Complete information on this high-reliability pulse transformer line is provided in Engineering Bulletin 502A, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

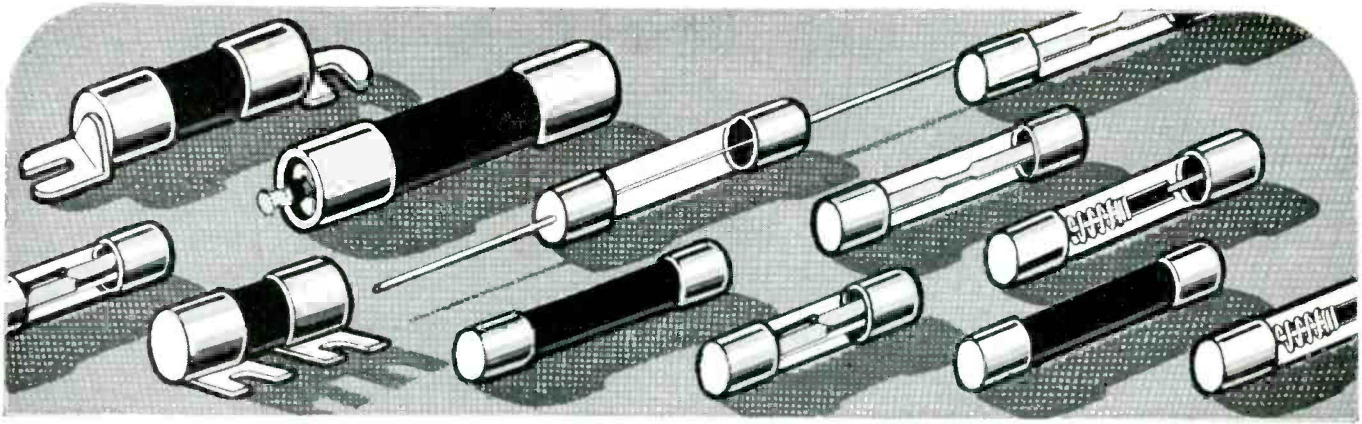
ELECTRICAL CHARACTERISTICS OF SPRAGUE PULSE TRANSFORMERS

Type No.	Turns Ratio	Pulse Width μ seconds	Rise Time μ seconds	Primary Inductance	Leakage Inductance	Repetition Rate	Load and Output	Typical Applications
10Z1	5:1	0.1	0.04	200 μH	5 μH	1 to 2 MC	15 volts 100 ohms	Used in digital computer circuitry for impedance matching and inter-stage coupling. Pulses are of sine wave type.
10Z2	4:1	0.07	0.03	200 μH	20 μH	1 to 2 MC	20 volts 100 ohms	
10Z3	1:1	0.07	0.03	125 μH	12 μH	1 to 2 MC	20 volts 200 ohms	
10Z4	3:1	0.07	0.03	160 μH	15 μH	1 to 2 MC	20 volts 100 ohms	
10Z6	4:1	0.1	0.04	200 μH	6 μH	1 to 2 MC	17 volts 100 ohms	
10Z12	1:1	0.25	0.02	200 μH	2 μH	12KC	100 volts	Blocking Oscillator
10Z13	1:1	0.33	0.07	240 μH	2 μH	2KC	50 volts	Blocking Oscillator
10Z14	7:1:1	0.50	0.05	1.2 mH	20 μH	1MC	25 volts	Impedance Matching
15Z1	3:1	5.0	0.04	7.5 mH	22 μH	10 KC	10 volts 100 ohms	Impedance Matching and Pulse Inversion
15Z2	2:1	0.5	0.07	6 mH	15 μH		40 volts	Blocking Oscillator
15Z3	5:1	10.0	0.04	12 mH	70 μH	10 KC	10 volts	Impedance Matching
15Z4	1:1.4	6.0	0.1	16 mH	15 μH	0.4 KC	15 volts	Blocking Oscillator
20Z1	5:5:1 Push-Pull	1.5	0.25	4.0 mH	0.3 MH		5 volts 10 ohms	Memory Core Current Driver
20Z3	6:1	1 to 4	0.22	18 mH	0.8 MH	250 KC (max.)	21 volts 200 ohms	Current Driver
20Z4	6:1:1	1 to 7	0.25	55 mH	0.3 MH	50 KC (max.)	22 volts 400 ohms	Current Driver and Pulse Inversion
20Z5	3.3:3.3:1 Push-Pull	2.4	0.2	2.8 mH	0.2 MH		2.5 volts 6 ohms	Memory Core Current Driver
20Z6	11:1	6.0	0.2	90 mH	0.2 MH	50 KC (max.)	10 volts 75 ohms	Current Transformer
41Z1	7:1:1	0.50	0.05	1.2 mH	20 μH	1 MC	25 volts	Impedance Matching

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

SPRAGUE® WORLD'S LARGEST CAPACITOR MANUFACTURER

Export for the Americas: Sprague Electric International Ltd., North Adams, Mass. CABLE: SPREXINT



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YOU CAN TURN TO BUSS FOR THE RIGHT FUSE!"

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The BUSS engineers are at your service and can save you engineering time by helping you choose the right fuse for the job. Whenever possible, the fuse selected will be available in local wholesalers' stocks, so that your device can be easily serviced.

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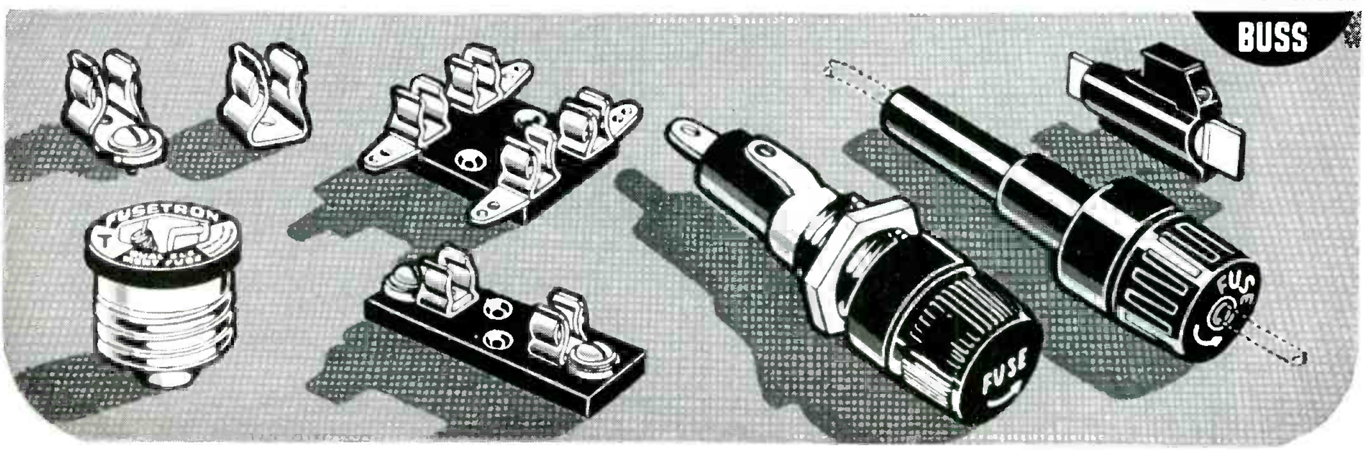
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

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



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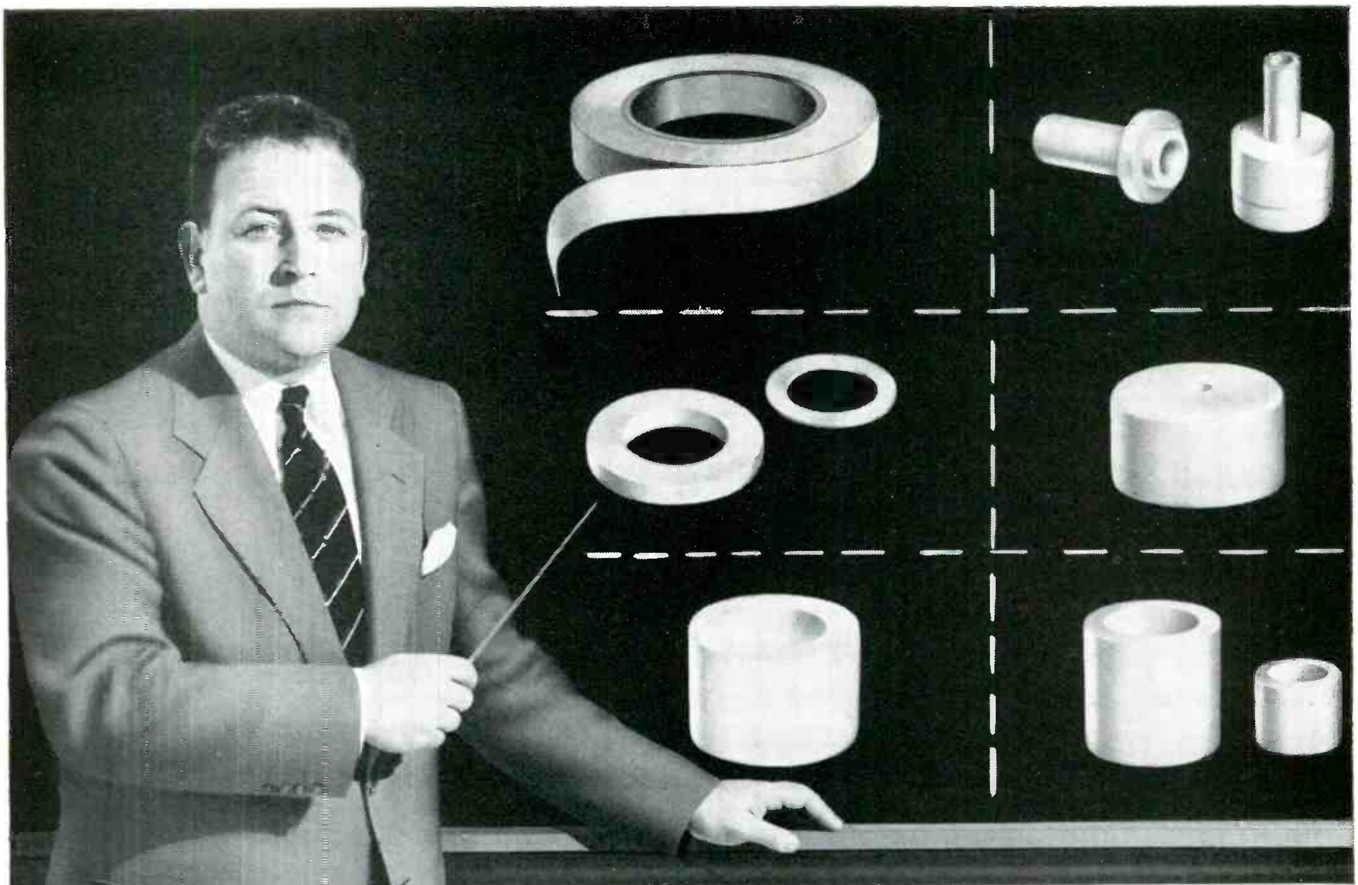

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BEFORE YOU SAY "IMPOSSIBLE!"

R/M "TEFLON" is blazing many trails that few people thought would ever open up. Daily it is instrumental in improving old products and processes, in developing new ones, and in effecting unheard-of economies. In the form of tape and other component parts, R/M "TEFLON" has already licked many electrical and electronics problems once thought unsolvable. So turn to R/M if you have a problem that "TEFLON" might possibly solve. We can fabricate to your specifications or supply you with "TEFLON" in the form of rods, sheets, tubes or tape. For complete information, write today.

PROPERTIES OF "TEFLON"

High dielectric strength • Moisture absorption zero • Unaffected by weather • Excellent heat stability up to 500°F. in continuous operation • As tape, leaves no carbon residue along discharge path • High impact resistance • Nonadhesive • Stretches easily • Tensile strength 1500-2500 psi

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

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ALLIED'S NEW

This new polarized relay, designed and manufactured by Siemens & Halske Company of Germany, is now available from Allied Control, and in the near future will be produced by Allied with the technical assistance of Siemens & Halske.

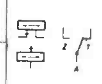
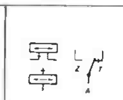
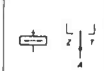
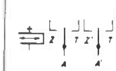
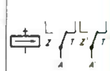
Types Trls 63 to 69 are recommended for use in industrial applications where the special features of a polarized relay are required, or where its inherent high sensitivity, long life and precision operation are desired. They are available with transparent or metal dust covers and are produced with solder terminals or 16 point plug-in bases (sockets are available from Allied Control). Bulletin TR gives complete details.

For military applications, these relays will be available hermetically sealed with either solder terminals or 16 point plug-in base.

Sensitive
Versatile
Stable

POLARIZED RELAY

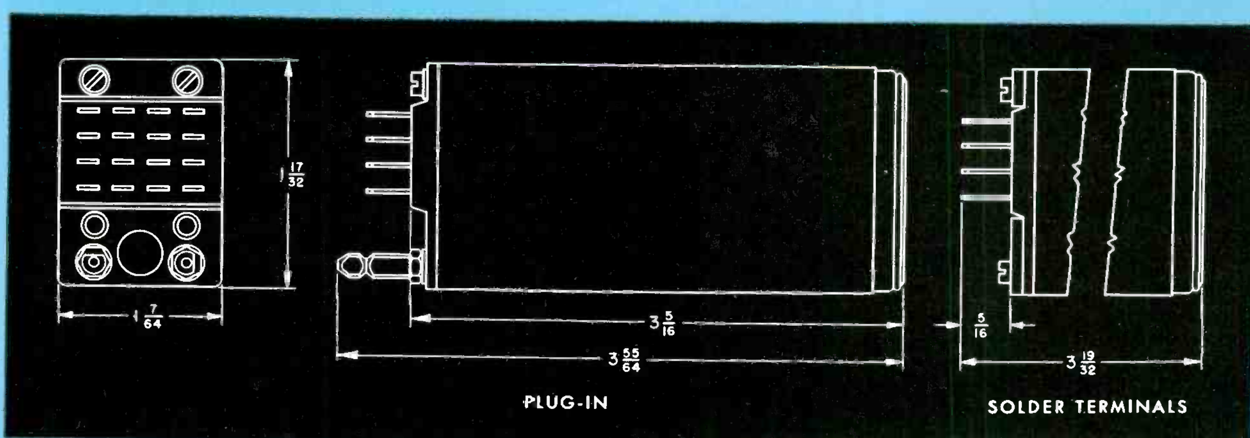
Specifications For Allied's Types Trls 63-69

Type Number		Trls 63	Trls 64	Trls 65	Trls 66	Trls 67	Trls 68	Trls 69
Description	Positions	2		3	2	2	3	2
	Operation	Magnetic Latch		Null-Center	Magnetic Latch	Spring Biased	Null-Center	Spring Biased
		High Contact Pressure	High Sensitivity					
Contact Arrangement		SPDT		SPDT	DPDT	SPDT	DPDT	DPDT
Circuit Symbols	for telegraphy / other purposes							
"Operate" Excitation	Amp. Turns	7	2	2.2	5.5	5	4	15
"Operate" Power	μ Watts	500	40	50	300	250	160	2250
Working Excitation	Amp. Turns	15	4	6	10	10	10	25
Working Power	μ Watts	2250	160	360	1000	1000	1000	6250
"Release" Excitation	Amp. Turns			2.2		2.4	4	5
Max. Rate of Operation	Oper./Sec.	200	200	200	200	100	200	100

Contacts:	Silver, General Purpose 2 amp., 28v d-c resistive load
	Platinum Alloy A. Low-Level Applications up to 1 amp.
	Platinum Alloy B. Heavy Duty Applications above 1 amp.
	Max. Continuous Current 5 amps.

Dielectric Test Voltage	Coil to Frame	500v rms.
	Contact to Contact	350v rms.
	Contact to Frame	500v rms.
	Coil to Coil	150-500v rms.
Standard Coils	Resistances from 1.1 to 18,000 ohms	
	Max. number of windings	8
	Max. Continuous Loading	1 watt
Temperature	Max. Ambient	85°C

DIMENSIONS



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PORTABLE RECEIVER TESTER

DIMENSIONS:
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WEIGHT:
17 lbs.

TYPE
TF888/3

70-kcs to 70-mcs
Signal Generator;
1000-cps Source;
1-mw to 1-watt A.F. Power Meter

The Marconi Receiver Tester Type TF 888/3 combines a crystal-standardized cw/am signal generator, a tone source of variable level, and a 3-range audio power meter. Ideal for servicing, the instrument can be fitted with either an a.c. power pack or a dry-battery unit.

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Now! 37 STACKPOLE MOLDED COIL FORM TYPES

. . . with the easiest-to-solder leads on the market
(*even for printed wiring techniques*)

. . . stocked for prompt delivery

. . . at rock-bottom cost

PHENOLIC TYPES . . .
Molded of dense, low-loss Bakelite. Stocked for immediate delivery in over 15 standard sizes with securely-anchored axial or hairpin leads.

IRON TYPES . . .
Molded of high-resistance powdered iron in standard grades G1F and Z25. Ready for immediate delivery in 20 standard sizes. Other types on special order.

PHENOLIC-with-IRON INSERT TYPES . . .
Combines the high-Q of iron types with the high resistance of phenolic. Stocked with 2, 3, and 4 hairpin leads in grades G1F and Z25.

37 standardized Stackpole Molded Coil Form types cover practically the entire range of today's requirements for r-f coils, chokes, and other low-loss inductors. They pave the way to real economies in smaller assemblies, point-to-point wiring and an absolute minimum of soldered connections. And, speaking of soldering, Stackpole forms solder firmly and surely at the touch of an iron . . . because all leads are hot tin-dipped right up to the body of the form.

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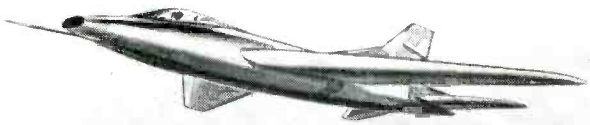

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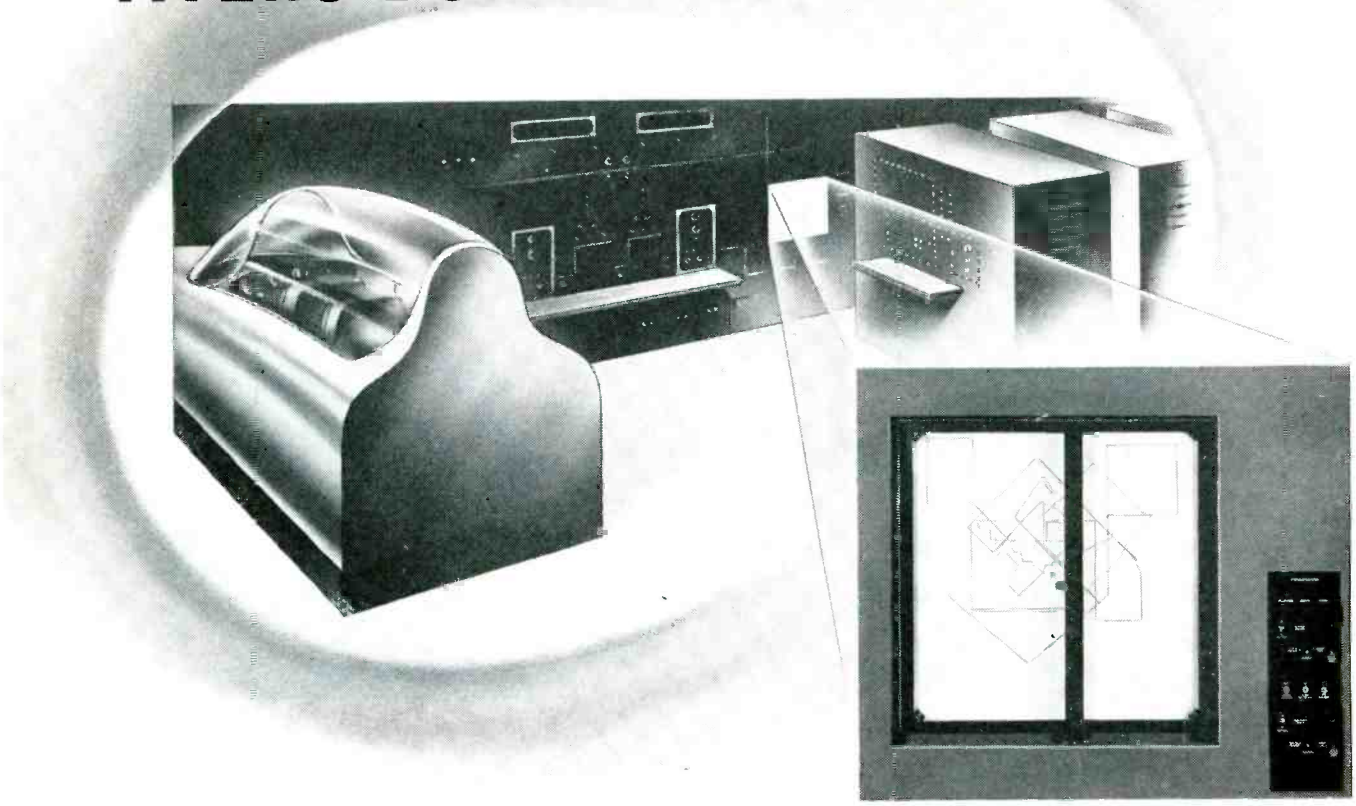


Scoreboard For Tomorrow's Pilots

THE plotting board designed by Melpar Inc.—scoreboard of the new U.S. Air Force supersonic simulator for F-100A planes—is another example of Atlas manufacturing ingenuity at work.

Atlas specializes in "precisioneering" electro-mechanical assemblies from the pilot stage to production efficiency. Furnishes the practical engineering step and the facilities between the idea and the production line.

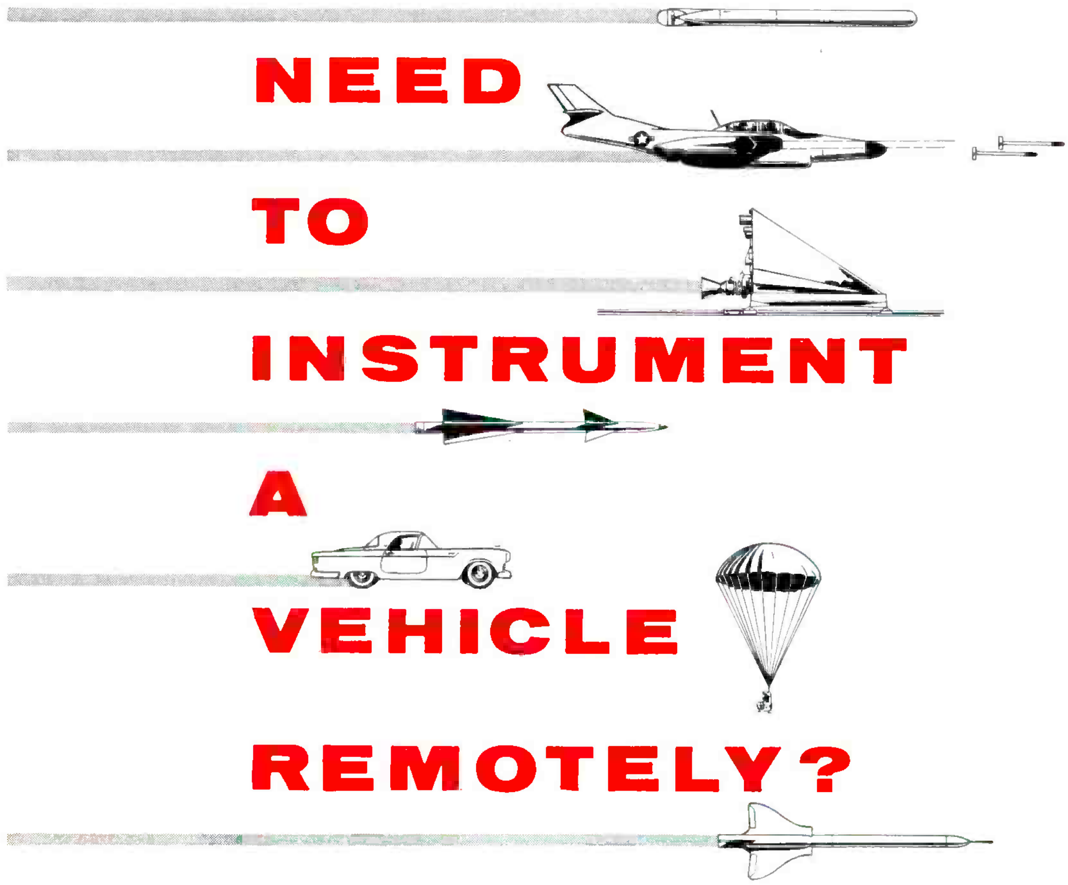
Bring your electro-mechanical designs to us. Our design, production and methods engineers, tool makers and skilled mechanics are ready to work on your project on a job basis . . . as many men, machines and hours of work it requires and no more. Every modern tool and cost cutting technique is at your service to save you time and labor on a complete electro-mechanical assembly or a special part for electronic equipment. Write today for your copy of "Precisioneering Electro-Mechanical Equipment." ATLAS PRECISION PRODUCTS CO., Philadelphia 24, Pa. (Div. Prudential Industries).

"From Drawing Board . . . to Production Line"



SERVICE ATLAS DEPENDABILITY QUALITY

ATLAS
Precision Products



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Wherever time, space or weight is a vital factor in successful instrumentation, Bendix-Pacific Telemetering Systems can solve your problem.

These miniature systems, installed in any type of vehicle, will accurately and reliably measure and transmit to a conveniently located receiving station any desired information. Strain, temperature, vibration, position, motion and acceleration are among the characteristics that can be measured.

Bendix-Pacific Telemetered Instrumentation provides you with six distinct advantages over conventional methods.

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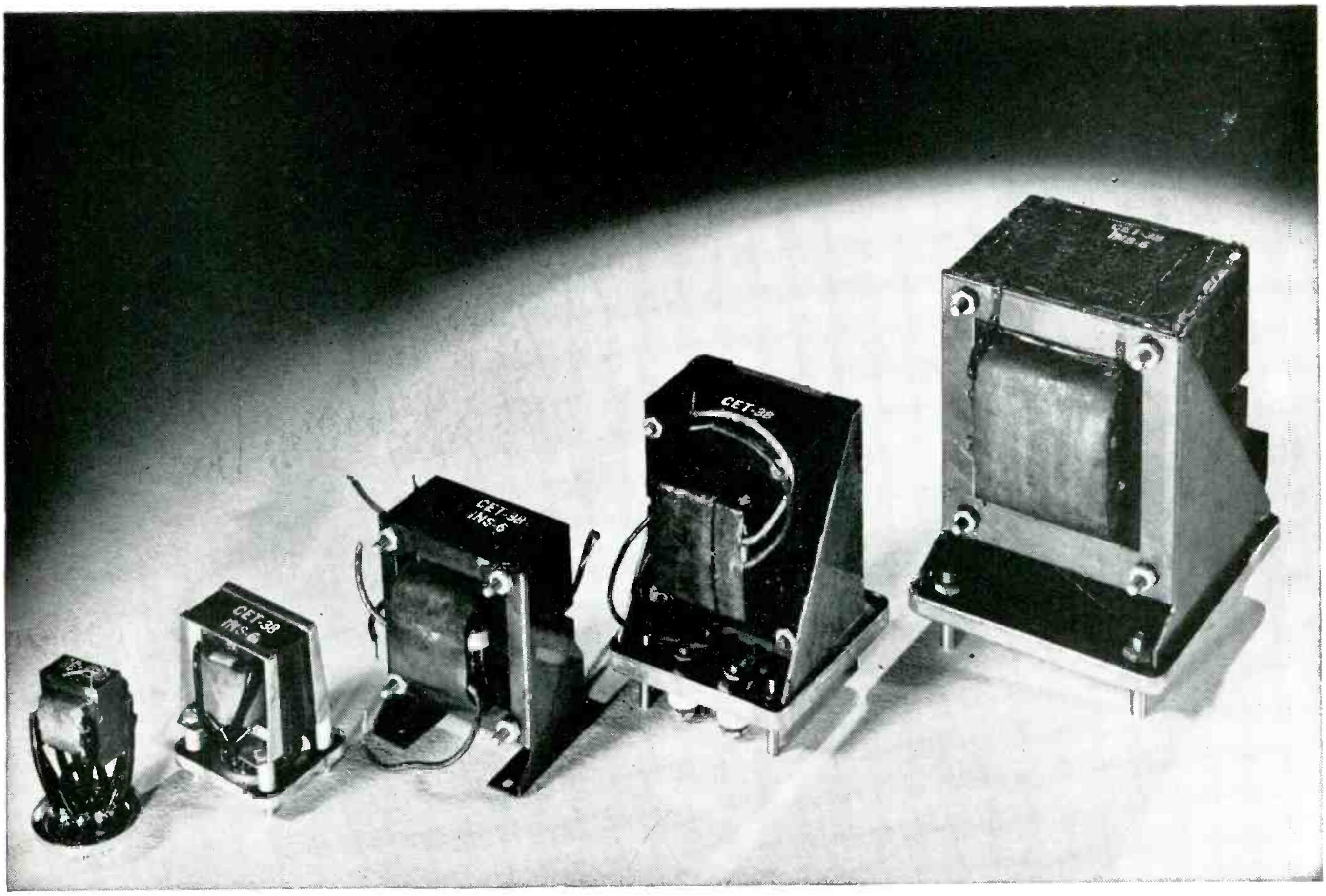

A Transformer becomes a precision device with Allegheny Magnetic Materials in the core

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84 pages of valuable technical data on standard and custom-made laminations from all grades of Allegheny Ludlum magnetic core materials. Prepared from carefully checked and certified laboratory and service tests —includes standard dimensions, specifications, weights, etc. Sent free on request . . . ask for your copy.

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The operation of a transformer is no better than the magnetic core around which it is built. With Allegheny magnetic materials in the core, you get the *best*—uniformly and consistently.

Sure there are reasons why! For one thing, there's the long experience of a pioneer in development and quality control of electrical alloys. But most important, the A-L line offers complete coverage of any requirement you may have, any service specification. It includes all grades of silicon steel sheets or coil strip, as well as Allegheny Silectron (grain-oriented silicon steel), and a wide selection of special high-permeability alloys such as Allegheny 4750, Mumetal, etc.

In addition, our service on magnetic materials includes complete lamination fabrication and heat treatment facilities. What's more, this extensive experience in our own lamination stamping department is a bonus value for all users of A-L electrical sheets or strip. ● Let us supply *your* needs. *Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pa.*

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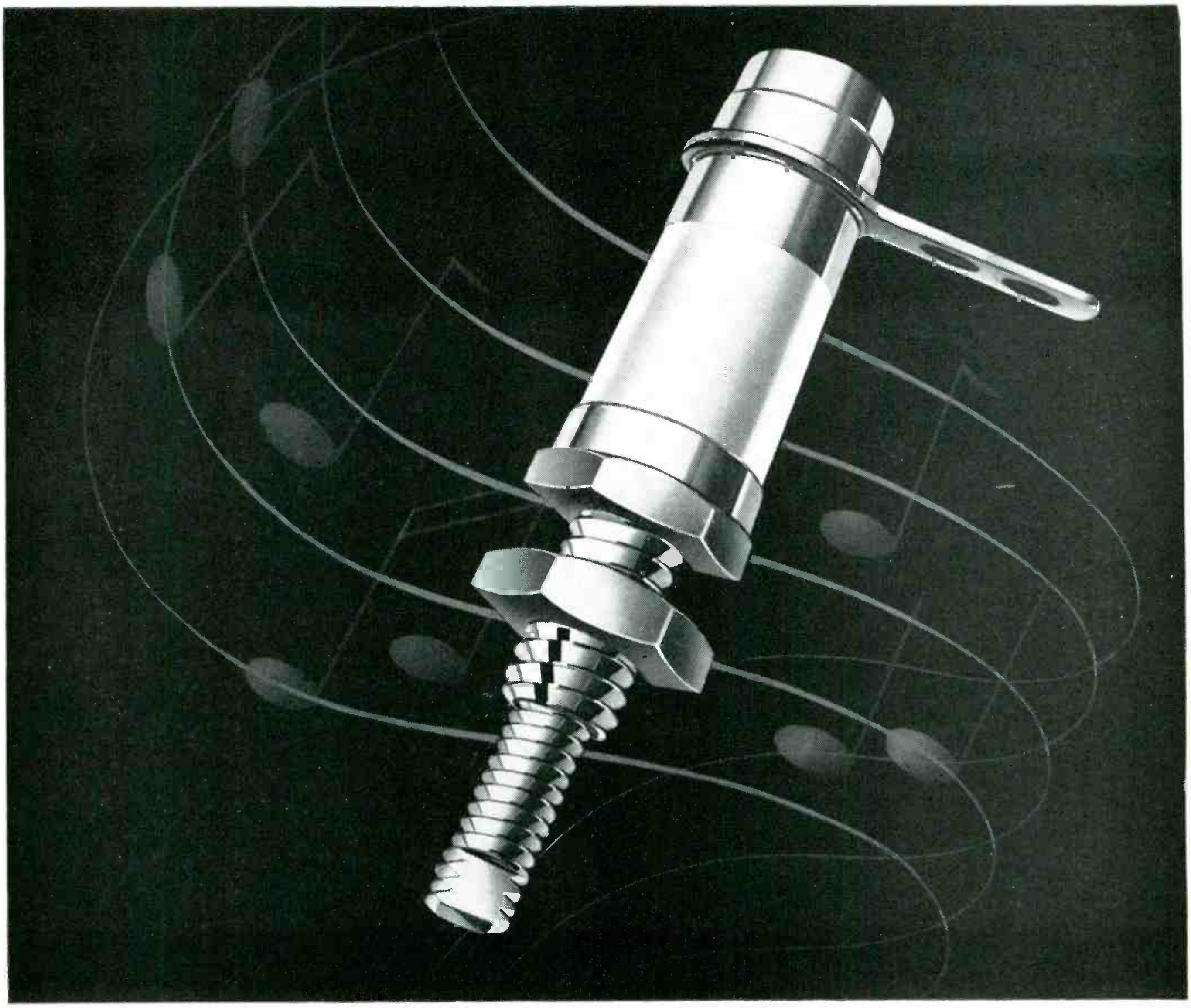
Allegheny Ludlum

A-L STEELS FOR THE ELECTRONIC AGE

WAD 5333



Mighty midget "tunes up" for major performance

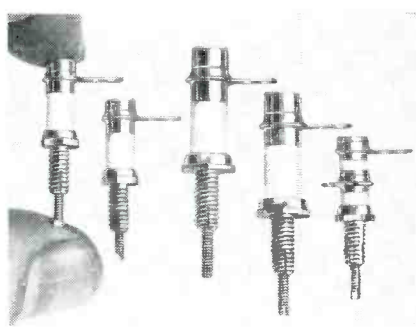
This miniaturized CST-50 variable ceramic capacitor outperforms capacitors several times larger. C.T.C.'s unique design includes a *tunable element* which virtually eliminates losses due to air dielectric. This results in wide minimum to maximum capacity range of 1.5 to 12 MMFD.

This tuning sleeve is at ground potential and can be locked firmly to eliminate undesirable capacity change. Each CST-50 is provided with a ring terminal with two soldering spaces.

This is *but one* of a versatile family of C.T.C. ceramic capacitors of this type, built to C.T.C.'s *quality control* production standards for guaranteed performance.

All C.T.C. components — standard or custom — are subject to this precision manufacture. Other C.T.C. components include coil forms, coils, terminal boards, terminals, diode clips, insulated terminals and hardware. C.T.C. engineers are glad to consult on *your* component problem. Write *now* for sample specifications and prices to Sales Engineering Department, Cambridge Thermionic Corporation, 437 Concord Ave., Cambridge 38, Mass. On West Coast, contact E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 or 988 Market St., San Francisco, Calif.

C.T.C. Capacitor Data: Metallized ceramic forms.
CST-50, in range 1.5 to 12.5 MMFDs.
CST-6, in range 0.5 to 4.5 MMFDs.
CS6-6, in range 1 to 8 MMFDs.
CS6-50, in range 3 to 25 MMFDs.
CST-50-D, a differential capacitor with the top half in range 1.5 to 10 MMFDs and lower half in range 5 to 10 MMFDs.



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makers of guaranteed electronic components, custom or standard

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INCREASE CIRCUIT RELIABILITY WITH TI-RADELL deposited carbon RESISTORS

newest line of precision components from Texas Instruments

For precise resistance values under extreme operating conditions, design with RADELL deposited carbon resistors — now manufactured by Texas Instruments. With resistance tolerance held to ±1%, Texas Instruments RADELL resistors provide exceptional stability plus a wide range of resistance values. Like all TI components, they are manufactured to exacting instrument standards.

Texas Instruments RADELL resistors are mass-produced in three lines and in ½, 1, and 2 watt sizes. Resistance values range from 25 ohms to 30 megohms.

WRITE for Bulletin No. DL-C 539 giving detailed specifications of all three lines of Texas Instruments RADELL resistors. Your best source for precision components, TI also manufactures a complete line of subminiature transformers as well as custom capacitors, delay lines, special transformers and other reliable electronic components.

Hermetically sealed line — designed for extreme conditions of moisture and temperature. Specially treated ceramic shell effectively seals out moisture and air, resists abusive handling, and assures complete insulation.

MIL-Line — designed for the broad field of military applications. Exclusive multi-layer coating provides environmental protection substantially equal to hermetic sealing throughout low and middle ranges of resistance. MIL-Line resistors more than meet MIL-R-10509A specifications.

Industrial-Line — differs from MIL-Line series only in type of coating. Industrial line resistors provide close tolerances for military, instrument and industrial applications where less extreme humidity conditions are encountered. Typical applications include computers, test equipment, communication and control systems.

RESISTORS SHOWN ACTUAL SIZE

TWENTY-FIFTH YEAR OF PLANNED GROWTH

TEXAS INSTRUMENTS
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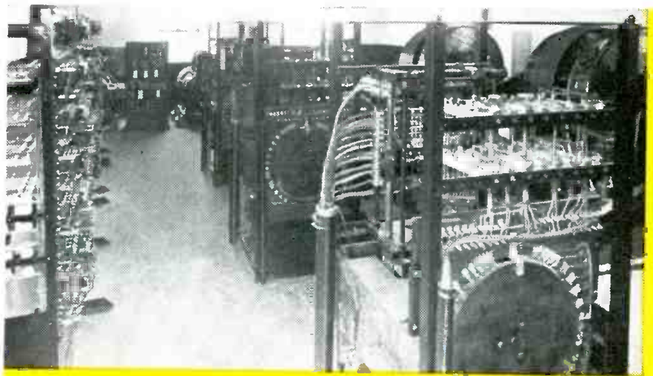
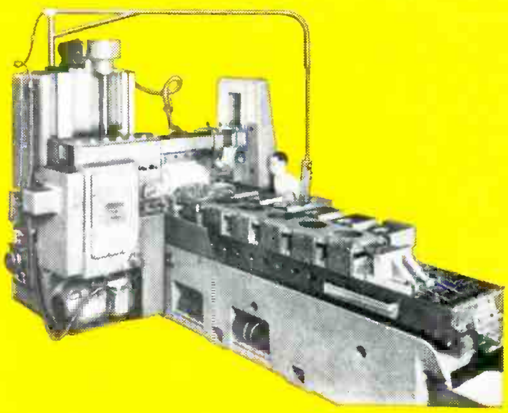


Special cable constructions for a huge variety of applications are the specialty of the house at Rome Cable. Fixture wires for elevator control panels are just one example.



Permanently clear color coding for circuit identification is vital to most modern electronically controlled equipment. Solid colors, spiral markings or colored braids are available.

Special cables for television cameras (and other television and radio equipment) are available from Rome. Years of engineering experience and competent research insure electronic constructions that match your needs completely.

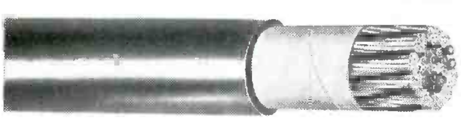
How to buy performance—*not just wire*

The performance of your equipment may well depend upon the electronic cable you use. Wires and cables are the nerve fibers of today's almost human machines.

Your customers buy performance when they invest in your products. And you specify and expect performance when you buy your components, such as special electronic cable constructions.

But how can you be *sure* the performance you specify will be there?

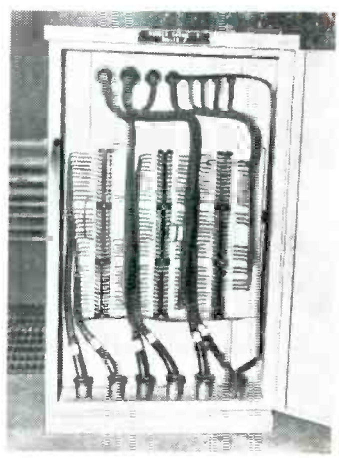
Only a cable manufacturer with complete research facilities and engineers experienced in the problems of electronic equipment, can assume full responsibility for giving you the *right* cable construction. Rome Cable has the experience, the facilities for research, *and* the plant facilities to produce complex multi-conductor cables such as this special 136-conductor, Rome Synthinol® insulated cable.



You can get a variety of cabled assemblies protected with either Rome Synthinol (polyvinyl chloride thermosplastic) sheath or tough Neoprene, or a braided fibrous covering.

And you can get a wide range of single-conductor constructions. *Standard* and *special* commercial- and military-type hook-up wires, high-frequency coaxial cables, and many other types for radio, television and electronic equipment applications are available from Rome. All carry the appropriate U/L, Armed Services or other military specification approvals.

To get *full* value from your electronic cable dollar, put Rome engineering, experience, and research to work for you. Write or phone for details.



Make neat, permanent installations with Rome Multiple-Conductor Cables sheathed in Rome Synthinol or Neoprene.

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Pesco 000

a good source for special purpose electric motors

Necessity created the Pesco DC and high frequency AC Electric Motors. Because Pesco could not get motors to meet its strict requirements, you can now buy better motors for your special applications.

Pesco engineered and developed this line of 1/100 to 11 horsepower motors to answer the need for completely dependable operation under critical conditions. Pesco Electric Motors assure optimum performance and efficiency throughout a long service life. They combine maximum power with minimum size and weight, yet withstand rugged environmental extremes. These motors are now available to you.

Both DC and AC types are made in five "coordinated frame" sizes which permits use of standardized parts having known characteristics. This expedites design and speeds delivery of motors built to your exact requirements.

Pesco high quality motors have many features not found in ordinary motors . . . such as dynamically balanced rotors, high strength alloy shafts, extremely tight windings, advanced-design brush rigging, multiple impregnations, brush material selected for specific use, high capacity sealed ball bearings and special insulations. If you are looking for a good source for special purpose electric motors, look to Pesco.

To learn more about Pesco Motors for industrial or aircraft uses, call in a Pesco sales engineer . . . or send for a brand new technical bulletin. Write: PESCO, 24700 North Miles Road, Bedford, Ohio.

engineering Pesco production

PRODUCTS DIVISION

BORG-WARNER CORPORATION

24700 NORTH MILES ROAD • BEDFORD, OHIO

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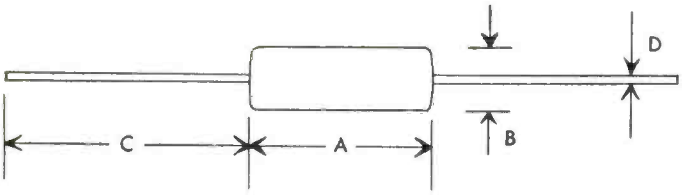
NOW

1/8, 1/4 and 1/2 watt *Molded* Precistors

IRC *molded* Deposited and Boron Carbon Precistors are now available in 1/8, 1/4 and 1/2 watt sizes. These 1% precision film type resistors combine the advantages of high stability, small size and low cost in either deposited carbon or boron carbon units. Ratings are based on full load at 70°C. ambient.

The *molded* plastic housing provides complete mechanical protection, minimizes the effect of moisture and improves load life characteristics.

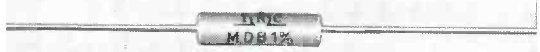
Equivalent In Size To IRC's Popular Types BTS • BW½ • BTA



Precistor Types	IRC Size Equivalent	Dimension			
		A	B	C	D
MDA — MBA	BTS	13/32"	1/8"	1½"	.025"
MDB — MBB	BW½	5/8"	3/16"	1½"	.025"
MDC — MBC	BTA	23/32"	1/4"	1½"	.032"

MOLDED DEPOSITED CARBON PRECISTORS

Type MDA — 1/8 Watt

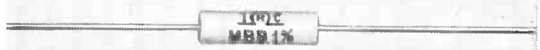


Type MDB — 1/4 Watt

Type MDC — 1/2 Watt

MOLDED BORON CARBON PRECISTORS

Type MBA — 1/8 Watt



Type MBB — 1/4 Watt

Type MBC — 1/2 Watt

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

Wherever the Circuit Says

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

IRC

INTERNATIONAL RESISTANCE CO.

Dept. 232, 401 N. Broad St., Philadelphia 8, Pa.

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

Send me data on:

☐ Molded Deposited Carbon Precistors

☐ Molded Boron Carbon Precistors

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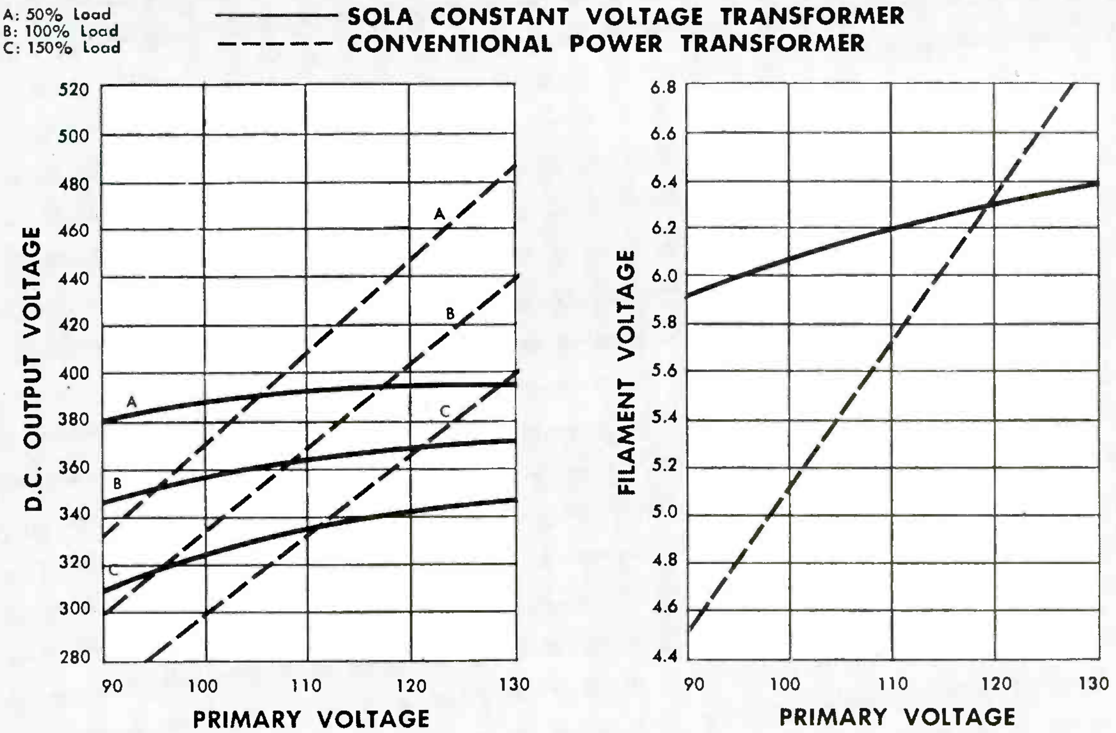


These curves contrast the plate and filament supply voltages obtained from a Sola and a conventional power transformer when line voltage is varied from 100v to 130v.

Improve Performance of electronic products with built-in regulating power transformer

You can make sure your product will always receive correct plate and filament voltages by building in a Sola Constant Voltage Power Transformer (Type CVE) in place of a conventional, non-regulating power transformer.

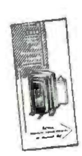
The Sola CVE provides ±3% regulation of plate and filament supply, with line voltage variations of 100 to 130 volts. Regulation is completely automatic, continuous and substantially instantaneous (1.5 cycles or less). Sola CVE stabilizers have no moving parts or tubes, require no manual adjustments or maintenance, and are self-protecting against short circuits.

Three stock units (all with high voltage ct, 5.0v and 6.3v regulated windings) are stocked by your electronic distributor. You can order production quantities of special units manufactured to your specification. We invite your inquiry.

TYPICAL STOCK UNIT: Sola Electronic Power Transformers are made for chassis mounting. They are furnished complete with separate capacitors and capacitor mounting brackets.

Automatic, Maintenance-Free Voltage Stabilization

SOLA *Constant Voltage* **TRANSFORMERS**



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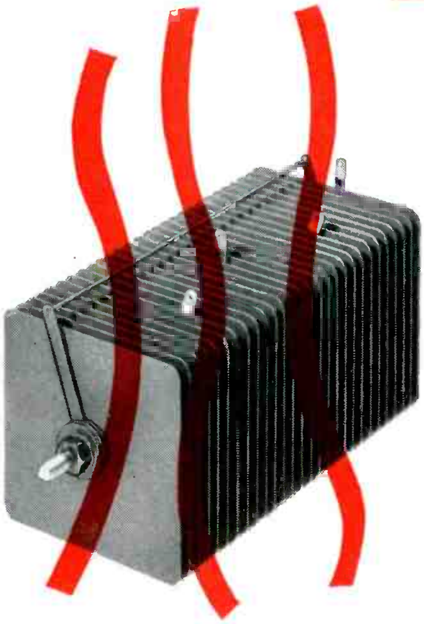
Ask for CIRCULAR 7G-CVE-195

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



Now... **HIGH TEMPERATURE RECTIFIERS** in the **LARGER CELL SIZES** up to 5″ x 6″ (to operate without derating at 125° C.) and...

AT REDUCED COST!

Also available in cartridge type

RADIO RECEPTOR high temperature rectifiers when first introduced less than three years ago were expensive and limited to 3″ x 3″. Now intensive research has brought the cost down and the cell sizes UP. That means the field is wide open for their use in many applications once considered prohibitive because of size and price.

At 125° C. these rectifiers have a minimum life of 500 hours without derating and at *normal* temperatures their span is almost indefinite...They can be hermetically sealed without derating, too.

That's why RRco. high temperature rectifiers are selected more and more for military and special industrial requirements by such blue-chip companies as Aeronautical Division of Minneapolis-Honeywell, Motorola Inc., Hamilton Standard Division of United Aircraft and many others.

If you have one of those "tricky" applications where high temperature rectifiers are needed, take advantage of RADIO RECEPTOR's continuing research and development in this field. Write now for full details about these as well as embedded rectifiers to section E-9.

We also manufacture transistors and silicon and germanium diodes

AMBIENT TEMPERATURE	POTENTIAL LIFE WITHOUT DERATING
125° C	500-1000 hours
100° C	1500-2500 hours
85° C	2500-4000 hours

CELL TYPE	CELL SIZE (Inches)	CONTINUOUS DC AMPERES SINGLE PHASE		MAX. REVERSE RMS VOLTS PER CELL
		Half Wave	Bridge or Center Tap	
X	¼ (Diam.)	.005	.010	24
Y	½ x ½	.025	.050	24
J	11/16 x 11/16	.065	.130	24
M	1 x 1	.075	.150	24
P	1 3/16 x 1 3/16	.150	.30	24
Q	1½ x 1½	.30	.60	24
S	2 x 2	.50	1.0	24
U	3 x 3	1.2	2.4	24
W	4 x 4	2.25	4.5	24
T	4¼ x 6	3.35	6.7	24
H	5 x 6	4.0	8.0	24

Really R&R *Reliable*

Semi-Conductor Division

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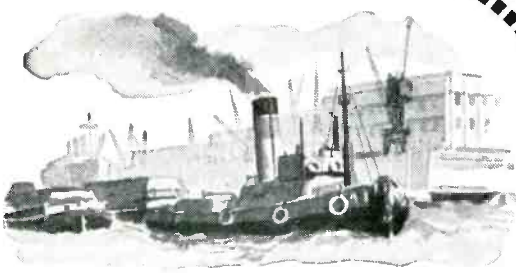

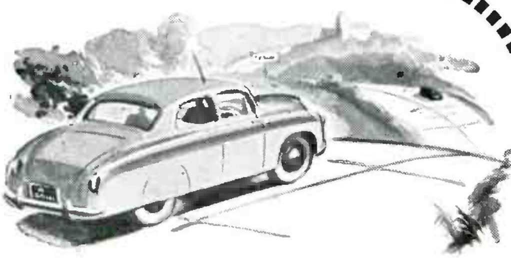

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LOW BATTERY DRAIN
MOBILE RADIO TELEPHONE

On airfields, in dockyards, in civil engineering and industry, operations reach their peak of speed and efficiency with the Pye "Reporter". All mobile personnel over a wide area can be contacted instantly through this compact and economical equipment which is quickly fitted to any vehicle. Control is simpler and swifter because wasted time and misunderstandings are eliminated. The Reporter enables four vehicles to do the work of five.

Pye Telecommunications are the largest suppliers of commercial 2-way radio in Europe and supply over 75% of British requirements.

PYE Telecommunications

CAMBRIDGE ENGLAND

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Now, *for the first time*, you can obtain 1, 2, or a dozen prototype *high alumina ceramic* parts for development work in your own plant . . . at low cost.

This new service, developed by engineers for engineers, is available to "custom-make" any small-lot number of Frenchtown *engineered* ceramic parts to your exacting specifications.

Here's an opportunity to put high alumina ceramics "through the mill" to help you solve a materials problem for a new product . . . or help you improve an existing one, without the barrier of buying production run quantities.

Why not find out more about the plus-advantages offered by Frenchtown's Prototype Service? Write, outlining your problem. Ask, too, for a copy of this 4-page bulletin which describes the complete line of Frenchtown *engineered* ceramics.

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California Representative: Edwin E. Starr, 4101 Rhodes Ave., North Hollywood, Cal. STanley 7-5879.

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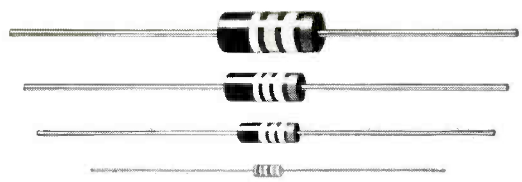


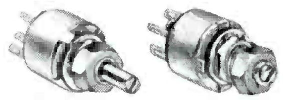
Allen-Bradley molded fixed resistors are available in four sizes—Type TR 1/10 watt; Type EB ½ watt; Type GB 1 watt; and Type HB 2 watt. They meet RETMA, JAN-R-11 and MIL-R-11 specifications. Rated at 70C ambient, they require no derating if used on plastic board assemblies. When used according to published ratings, they will not open circuit nor have large erratic resistance changes. In cartons or on reels for automatic assembly.

Allen-Bradley Type J molded variable resistors are made in single, dual, and triple unit construction in total resistance values from 50 ohms to 5 megohms. They are rated at 2 watts at 70C ambient. They are outstanding for their low noise characteristics, initially and after use. Metal parts are made of corrosion-resistant materials. Taps can be supplied at 40, 53, and 68% of effective rotation. A Quality product throughout.

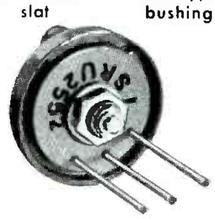
ALLEN-BRADLEY QUALITY COMPONENTS for ELECTRONIC CIRCUITS

Type G molded variable resistors (½ inch diam) are ideal for subminiature assemblies. Available with plain bushings or lock-type bushings with plain or screwdriver shafts. Rated at ½ watt. Total resistance from 100 ohms to 5 megohms.

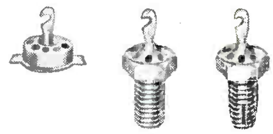
Type T molded variable resistor (1 inch diam) are compact ½ watt rheostats or potentiometers for hearing aids and other compact applications. Rated at 70C ambient. Total resistance available from 100 ohms to 5 megohms.



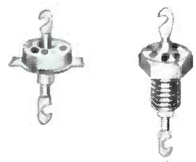
Screwdriver slot — Lock-type bushing



Type T potentiometer



Type SO stand-off capacitors



Type FT feed-thru capacitors

Type FT feed-thru and Type SO stand-off discoidal capacitors exhibit no parallel resonance effects normally encountered with tubular capacitors in VHF and UHF frequency ranges.

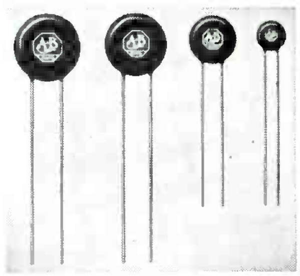
Type FT feed-thru capacitors are furnished with soldering tabs or with screw thread mountings.

Type SO stand-off capacitors have soldering tabs, screw thread mountings or self-tapping threads.

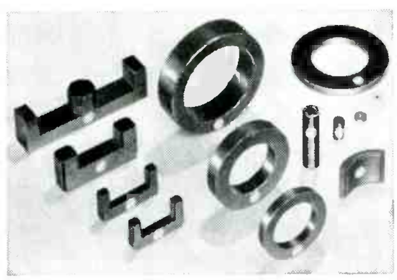
Both types are available from 5 mmf to 1000 mmf.

Ceramic dielectric capacitors Type GP—General purpose capacitors for by-pass and filtering at ambient temperatures up to 85C. In RETMA, JAN, and MIL values from 10 mmfd to .022 mfd in d-c voltage ratings of 500, 1000, 2500, and 5000 volts.

Other capacitors are Type TC temperature compensating; Type LB line by-pass; and Type DY deflection yoke capacitors for television scanning frequencies and voltages in standard nominal values from 5 mmf to 470 mmf.



Every step in the manufacture of these capacitors is performed in the Allen-Bradley plant.



Available in various shapes and sizes to fit black and white and color television circuits or for general electronic applications.

A-B ferrite cores are offered in 3 performance classifications—WO-1, WO-2, and WO-3. The WO-2 material has lower losses and higher permeability, making possible appreciable cost savings in designs of television receivers. Write for performance data on Allen-Bradley ferrite cores.

Allen-Bradley radio, electronic, and television components are a QUALITY line of basic units for all types of electronic equipment. Their stable performance characteristics and their conservative ratings make them ideal components for critical applications in military electronic devices. They are widely used in industry, and by manufacturers of radio and television receivers. There are many additional QUALITY items in the Allen-Bradley line, that are not shown here, which merit your consideration. Allen-Bradley sales engineers are located in principal cities from coast to coast. Call your nearest Allen-Bradley office for technical data, today.

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Milwaukee 4, Wis.

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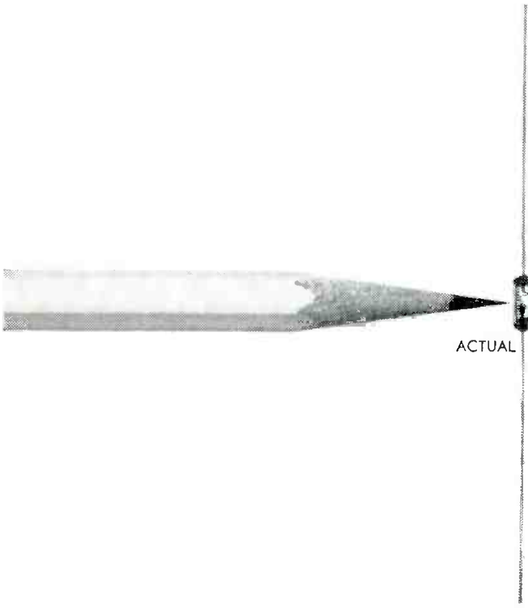
RADIO & TELEVISION COMPONENTS
QUALITY

In Canada
Allen-Bradley Canada, Ltd.
Galt, Ont.



34 Years of Glass Technology and Skill in Tube Manufacturing is Your Assurance of Stability in CBS Glass Diodes

Here's why CBS diodes have uniformly stable electrical characteristics.

1. During manufacture, mechanical pressure of each catwhisker on its crystal is the same.
2. This pressure is locked in permanently by rigid glass-to-metal seals.
3. Humidity and contamination are *sealed out* . . . stability is *sealed in.*
4. CBS glass diodes are rugged. Repeated bending of leads will not break glass.

CBS-Hytron's Commercial Engineering Department will recommend the best in diodes, or tubes, for your applications upon request.

Ask for data on CBS Glass Diodes

Gold bonded computer . . . silicon uhf . . . video detector and harmonic generator . . . and general purpose diodes . . . all available in the new CBS subminiature line.

Quality products through *ADVANCED-ENGINEERING*

CBS

CBS-HYTRON, Danvers, Massachusetts . . . A DIVISION OF COLUMBIA BROADCASTING SYSTEM, INC.

NOW, A REMARKABLE "READY-TO-SOLDER"

PHELPS DODGE

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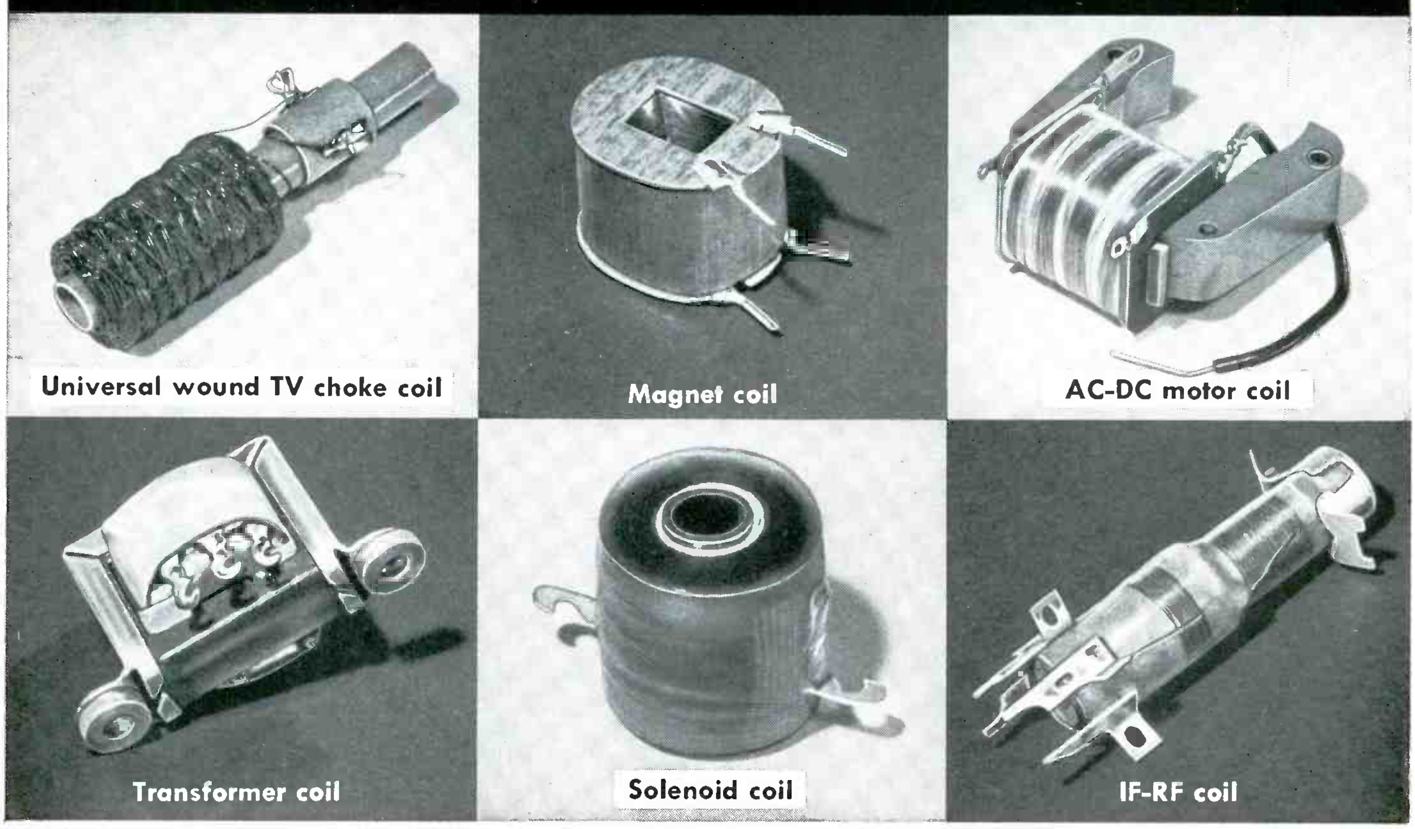

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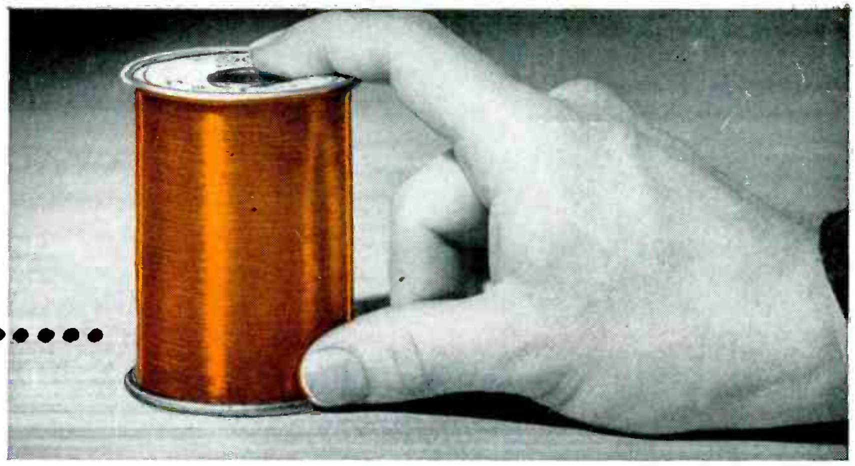

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NEW SODEREZE!*

- **Instant Soldering Without Stripping**
- **Improved Moisture Resistance**
- **Good Electrical Properties**
- **Excellent Flexibility and Toughness**

New Sodereze represents a spectacular advance in ready-to-solder magnet wire. It's a new and typical Phelps Dodge development designed to keep pace with industry's growing need for wires that handle easily, save time, reduce overall costs and satisfy a variety of different operating conditions. The versatility and outstanding properties of New Sodereze not only permit its use wherever solderable wire has been *proved* practical and dependable but suggest its application in unlimited other electronic and electrical fields to replace conventional wires.

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

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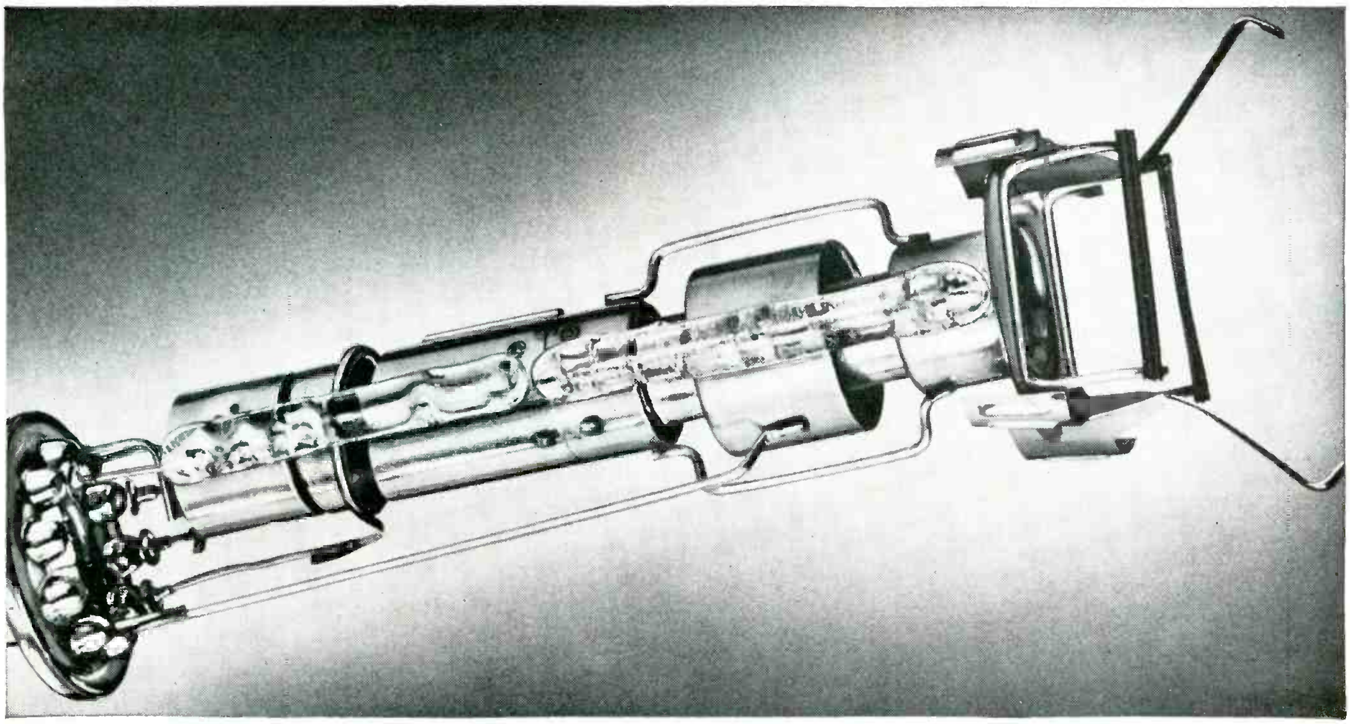


The new Westinghouse *electrostatic* gun *improves* picture tube focus, *extends* tube life, eliminates arcing at high voltages. That's why you can . . .

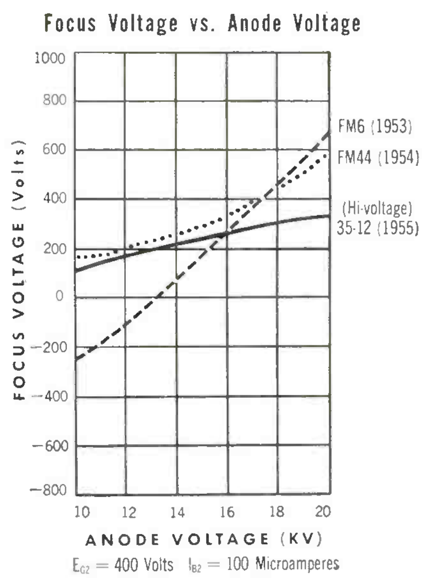
Now...Get Safe, Reliable 20 KV Picture Tube Operation

With the new Westinghouse electrostatic gun, *reliable* high voltage operation is now a reality. Westinghouse design engineers have successfully developed a new electrostatic gun capable of withstanding extreme voltages, without arcing. For *your* equipment this means improved picture tube performance, extended picture tube life, better focus.

Check These Advantages:

YOU GET . . .	FROM . . .
• Arc-free high voltage operation	• Increased focus electrode to anode spacing
• Better focus over a wider range of anode voltages.	• (see graph)
• More uniform spot shape	• Use of split ring positioning between gun parts
• Extended life	• Use of new cathode base metal and broadening of active getter area
• Possible Leakage Paths reduced by 50%	• Elimination of 2 Glass Beaded side arms

This new Westinghouse electrostatic gun is presently available in Westinghouse equipment picture tubes. Be sure your sets give *top picture tube performance*. See your Westinghouse representative or write to the address below — today.



ET-95071

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

RELIATRON® TUBES

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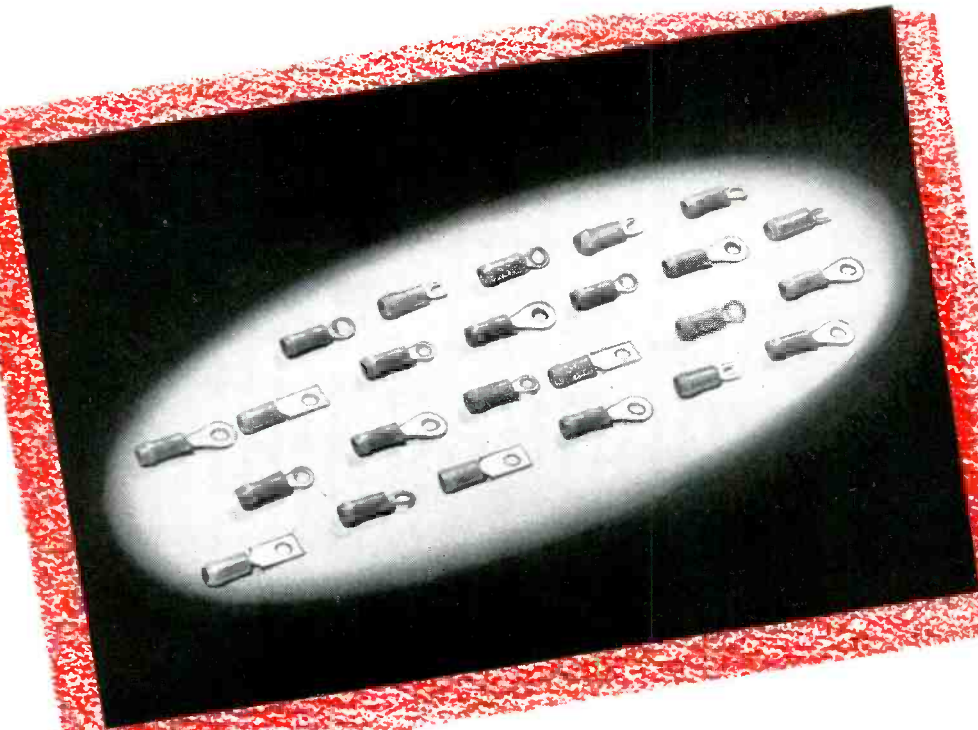
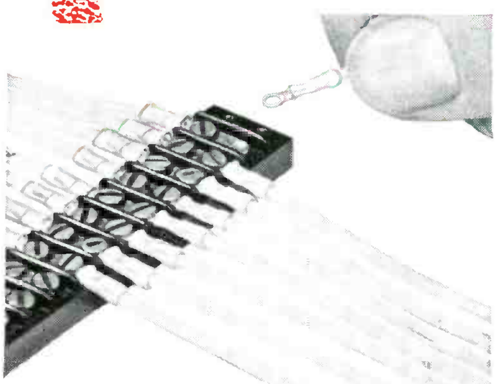


meet AMPli-mite

Trade-Mark

Especially designed for use with miniaturized components and blocks in Guided Missiles and Electronic Equipment, these small (AWG 26-22) Pre-Insulated Diamond Grip Terminals and Connectors have all the features that made A-MP's larger size Pre-Insulated Diamond Grip terminations famous.



A-MP's Miniature AMPLI-MITE terminals and connectors will help you • save valuable space • improve reliability • reduce cost

A-MP's precision confined wire crimp assures maximum area, high pressure contact for stable, low resistance connections for your most critical electronic and electrical circuits.

A-MP Pre-Insulated terminals are also available for larger size wire—up to 4/0.

A-MP

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In Canada: AIRCRAFT-MARINE PRODUCTS OF CANADA, LTD., 1764 Avenue Road, Toronto 12, Ontario, Canada

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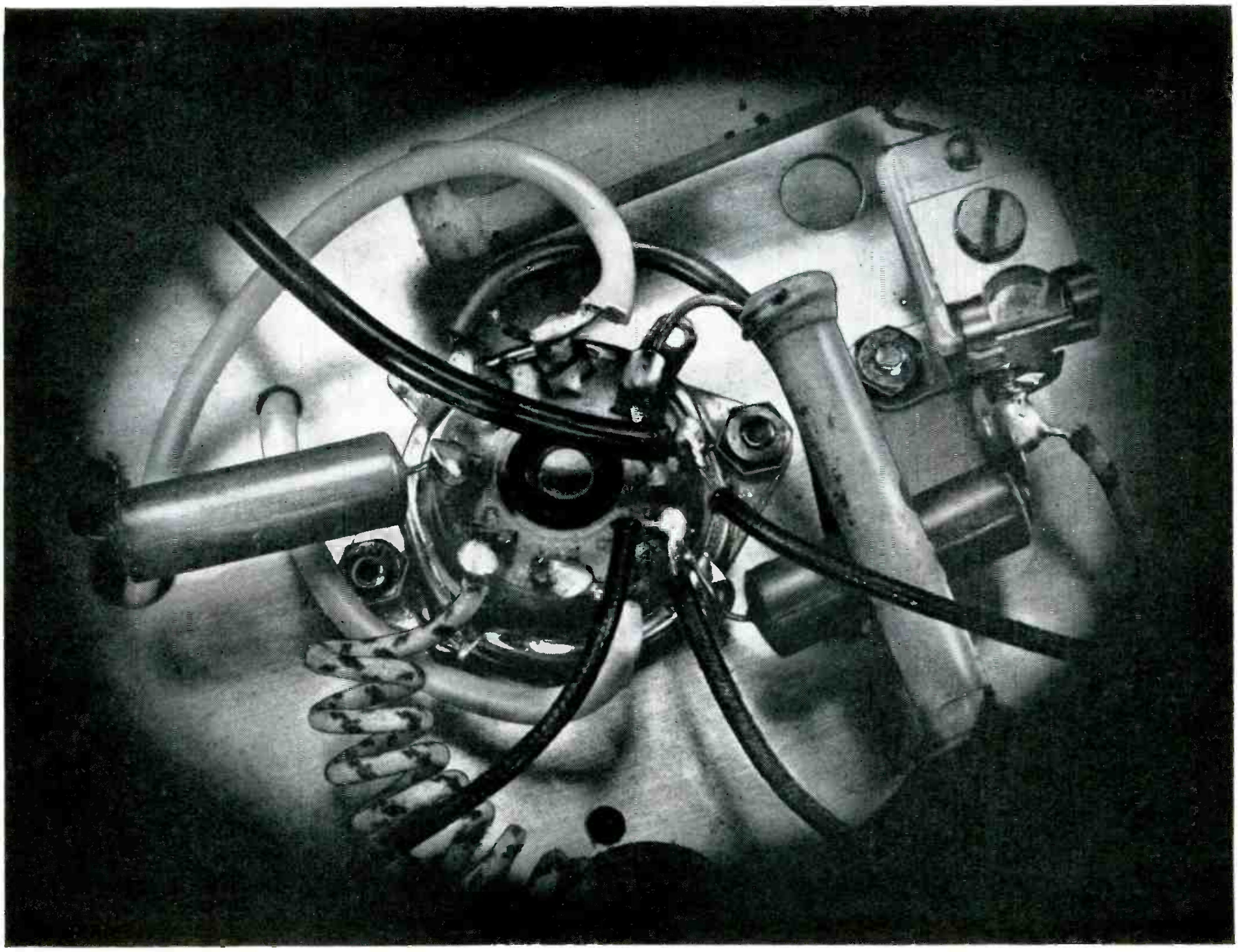

Vacuum-melted alloys give superior electrical properties...

HERE ARE SOME EXAMPLES . . .

Vacuum-melted cathode nickel alloys, iron and metal-glass-seal alloys are held to extremely close standards of purity, composition and uniformity. Secondary emissions and outgassing are minimized — shelf life increased — for vacuum tubes of many kinds.

Vacuum-melted copper shows marked increase in purity, soundness and conductivity.

Soft magnetic alloys achieve improved permeability, both initial and saturation — with stronger directional properties.

The reason lies in the process itself. Undesirable interstitial elements such as oxygen, nitrogen and carbon are literally sucked from the molten metal by the high vacuum that's used. The result is high-purity, gas-free alloys of closely controllable composition . . . alloys that may far outperform conventional air-melted metals.

Vacuum Metals Corporation, with its newly expanded facilities, can now deliver a wide range of vacuum-melted alloys for electrical and electronic uses. But can these superior materials improve *your* products? Let our engineers help you decide. Write us, giving full details of the application in which you are interested. *Vacuum Metals Corporation, P.O. Box 977, Syracuse 1, N.Y.*

VMC

VACUUM METALS CORPORATION

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"Silver-Mike"* capacitors.

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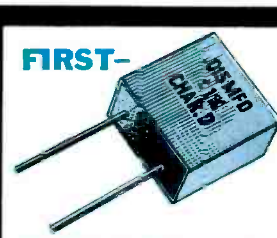

Super-Micadon* mica capacitors.

In the parade of progress as in the manufacture of capacitors it takes vision to lead. That is why, we, at Cornell-Dubilier, have proven our leadership with constant foresight . . . by always being first to develop new and more efficient capacitors to meet tomorrow's demands. Too, this vision has given

C·D...45 YEARS OF FAMOUS FIRSTS

Shown here are three examples of C-D's "Famous Firsts" – *proof* that whatever your capacitor requirements, a C-D engineer can show you money saving answers. Write to Cornell-Dubilier, Dept. K-75, South Plainfield, N. J.

FIRST–

postage stamp (Micadon*) mica capacitors.

CONSISTENTLY DEPENDABLE
CORNELL-DUBILIER CAPACITORS

PLANTS IN SO. PLAINFIELD, N. J.; NEW BEDFORD, WORCESTER AND CAMBRIDGE, MASS.; PROVIDENCE AND HOPE VALLEY, R. I.; INDIANAPOLIS, IND.; SANFORD AND FUQUAY SPRINGS, N. C.; SUBSIDIARY, RADIART CORP., CLEVELAND, OHIO.

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THERE ARE MORE C-D CAPACITORS IN USE TODAY THAN ANY OTHER MAKE

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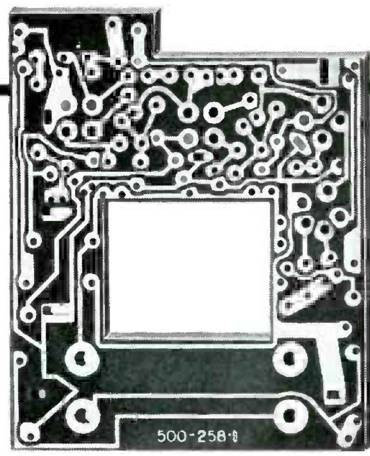
FIRST TRANSISTOR RADIO MADE POSSIBLE

.. by INSUROK® copper-clad printed circuits!

Here's a remarkable example of miniaturization .. made possible mainly through the use of printed circuits and transistors. This diminutive radio weighs a scant 12 ounces, complete with battery. Yet, it has good tone, is selective, and delivers plenty of volume.



Here's the printed-circuit board used in the Regency .. made with Richardson T-725 copper-clad INSUROK. Engineers of I.D.E.A., Inc. of which Regency is a division, laid out the circuit. Croname, Inc.* Chicago, took it from there .. printed the complex circuit on Richardson T-725 copper-clad INSUROK, then etched it. Results: a lightweight, compact, efficient circuit .. tedious, time-consuming wiring eliminated .. faster assembly.

Many grades of Richardson laminate INSUROK are available copper-clad on one or both surfaces. We invite your inquiry.

**Here's what Croname has to say about T-725 copper-clad INSUROK, "Quality is superior .. service good. And Richardson gives us helpful engineering assistance."*

Ask for descriptive bulletin, "INSUROK Copper-Clad Laminates."

RICHARDSON
Laminated and Molded Plastics

The RICHARDSON COMPANY

FOUNDED 1858

2797 Lake St., Melrose Park, Ill. (Chicago District)

SIX PLANTS: Melrose Park, Ill. • Indianapolis, Ind.
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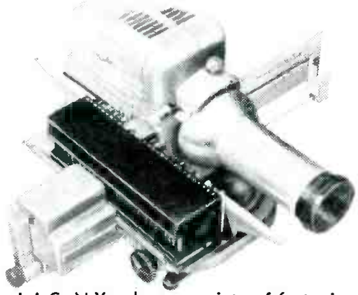
SALES OFFICES IN PRINCIPAL CITIES

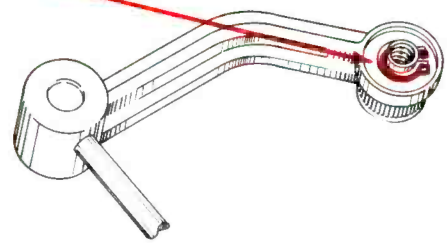
Waldes Truarc Rings Permit Better and More Economical Design—Fewer Parts, Faster Assembly, Minimal Rejects!

Viewlex's Change-O-Matic



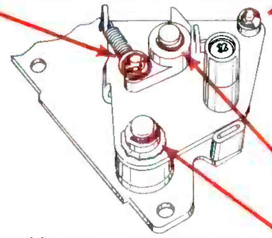
Viewlex, Inc., L. I. C., N.Y. solves a variety of fastening problems in their new model Change-O-Matic automatic slide changer. Assembly time is speeded, parts eliminated, rejects lowered, and compact, economical product design achieved.

Connecting Arm Assembly



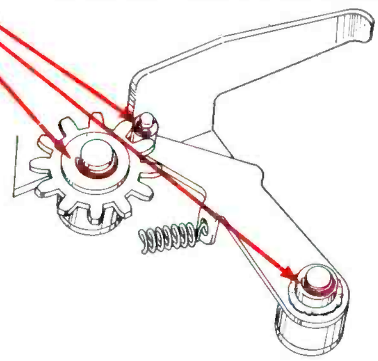
Use of one Waldes Truarc Ring (Series 5100) eliminates time-consuming riveting over the flange, retains and holds the connecting knob captive. A compact, neat design is made possible, rejects caused by poor riveting eliminated.

Actuating Plate and Pawl Assembly



Three types of Waldes Truarc Retaining Rings are used in this assembly. One circular self-locking ring (Series 5105) retains pawl return spring. One external E-ring (Series 5133) retains roller used to prevent gear motion during transport cycle. One crescent ring (Series 5103) retains pawl which indexes gear. Second crescent ring retains sub-assembly. Truarc Rings speed assembly, cut rejects, eliminate parts.

Dentent Lever Assembly



Truarc E-ring (Series 5133) eliminates use of tapped hole and shoulder screw, retains roller which prevents over-travel of gear. Assembly is rapid.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product . . . to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types . . . as many as 97 different sizes within a type . . . 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today . . . let our Truarc engineers help you solve design, assembly and production problems . . . without obligation.

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

Send for new catalog supplement

WALDES TRUARC® RETAINING RINGS

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

Name ....
Title ....
Company ....
Business Address ....
City .... *Zone* ...... *State* ....
E077

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

TUNG-SOL "Magic Mirror" ALUMINIZED PICTURE TUBE

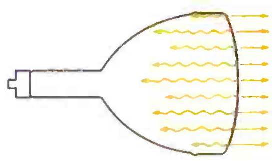
BRIGHTER-SHARPER
MORE DETAIL
MORE CONTRAST

The "Magic-Mirror" Aluminized Picture Tube produces the brightest, most realistic picture ever seen in the American home. The "Magic-Mirror" tube effectively utilizes *all* the light generated by the phosphor screen.

Tung-Sol has developed a unique "fogging" method of backing up the phosphor screen with a mirror-like aluminum reflector. This reflector prevents light radiating uselessly back into the tube. It brings out all the detail of which the receiver circuit is capable. So smooth and true is the Tung-Sol aluminum reflector that mottling, streaks, swirls, "blue-edge", "yellow center" and other objectionable irregularities are eliminated.

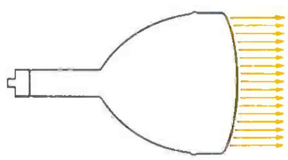
Tung-Sol pin-point-focused electron gun assures a steady, brilliant picture—free from alternate fading and overlighting. Tung-Sol's exacting standards of quality control, manufacture and testing further guarantee the high uniformity and maximum performance of the "Magic-Mirror" TV Picture Tube.

Let the superior qualities of "Magic-Mirror" Picture Tubes add selling advantages to your set.



ORDINARY TUBE—Only *half* the light produced by the phosphor screen is utilized in the picture. Other half radiates wastefully back into tube.

RESULT—A light background within the tube which reduces picture contrast.



MAGIC-MIRROR ALUMINIZED TUBE — Aluminized reflector allows electron beam through. Blocks wasted light from backing up into tube. Reflects *all* the light into picture.

RESULT—Pronounced increase in contrast to make a bright, clear, more realistic picture.

TUNG-SOL ELECTRIC INC., Newark 4, N. J.

Sales Offices: Atlanta, Chicago, Columbus, Culver City (Los Angeles), Dallas, Denver, Detroit, Montreal (Canada), Newark, Seattle.

Tung-Sol makes All-Glass Sealed Beam Lamps, Miniature Lamps, Signal Flashers, Aluminized Picture Tubes, Radio, TV and Special Purpose Electron Tubes and Semiconductor Products.

TO AMERICAN BUSINESS...

Thanks for Taming a Wild Horse

This is a message of appreciation to American industry. The occasion for the message is the completion of our eighth annual McGraw-Hill Survey of Business' Plans for New Plants and Equipment.

To a considerable degree, our appreciation is personal. It goes to the companies whose cooperation made our survey possible. Twice as many companies as in any previous McGraw-Hill annual survey carefully answered our questions about their plans to invest in new producing facilities. They gave a great deal of expensive time to the job. The cooperation of these companies, which employ nearly eight million workers, put the results of our survey on the firmest footing, in terms of coverage, it has ever had. For this cooperation we are most grateful.

But our appreciation is much more than personal. It extends in even greater degree to the kind of planning of investment in new plants and equipment which our survey revealed. The nature of this planning holds out promise that American industry is on the way toward bringing under control what historically has been one of the most upsetting forces in the American economy—the violent fluctuations in business capital investment. Progress in ironing out these fluctuations gives occasion for public gratitude.

A full report of the results of the eighth annual McGraw-Hill Survey of Business' Plans for New Plants and Equipment will be sent to anyone requesting it from the Department of Economics, McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York 36, N. Y.

Very Good Business News

The part of our surveys that attracts the widest interest is the news they give about immediate business prospects. And this year the news is very good. The survey results indicate that American business as a whole plans to invest $29.5 billion in new plants and equipment this year. That is 5% more than was invested last year, and a new high for any year.

Plans for the years 1956-1958 are also remarkably encouraging in terms of the amount of investment in prospect. American business reports that it is already planning to spend within 3% as much for new plants and equipment in 1956 as in 1955. In the past, the expenditures planned for future years have always been sharply lower than those planned for the current year. This is understandable enough. It is sometimes impossible to anticipate all the expenditures that will be necessary a year or more hence. Thus the fact that plans are already made to spend almost as much in 1956 as this year is very good news about business prospects. The level of investment now planned for the years 1957 and 1958 is also remarkably high—far higher than ever reported for years that far ahead in previous McGraw-Hill surveys.

Taking the Long View

The fact that these plans exist is of immense constructive significance. It clearly indicates that more and more, and now in dramatic degree, American business is taking the long view in making its plans for capital investment. It is developing a program which, if successfully carried out, will go far toward eliminating the habitual, destructive surging and sagging of what is in effect the central power house of our economic system — capital investment by business. Upon the level of this investment depends not only the general state of our prosperity but our progress in raising the American standard of living with new products and new and better industrial processes.

Seven years ago, when we first asked industry to estimate its capital spending beyond the current year, only a small minority of companies could give us any estimates at all. This year, 87% of the cooperating companies—and it was a far larger number of companies—could comply with our request for estimates for the years 1956-1958.

It Pays to Bet on Growth

A number of developments help explain the increase in long-range planning of capital investment. One is the increasing technical complexity of American industry. It often takes longer, in this complicated age, to work out a successful installation of new plants and equipment. Another reason for long-range planning is American business management's increasing conviction that it pays to bet on the demonstrated capacity of the American economy to grow over the long pull. With this goes a corresponding determination not to let short-term business fluctuations upset individual company plans for growth through addition of new plants and equipment. An additional factor, and one of great and increasing importance, is the sense of public responsibility on the part of American business leaders who want to help prevent destructive swings in the levels of new investment.

It cannot be too strongly emphasized that there is still nothing automatic about the carrying out of these long-range plans for business spending. Actual expenditures are still governed in major degree by the general health of our economy. This is fully attested by the fact that the current business recovery has led to a substantial upward revision of the investment plans reported to us last fall when we made a preliminary check of plans for 1955. Either private economic excesses or a reversal of the recent improvements in federal tax policy could gravely upset realization of present plans. Fortunately, neither of these possibilities seems to be an immediate threat.

The very fact, however, that American business management has made these plans and will do its utmost to carry them out is a development of tremendous constructive importance for the American economy. It means that major efforts are being made to tame what historically has been an economic wild horse—the process of capital investment by business. Both for doing it, and for telling us about it in our annual surveys, we extend to American industry our sincere thanks.

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

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Donald C McGraw
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"TOP" CHARACTERISTICS

GOOD-ALL

FILM-X CAPACITORS

WITH "MYLAR"* DIELECTRIC

Metal enclosed, hermetically sealed,
Extended foil or tab construction,
Miracle X impregnated.

*Du Ponts Trade Mark for its Polyster Film

★ Exceptionally High Insulation Resistance.

Example—2.0 mfd.—600 V FILM-X displayed a minimum insulation resistance of 5000 megohm-microfarads at 85°C.

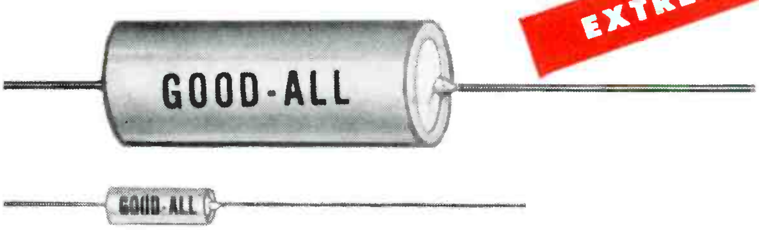
★ High operating temperature.

Standard series may be operated at 85°C at full rated voltage and at higher temperatures with de-rating.

HT Series (High Temperature) operated to 125°C at full rated voltage and to 150°C with de-rating.

★ Low Power Factor of .005.

★ Low Capacitance Change over a temperature range of −55°C to +150°C.



Sizes smaller than other miniaturized brands—approximately ½ the size of equivalent paper dielectric capacitors.
Example: —.01 mfd—600V as small as .173 dia. x ½ inch.

We invite sample orders for your evaluation.

EXTREME ADAPTABILITY

PRINTED CIRCUIT
Style PCF-Flat plate mount. Designed to withstand shock in excess of 50,000 g's

SCREW MOUNT
Style S3DL-with double eyelets and lug terminals for mobile and airborne application.

PILLAR TERMINAL
Style PT – for high voltage and high altitude operation

We build to your specifications in many other case styles. Designed to fit exacting physical or electrical requirements

No. 612G and **613G**
extended foil construction

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tab construction

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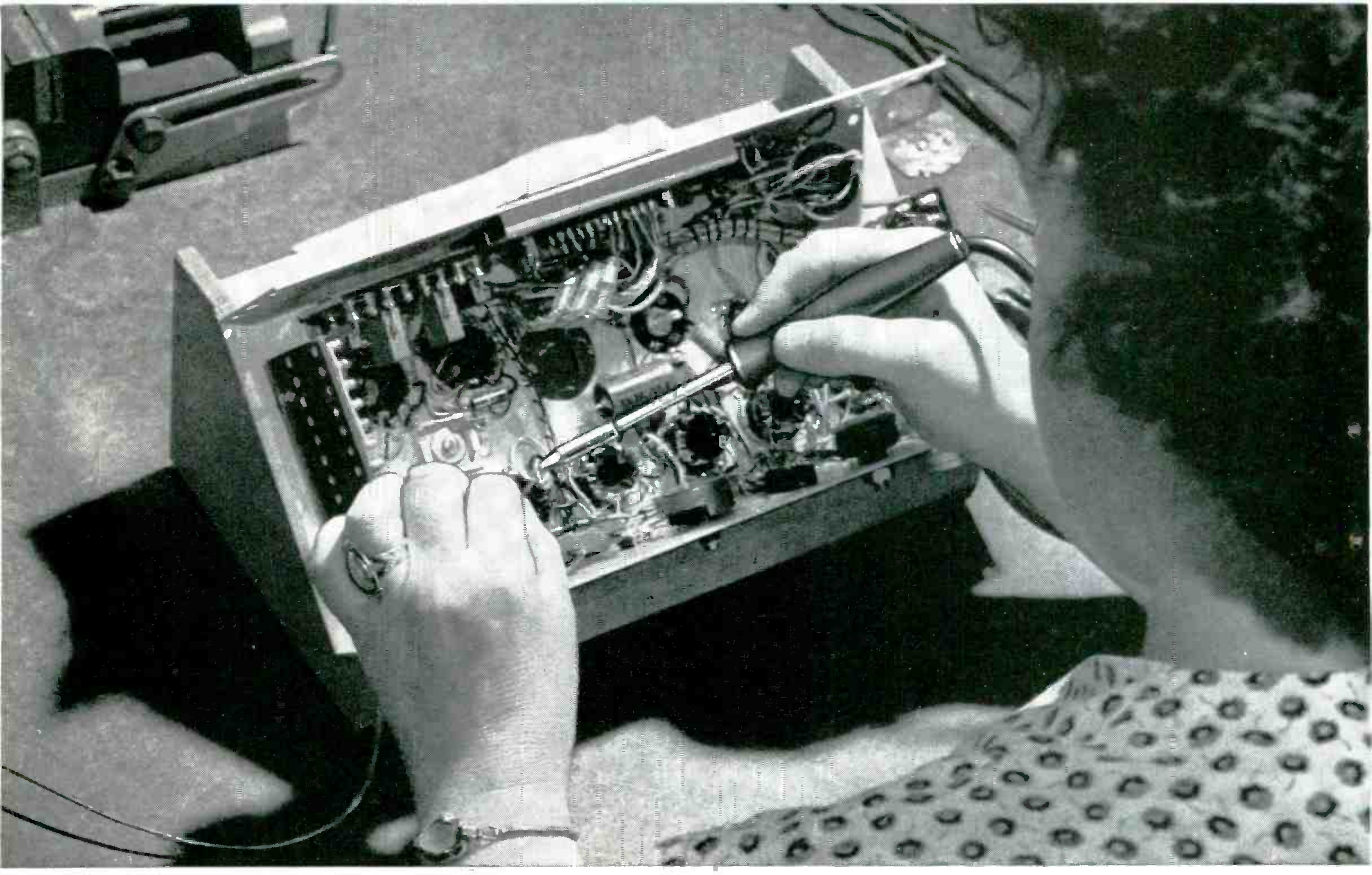
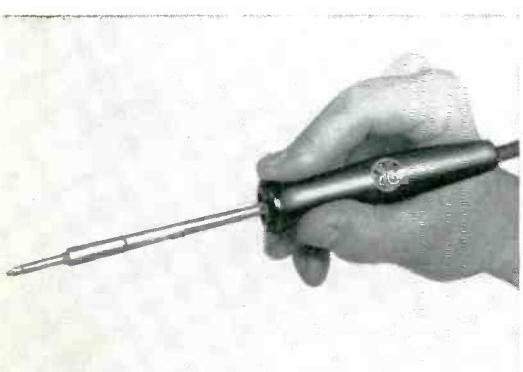
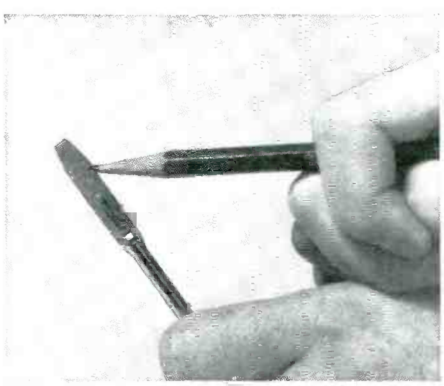


HARD-TO-REACH JOINTS in Sanborn Co.'s electro-cardiographs are soldered quickly with the fine-point G-E Midget iron—with no damage to adjacent parts. Weight of iron—less than 3 ounces—helped increase output by reducing operator fatigue. The Midget's ironclad-copper tip saves Sanborn ½ hour cleaning and tinning time daily, per operator station.

Sanborn speeds assembly 13% with G-E Midget iron, a small soldering iron with big-iron efficiency

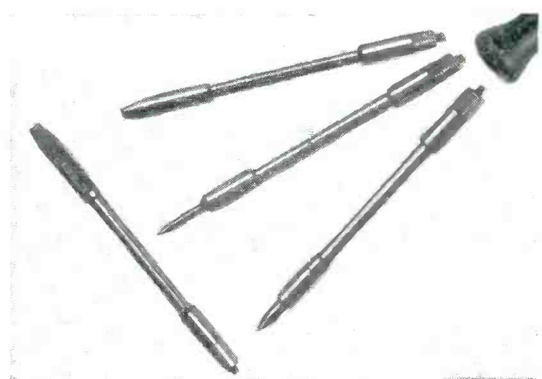


HANDLES LIKE A PENCIL—Weighing less than a package of cigarettes, the General Electric Midget soldering iron speeds production by reducing operator fatigue.



RAPID HEAT TRANSFER is achieved through a famous Calrod* heater located in the ironclad-copper tip. Result—the G-E Midget iron's heat efficiency is 90%.

*Reg. trademark of the General Electric Company



THREE-IN-ONE IRON with ⅛", ¼", $\frac{3}{16}$" tip sizes gives you greater versatility to meet your soldering requirements. Tips can be changed in only 5 seconds.

For more information write for GED-2263, G-E Midget Soldering Iron, Section 724-2, General Electric Co., Schenectady 5, N. Y.

GENERAL ELECTRIC

Announcing the new Model 581 Oscillograph, designed to fill the need for an extremely small flight-test instrument when automatic features are needed. Dimensions have been held to a minimum without affecting its ability to obtain highly accurate recordings. It measures stresses, strains, vibrations and other physical phenomena under extreme acceleration, shock and temperature conditions. Components will withstand severe conditions of both laboratory and field usage. A few features are: *Automatic record-numbering* • *Automatic length control (resettable by remote control)* • *No-record warning* • *Lamp burn-out indicators* • *Full width timing lines at 0.01 and 0.1 seconds* • *Trace identification* • *Footage indicator* • *Wide selection of paper speeds*

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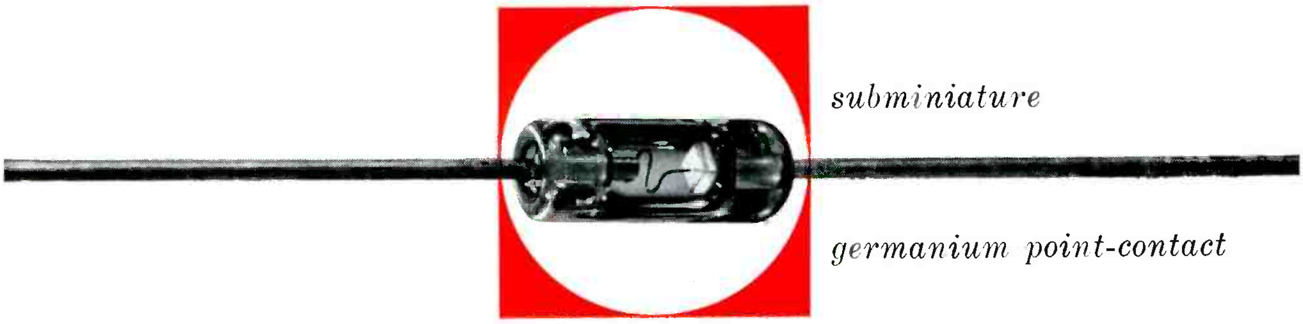


subminiature

germanium point-contact

DIODES

A greater range of diode characteristics—this is what the vigorous and continuing Hughes program of research and development means to you. For instance, you can spell out your requirements for germanium diodes in terms of your particular circuit application. Frequently, you will find that there is a Hughes type in the extensive line that matches those requirements with just the right characteristics. If not, a special type, tested to meet your exact requirements, can be supplied readily.

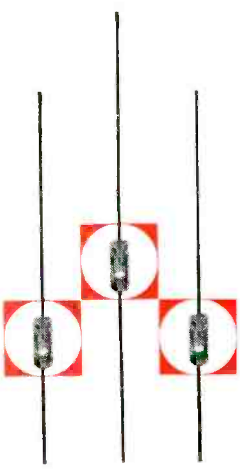
The Hughes line of semiconductors is being steadily expanded. New germanium and silicon devices, including transistors and power rectifiers, now under development, are being readied for commercial production. Watch for their release. Meanwhile, whenever your equipment design calls for subminiature germanium diodes, be sure to specify Hughes. With extraordinary records of failure-free service, they are *first of all* ... for RELIABILITY!

Listed below are a few of the more popular types, arranged for quick and easy selection, according to forward and reverse characteristics. More detailed specifications are given in pertinent data sheets.

WORKING INVERSE VOLTAGE		FORWARD CURRENT (Milliamperes)							
		3-5	**5**	**10**	**20**	**50**	**100**	**150**	**200**
30	200μA @ – 20V						HD 2152		
40	10μA @ – 10V	1N128*							
60	50μA @ – 50V 100μA @ – 50V 500μA @ – 50V 850μA @ – 50V		1N116 1N90 1N126*	1N117 1N95	1N118 1N96	HD 2167 HD 2166 HD 2155	HD 2173 HD 2174 HD 2162		HD 2160 HD 2171 HD 2172
80	50μA @ – 50V 100μA @ – 50V 125μA @ – 50V** 250μA @ – 50V** 250μA @ – 50V 500μA @ – 50V	1N67A 1N89	1N191** 1N192** 1N198*	1N99 1N97	1N100 1N98	HD 2151 HD 2168 HD 2169	HD 2150 HD 2163 HD 2175		HD 2158 HD 2157 HD 2159
100	180μA @ – 90V 500μA @ – 100V 625μA @ – 100V 300μA @ – 50V 50μA @ – 50V	1N68A 1N127* HD 2051				HD 2170	HD 2165	HD 2154	HD 2161
150	500μA @ – 150V		1N55B						

*JAN Types. 1N198 only high-temperature tested at 75°C.
**Computer Types. Special recovery tests. 1N191 and 1N192 tested for back current at 55°C.

All Hughes diodes are presently packaged in the famous one-piece, fusion-sealed glass envelope, impervious to moisture and to external contamination. Maximum dimensions, standard glass envelope:
Length, 0.265 inch; Diameter, 0.105 inch.



HUGHES

SEMICONDUCTOR SALES DEPARTMENT

Aircraft Company, Culver City, California

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ONE INTEGRATED UNIT—no associated amplifiers and compensators needed because of the small variation in transformer ratio and phase shift with varying input voltage.

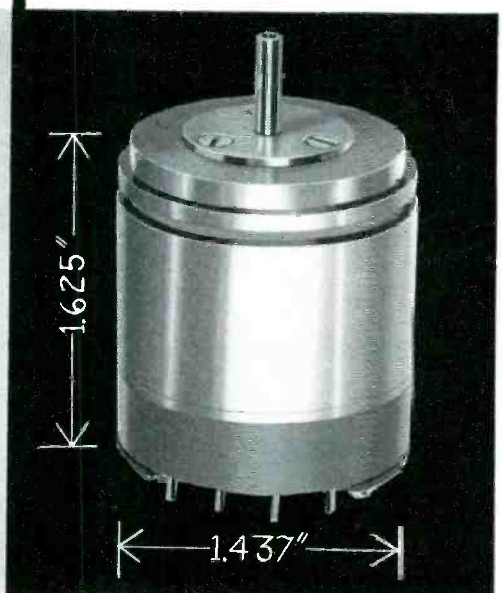
EXCEPTIONAL ACCURACY: ± 2 min. null spacing, ±3 min. interaxis error, 0.05% max. amplitude error.

COMPACT—weighs only 5.87 oz.

- 0-16V 400 CPS input voltage range. Special units may be designed for higher input voltages.
- 740/79° input impedance.
- Available with 1 and/or 2 input or output windings.
- Transformation ratio: (S/P) .955±.015.
- Phase shift: 4°30′±30′.
- Max. static torque (oz.in.^{2}): .5.

Oster®

SIZE 15 DESIGN-COMPENSATED
precision resolver



Actual Size. Type 3D-2348.

Write for complete information on Type 3D-2348 today. For your special applications, send detailed design requirements to help us to help you faster.

Other products include Actuators, AC Drive Motors, DC Motors for Special Applications, Motor-Gear-Trains, Servo Torque Units, Low Inertia Servo Motors, Synchro Differentials, Two-Phase Reference Generators, Tachometer Generators and Motor Driven Blower and Fan Assemblies.

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MANUFACTURING CO.
AVIONIC DIVISION
RACINE, WISCONSIN
Your Rotating Equipment Specialist

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Shown in combination cutaway and phantom

Why these WESTON PORTABLES excel in

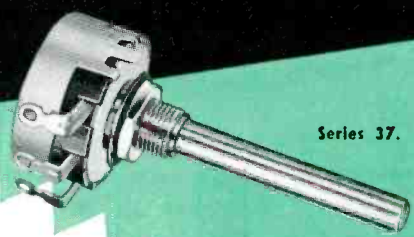
STABILITY . . . RUGGEDNESS . . . SHIELDING!

Familiar in external appearance, all these portables are totally *different* inside. The movement employed is the highly stable, shelf-shielded WESTON CORMAG® mechanism. The *difference* is evident, in service, in several ways. The movement is far more rugged . . . more resistant to vibration and shock . . . thus protecting instrument accuracy and dependability over far longer periods. There never need be concern about external magnetic fields, for the yoke design provides a permanent magnetic shield . . . so efficient that an instrument may be used at a distance of only 15 inches from a conductor carrying 1000 amperes and show an effect of less than 1/10 of 1%. And the instrument is far lighter in weight . . . more convenient in handling. Complete details on these Weston CORMAG® portables may be obtained from your local Weston representative, or direct from WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

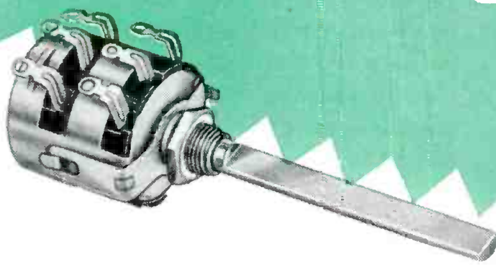
WESTON *Instruments*

STAND PAT WITH CLAROSTAT

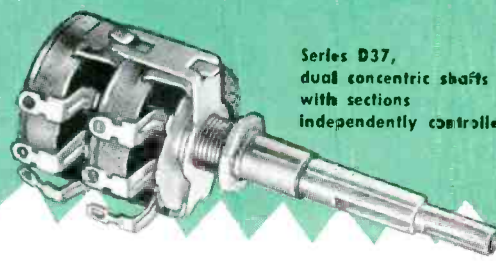
Composition-Element CONTROLS



Series 37.



Series D37, dual with single shaft.



Series D37, dual concentric shafts with sections independently controlled.

It's better, quicker, cheaper, to specify CLAROSTAT for those carbon control requirements, because:

For **usual needs**, there's an adequate choice of standard Clarostat types such as:

SERIES 37: 1-1/8" d. 0.5 watt. Linear or tapers. One to three taps. Available with switch. Choice of shafts. Singles or duals. 500 ohm to 5 megohms. Approved for Type RV3, characteristic U, MIL-R-94 specification.

SERIES 47: 15/16" d. 0.5 watt. Linear or tapers. One tap, choice of three positions. Available with switch. Choice of shafts. Singles or duals. 500 ohms to 5 megohms.

SERIES 48: For miniaturization. 5/8" d. 0.2 watt. 500 ohms to 5 megohms, linear; or 2,500 ohms to 2.5 megohms, tapers. Singles or duals. Available with switch.

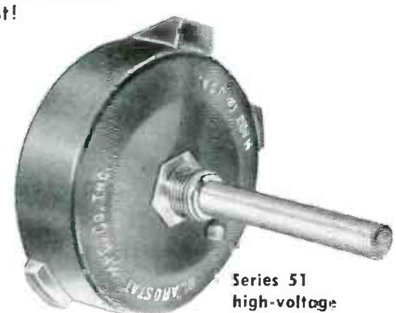
SERIES 51: For high-voltage high-resistance electronic circuitry. 1-17/32" d. phenolic case. 1 watt. 5,000 ohms to 50 megohms. 10,000 V.D.C. breakdown test between terminals and mounting bushing. Maximum operating voltage, 4,000. Tapers available.

And for **unusual needs**, Clarostat can design and put into production those special types—quickly, satisfactorily, economically — often based on ingenious adaptation of standard features and available tooling.

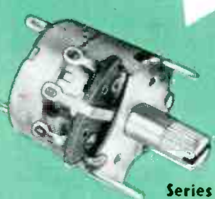
SEND FOR LITERATURE. Engineering collaboration, quotations and prompt delivery cycles, available on request!

Series 47.

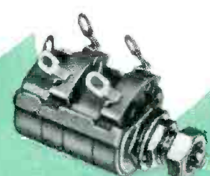
High-voltage couplers for use with elevated potentials.



Series 51 high-voltage high-resistance control.



Series 47S, with switch, and twist-tab mounted.



Series D48 dual control for miniaturization requirements.

CLAROSTAT®

Controls and Resistors

CLAROSTAT MFG. CO. INC., DOVER, NEW HAMPSHIRE

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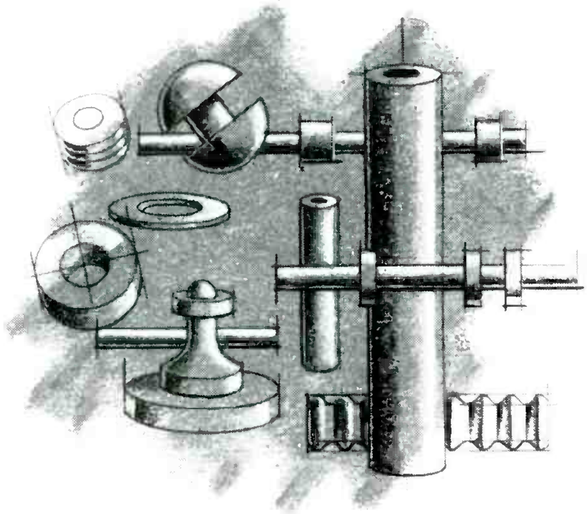
No need to settle for less than DIAMOND-HARD insulators and small parts!



New Centralab facilities cut cost of Grade L-5 Steatite Ceramic

NOW prices are lower than ever before on Centralab Steatite. So now you can enjoy its extra advantages — at substantial savings.

We're talking about Grade L-5 steatite — not slip-cast porcelain material or flower-pot clay. We're talking about Centralab's high-quality steatite that is harder than quartz — and provides low loss at high frequencies.

See for yourself that Centralab's new production equipment and methods can save you money on the small parts you use in volume, such as feed-throughs . . . coil forms . . . tubes . . . insulators . . . bobbins . . . igniter parts. Whatever their shape, whatever their size, ask us to quote on your requirements.

Here's a typical example:

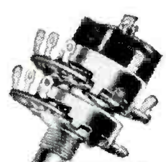
Shown actual size

$5 or less per thousand for this precision feed-through

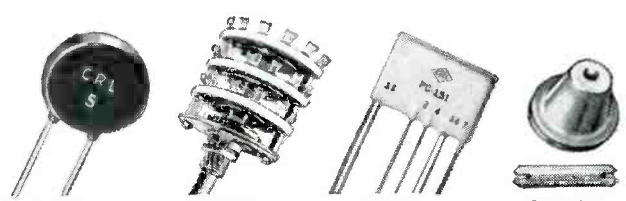
There's a gold-mine of know-how in Centralab's Ceramic Buyer's Guide, Bulletin 42-221. Refer to it in Sweet's Product Design File — or write for your personal copy.

More proof that if it's a job for electronic components, it's a job for Centralab

Centralab's advanced engineering continues to create the prototypes of the components industry



Volume Controls



Capacitors

Switches

Printed Electronic Circuits

Ceramics

†Nothing to buy. Employees of Centralab and their advertising agency not eligible. Duplicate prizes awarded in case of tie. Entries become the property of Centralab—none can be returned.

X-554

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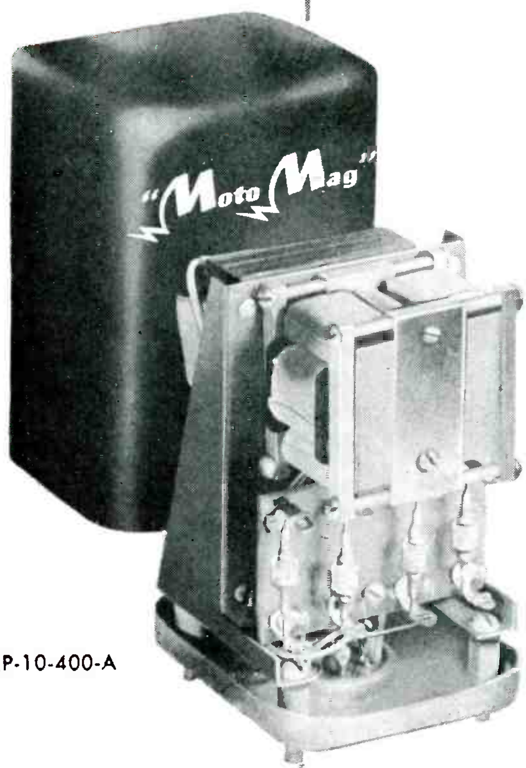
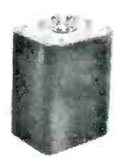
Better magnetic amplifiers can dramatically improve the performance of *your* product or control system. Write today for information on new, improved Keystone Moto Mags.

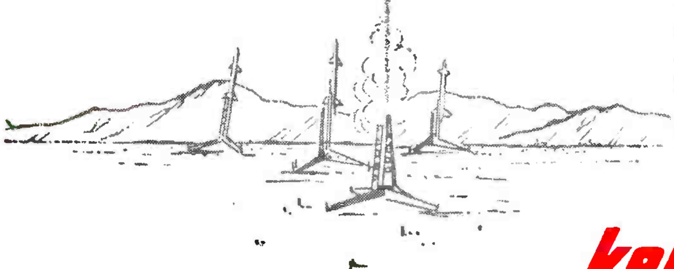


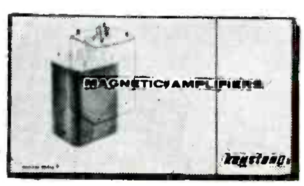
KP-10-400-A

KP-10-400



KP-10-410





Send for new magnetic amplifier catalog showing specifications, performance data and quotes.

keystone PRODUCTS COMPANY

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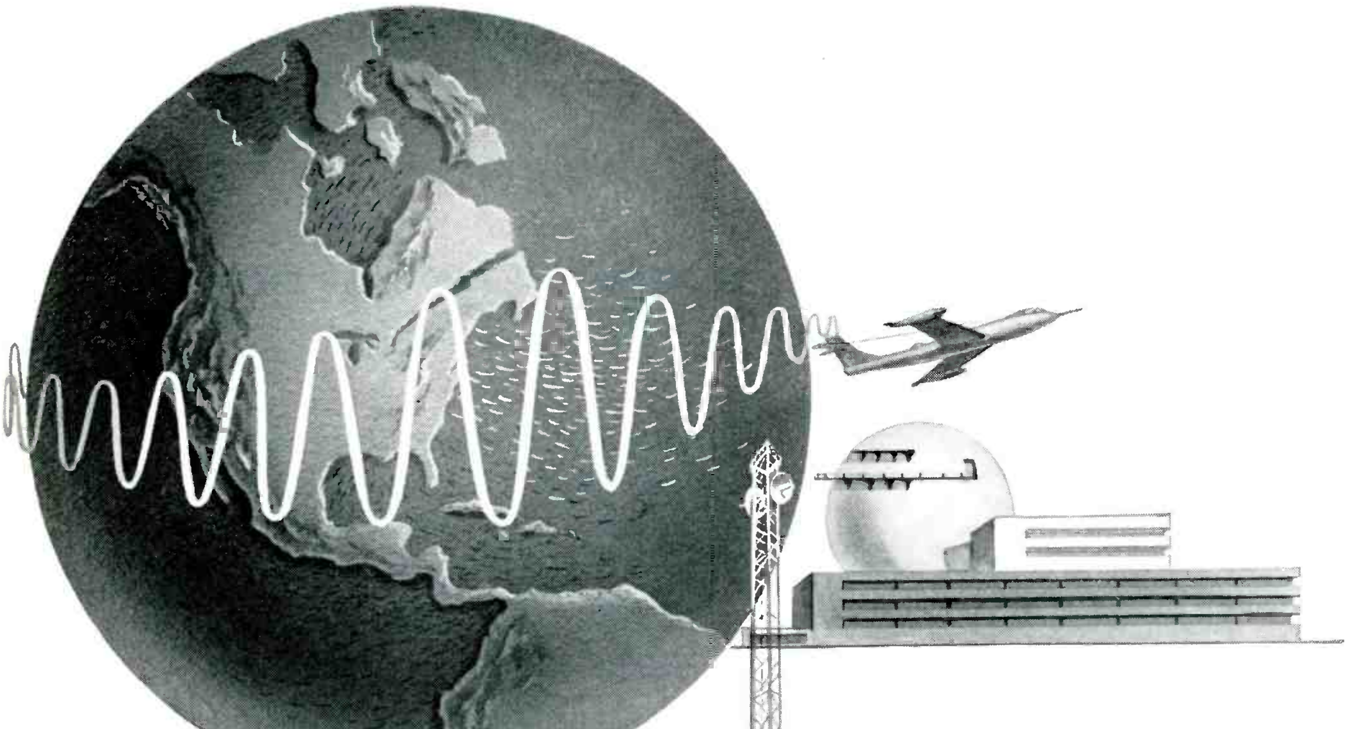
Communications



Opportunities exist at Ramo-Wooldridge for professional communications personnel in the following categories:

At Ramo-Wooldridge New Techniques in Communications Are Being Developed

In this age of fast moving transportation and shrinking distances, communication of ideas, plans, and actions becomes steadily more critical. New techniques are urgently needed to provide better means for transmitting information from point to point. Engineers and Physicists of the Communications Division of The Ramo-Wooldridge Corporation are applying advanced methods of system analysis to complex military communication problems. Basically new techniques are being developed to provide better answers to long standing needs for greater transmission capacity, better presentation of information, and higher system reliability in communication systems.

The military challenge of today sets the pace for the industrial development of tomorrow. New techniques in picture transmission, facsimile, information coding, and bandwidth compression are revealing new horizons in the world of communications.

ELECTRICAL ENGINEERS AND PHYSICISTS *qualified to conduct advanced analysis and development work in one or more of these fields: Video or radio frequency amplifiers, networks, pulse forming and shaping circuits, magnetic recording and reproduction, low and medium power transmitters, application of information theory, receiver design, communication and navigation systems engineering.*

MECHANICAL ENGINEERS *having from eight to fifteen years experience in the design and development of precision mechanical assemblies and electro-mechanical mechanisms. Experience in the design for production of miniaturized airborne communication equipment especially desirable. The minimum educational requirement is a B.S. degree in mechanical engineering.*

Consideration must be given to whether relocation of applicant will disrupt other important military work.

COMMUNICATIONS DIVISION

The Ramo-Wooldridge Corporation

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Over the twelve years that Fairchild has been making precision potentiometers — from our first unit (Type 736), on through the more than eighteen different types now in production — we have established and are carrying out a research and development program on new designs and materials, techniques and equipment that is constantly improving our potentiometer reliability. The results of this program are quickly applied to production units and these improved methods and designs are maintained by comprehensive quality control and type testing programs.

MAXIMUM RELIABILITY . . .

how do you get it?

Reliability in precision potentiometers resolves itself into three basic factors; longer shelf life, longer rotational life, and longer environmental life. Fairchild has increased the average shelf and rotational life expectancy of precision potentiometers far beyond usually expected life cycles, in one way, by compounding and using special potentiometer lubricants. Life expectancy and stability under abnormal operating conditions have been vastly increased through the use of precision-machined aluminum alloy case construction. Epoxy resin insulation, one-piece Paliney conductive springs and contacts, and precious metal alloy resistance elements, for certain applications, also contribute to increased life and functional reliability. Whether one or all of these factors of reliability are important to you, you'll do better to choose Fairchild Precision Potentiometers. For specific facts, write Fairchild Camera and Instrument Corporation, Potentiometer Division, 225 Park Avenue, Hicksville, Long Island, New York, Department 140-64A1.

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PRECISION POTENTIOMETERS

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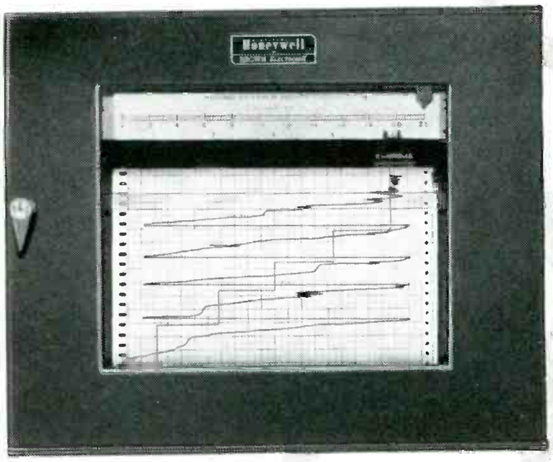
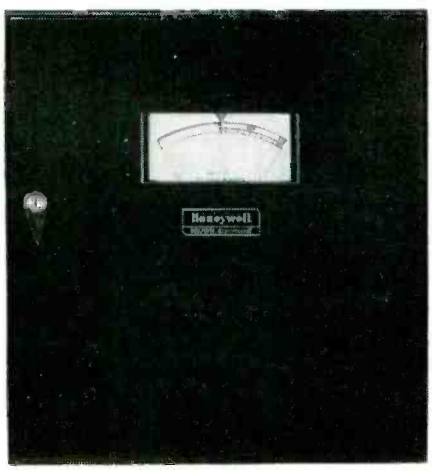


51 inches of chart width.

ElectroniK Extended Range Recorder has complete range of 10.2 millivolts, in five steps of 2.2 MV each. Overlap of 0.2 MV at end of span facilitates recording near the changeover point. Dual pens record the span reading and millivolts to be added. Pen speed is $4\frac{1}{2}$ or 2 seconds for span travel.



110 inches of indicating scale.

ElectroniK Extended Range Indicator gives resolutions up to one part in 5,000. Range is on five spans, which automatically change over when the measured variable reaches either span limit. Automatically positioned mask exposes only the correct span on the concentrically marked circular scale. Ranges calibrated in millivolts, pounds or other units are available.

want test measurements with 5 times greater readability?

WOULD an indicating scale or chart record five times as long as in conventional instruments be useful in your laboratory work?

That's what you get in these *ElectroniK* Extended Range instruments. They have five equal measuring spans. The instant the measured variable reaches either end of the span on which it is being measured, the instrument automatically switches to the adjoining range. You're thus able to watch a variable at full readability, across an exceptionally wide range of values, which in ordinary instruments would have to be compressed within the usual chart or scale width.

These instruments prove particularly useful in weight and force measurements with strain gages, and in scores of other tests where high resolution is essential. For a discussion of applications to your own projects, call your local Honeywell sales engineer . . . he's as near as your phone.

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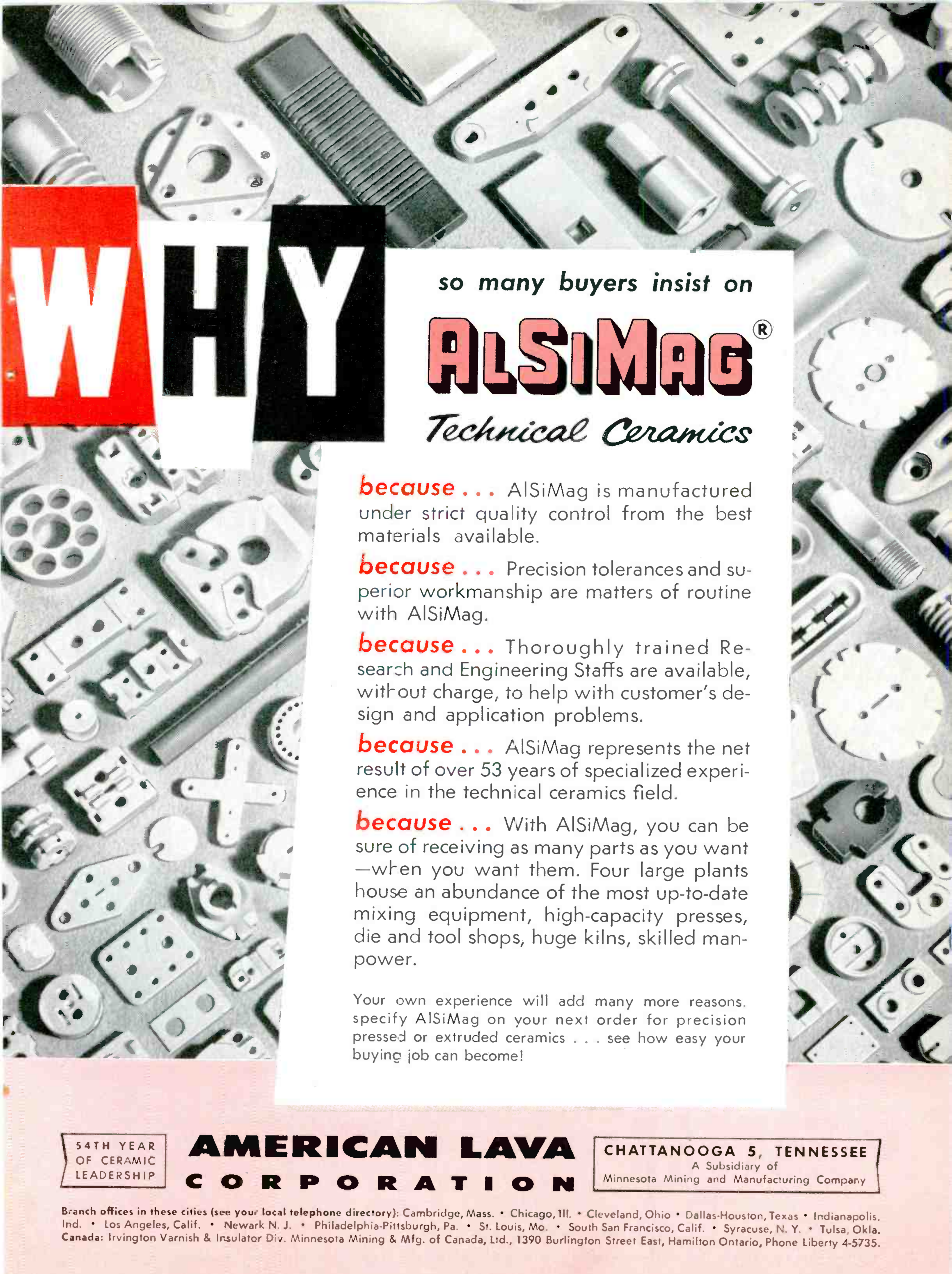
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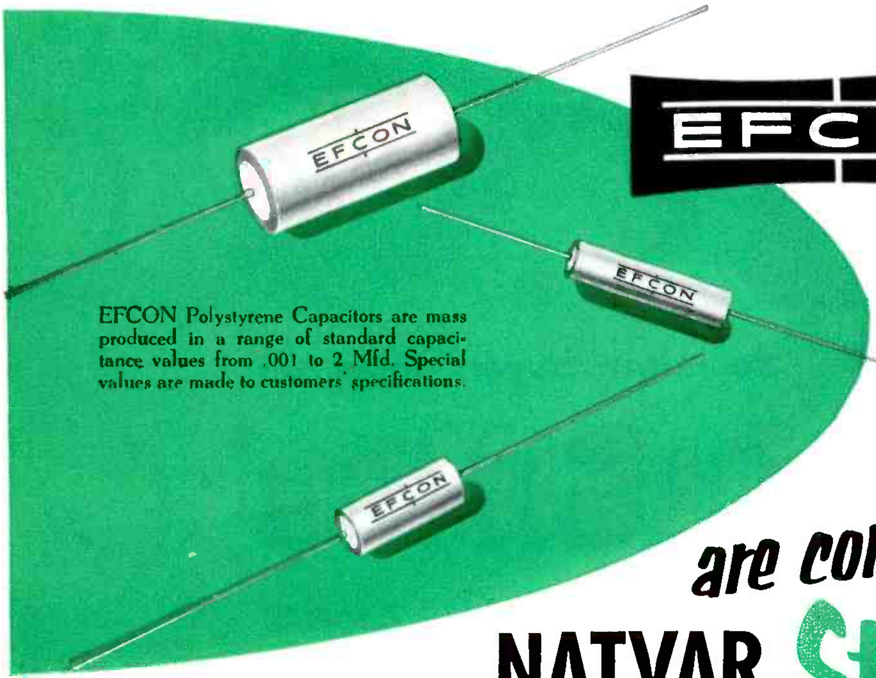

EFCON Polystyrene Capacitors are mass produced in a range of standard capacitance values from .001 to 2 Mfd. Special values are made to customers' specifications.

EFCON

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CLOSE TOLERANCE
MINIATURE
CAPACITORS

are constructed with

NATVAR Styroflex® FILM

EFCON Polystyrene Capacitors manufactured by Electronic Fabricators, Inc., New York, have become standard for the electronic industry. They were developed for uses where high insulation resistance, low power factor and low leakage are necessary. These miniature capacitors are used extensively for filters, timing circuits, computers, and similar applications where close tolerances are essential.

Temperature and humidity are closely controlled in the winding department, and air is filtered to protect against dirt, dust, or other contamination.

Each unit, from start to finish, is checked at least 5 times for voltage and capacitance before being shipped. In this step, capacitors are tested at DC voltages at least 200% of rated voltage at 25°C.

These polystyrene capacitors are made to tolerances closer than ± 1%. Their development was made possible by the application of Natvar Styroflex® dielectric due to its flexibility, toughness, and uniformity.

In fact a distinguishing characteristic of all Natvar flexible insulations is that they are always uniform and always the same no matter where purchased.

Natvar

Natvar Products

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Introducing...

the Eimac

4X250B

Radial-beam power tetrode

- ***Higher Power***
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- ***Longer Life***

ACTUAL SIZE

4X250B, a new, superior radial-beam power tetrode by Eimac—originators of the famous 4X150A—is now available. Unilaterally interchangeable with the 4X150A in practically all applications, this amazing new bantam for modulator, oscillator and amplifier application from low frequencies into UHF, offers these advantages:

HIGHER POWER—Electrical advances permit an increased plate dissipation rating of 250 watts, plate voltages to 2000 volts and doubled plate power input capabilities of 500 watts.

EASIER COOLING—Development of the Eimac integral-finned anode makes cooling so easy that only one-third the air-pressure and one-half the cubic feet of air are required. Forced air is unnecessary during standby periods.

LONGER LIFE—A newly designed, highly efficient oxide cathode and increased temperature tolerances, coupled with Eimac-developed production and testing techniques enable the 4X250B to meet the most critical standards. New techniques in grid production, high vacuum outgassing and product evaluation are among the features that insure uniform incomparable quality and more hours of top performance.

The small, rugged, versatile 4X250B is now available for existing sockets or sockets of yet-to-be-designed equipment demanding optimum quality and performance.

TYPICAL OPERATION

(per tube, frequencies to 175mc)

4X250B radial-beam power tetrode

	Class C CW FM Phone	Class C AM Phone	Class AB RF Linear
D-C Plate Voltage	2000v	1500v	2000v
D-C Screen Voltage	250v	250v	350v
D-C Grid Voltage	-90v	-100v	-60v
Zero Sig D-C Plate Current	—	—	50ma
D-C Plate Current	250ma	200ma	250ma*
D-C Screen Current	12ma	10ma	5ma*
D-C Grid Current	22ma	23ma	0ma*
Peak RF Grid Voltage	114v	125v	60v*
Driving Power	2.5w	2.9w	—
Plate Power Input	500w	300w	500w*
Plate Power Output	400w	240w	325w*

*Maximum Signal

For further details contact our Technical Services Department.

Eimac

EITEL-McCULLOUGH, INC.

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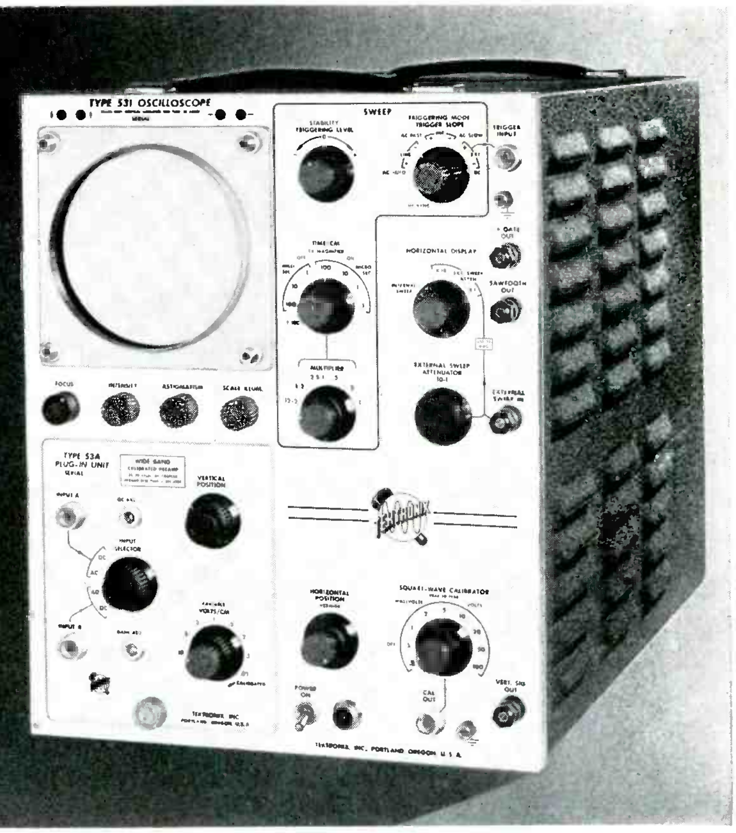
5 BIG REASONS why you should own this oscilloscope



The Tektronix Type 531 Oscilloscope is far ahead in performance characteristics, and is capable of a much wider range of applications than the ordinary general-purpose laboratory oscilloscope.

1 THE TYPE 531 EXCELS *in vertical-amplifier characteristics*—with the Type 53B Plug-in Preamplifier it offers accurately calibrated sensitivity to 0.05 v/cm from dc to 10 mc, 0.035-μsec risetime... to 0.005 v/cm from 5 cycles to 9 mc, 0.04-μsec risetime.

2 THE TYPE 531 EXCELS *in sweep characteristics*—Miller-runup circuitry generates linear sweeps in the extremely wide range of 0.02 μsec/cm to 12 sec/cm (600,000,000-to-1 ratio), with 24 accurately calibrated sweeps from 0.1 μsec/cm to 5 sec/cm. 5x magnifier is accurate on all ranges.

3 THE TYPE 531 EXCELS *in triggering facilities*—offering amplitude-level selection, automatic triggering, and 30-mc sync in addition to all standard triggering modes.

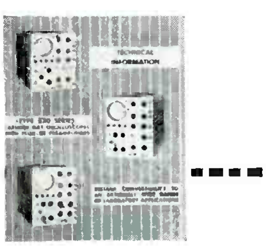
4 THE TYPE 531 EXCELS *in writing characteristics*—new Tektronix precision metallized crt with 10-kv accelerating potential provides high brightness, improved focus, and excellent linearity. (Recorded writing rate exceeds 175 cm/μsec).

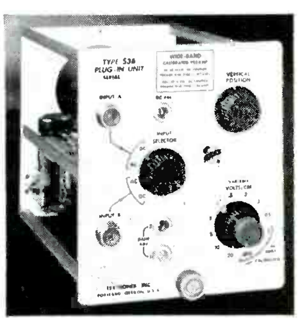
5 THE TYPE 531 EXCELS *in versatility*—Quick change plug-in preamplifiers and inherent oscilloscope capabilities combine to convert the Type 531 to applications normally requiring separate highly-specialized instruments. Available plug-in units provide for dual-trace... low-level differential... wide-band differential... and micro-sensitive applications in addition to wide-band high-gain applications. Current development work promises greatly-extended capabilities through new designs in plug-in units.

Type 531 Oscilloscope—$995

Type 53B Plug-In Unit—$125

prices f.o.b. Portland (Beaverton), Oregon





New 16-page booklet contains full specifications on the Type 531 and Type 53B, as well as all Plug-In units and other Oscilloscopes in the Type 530 Series.
Please call your Tektronix Field Office or Representative, or write direct for free copy.

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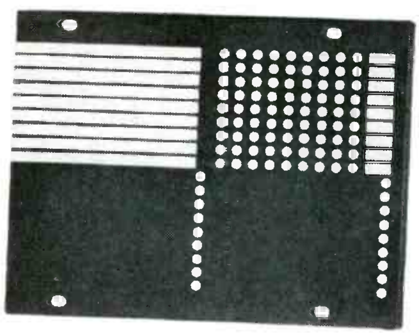
Why the leaders choose **RESINOX* 3700**
for molding profit-making electrical parts

Arrow-Hart & Hegeman are making profitable use of critical electrical parts molded of Resinox 3700 in their combination starter where high arc-resistance is a must.

Wells Manufacturing ignition coil top molded of Resinox 3700 outperformed all others in racing car tests on Utah salt flats. Because of Resinox 3700 no spark power was lost at speeds up to 140 m.p.h.



IBM specifies Resinox 3700 for cross bar emitter —and cuts production costs of this vital "Check Prover" part in half because Resinox 3700 has outstanding dimensional stability.

American Bosch uses this distributor plate molded of Resinox 3700 where its superior arc-resistance is giving top performance in the field. (Part made for them by Specialty Insulation Mfg. Co.)

THE PREFERENCE FOR RESINOX 3700 grows every day. This thermosetting mineral-filled molding powder was developed by Monsanto for superior performance in magneto ignitions, motor control and transmission circuits, and countless other electrical applications. • It combines high arc-resistance with outstanding dimensional stability. • It eliminates undesirable after-shrinkage. • Its moldability is excellent and its impact resistance is good. • It has good transfer molding properties. • It offers superior heat resistance. For full information on Monsanto's Resinox 3700, write today to Monsanto Chemical Company, Plastics Division, Dept. E7, Springfield 2, Massachusetts.

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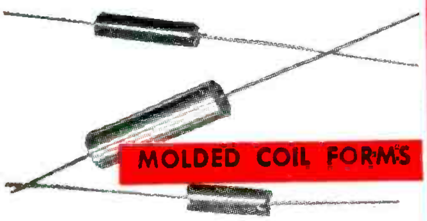
Moldite Core "Standards"

They are precision mixed, precision made, and precision controlled for every electronic use.



Give your products the advantages of MOLDITE Core Standards that offer you . . .

ECONOMY	INTERCHANGE-ABILITY
AVAILABILITY	HIGH QUALITY
UNIFORMITY	FLEXIBILITY

MOLDITE "WROTE THE BOOK" for IRON CORES

MOLDITE'S record of performance for the past ten years in producing millions of cores, coil forms and ferrites has contributed substantially to the accomplishments of the electronic industry.

To check with MOLDITE is a Must, because only MOLDITE leads in all three . . . iron cores, coil forms and ferrites.

MOLDITE *iron cores, ferrites* and *molded coil forms* (iron and phenolic) are being selected for use in high quality equipment by all leading television, radio and electronic manufacturers as well as all branches of the Armed Forces. Only MOLDITE makes them all . . . for your service and convenience. One source for all three — iron cores, ferrites and molded coil forms.

We are particularly proud of a Certicate of Cooperation awarded us by the U. S. Foreign Operations Administration for furnishing technical assistance.

Our success is measured by the ever increasing number of loyal satisfied customers. MOLDITE'S quality, service and spirit of progress sets the keynote for tomorrow. No specification is too difficult, no order too small, no requirement too rigid. The MOLDITE label is your guarantee of complete satisfaction.

MOLDITE'S world-wide reputation is a result of . . .

1. Creative research and engineering.
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3. High quality mass production facilities
4. Modern core manufacturing facilities for precision molding.
5. Exclusive, specially designed, press controls.

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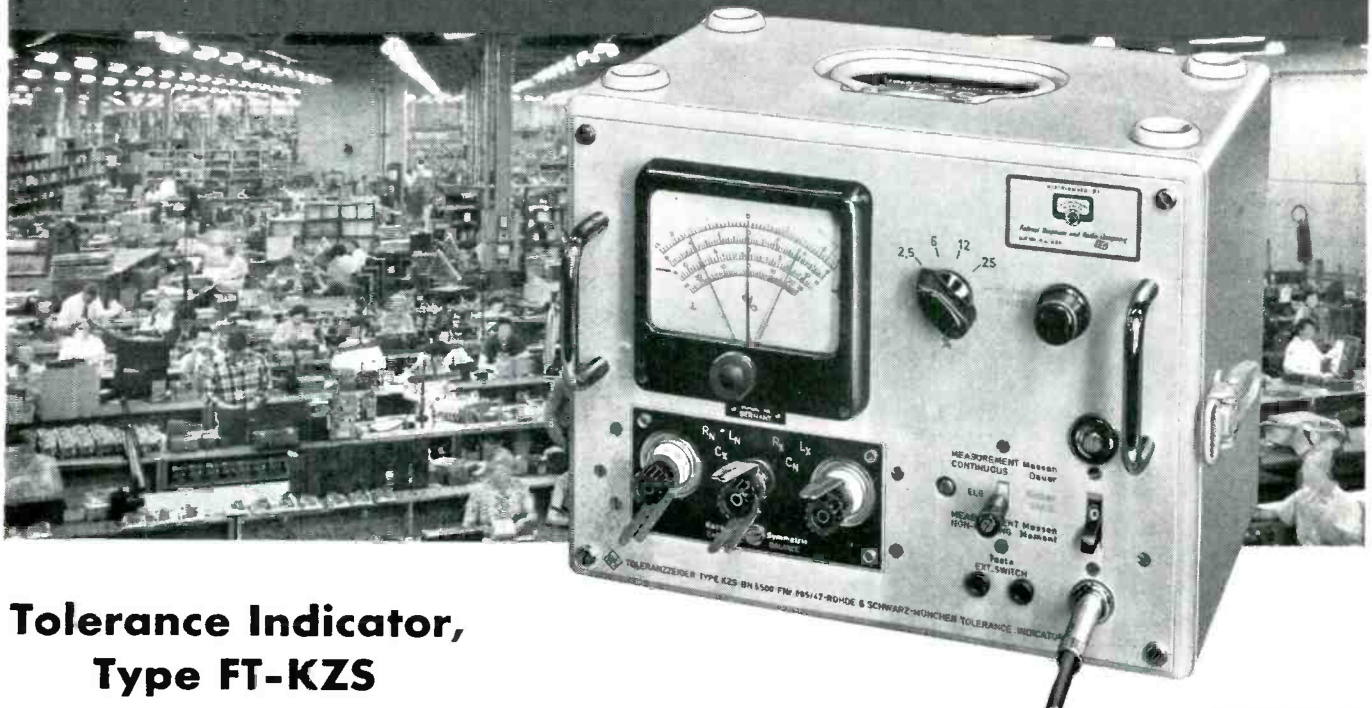

Tolerance Indicator, Type FT-KZS

Accelerates incoming inspection...Simplifies component testing...Improves "Quality-Control"

INSTRUMENT DIVISION

A precision unit designed for production testing, the Tolerance Indicator, Type FT-KZS, reduces the cost of checking electrical components to a bare minimum. Large and small quantities of resistors, condensers, and inductors are checked against standards with a minimum of effort. The indicating meter is provided with two manually-adjustable pointers with which the required tolerance limits can be set. As no judgement is required by the operator, his work can be done at maximum speed.

With four tolerance ranges (±2.5, 6, 12, and 25%) the Tolerance Indicator checks components of all normally-used values. It is ideally suited for production use because of its compact, self-contained design, its ease of operation, and its rugged, reliable performance. Its sensitivity and stability are sufficiently great to permit a separate accessory meter to be used to give a full-scale deflection for differences of 0.5% (0.01% per division).

Important applications include rapid matching of components for use in critical circuits, tracking of ganged condensers and precision potentiometers, and locating of winding center taps. The Tolerance Indicator has also found wide acceptance for measuring the temperature coefficient of resistors and capacitors.

FEATURES:

- Simplicity . . . Accuracy . . . Speed
- Rugged, fully protected from overload
- Adjustable limit indicators eliminate meter reading
- Checks wide range of components
- High sensitivity and stability

SPECIFICATIONS:

Tolerance Ranges: .... ±2.5, 6, 12, and 25% full-scale.

Impedance Range:

Resistance .... 10 ohms to 1 megohn.
Inductance .... 100 μh to 2 mh.
Capacitance .... 10μμf to 1 μf.
(1 μμf to 10 μμf using correction factor as supplied).

Accuracy: .... ±5% of full-scale reading.
Measuring Voltage: .... 1 volt.
Measuring Frequency: .... 17 kc.

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Federal Telephone and Radio Company, *A Division of*
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☐ Please send further information on Tolerance Indicator.
☐ Please send latest Instrument Catalog.

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Company ____________________________________
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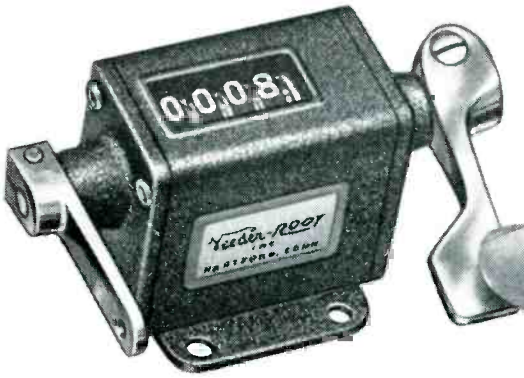
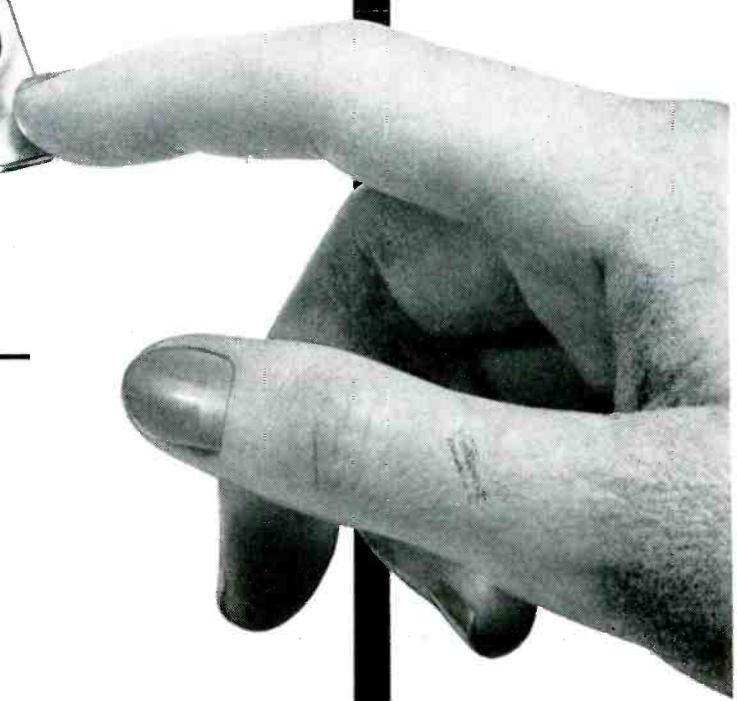
Quick Lever Reset





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Where time consumed in resetting is at a premium . . . on short machine-runs, inspection, military equipment and other applications . . . this new time-tested Quick-Reset Ratchet Counter is exactly the time-saving device you need. Just depress the easy-acting lever on the right side through 45° . . . *all 4 figures reset instantly to zeros*. And a thumb-lever may be used on the left side also if the counter is to be operated manually.

This compact, standard counter, now readily available from stock, is one of scores of Veeder-Root Counters (both standard and special) for manual, mechanical and electrical operation in every field from electronics to atomics. Just name what you want to count . . . and "The Name that Counts" will help you do the job. Write:

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Fastest Delivery
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of 64
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AN EXAMPLE:

N.J.E. Laboratory Grade

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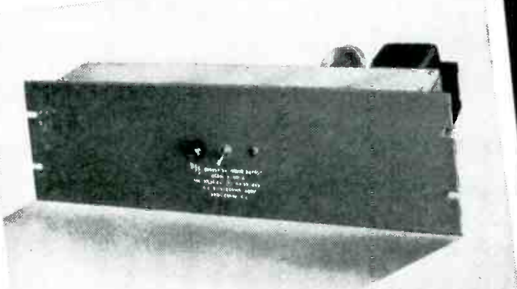

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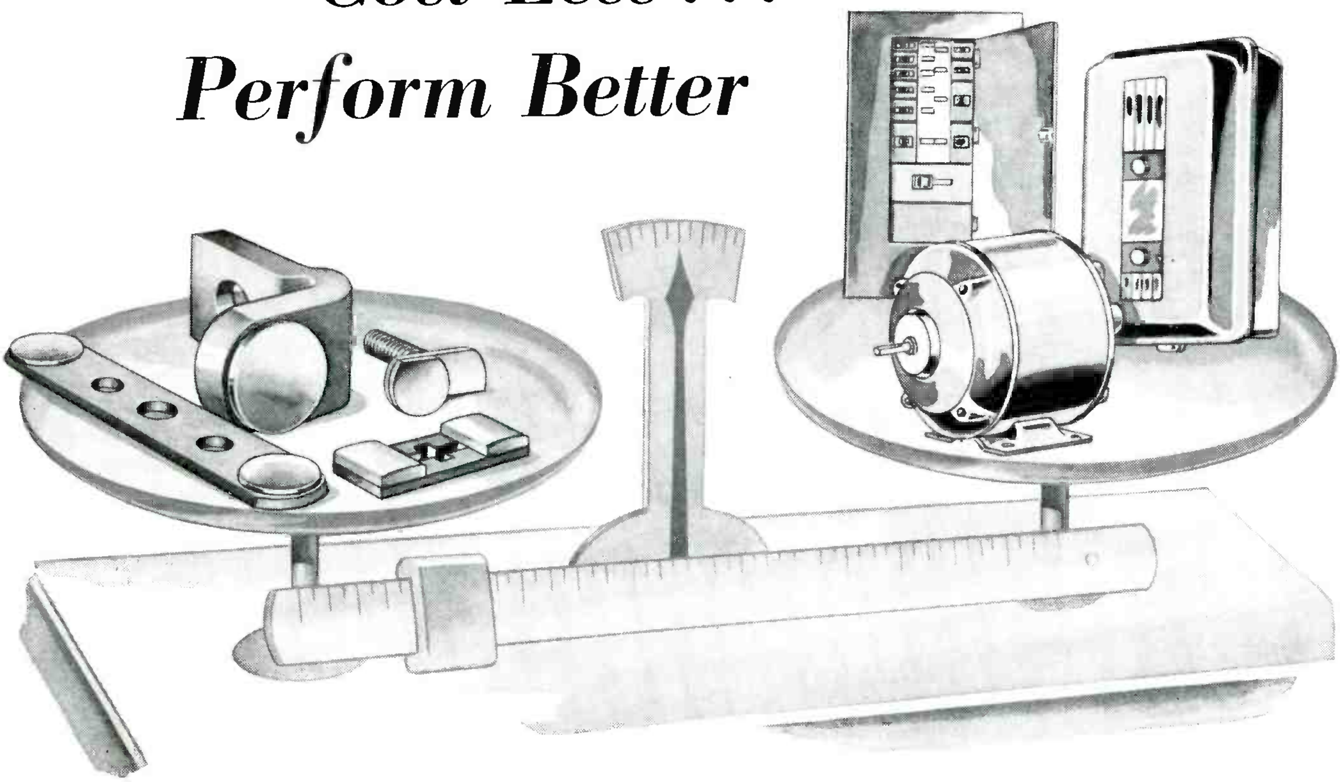

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electronics

W. W. MacDONALD, Editor

JULY • 1955

CROSS TALK

▶ **BROADCASTING BOILDOWN** . . . Most broadcasters are making money and expect to do well in the future. This was apparent at the NARTB convention in Washington.

Preoccupations of the group appear to be political, economic and technical, in this order.

On the political front there is some concern about the current interest of Congress in programming, time for candidates eyeing 1956 elections and the ratio of advertising to editorial material. Consensus of opinion seems to be that any investigation of program content would disclose that it is pretty good, that advance planning and early announcement of schedules available for campaign speeches can avoid most partisan criticism and that the industry's major point of vulnerability is its sequential handling of commercials rather than their length.

Television economics are not yet a matter of great concern to most operators of established vhf stations because this group is riding near the crest of the competitive wave; here most thought is being given to finding ways and means of preventing sponsor costs from going still higher. Operators of uhf stations are hoping pending proposals before the FCC for higher power or boosters or satellites or all three will be approved and sweeten the financial picture. Radio stations operating in the a-m band are now rapidly learning to compete with television by relying more upon local programming and less upon the networks, and are effecting economies by adopting many new types of equipment. The f-m stations see possible daylight in newly authorized systems permitting transmission of auxiliary services on their existing frequencies.

Technically, interest is running high among tv station management in simplified and improved studio gear, and they are closely watching the development of video tape recorders. The a-m radio men seem particularly interested in remote control and automatic programming devices. The f-m men appear to be equally interested in multiplexing systems and are looking for methods of making this comparatively unknown media pay off now that the work of the engineer is largely complete.

All in all, broadcasters feel they are doing a good job of rendering a free service to the public, if it is indeed free. Their keynote speaker pointed out that while stations have so far spent about $400 million, advertisers have contributed $3 billion and the public has paid $15 billion for sets.

LOOKING AHEAD . . .

Engineer shortage is more severe in our industry than in most others but we think we see signs of it easing. Some shortages are more apparent than real

Look for expansions in the recording-tape business. Tape has a particularly bright future because applications are rapidly expanding not only in communications but also in science and industry

Military pilots may soon see friendly planes as green blips, hostile ones in red. Several firms are working on color radar

The coherer, familiar to oldtimers of the wireless days, may be set for a comeback . . . as a storage element for computer memories

Loading hopper of vibratory work feeder at input of test setup using 1-kc capacitance limit bridge. Disks slide down slanting tube one by one and go through roller-type contacts under table. Four rows of 0-9 buttons at left on panel set capacitance value to four digits. Buttons at right give 0 to 99 percent high limit and 0 to 49 percent low limit for desired tolerance

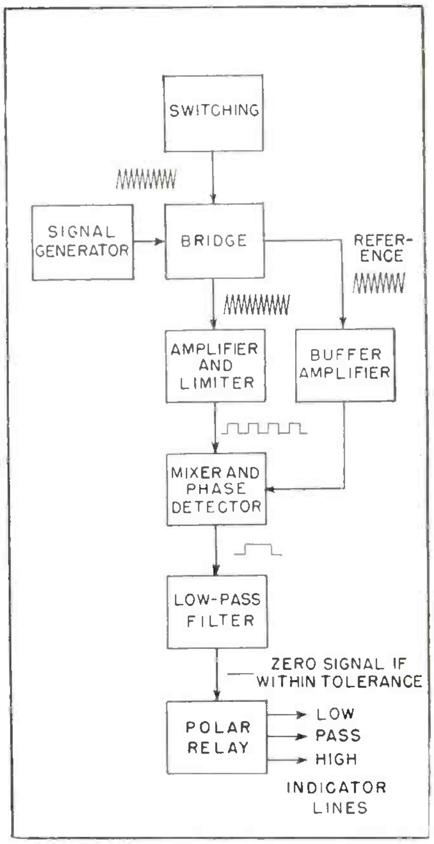


FIG. 1—Capacitor disk under test forms one leg of a-c bridge in which a different leg is automatically switched between desired tolerance limits of preset capacitance to give waveforms shown

Automatic A-C Bridges

It is often advisable to test ceramic capacitors at different stages of production as well as after production. Such extra tests save material and labor as well as increase the efficiency of production facilities.

To be profitable, the measurement system must provide accurate indications rapidly. High accuracy allows a greater number of borderline components to be saved and gives better control in manufacture. High speed reduces duplication of equipment. An indication which lags the insertion of the capacitor in test terminals by 0.1 sec is adequate for mechanical handling devices thus far encountered.

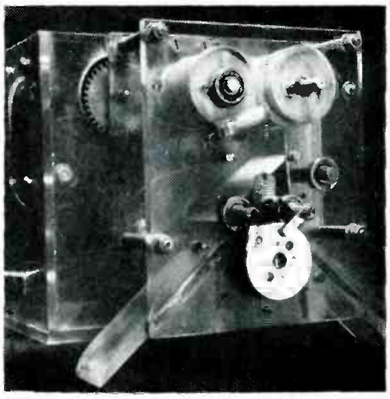
The measurement device to be described gives a high-pass-low capacitance indication so that capacitors within a specified tolerance can be checked. Where more than one tolerance is to be checked, as for example ± 2 percent and ± 5 percent, the measurement devices can be cascaded.

In addition to production requirements, there are generally environmental conditions. The measurement of capacitors between 0.001 μf and 1.0 μf should be made with a 1,000-cps signal, such that between 4 and 8 v rms are applied to the capacitor. Unsymmetrical tolerances are often specified, such as −0 percent and +50 percent.

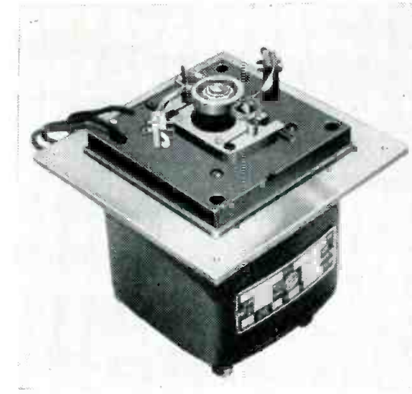
Measurement of capacitors below 0.001 μf is usually made with a 1-mc signal such that between 0.5 and 5 v rms are applied to the capacitor. Generally, symmetrical tolerances are specified for capacitors in this range.

Principle of Operation

As one component is varied so that the bridge passes through an exact balance, the bridge output voltage is abruptly phase-shifted 180 degrees. Large variations in output amplitude naturally occur; however, if amplitude variations are obscured by an avc effect, phase detection of the output signal provides a well-defined indication of a measured component relative to the value of bridge balance. Specifically, if the bridge is set to bal-



Disks are measured as they drop down between roller-type contacts driven by motor at speed just slow enough to give time for setting sorting gates below



Closeup view of motor-driven switch that switches bridge from high-limit to low-limit standards at rate of 30 times per second to check tolerance

Front panel of 1-mc bridge used for checking low-value disk capacitors. Here only one set of tolerance buttons is used, for 0 to 49 percent

SUMMARY —— Production test set cuts costs by checking capacitance values of silvered ceramic units before leads are attached. Batches of disks dumped into hopper are sorted into high, pass and low bins at 7,000-per-hour rate with accuracy better than 0.5 percent. Desired capacitance and tolerance limits are set up by pushbuttons

By J. L. UPHAM, JR.
Gulton Mfg. Corp.
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Sort Ceramic Capacitors

ance at a capacitance value C_x, capacitors greater than C_x will generate a positive voltage from the phase detector while those less than C_x will generate a negative voltage.

In the above system, if the bridge balance value is periodically changed from C_x to C_x', there are three possible signals from the phase detector. If the measured capacitor is less than C_x and C_x', a continuous negative signal is generated. If the measured capacitor is greater than C_x and C_x', a continuous positive signal is generated. If the measured capacitor is between C_x and C_x', a square wave, alternately positive and negative, is generated. A low-pass filter rejects the square-wave signal, so that a zero signal appears at the filter output for units within tolerance.

The general arrangement of the test system is given in Fig. 1. The waveforms shown were taken from the 1-kc equipment while measuring a capacitor within tolerance, but closer to one limit than the other. The signal generator provides a driving signal for the bridge circuit.

In the simple bridge circuit used, each of the four arms of the bridge performs a function. Arm X is the section in which the component to be measured is inserted. Arm B is adjustable over a broad range and is set according to the nominal value of the component to be measured. Arm S is a constant reference for the reactive measurement, but provides an adjustable loss in order that a true null be obtained. Arm A, adjustable in terms of percent deviation from bridge balance, consists of two components that are alternately inserted in the bridge. The value of one section is adjusted in terms of percent below bridge balance, and that of the other in terms of percent above balance.

For one position of the bridge switching, balance occurs for a component whose value is greater than that entered in arm B by the amount entered in arm A. For the other switch position, balance occurs when the component value is less than that entered in arm B

by the amount entered in arm *A*.

The bridge output signal is of widely varying amplitude. The amplifier-limiter stage serves as a wide-range avc to provide a signal which is in phase with the bridge output, but of constant amplitude.

The mixer stage in Fig. 1 is functionally a phase detector, but operationally is a mixer or modulator in which the difference frequency signal is finally used. When the two signals being mixed are of the same frequency, the difference frequency is zero and the mixer output is a d-c signal whose magnitude and polarity are related to the cosine of the phase difference of the two input signals.

The second signal driving the mixer is a reference. Depending on the bridge configuration used, this signal is taken directly from the bridge input or from a circuit associated with the bridge. In either case, the amplitude of this signal is substantially constant and sufficiently large that its immediate injection in the mixer is prevented only because of a possible regenerative loop consisting of the bridge, amplifier-limiter and mixer. A buffer stage is therefore necessary in this link.

The usable output of the mixer stage is a constant which may change abruptly with the bridge switching. If the measured component is above the high tolerance, a continuous signal which can be called positive results. If below the low tolerance, a continuous negative signal results. If within tolerance, an alternately positive and negative signal which follows the bridge switching is generated. The signal at the mixer output point is a rectangular wave of current originating from a high-impedance source, but because of the capacitive load of the filter, the voltage waveform is triangular.

Low-Frequency Bridge

The circuit of the 1-kc bridge system is given in Fig. 2. The oscillator of the signal generator is a somewhat elaborate version of a simple phase-shift oscillator. At the frequency of oscillation a 180-degree phase shift occurs through the lattice. This supports oscillation. The characteristic which limits the amplitude of oscillation is the plate rectification which occurs as the plate swing tends to exceed the supply voltage. The result is a lowered d-c plate voltage which is coupled resistively to the grid and an increased cathode voltage as a result of the higher d-c plate current. An increasing a-c voltage thus increases the grid bias.

The oscillator drives a simple class AB_1 power amplifier. This section generates more power than is necessary for the bridge operation, but a signal source of low impedance is desirable to prevent large variations in the signal amplitude applied to the capacitor under test.

The measurement circuit of Fig. 2 is basically a resistance ratio bridge with a floating signal source and a grounded output. The R_A arm is the section in which the high and low tolerances are introduced. The low-limit portion performs the function of a potentiometer, while the high-limit portion is a variable

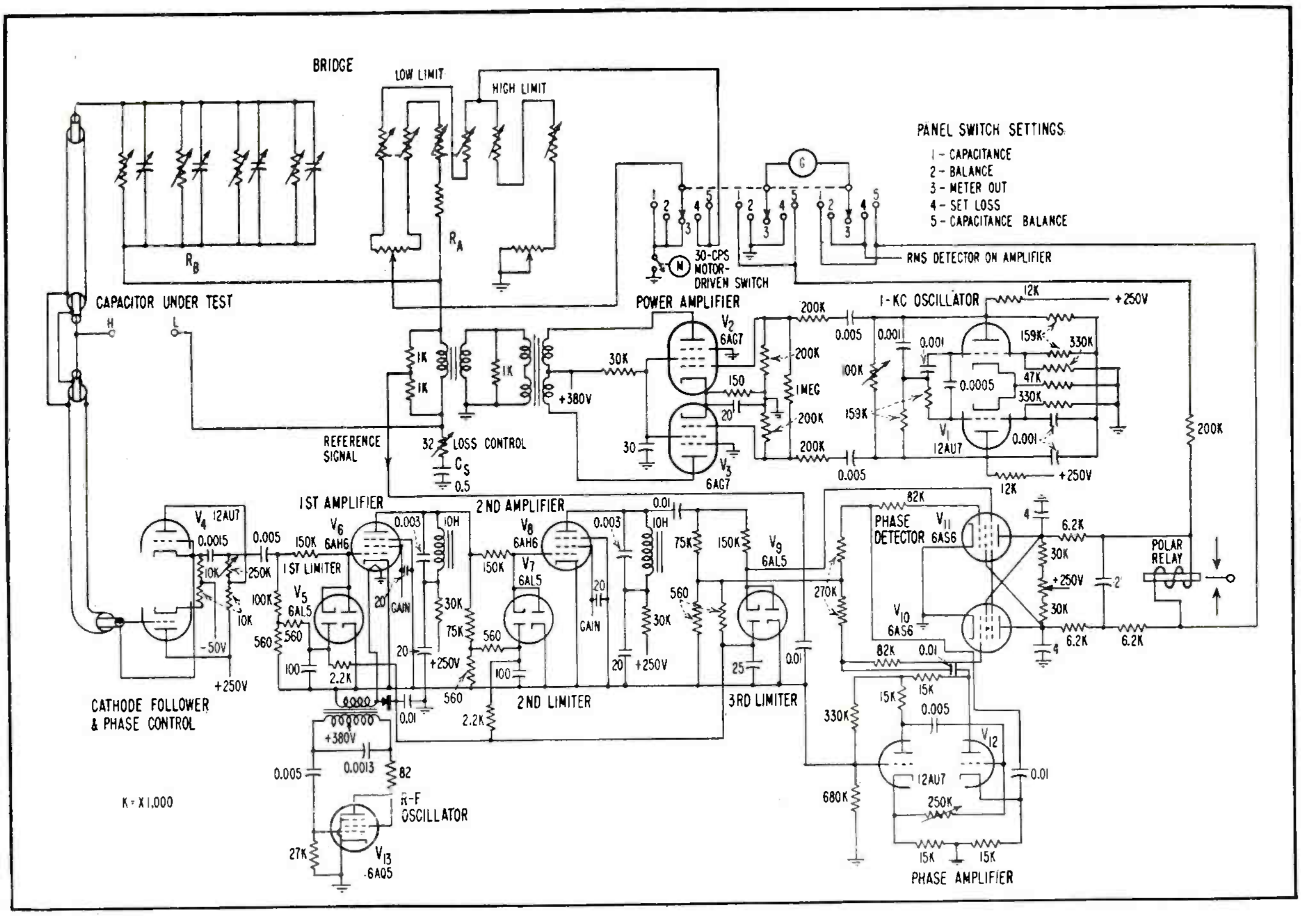


FIG. 2—Circuit of 1-kc limit bridge. Capacitor under test goes into bridge network at upper left. Polar relay controls sorting

resistance. This construction reduces the switching operation to a grounding of the movable arm of the potentiometer in the low-limit section. This is done at 30 cps by a motor-driven switch.

The C_S arm consists of a standard 0.5-μf capacitor and a loss control. The relatively large value of capacitance was chosen so that a reasonable accumulation of stray impedance in parallel can be tolerated without seriously changing its effective value.

The R_B arm is a decade conductance with values such that its conductance is equal to the admittance at 1 kc of nominal capacitance entered on the panel control.

This latter arrangement provides the highest bridge sensitivity and requires a similar relation between the R_A and C_S arms. Thus the zero-percent value of R_A is the reactance of the 0.5-μf capacitor at 1 kc or 418.31 ohms. These conditions apply a 6.3-v signal on a capacitor of nominal value when the bridge is powered by its normal 9 v.

The reference signal is taken from a center tap of the bridge supply in order that its phase may track that of the bridge output.

The R_A-R_B circuit of the bridge provides a d-c ground connection for the bridge output. This condition allows the omission of a grid-leak resistor in the first stage of the detector. This omission is desirable since the inclusion of a safe grid leak (1 megohm) can cause harmful phase shifts when measuring low-value capacitors.

Amplifier-Limiter

The function of this section of the equipment is to convert the bridge signal to a signal of essentially constant amplitude which tracks the phase of the bridge signal. Since 1/60 second is allowed for measurement at each limit, this section must provide a coherent signal within 3 milliseconds of its application to the input.

The minimum input signal is 0.5 mv, while the maximum is approximately 7 v. Freedom from blocking and rapid recovery from large signals are thus major requirements.

The bridge output feeds cathode follower V_4 which provides a high input impedance. The cathode is connected to the intermediate shield of a double-shielded cable to decrease the loading effect of the cable.

A phase-shift network, also using V_4, is followed by alternate limiter and amplifier stages. Phase adjustment is necessary since the reference signal tracks the bridge output in quadrature. These signals must be brought in phase for proper operation of the phase detector. In addition, the minor phase shifts which occur in signal transmission require correction.

In employing successive amplification and limiting, interstage coupling must be fairly high to avoid phase shifts between signals which are limited and those which are not. In employing high coupling, however, care must be taken to avoid a condition which allows a large grid bias to develop. Such a condition can arise because of grid current flow or plate rectification.

In the circuit of Fig. 2, plate rec-

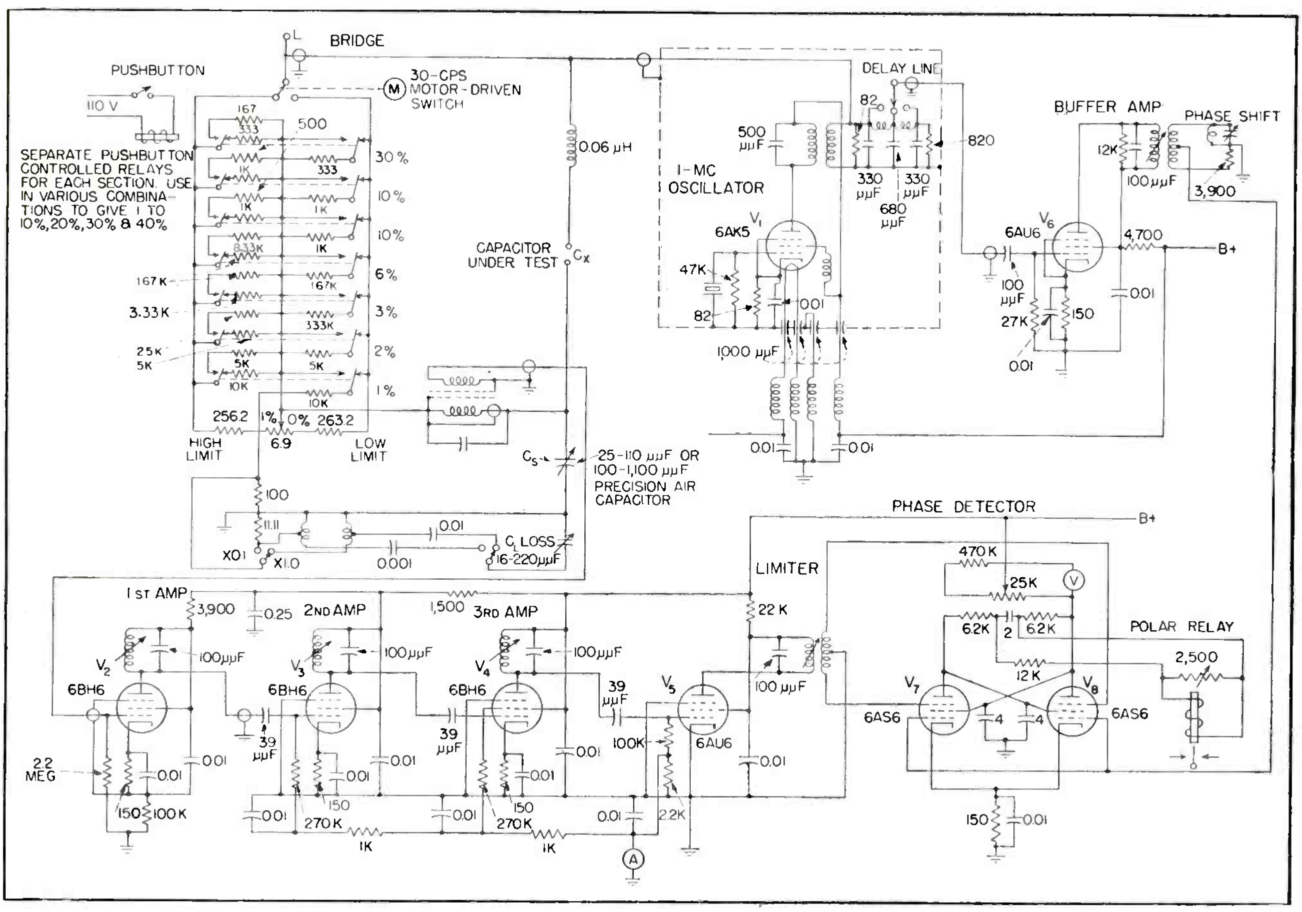


FIG. 3—Modified circuit using 1-mc signal source for sorting low-value capacitors

tification is avoided by using a tuned circuit which connects the plate directly to the plate supply. The tuned circuit is broad-banded by close coupling to a relatively small resistance. This arrangement provides a correction so that limited signals and sine wave signals are transmitted with the same phase shift and also provides a rapid discharge path for any bias which may develop across the coupling capacitor.

The output signal of 3rd limiter V_9 is a 1,000-cps square wave of approximately 4-v peak-to-peak amplitude.

With the filament of the first limiter energized by the main supply, a 60-cps pulse train was transmitted, producing an instability in the region of transition. The alternatives to a 60-cps supply are a d-c or r-f source. The r-f source was chosen to save weight and space.

The r-f filament voltage from V_{13} is also rectified to provide a low impedance bias source for V_6.

Reference Signal

The reference signal is taken from a voltage divider across the bridge supply. This is done because the phase of the voltage at this point tracks the phase of the bridge output as the tolerances are changed. This signal is fed through an adjustable phase shift and a phase inverter to the final stage of the detector.

A phase adjustment is included in this loop which augments that of the amplifier, bringing the effective phase control nearly to 360 degrees. The phase inverter is used to generate the necessary signals for the operation of a phase detector. These two stages serve also as buffers to prevent a possible feedback from the amplifier-limiter through the phase detector to the reference line and finally through the bridge to the amplifier-limiter.

Phase Detector

Phase detector V_{10}-V_{11} is a conventional balanced modulator except that variations in screen current are added to those of the plate current by cross-connecting. This step results in about half again as great a differential current. The screen connection is similar to a multivibrator circuit, with sufficiently low plate-to-plate load so that regenerative action is not appreciable.

The single-ended constant-amplitude bridge signal and the constant-amplitude balanced reference signal are applied as inputs. The push-pull output is filtered and applied to a three-position polar relay which in turn controls two power relays that turn on panel lamps and ground appropriate panel jacks.

Operation

In positions 4 and 5 the panel switch eliminates the 30-cps switching action and allows the bridge to function in a conventional manner. In this condition, by balancing the bridge with a representative capacitor of those to be tested in the measurement arm, a proper loss setting is accurately entered.

To achieve balance in this operation, the bridge circuit is altered so that the high and low limit readings are additive. If a high indication appears as the limit arm is changed, a greater high limit is entered; if the indication is low, a greater low limit is entered. When a pass indication is achieved, the bridge is sufficiently near balance to employ an rms indication. In position 4, the panel meter indicates the rms voltage at the plate of the final bridge signal amplifier; by manipulation of the limit and loss controls, this reading can be brought to zero.

With the panel meter in positions 1, 2 or 3, bridge switching occurs, the desired tolerances can be entered, and limit measurements can be made.

High-Frequency Bridge Circuit

For measurements at 1 mc a somewhat different circuit is used, as shown in Fig. 3. The reduced power requirement on the signal generator allows use of a simple tri-tet or electron-coupled circuit. Crystal control is employed more to obtain simplicity than stability. The degree of isolation afforded by the tri-tet operation is sufficient to prevent the oscillator from dropping out due to varying load conditions. The cathode bias protects the oscillator tube if the crystal is removed.

Plate and filament supply filters for this stage are necessary to avoid introducing a spurious signal into the detector.

The basic measurement circuit is again a resistance ratio bridge. Here, however, since a tuned transformer does not excessively load the bridge, a grounded signal source is used and the bridge output is obtained through a doubly shielded tuned transformer.

To avoid excessively large stray inductive and capacitive reactances the R_A arm consists of seven relays along parallel low-impedance open-wire transmission lines. These relays, controlled from the panel, insert proper conductance values for the required tolerance. The 30-cps bridge switching in this case involves the introduction of independent arms.

The R_B arm is arranged so that a 1.0 or 0.1 multiplier is applied to the nominal capacitance. Since the loss control must be entered in this arm, the transformer arrangement shown was used to change the effective value of shunting capacitance for the two multiplier positions.

The nominal capacitance is entered in the C_S arm by a precision variable air capacitor. The range of this capacitor is 25 to 1,100 $\mu\mu$f. Used with the multiplier, this range becomes 2.5 to 110 $\mu\mu$f.

Amplifier-Limiter

Because the bridge switching rate remains the same while the operating frequency is increased by 1,000 recovery-time requirements are eased, permitting use of simple capacitive interstage coupling which allows the stage to operate class C when a large signal is injected. This feature provides each stage with limiting action.

Some broad-banding was found necessary in individual amplifier stages to reduce phase shifts during warmup, but nevertheless each stage, in class A operation, has a voltage gain of 350. The final r-f limiter is included to remove residual amplitude variations.

As in the 1-kc instrument, provision is made to stop the bridge switching action in order that a loss setting may be entered directly by bridge balance. The rms indication for this operation consists of

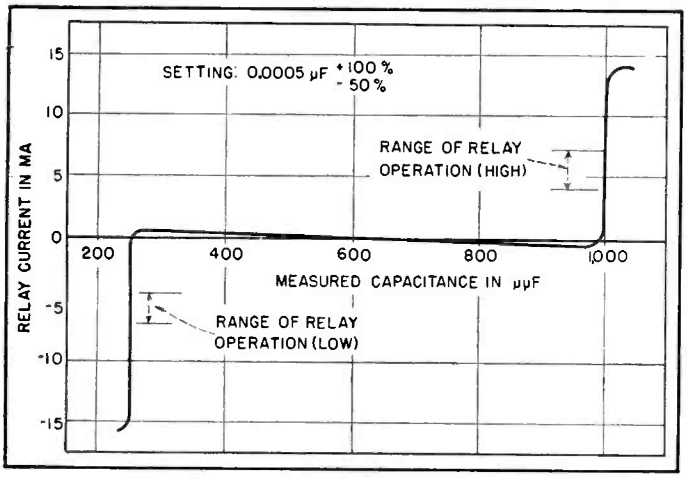


FIG. 4—Current in polar relay of 1-kc bridge when set for tolerance range of 150 percent at 0.0005 μf

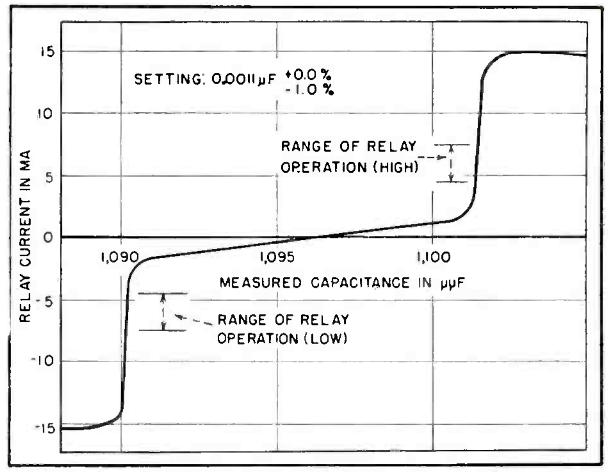


FIG. 5—Current in polar relay of 1-kc bridge when set for tolerance range of 1 percent at 0.0011 μf

a panel meter indication of the total grid current of the second and third bridge signal amplifiers and the limiter. This arrangement gives a logarithmic response so that at a high signal level proper indication of a changing amplitude is seen by variations in the grid current of the second amplifier. For very low level signals, the entire amplifier is in class A operation and signal variations are seen as changes in the grid current of the limiter stage.

Performance of Bridges

The accuracy of the 1-kc bridge is determined primarily by the accuracy of the components used in the bridge network. These are such as to give a possible error of ± 0.3 percent. An additional error appears when the loss setting of the bridge does not coincide with the loss of the measured capacitor. When this error is encountered, if the discrepancy in loss in percent is less than half the assigned tolerance spread, the tolerances at which the bridge acts are reduced by approximately the same value as the discrepancy in loss.

The graph of Fig. 4 shows current in the polar relay as a function of the capacitance under test. The solid line shows the performance on a linear scale from 200 to 1,100 $\mu\mu$f. The broken line corresponds to an expanded capacitance scale in the region of transition. Figure 5 is a similar plot with tolerance spread reduced to 1 percent.

The accuracy of the 1-mc bridge is ± 0.5 percent and performance is comparable to that of Fig. 4 and 5.

The time lapse between the connection of the capacitor to be tested and the proper indication by either instrument is primarily dependent on the characteristics of the filter preceding the polar relay. Incidental variations can occur dependent on the point of the bridge switching cycle at which connection is made. Under any condition, proper indication is presented 0.1 second after connection of the capacitor to be tested and is retained 0.03 second after connection is broken.

Measurement Techniques

Only the effect of the measured component appears in the measurement arm. The effect of stray capacitance to ground is felt in another arm of the bridge and across one diagonal.

In the 1-mc bridge, the stray capacitance from H to ground appears across the reference air capacitor. Generally this is sufficiently large that account must be made of it. The stray capacitance from L to ground, across the signal source, has no effect.

In the 1-kc bridge, stray capacitance from L to ground shunts the bridge standard. Generally this effect is insignificant; for example, 500 $\mu\mu$f shunting the 0.5-μf standard gives an error of only 0.1 percent. The stray capacitance from H to ground shunts the bridge output and can cause harmful phase shifts. It is to minimize the latter that the cathode follower and inner shield are used. The shield is not a part of the passive bridge network and so when used must be shielded from parts other than H by a ground shield.

Applications

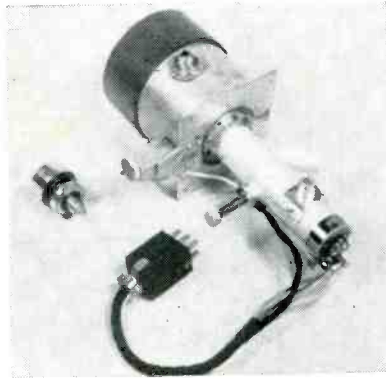
In one application the 1-kc capacitance limit bridge is incorporated in a mechanism used to sort ceramic plates. The plates, in the order of ¼ inch square, are fed one at a time to a roller assembly. Because of the possibility of poor contact and roller bounce, the plate is held in the rollers for about ¼ second while being measured. The position of two vanes below the rollers is controlled by the bridge indication, and these vanes in turn guide the plate to the proper box.

It was necessary to include a slow-release relay in order to maintain the vane position sufficiently long for proper selection. Although bridge operation is immune to line voltage fluctuations, regulation is included in the relay power supply to stabilize this delay.

The speed of testing is severely reduced by the presence of broken pieces and the necessity of allowing sufficient delay for the plate to drop. In use the device averages from 4,000 to 7,000 plates per hour.

The systems covered in this article were developed for the Glenco Corp. and appreciation is expressed for their permission to publish the descriptions. Acknowledgements are also due W. Londell and K. Cortwright for the component construction and valuable suggestions.

SUMMARY — Unattended, self-contained radio-frequency amplifier steps up television signals from a distant station and beams them into otherwise inaccessible community. Ten-watt broadband equipment gives effect of a kilowatt when connected to a high-gain antenna



Power output stage is designed around an existing type of cavity

By JESS EPSTEIN, WENDELL C. MORRISON and O. M. WOODWARD, Jr.
RCA Laboratories
Princeton, N. J.

Extending UHF-TV

INVESTIGATIONS of propagation in the ultrahigh-frequency band between 470 and 890 mc indicate that losses caused by hills, trees and buildings increase with frequency. Consequently many uhf broadcasters find that they are unable to provide adequate coverage in nearby towns that might normally be considered well within their primary service area.

Satellite-Booster

The authors have been engaged in a program to find methods that could be used to increase the field strength in such areas. This has included investigation of satellites and boosters. In this paper a satellite is defined as a low-power transmitter operating on a channel other than the main station and receiving the signal by direct reception, microwave or cable.

A booster is an arrangement of equipment located near the secondary area to be covered, which picks up the signal on a receiving antenna, amplifies the signal and reradiates the signal on the same channel by means of an antenna directed towards the required area.

Station WJTV, channel 25, in Jackson, Miss. was selected for co-operative effort on a booster experiment. This station, with an effective radiated power (erp) of 17.7 kw, was said to have trouble in covering Vicksburg, Miss. located about 35 miles to the west. The major portion of the town is shielded from the station by a ridge of hills.

A preliminary survey was made in Vicksburg to determine whether there were any receiving sites where a reasonably noise-free picture could be obtained. Several such locations were found and one was selected in the far northern end of town.

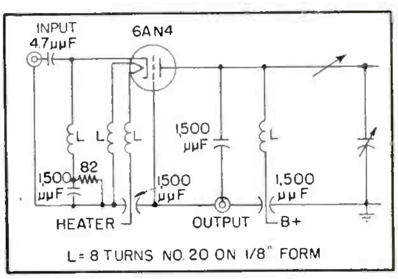
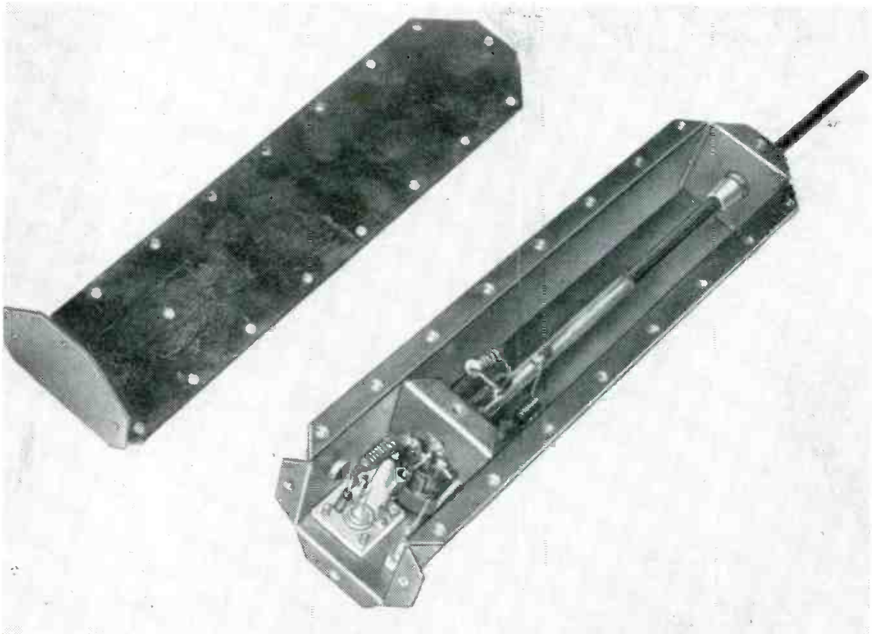


FIG. 1—Circuit of the 6AN4 amplifier stage used to drive power amplifier. Several stages are cascaded to improve bandwidth

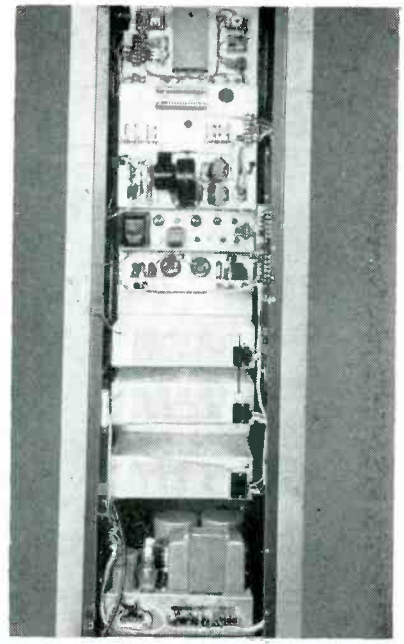
Booster Criteria

Input power to the booster amplifier is set by the level required to obtain a noise-free picture. This determines the required power gain of the receiving antenna for known values of field strength. The pattern of the transmitting antenna is determined by the area to be covered.

Power gain of the transmitting antenna can be computed since it is directly related to the radiation pattern. The erp needed to obtain a given grade of service is then specified. A reasonable estimate of this factor can be made from the topography of the given area. Required power output of the amplifier is then equal to erp divided by the antenna gain.



Voltage amplifier stage uses simple design that provides good shielding



Rear of booster equipment cabinet

With Booster Amplifiers

The power gain of the amplifier is equal to the ratio of output to input power. A final factor of vital importance is the magnitude of coupling between the input and output terminals of the amplifier. Severe ghosting of the booster output will occur if this coupling is sufficiently high. Experiments indicate that the attenuation required to obtain a ghost-free picture should be 15 to 20 db more than the amplifier gain.

It was decided that a receiving antenna having a power gain of 100 with respect to a half-wave dipole would give a noise-free picture. Power gain of the transmitting antenna as deduced from pattern requirements was also in the order of 100. A general estimate of the Vicksburg topography indicated that an erp of 1 kw would be required to obtain adequate coverage. With a transmitting antenna gain of 100, a 10-watt amplifier would be needed. Hence, on the basis of the anticipated input power, an amplifier having a gain of approximately 85 db would be required.

Decision to use a 10-watt amplifier that carries both sound and picture information presents certain problems. There must be negligible cross-modulation between the two signals; the response must be relatively constant over the entire 6-mc channel. The system must have adequate gain to produce normal output—with minimum noise contribution—for the minimum input level. Finally, automatic gain control must be provided to keep output constant.

Several different approaches were available. The signal could be demodulated to both video and audio frequencies and then these two signals used to remodulate separate small transmitters. A second approach would be to heterodyne both sound and picture carriers down to some intermediate frequency, amplify and then reheterodyne the signals back to the original frequencies for radiation.

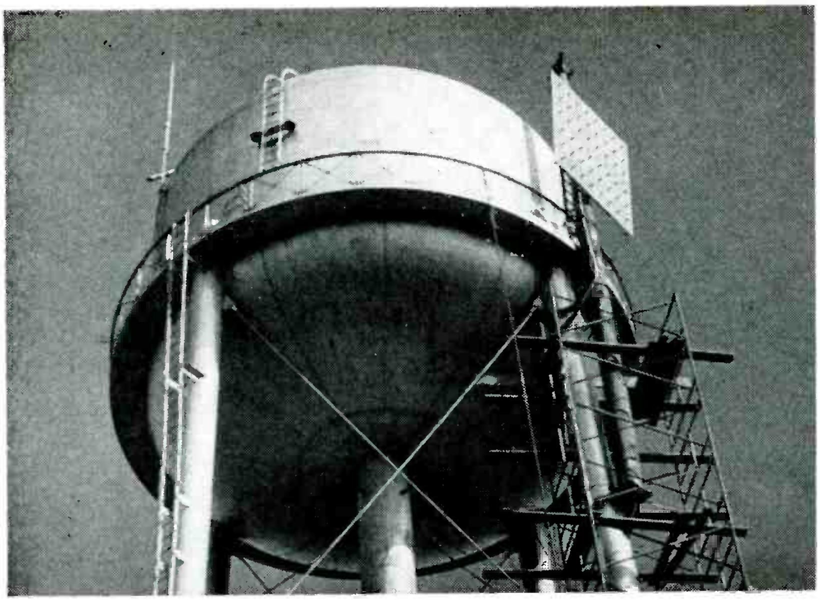
The third approach, which is the one used, employs straight amplification at the carrier frequencies. The principal disadvantage of this approach is that nothing can be done to improve the video signal in passing through the amplifier.

As an aid to producing a linear system, class-A amplification has been used throughout.

Voltage Amplifiers

The grounded-grid triode amplifier is characterized by inherent stability and low input impedance. One scheme for making such an amplifier tunable over the uhf television band has been described by Boden of Sylvania and an amplifier using this technique is illustrated.

It was decided to assemble the booster amplifier from a number of basic building blocks, coupling several amplifier units in cascade with coaxial cable. The low input impedance of the grounded-grid amplifier makes matching to the coaxial line a relatively simple matter. The plate circuit deter-



Billboard type of receiving antenna is mounted on nearby water tank and connected with the amplifier through coaxial cable

mines the passband of the amplifier and must be tuned quite accurately; however only this single tuning-control is needed for each stage to cover several uhf tv channels.

The circuit of the voltage amplifier is given in Fig. 1. Input and output circuits are separated by a plate soldered across the channel. The tube socket is supported by soldering the grid terminals to this plate. The uhf input impedance of such a stage is determined by the tube, components used and their relative locations. For this amplifier configuration, the input impedance was measured and found to be a resistance in series with an inductance.

By reducing the input-coupling capacitor to 4.7 $\mu\mu$f, the reactances canceled and the input impedance became 75 ohms resistance to terminate RG-59/U coaxial cable. If input impedance does not match that of any available cable, the cable giving the best match should be used and the length of the coupling lines made multiples of a half wavelength. This will put a relatively unimportant standing-wave on the coupling lines and the preceding amplifier will be feeding a load that is nearly resistive over the channel.

An open-ended half-wave line is used. This raises the stored energy so that the gain-bandwidth product is reduced but obviates need for the sliding short and blocking capacitor required with a shorted quarter-wave line. The problem for this case is to get the plate power fed to the tube without shorting the r-f. This is solved easily by using a simple r-f choke.

Output-coupling is provided by a series capacitor appropriately tapped on the plate line. This tap point was chosen to give a mid-band gain of 10 db and a bandwidth flat within 1.5 db over the 6-mc channel. These amplifiers have a noise figure of approximately 12 db. The power requirements are 225 ma at 6.3 v for the heater and 11 ma at 200 v for the plate.

For anticipated use in low-signal areas, an input amplifier stage using a planar triode has been designed with a noise figure of 9 db. This means that satisfactory output would be obtained with an input in the order of 300 microvolts across 50 ohms. The voltage amplifiers are assembled in groups within well-shielded cases.

It was learned that tv receiver designers had encountered considerable trouble in handling variable gain because the process of changing gain resulted in a change in bandwidth. However, booster equipment is not limited by economics to a single variable-gain stage.

By utilizing two stages appropriately tuned, the bandwidth remains practically constant over a 50-db range. The physical structure of the variable-gain stages is nearly identical to the voltage amplifier previously described. The only difference consists in tying the grid of the tube to a metal plate which is then by-passed to ground, so that a control voltage can be applied to the grid. The gain and bandwidth of these stages are nominally the same as for the voltage amplifiers.

High-Level Stage

To produce 10 watts of power at uhf with class A operation, a relatively large tube is required. From a previous experiment cavities were available for type 4X150A tubes in grounded-cathode circuits. It was estimated that tubes of this size would be reasonable and that high-level stages could be produced quickly by modifying these cavities. Consequently they were changed to utilize type 4X150G tubes in grounded-grid circuits. One such stage is shown in the photograph. For these tubes, the input consists of a coaxial line that is electrically ¾ wavelength long and uses shunt-capacitance tuning.

For these frequencies, the first quarter-wave of this line is almost entirely within the 4X150G tube. This makes it impossible to use just a one quarter wavelength line. An open-ended, half-wave line could have been used but the stresses encountered when replacing a tube made a solid cathode-line structure desirable. Since bandwidth in the cathode circuit is no problem, the line used appeared to be a reasonable choice. Input impedance of these stages was adjusted by selecting the tap point on the line.

A re-entrant cavity is used in the plate circuit with a built-in blocking capacitor so plate power can be applied. Tuning is accomplished by moving a capacitance plate near the anode heat-exchanger. Output-coupling is through a rotatable loop that is series-tuned to the operating frequency.

One stage of this type has a gain of 10 db. Two such stages are used in the booster, one as a power output stage and the other as a driver for the other.

With the amplifier assembled utilizing several 6AN4 stages and the two 4X150G stages just described, the amplifier can be tuned for adequate bandwidth and gain. However, the last 6AN4 stage operating class A is not capable of supplying sufficient power to drive the final to 10 watts peak power. This makes necessary another medium-level stage.

It was decided to use two 2C39A tubes since they are somewhat smaller than the 4X150G and easier to cool. The circuitry of these stages closely follows the 6AN4 design. More recently a stage has been built that utilizes a 2C39A in a coaxial cavity to give a gain of 15 db and a bandwidth of 10 mc. One of these stages would replace both 2C39A stages used originally.

Although the evidence is far from adequate, it appears that the signal changes requiring keyed agc are not present in the Vicksburg installation in an amount sufficient to warrant the inclusion of this type of control.

Vicksburg Test

The relative location of the Vicksburg area and WJTV with respect to the booster station is shown in Fig. 2. Vicksburg is approximately at right angles to the radial between Jackson and Vicksburg.

The receiving and transmitting antennas are located 100 feet apart on the radial drawn towards Jackson. Consequently the main lobes of the two antennas are approximately at right angles to one another. The coupling between the antennas for this orientation is low.

Another factor of importance is that the receiving antennas in the Vicksburg area that are oriented toward the booster will receive minimum interference from WJTV because of their directivity. A similar condition prevails in the Jackson area for those antennas receiving Jackson. This condition only holds in a general way for the region between the booster and WJTV antennas.

The receiving antenna was centered on the east face of a water tower. The tank, shown in the photograph is approximately 30 feet in diameter and 20 feet high, with its center 110 feet above the ground. The transmitting antenna is set on a wooden tower 100 feet away on a radial drawn between WJTV and the receiving tower.

The measured input voltage to the amplifier from WJTV was 4.2 mv which is approximately 10 db greater than the voltage anticipated. Attenuation between the antennas was around 105 db. No problem with self-ghosting was encountered since the difference between the required amplifier gain of 75 db and the 105 db of attenuation is 30 db.

In making the field tests, it was of interest to determine several important factors. The first was a thorough sampling of the field strengths in the primary Vicksburg area for both the booster and WJTV. Determination was needed of critical areas surrounding Vicksburg in which trouble might be expected because of the difficulty in discriminating against the unwanted signal. A determination of the ratio of desired to undesired signals is likewise important.

Field strengths in the Vicksburg area for both the booster and WJTV have been analyzed statistically and are shown in Fig. 3. The median ratio of booster to Jackson signals is 23 db. This means that WJTV would have to increase its power 200 times to achieve the same results as with the booster.

Interference

There are many locations where either or both signals can be received. The undesired signal appears as a displaced image with respect to the desired signal. Measurements made to determine the ratio of the desired-to-undesired signal required to receive a ghost-free picture indicate that this value lies between 15 and 20 db.

A critical area exists where the two signals are of equal strength. In general, a booster station will be surrounded by a strip in which this condition exists. Knowledge of specific receiving antennas is necessary to evaluate properly the performance within this strip. Let us assume that the antenna has a pattern discrimination of desired to undesired signal of 10-to-1 in voltage (20 db). This would mean there would be no area in which the desired signal could not be obtained and that a ghost-free picture could be received.

If, however, the receiving antenna pattern discrimination were less than 10-to-1 and Jackson was desired, it would be necessary to advance towards Jackson to obtain the desired 10-to-1 ratio of Jackson to booster signal. Conversely, if the booster signal were desired, it would be necessary to move towards the booster. The area between these two contours would then represent a region where neither signal could be obtained free from ghosting.

The authors express sincere appreciation to the Mississippi Publishing Corporation for generous co-operation, to our co-workers for contributions in building and testing this system and to the engineering staff of WJTV for untiring effort and interest.

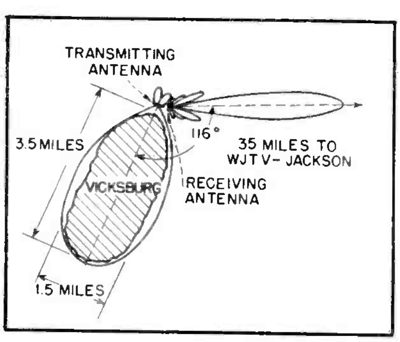


FIG. 2—Relative location of the booster, originating station and area to be served by it

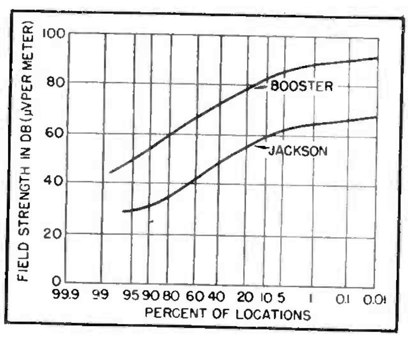
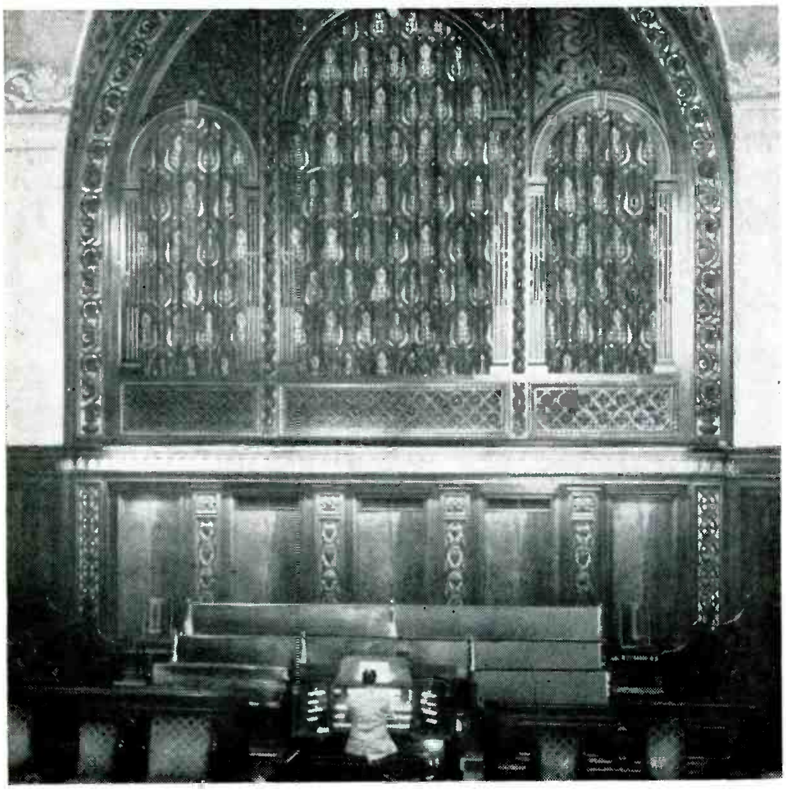


FIG. 3—Percentage of locations that have field strengths greater than ordinate show usefulness of booster



Installation of organ console in church. Loudspeakers are placed behind grill formerly housing organ pipes

THE ORGAN

A complete organ consists of one to five keyboards, or manuals, each controlling a separate set of pipes (or oscillators in an electronic organ). A foot-operated pedal organ provides an additional 32 deep-toned bass notes. A complete set of pipes of similar tone is called a stop. Stop knobs on the organ console select the set of pipes to be controlled by each keyboard. Coupler knobs permit playing a combination of stops from one keyboard.

The stops that make up an organ are governed by the place where the organ will be used. Some of the more common types are: the choir organ providing low volume for accompaniment; the great organ, having the loudest tone; the swell organ, equipped with means for raising and lowering the sound level; and the vox humana, producing a sound imitative of the human voice.

The tones generated by the pipes may be classified as flute, reed, string, or diapason. The latter is the foundation or basic organ tone.

In simulating the operation of a pipe organ by electronic means, the attack, or fidelity of pitch at the beginning of a tone; pitch fringing, or pitch indefiniteness; spatial relation of the pipes; and the harmonic content of the various organ tones are involved

Electronic Organ Uses

SUMMARY —— Pitch indefiniteness necessary for maximum realism is provided by loudspeakers mounted on rotating baffles. Qualities of pipe-organ stops are simulated by using semiconductor diodes to modify Hartley oscillator output

DESIGN of an electronic organ for church use requires a system that will produce as closely as possible the acoustical characteristics of the traditional pipe organ.

For an electronic instrument to compare with even one set of pipes, an audio system covering the complete sound spectrum is needed. In the system described here, the output of the pedal organ, having a frequency range from 32 to approximately 5,000 cps including harmonics, is fed into a good quality amplifier which in turn feeds a series of woofers. The manual organ outputs, covering a range of 64 cps to the threshold of hearing for harmonics of fundamental frequencies, are fed to an amplifier with a substantially flat response to beyond 20,000 cps.

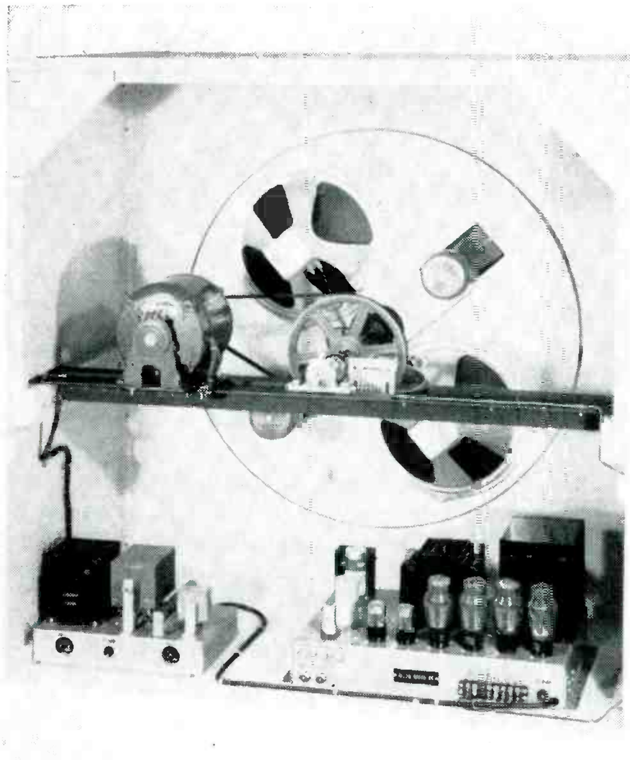
A cone speaker and horn tweeter combination is used with the manual organs thus providing a three-way system. These loudspeakers are mounted on a rotating baffle which provides a continuously variable acoustic phase shift. By increasing the speed of rotation a tremolo effect is obtained.

Tone Generators

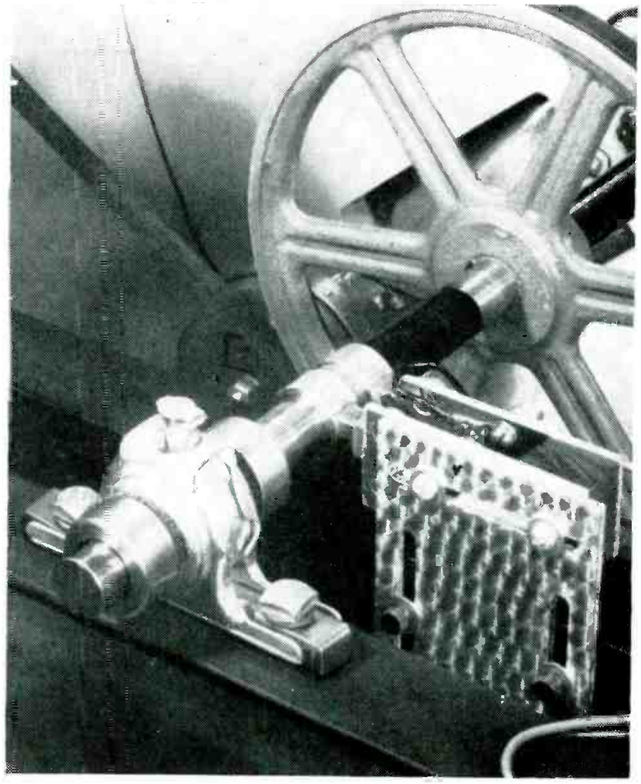
The console controls an individual tone-generator system for each of its three manual organs and the pedal organ as shown in Fig. 1. Each tone generator system has its own rotating loudspeaker system, excepting the pedal organ which employs a nonrotating unit.

Figure 2 shows the circuit of the tone-generating oscillator. Use of an air-core inductance provides an output frequency substantially independent of supply voltage. This is important not only for frequency stability but also so that no unwanted frequency shift will occur during the keying period.

To produce a satisfactory attack the natural inertia of the L-C circuit is loaded with capacitance. A



Loudspeakers are mounted on motor-driven baffle plate to produce pitch-fringing effect for realistic imitation of pipe organ



Audio signal is fed to rotating loudspeakers through coin-silver slip rings and silver graphite brushes

Rotating Loudspeakers

By JEROME MARKOWITZ

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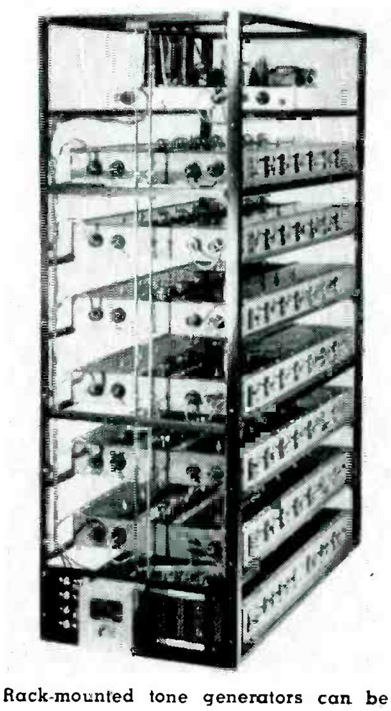
normal decay is produced by a 4-μf keying capacitor discharging into the oscillator plate circuit after the key is released.

No special keying system is required. Since substantially no audio flows in the keying lines, ordinary contacts can be employed. Keying lines may be extended 100 feet or more where necessary.

A further advantage of a stable oscillator is that a relatively long sustain can be produced by the inclusion of an additional decay-producing capacitor in the keying circuit. The production of such sustained tones results in an instrument with musical potential beyond



Rack-mounted tone generators can be placed up to 100 ft from console

Table I—Three-Manual-Organ Tube Functions

Stage	Type	Function	Quantity
Great Organ			
Tone gen	6SN7GT	Osc	84
Preamp	6SN7GT	Amp	4
Tone gen	Copper-oxide Diode	Shaper	252
Swell Organ			
Tone gen	6SN7GT	Osc	54
Preamp	6SN7GT	Amp	3
Tone gen	Copper-oxide Diode	Shaper	162
Choir Organ			
Tone gen	6SN7GT	Osc	42
Preamp	6SN7GT	Amp	3
Tone gen	Copper-Oxide Diode	Shaper	126
Pedal Organ			
Tone gen	6SN7GT	Osc	36
Preamp	6SN7GT	Amp	3
Tone gen	Copper-Oxide Diode	Shaper	72
All Sections			
Speaker amp	6AU6	Amp	4
Speaker amp	6SN7GT	Amp	8
Speaker amp	6L6	Amp	24
Speaker amp	OC3	Voltage reg	4
Speaker amp	5U4	Rect	8
Power supply	866	Rect	2
	5Y3	Rect	5

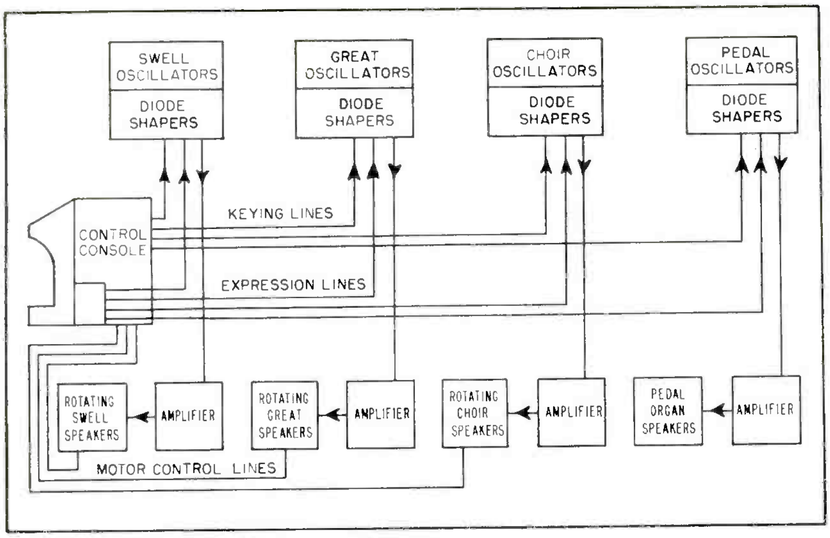


FIG. 1—Three keyboard organs and one pedal organ are controlled from console. Keying lines select one oscillator and expression lines determine waveshaping

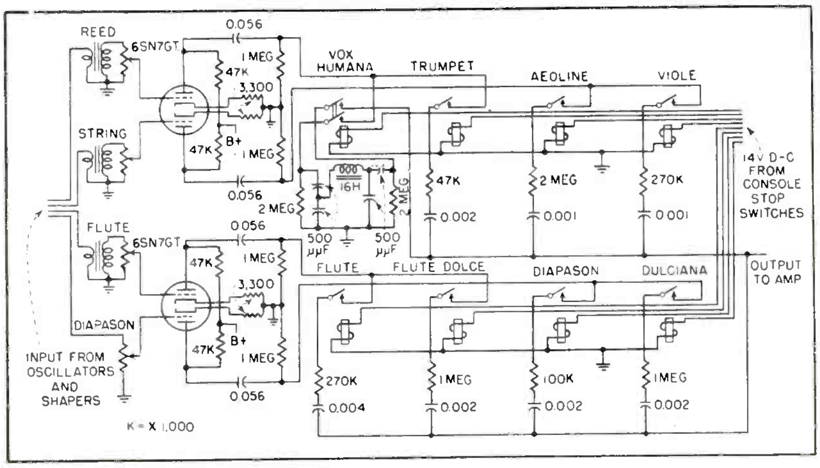


FIG. 3—Four basic tones from oscillator section are further subdivided in tone-modifier section to provide equivalent of eight sections of pipes

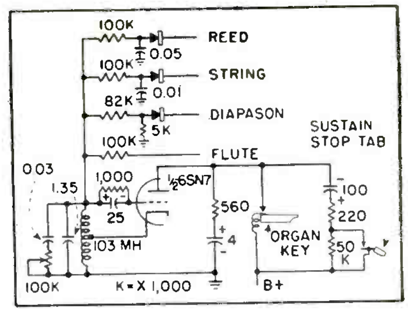


FIG. 2—Sinusoidal output of Hartley oscillator is modified by copper-oxide rectifier circuits to provide four basic tones

that of the pipe organ. Percussion effects including the harp, harpsicord, harp celeste and glockenspiel are directly produced by the electronic oscillators rather than by electromechanical pick-up systems which have been previously employed. A carillon tone is produced by combining the sustain, the sine-wave tone plus coupler switches which provide borrowed tempered harmonics and enharmonic partials from one of the manual generators.

The relatively pure sine waves from the oscillators are available for the production of open flute tones without filter circuits.

Tone Modifier

Oscillator outputs are also available for processing by the semiconductor diodes. As shown in Fig. 2, a single copper-oxide diode in combination with two resistors provides a diapason output waveform.

The output of the various basic tone sections such as flute, string and reed are paralleled and feed into a tone modifier. As shown in Fig. 3, each tone group other than the sine-wave diapason tone is fed into a low-impedance-to-grid matching transformer. These in turn feed to triode preamplifiers which raise the output to a level sufficient to eliminate the need for high-gain power amplifiers thus reducing the possibilities of extraneous noise generation or external electrical interference. After preamplification, a given tone line is fed into one or more relay contacts and associated tone circuits.

Tuned filter circuits are used only sparingly and are restricted to solo tonalities. A plurality of tones from one line is utilized only in cases where the tones involved are closely related in character and where the difference is mainly intensity. An ideal instrument would have a separate tone line and associated diode for each and every tonality but the compromise system provides satisfactory results.

Loudspeaker System

Assuming that a series of electrical waveforms are produced having harmonic structures equivalent to those produced by a group of organ pipes, a tangible difference is still observed when a comparison is made by even the average listener. This difference can be accounted for by pitch fringe or pitch indefiniteness, and by a spatial effect due to the relative positioning of the various pipes.

Pitch fringe is produced by the rotating loudspeaker assembly. The spatial effect is partially produced by the individual loudspeaker units and is further enhanced by using separate loudspeaker units for each of the various manuals and their associated tone generators. Generally, the loudspeakers are positioned so that the sound sources will approximate the position of various divisions of pipes in a pipe organ.

The loudspeaker unit includes a rotating baffle member carrying the middle-frequency cones and the high-frequency tweeters. The drive mechanism includes a shunt-wound ⅛-hp d-c motor. To maintain speed regulation the field and armature have separate rectifiers. Speed is controlled by varying the armature voltage. The amplifier output feeds the rotating loudspeakers through coin-silver slip rings and silver-graphite brush assemblies.

Table I lists all of the sections of a typical three-manual instrument, including the tube complement.

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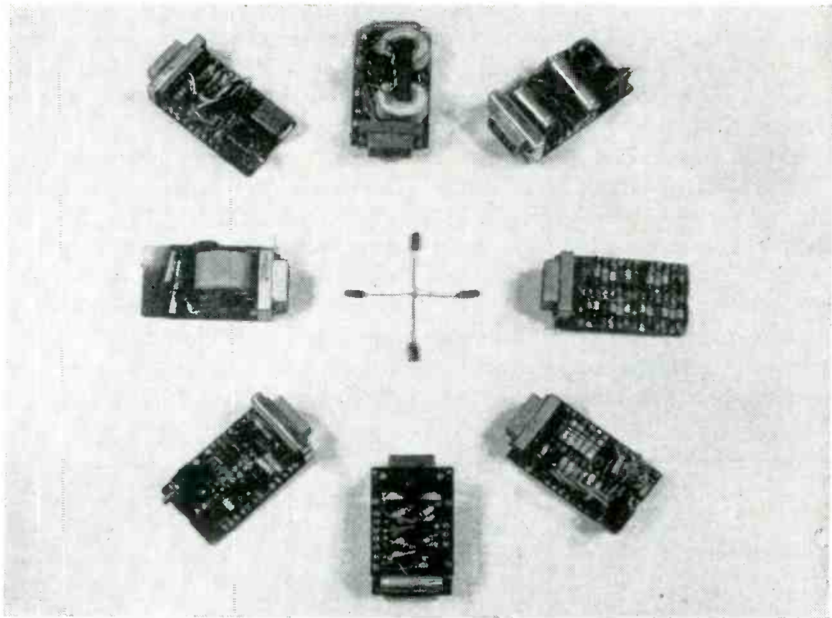

Complete transistor units compared with transistor types used. Reading clockwise from bottom: high-gain tape-recorder amplifier; low-gain d-c amplifier; power-supply unit; voltage discriminator; magnetic modulator; high-gain d-c amplifier; voltage-controlled attenuator; audio amplifier

Transistor Amplifiers for Analog Computers

SUMMARY —— Functionally interchangeable transistor amplifiers and vacuum-tube d-c amplifiers are now feasible. High and low-gain transistor amplifiers for servo use are described and effects of power-supply variations and temperature coefficients are shown

IMPORTANT CRITERIA in the design of amplifiers for analog computers include reliability, minimization of random and temperature-dependent characteristic changes and low cost.

A range of transistor amplifiers was designed to replace, ultimately, a corresponding range of vacuum-tube d-c amplifiers. Most of the work to be described was done with transistors rated at only 6-milliwatts dissipation.

Transistor Servo Amplifier

The servo amplifier of Fig. 1 uses four Mullard type-OC71 *pnp* junction transistors and has a power consumption of approximately 0.11 watt. A vacuum-tube amplifier, with power-output stage, performing the same function consumed approximately 25 watts.

This amplifier is, in effect, a bidirectional voltage discriminator, which operates a center-stable relay in response to an input signal change of 10 mv. It comprises a grounded-collector input stage followed by a grounded-emitter amplifying stage and an emitter-coupled push-pull base-input stage.

Power gain from the amplifier input to the collector of the output stage is approximately 32 db. Input drift over a period of 24 hours is less than ±15 mv without temperature compensation. Sensitivity to power supply changes is 1.2 mv equivalent input for 1-percent change of the ±8 v supplies. This amplifier has been operated continuously for six weeks with no transistor, component or printed-circuit failures.

The grounded-collector input stage and the second stage are operated at low current to maintain a relatively high input resistance of approximately 50,000 ohms. A resistance of 39,000 ohms is connected between base and ground to minimize variations of grounded-collector transistor output resistance with change of signal-source conductance.

Negative bias is provided on the

* Work done at Air Trainers Ltd., Aylesbury, England.

emitter of the second stage of the d-c amplifier by a potential divider using 47 ohms and 1,200 ohms. It is desirable to make these bias resistances high to reduce current drain from the power supplies. Degeneration due to the high emitter resistance of 47 ohms is counteracted to some extent by a resistance regeneratively connected from a point on the collector load to the emitter.

In the push-pull output stage a d-c zeroing adjustment is provided by a voltage control in the base circuit of the last transistor. Relay coils are only 120 ohms; hence a resistance of 820 ohms, common to the two collector circuits, is connected between the −8 v line and the relay windings.

The transistor discriminator was connected to control a positional servo mechanism. The time constant of the amplifier-relay combinations was less than 20 milliseconds and the bandwidth of the complete servo mechanism was approximately 0.7 cps. This figure is similar to that found when the same servo components were tested with a vacuum-tube amplifier.

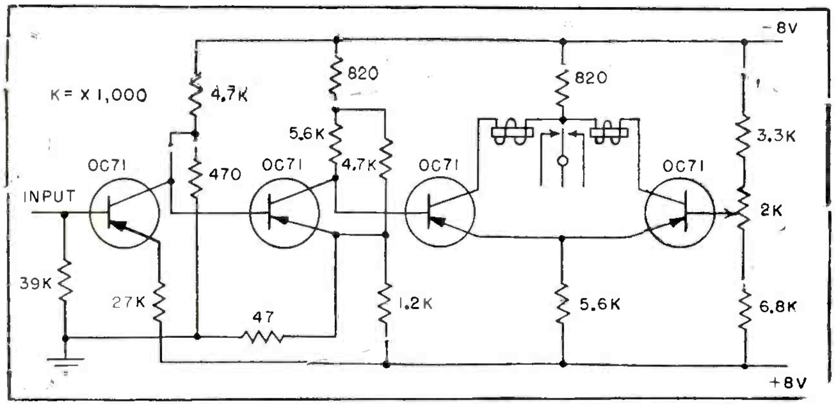

FIG. 1—Transistor servo amplifier with 0.11-watt power drain replaces vacuum-tube counterpart with 25-watt drain

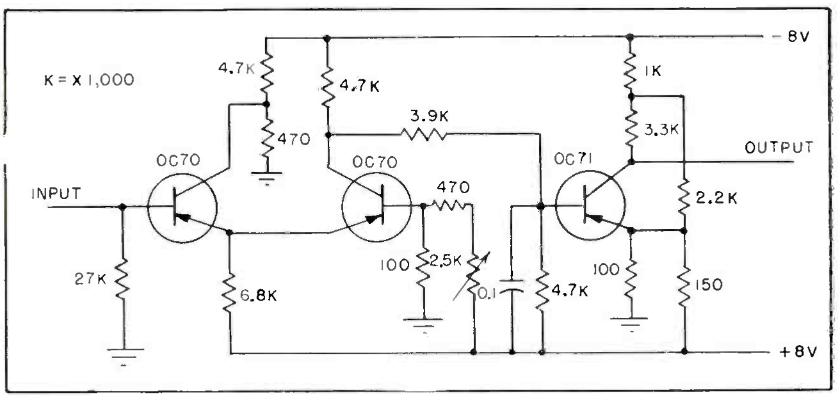

FIG. 2—Direct-coupled amplifier has gain of 500 and 30-kc bandwidth without feedback. Input impedance is approximately 50,000 ohms

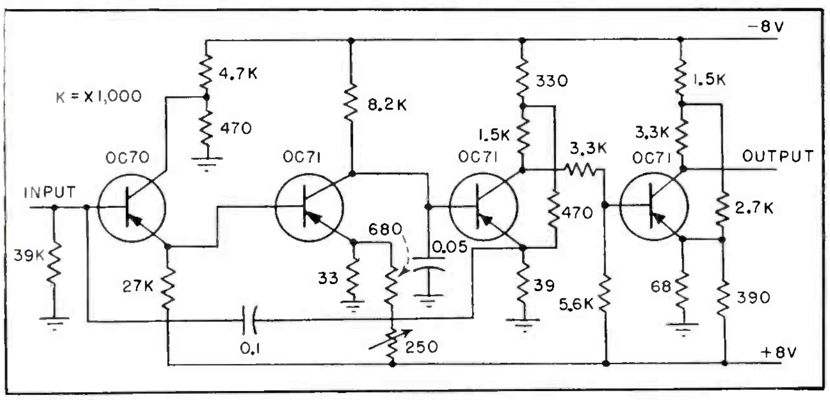

FIG. 3—Direct-coupled amplifier has gain of 25,000 with maximum output voltage of 5 volts into 1,500 ohms

The amplifier of Fig. 2 consists of a cascade arrangement of grounded-collector, grounded-base and grounded-emitter transistors. Considerable mismatch occurs between the first and second stages; however, a GC-GE-GE arrangement could not be used because phase reversal was required in the feedback amplifier.

Operating conditions of the grounded-collector stage are similar to those for the input stage of the servo amplifier described previously. A d-c bias control is provided in the base circuit of the second stage.

Low-Gain D-C Amplifier

To obtain positive and negative-going output from the collector of the last stage the base and emitter are made positive with respect to ground. About 6-db gain is lost in the 3,900/4,700-ohm divider. This, as in the case of vacuum-tube d-c amplifiers, is inevitable. Regeneration is provided from the collector circuit of the last transistor through a 2,200-ohm resistance.

Amplifier gain is 500, input impedance approximately 50,000 ohms (in shunt with a 27,000-ohm base resistance) and power consumption is 0.17 watt. Drift was recorded over a period of two weeks, with negative feedback applied over the amplifier through resistances of 4,700 and 47,000 ohms to give a feedback gain of 10 and a loop gain ($\mu\beta$) of 35 db. Maximum voltage drift over this period, referred to the input, was equal to ± 8 mv; maximum drift during a 24-hour period was 3 mv equivalent input. With these feedback resistances, ± 10-percent changes of either of the supply lines (usually ± 8 v) caused ± 40-mv changes of equivalent-input voltage.

Simultaneous decrease of both the positive and negative power supply voltages caused equivalent-input changes at the rate of 10 mv for 10-percent change of supply voltage. Bandwidth of the amplifier, without feedback was of the order of 30 kc. The amplifier was stable with up to 60-db feedback giving a gain with feedback of 0.5.

The d-c amplifier of Fig. 3 has

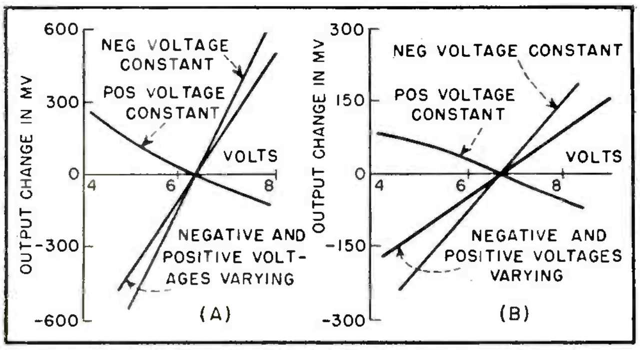

FIG. 4—Change in output of amplifier of Fig. 3 with variation of supply voltages for 68-db (A) and 78-db (B) feedback

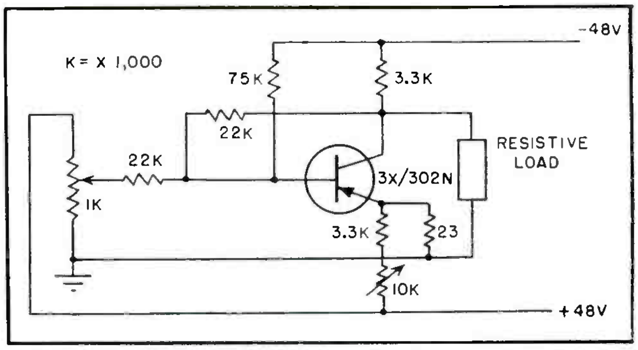

FIG. 5—Experimental high-output power amplifier uses 200-milliwatt *pnp* junction transistor

a gain of approximately 25,000. It consists of a grounded-collector stage followed by three grounded-emitter stages. The compensating capacitances of 0.1 and 0.05 μf make the amplifier stable for feedback up to 90 db.

Cyclic drift of this amplifier represented 30 mv equivalent input over 24 hours. Most of this was due to diurnal variations of ambient temperature. Preliminary tests on a single-stage grounded-collector junction-transistor amplifier, compensated with germanium point-contact rectifiers[1], indicate that temperature effects can be reduced by a factor of the order of 10 to 1.

Power consumption of the high-gain d-c amplifier is 450 milliwatts. The dependence of output level on power-supply voltages is shown in Fig. 4 for two feedback ratios. Maximum output is ±5 volts into 1,500 ohms.

A higher-output d-c power amplifier employing a 200-milliwatt 3X/302N *pnp* junction transistor has been constructed (Fig. 5). With a maximum collector dissipation of 186 milliwatts, this grounded-emitter stage subjected to as little as 12-db feedback gave the following linear outputs: 31 v into 10,000 ohms; 25 v into 5,000 ohms; 20 v into 3,000 ohms; 12.5 into 1,500 ohms; 10 v into 1,000 ohms.

Audio Amplifier

An experimental audio amplifier was designed with point-contact transistor push-pull output before higher-power junction transistors were available. In the course of later tests on two type 3X/302N junction transistors in push-pull, each transistor operated at 150-milliwatts dissipation and a power output of 170 milliwatts was obtained under class-A conditions. Bandwidth was 28 kc into a resistive load and 23 kc into a transformer-coupled resistance load.

The low-gain d-c amplifier is shown in the photograph. The component interconnections on the panel are established by painted conductors. The coating material is air-setting silver conducting paint applied to $\frac{1}{16}$-in. wide × $\frac{1}{32}$-in. deep grooves cut into the panel. With two coats of the paint, a 6-in. conductor had a resistance of less than 0.20 ohm within 6 hours after application.

In d-c analog-computer work it is desirable to use amplifiers having substantially infinite input resistance. This condition cannot readily be met with transistors. A review of various types of junction transistors presently available indicates that input resistances, even in the grounded-collector configuration, cannot exceed about 100,000 ohms. Such input impedances will degrade to some extent the performance of summing amplifiers employing feedback resistances of the order of several megohms. For many applications, however, feedback resistances and signal-source impedances may be suitably scaled in relation to, say, 50,000-ohms transistor amplifier input impedance. With some sacrifice of gain, a feedback circuit similar to that described by Schenkerman[2] may be employed to increase input impedance.

Long-Term Stability

Dependence on power supplies of the transistor d-c amplifiers is not critical. In a typical amplifier with large feedback a ±10-percent supply variation causes equivalent input change of less than 10 mv. Temperature effects are presently under investigation. Using no temperature compensation, drift of a type-OC70 junction-transistor grounded-collector input stage was 5 mv per degree centigrade as shown in Fig. 6. Temperature compensation with germanium point-contact diodes (Fig. 7) reduced this drift to about 0.25 mv per degree over a range of 30 degrees centigrade and ±1 mv over a 15-degree range.

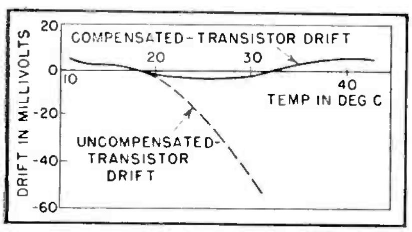

FIG. 6—Amplifier drift characteristics with and without temperature compensation

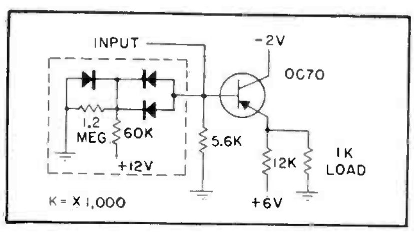

FIG. 7—Experimental temperature-compensating circuit uses germanium point-contact diodes

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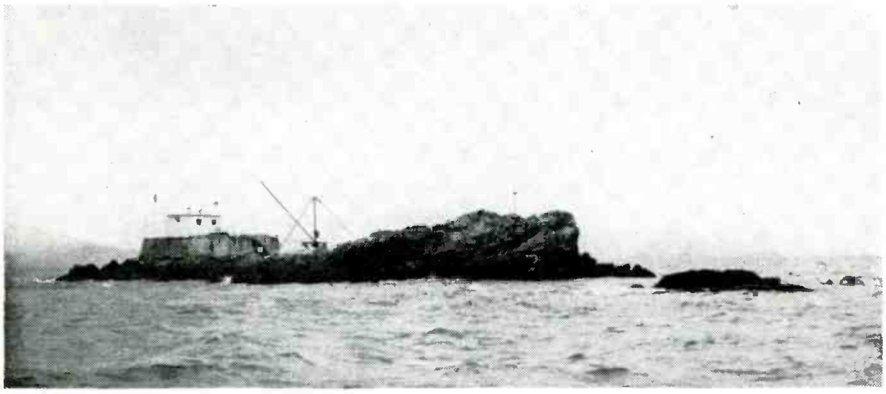
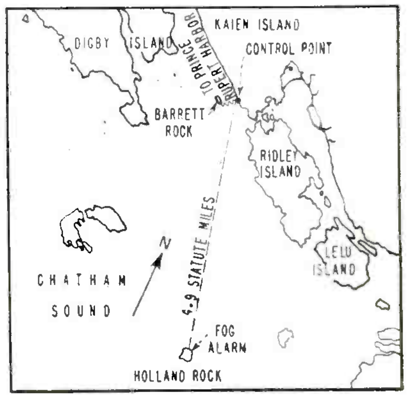
(1) R. F. Shea, "Principles of Transistor Circuits", p 180, John Wiley & Sons, Inc., New York, N. Y., 1953.
(2) S. Schenkerman, Feedback Simplifies Transistor Amplifiers, ELECTRONICS, p 129, Nov. 1954.

Microwave System





Holland Rock, is site of first remotely controlled fog-alarm installation. Map shows location of Holland Rock and control point at Barrett Rock near Prince Rupert, British Columbia

IN AN EVER-EXPANDING SERVICE, the aids to navigation section of the Canadian Department of Transport has found it necessary to increase the number of its installations of fog-alarm equipment.

Many of the sites for these new installations consist of isolated islands or rocky shoals where it is not desirable to maintain an operator and where, for various reasons, control by submarine cable is not economically feasible.

Use of microwave frequencies makes it possible to obtain high directivity or gain with relatively small antennas, thus simplifying the receiver requirements and materially reducing the possibility of interference between adjacent systems operating on the same frequency or from other sources such as atmospherics or a passing ship's radar or communications equipment.

Description

The fog-alarm equipment at Holland Rock consists of two air-cooled gasoline-engine-driven compressors supplying compressed air to a Type-B diaphone horn which is coded to give three, equally spaced, 2-second blasts per minute. The microwave remote-control equipment provides the resident lightkeeper at Barrett Rock, 4.9 miles away, with a means of selecting either of the two gasoline-engine-driven compressor units at Holland Rock and starting and stopping it at will.

If the wind is blowing in an adverse direction, the operator at Barrett Rock often cannot hear the sound of the horn at Holland Rock. To check its operation, there is a small radiotelephone transmitter at the remote site, which is turned on automatically every time an engine is started or stopped. This trans-

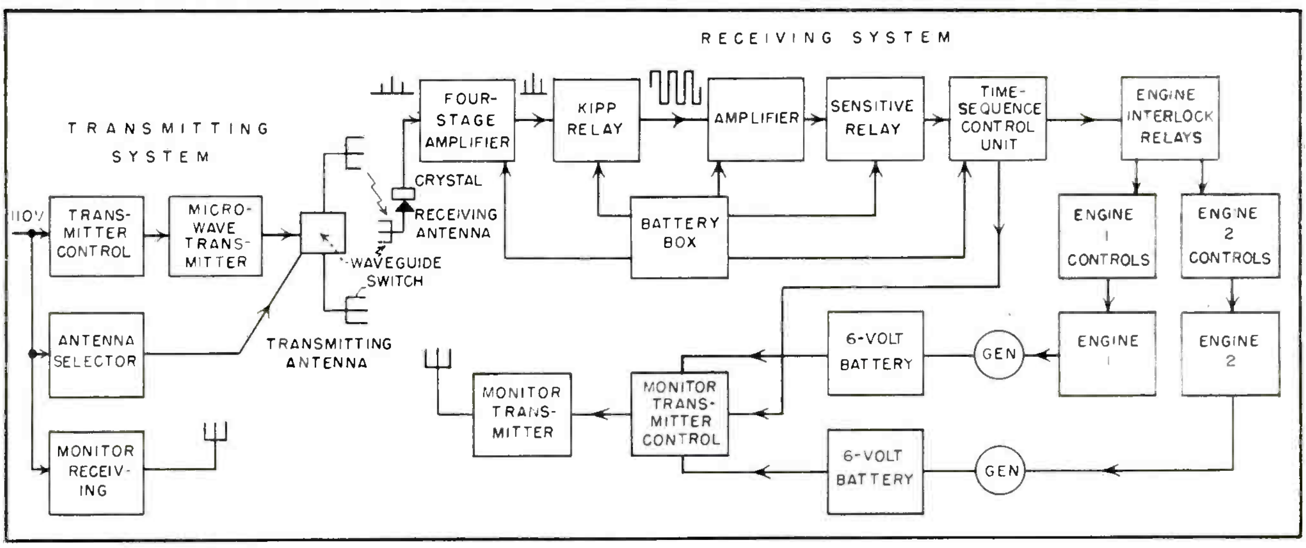


FIG. 1—Block diagram of microwave transmitting and receiving systems of remotely controlled fog alarm

Controls Fog Alarm

SUMMARY — Unattended fog alarm on isolated rock is controlled over microwave link by keeper of lighthouse 4.9 miles away. Radiotelephone link transmits sound from horn back to lightkeeper should wind be blowing in adverse direction

By F. R. PARK

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mitter broadcasts the sound of the horn and the engine on the lighthouse communication channel for a period of two minutes, after which it is turned off automatically.

This monitoring operation can also be performed at will, as often as is necessary to ensure that the engine is running and the horn blowing satisfactorily.

The complete system, shown in Fig. 1, consists of a 3.2-centimeter-wavelength transmitter and control unit at Barrett Rock and a receiver and time-sequence control unit at Holland Rock. Selection of either engine, or the monitoring radiotelephone transmitter, is accomplished through the use of the time-sequence unit by controlling the length of time the signal is transmitted.

Propagation Problem

One of the problems encountered in the design of the Prince Rupert installation was variation in effective height of transmitting and receiving antennas caused by tide-level changes.

The signal at the receiving antenna is the resultant of the direct signal and the signal which arrives after reflection from the surface of the water. These two signals add or subtract, depending upon their relative phase as determined by the difference in the distance they have travelled.

As the height of the surface of the sea relative to the transmitting and receiving antennas changes, the path length for the reflected signal changes and a condition can arise in which the two signals arriving at the receiving antenna cancel each other. This condition can occur several times during the extreme tide-level changes (23 feet) which occur at Prince Rupert.

Power Density

The power density at distance R in free space from a transmitter of peak power P_t with a transmitting antenna gain, over an isotropic radiator, of G_t is[1]

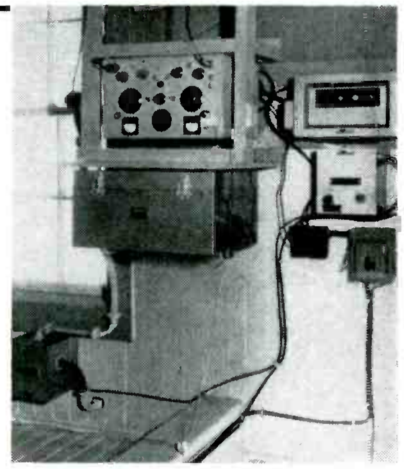
$$P_r = P_t G_t / (4\pi R^2) \quad (1)$$

If the transmitting antenna is located a finite height above a flat, perfectly reflecting surface, the power density at distance R will vary with height, passing through maxima and minima as the phase of the reflected wave, relative to the direct wave, changes.

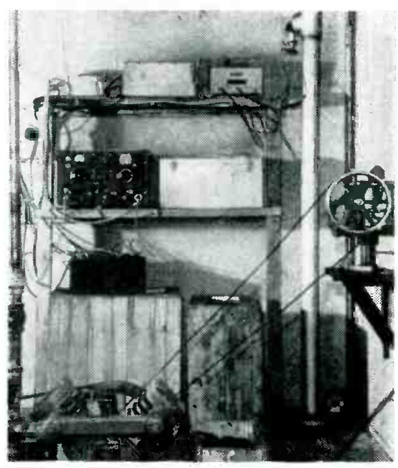
The presence of a flat, perfectly reflecting surface will modify the power density at any point by[2,3]

$$F^2 = 4 \sin^2 (2\pi/\lambda)(h_t h_n / R) \quad (2)$$

where h_t is height of transmitting antenna, h_n is height above surface at which the power density is measured, λ is wavelength and F is pattern-propagation factor, which is defined as the ratio of resultant electric-field amplitude at point in question to value it would have



Interior installation at Barrett Rock control point. Antenna changeover switch is at upper right; radiotelephone receiver, with microwave transmitter mounted above, is at center. Antenna selector and transmitter controls are at left side of photograph



Interior installation at Holland Rock. On top shelf, from left to right, are: radiotelephone-transmitter control; time-sequence control; microwave receiver. Radiotelephone transmitter and batteries for receiver are below. Air compressor at lower left drives foghorn coding timer at right

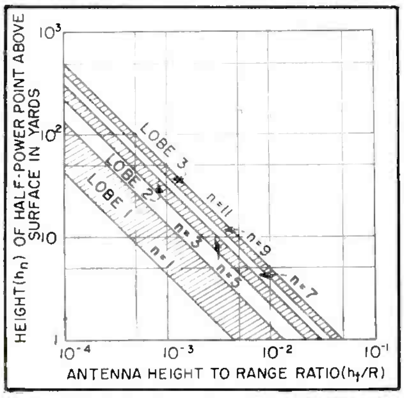


FIG. 2—Half-power width and lobe height for antenna mounted above perfectly reflecting plane surface

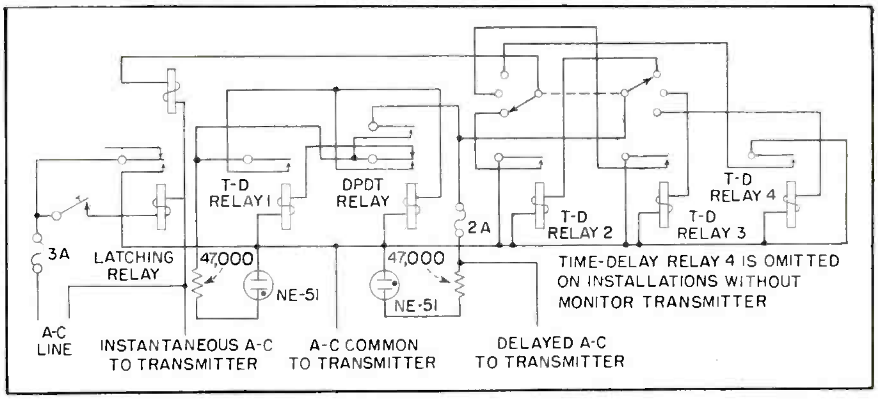


FIG. 3—Wiring diagram of transmitter control unit. Time-delay relays provide warmup period for transmitter and determine transmission periods. Unit has two controls, one to select desired operation and other to turn equipment on

under free-space conditions.

Power density at distance R and height h_n above the reflecting surface is

$$P_r = \frac{P_t G_t}{4\pi R^2} 4 \sin^2\left(\frac{2\pi}{\lambda} \frac{h_t h_n}{R}\right) \quad (3)$$

If the receiving antenna has an effective aperture of A_r then the signal power at the input to the receiver is

$$S_r = \frac{P_t G_t A_r}{4\pi R^2} 4 \sin^2\left(\frac{2\pi}{\lambda} \frac{h_t h_n}{R}\right) \quad (4)$$

Thus the received signal may vary between zero and four times the free-space value depending upon the magnitude of

$$\sin^2\left(\frac{2\pi}{\lambda} \frac{h_t h_n}{R}\right)$$

The energy density in the lobe will be half the maximum value when

$$\sin^2\left(\frac{2\pi}{\lambda} \frac{h_t h_n}{R}\right) = 0.5$$

This condition will be satisfied when

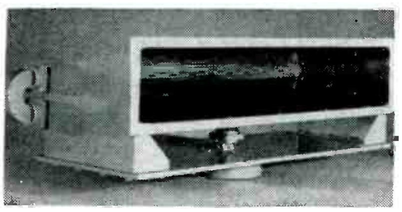
$$h_n = \frac{n\lambda}{8} \frac{1}{h_t/R} \quad (5)$$

where n is odd.

In Fig. 2 this equation is plotted for a wavelength λ of 3.2 centimeters. The values of h_n obtained in this way are assumed to apply only when $(h_t + h_n)/R < \pi/180$, that is, when the grazing angle is less than 1 degree.

From Fig. 2 it can be noted that, where the tide-level changes are large, there could be periods when the receiving antenna would be in a null and it would be necessary to change the height of either the receiving or transmitting antenna to restore the signal level.

Because of several factors, most important of which is the fact that the sea does not always reflect energy in a simple manner, these cancellations or nulls in the received signal are seldom complete. During the course of the Prince Rupert installation, signal-power variations of 20 to 25 db were measured as the tide level changed. The grazing angle was never greater than 0.2 degree and the sea surface was essentially calm with 3 to 4-foot waves present.



Vertically polarized receiving-antenna aperture has Vinylite-window weather seal for all weather operation

In the case of the Prince Rupert installation, the effect of tide level changes is overcome by the use of two transmitting antennas mounted at different heights. Power can be fed to either antenna by an electrically operated waveguide switch.

Control Method

Information determining the selection of either engine or the radiotelephone-monitoring transmitter is contained in the duration of the transmitted signal. The three distinct transmission periods used are determined automatically by timers in the transmitter control unit. Selection is performed, at the receiving site, by the time-sequence unit, which is a motor-driven timer. This system provides for a very simple method of modulating or coding the transmitted signal with the desired information and of decoding the signal at the receiving end by a device which draws no current when the signal is absent.

An effective narrowing of the overall bandwidth is obtained in the decoding or time-sequence unit.

Control Unit

The control unit, shown in Fig. 3, contains four time-delay relays, which provide the warmup period for the transmitter and determine the three transmission periods for selection of either engine or the radiotelephone monitoring transmitter at the fog-alarm station.

The unit has only two controls, one to select the desired operation and the other to turn on the equipment. When the desired operation has been chosen by the selector switch, pressing a button closes the latching relay. This applies power to the filaments, the low-voltage supply in the transmitter and to the 3-minute time-delay relay 1.

At the end of the 3-minute warmup period the dpdt relay is energized, applying power to the high-voltage supply in the transmitter and removing the voltage from time-delay relay 1, allowing it to reset. The dpdt relay has a holding contact, which allows it to remain energized while the latching relay is in the closed position. Depending upon the position of the selector switch, one of the remaining three time-delay relays will have been energized, determining the duration of the transmission.

At the end of the transmission period, voltage is applied to the release coil of the latching relay, permitting it to open. This removes voltage from the dpdt relay, the transmitter and the interval timer. The unit is then ready for the next operation.

The NE-51 neon lamps indicate when the power is on and when the transmitter is operating.

Transmitter

A circuit diagram of the transmitter is shown in Fig. 4. It employs a 2J42 magnetron as the source of pulsed 3.2-centimeter microwave energy.

The trigger circuit consists of two 6J6 tubes. One operates at 400 cps as a free-running multivibrator and the other as a cathode follower, to provide a low-impedance source from which to supply positive trigger pulses to the grid of the 3C45 thyratron.

The full-wave rectifier circuit provides about +1,300 volts for charging the pulse-forming network through the charging choke and hold-off diode. When the trigger pulse is applied to the grid of the thyratron, the thyratron conducts short circuiting the input to the charged pulse-forming network. The discharge pulse passes through the primary of the pulse transformer causing a negative pulse of 5,000 to 6,000 volts and 2.25 microseconds duration to be applied to the cathode of the magnetron.

The average input current to the magnetron is measured by the meter.

Microwave pulse energy of 5 to 7 kw peak, which is obtained from the magnetron, is transmitted to the antenna through a waveguide.

Since merchant-marine radar sets emit horizontally polarized waves, vertical polarization was employed in the design of the fog-alarm remote-control equipment to eliminate the possibility of interference from marine-radar sets operating in the same frequency band.

The receiving antenna, shown in one of the photographs, consists of a 24-slot, resonant waveguide array radiating into an 8-inch, 20-degree-flare horn to control the vertical beamwidth. A vinylite window seals the aperture from the weather. The half-power beamwidths are 3.7 degrees in the horizontal plane and 16.5 degrees in the vertical plane.

Receiver

The circuit diagram of the receiver is shown in Fig. 5. With the exception of the sensitive-relay stage, subminiature hearing-aid-type tubes are used because of their low battery current drain requirements.

The input to the receiver is from a 1N31 crystal detector mounted in a fixed-tuned, crystal holder terminating the waveguide run from the

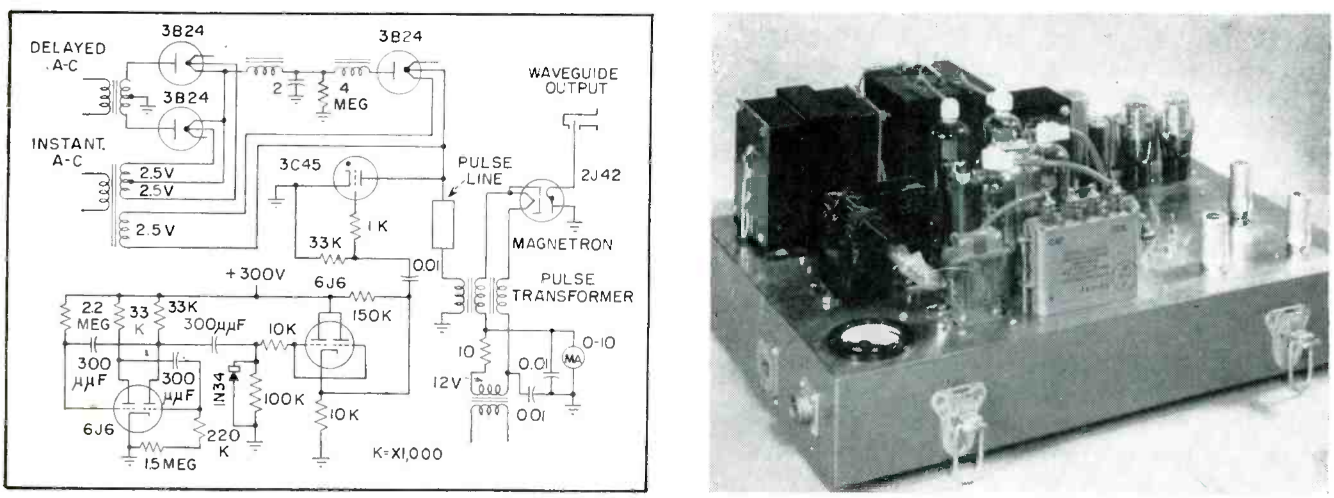


FIG. 4—Microwave transmitter and modulator. Magnetron output tube is mounted on left side of chassis

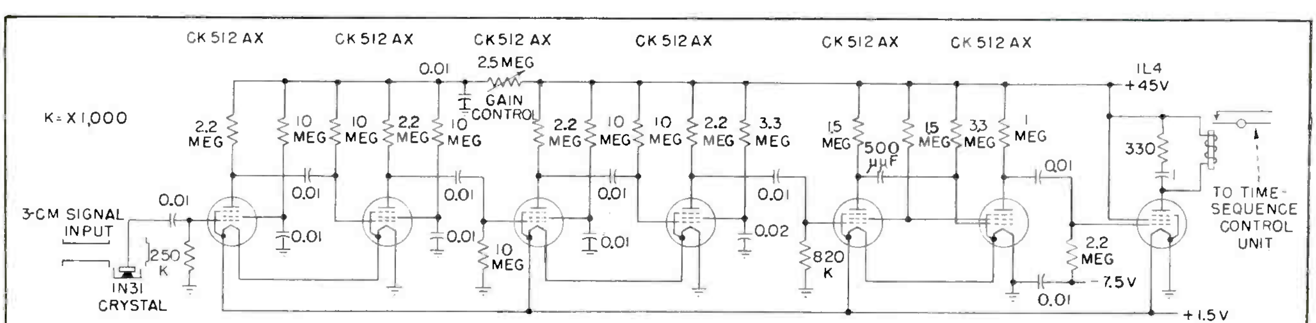


FIG. 5—Receiving unit uses CK512AX subminiature hearing-aid-type tubes to reduce battery current drain

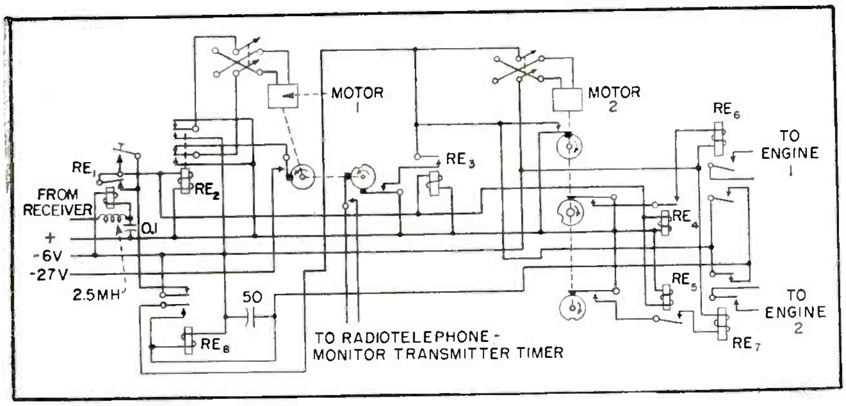


FIG. 6—Time-sequence unit has timing cams driven by reversible motors

antenna. The first four stages of the receiver constitute a sensitive, pulse-voltage amplifier.

The output of the amplifier triggers a monostable multivibrator or Kipp relay. This stage employs common-screen rather than common-cathode coupling and thus avoids the need for a separate filament supply with low capacitance to ground. The Kipp relay responds readily to the pulse recurrence rate of the received signal and its output results in a large power gain.

The output of the Kipp relay is fed to the 1L4 power amplifier, which has the high-resistance coil of a sensitive relay in its plate circuit. This tube is normally biased beyond cutoff by a 7.5-volt battery. The signal is integrated at the grid until this bias voltage is overcome, at which point the tube draws current and closes the relay. The resistor and capacitor across the relay coil provide for some additional integration of the signal, or delay, before the relay closes. This insures that the relay will not close on short-duration, spurious signals.

Current requirements of the receiver are 125 microamperes at 45 volts for the plate circuit and 110 milliamperes at 1.5 volts for the filaments. The relay stage draws current only when a signal is received. The receiver will operate for several months from two heavy-duty dry batteries.

Time-Sequence Unit

The schematic diagram of the time-sequence unit is shown in Fig. 6.

When the sensitive relay in the receiver operates, it connects the input lead of the time-sequence unit to ground, which is also the positive side of the 6-volt and 27-volt batteries. The 2.5-mh choke and 0.1-μf capacitor constitute a filter to prevent interference or noise from appearing on the input cable. When the input lead is connected to ground, relay RE_1 closes applying voltage to RE_2, RE_3, RE_4 and RE_5, causing these relays to close also. The closing of RE_2 applies power to motor 1, which has two cams on its output shaft. After an interval of 10 seconds the second cam closes a switch and starts a timer controlling the operation of the radiotelephone-monitoring transmitter. After a further interval of 10 seconds, the second switch on this cam closes, applying power to motor 2. This switch stays closed for a sufficient time to allow motor 2 to operate the switch on its first cam. Power is then applied to motor 2 independently of the cams on motor 1.

Twenty-five seconds after motor 2 has started, the second cam on its shaft closes a switch. If the signal from the receiver ends between the time that motor 2 has started and the operation of this switch, relay RE_6 will be energized through the contacts of RE_4, closing the circuit to engine 1 cranking control. However, if the signal from the receiver continues, RE_6 will not close and engine 1 will not be selected.

Thirty-five seconds after motor 2 has started, the third cam closes a switch. If the signal from the receiver is still present, RE_7 will be energized through the contacts of RE_5 and the circuit to engine 2 cranking control will be closed. Motor 2 will continue to operate until the first cam returns to its original position, causing the switch to open and power to be removed from the motor.

At the instant RE_6 or RE_7 operates, auxiliary contacts on these relays apply power momentarily to RE_8. This relay stays closed since its energizing circuit is completed through its own holding contacts and the switch on the first cam of motor 2. The 50-μf capacitor across the coil of RE_8 delays its opening to insure that the circuit through its holding contacts is completed. As soon as RE_8 closes, the energizing voltage to RE_2, RE_3, RE_4 and RE_5 is removed, rendering the unit insensitive to any further signal until it has completed the selection cycle and reset itself. At the instant RE_2 opens, a reversing voltage of 27 volts is applied to motor 1, causing it to reset very rapidly.

A signal must be present for at least 20 seconds to cause an engine to be started, or similarly, to be stopped if it had been started previously. Any break in the signal would allow motor 1 to reverse rapidly and reset itself. This feature is designed to eliminate the possibility of an engine selection being performed by an interfering signal.

No current is drawn from the battery supply by the time-sequence unit except during a selection period. By transmitting a signal of approximately 15-seconds duration, the unit will select the radiotelephone-monitoring transmitter as often as required without interfering with the engine selection.

The experimental installation at Prince Rupert, believed to be the first of its kind for remote control of a fog-alarm station by a microwave link, was completed in June 1952. Since then, a number of the experimental units have been replaced by those of more recent design. A second installation was completed in October 1953.

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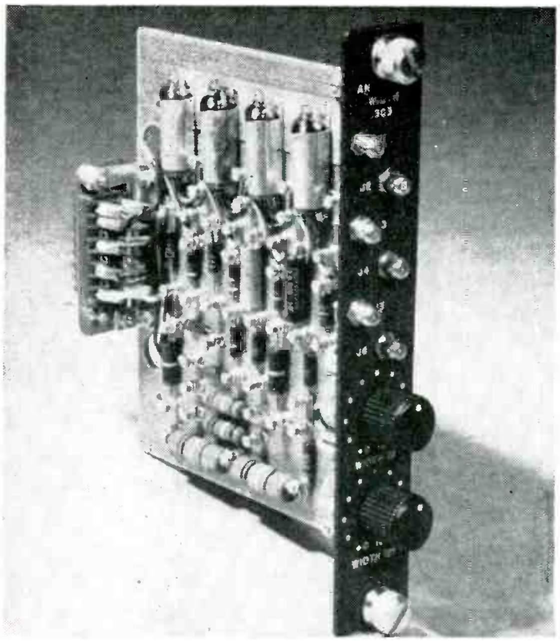
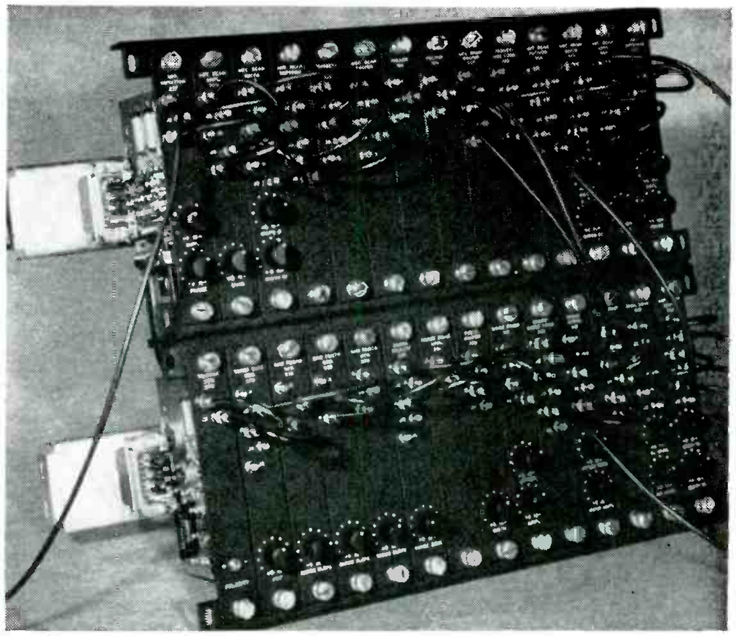
(1) Arthur Roberts, "Radar Beacons" MIT Rad Lab Series, Vol 3, p 31, McGraw-Hill Book Co., Inc., New York, N. Y., 1947.
(2) Same as above, chapter 3.
(3) D. E. Kerr, "Propagation of Short Radio Waves", MIT Rad Lab Series, Vol 13, p 535, McGraw-Hill Book Co., Inc., New York, N. Y., 1951.



Terminal-board construction is used in modulars. Plug at rear connects unit into system



Rack-mounted group of simulator modulars. Unitized construction provides for testing wide variety of radar systems

Modular Simulator Tests Missile Radar

SUMMARY —— Bench testing of radar units under dynamic conditions requires a flexible simulator system. Modular design of tester permits a wide variety of antenna beam pattern and motion characteristics

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IN AUTOMATIC tracking and homing radars, it is not sufficient to statically align and calibrate a radar system on a fixed target. The performance of range and angular tracking loops, the latter involving antenna-pedestal servomechanisms, must be adequate for high-speed, accelerating and evasively maneuvering targets often obscured by noise.

The simulator to be described can be adjusted to match any practical combination of radar pulse-repetition rate, pulse width, antenna beam pattern and target attenuation. Likewise, nearly any possible motion of single or multiple point targets can be inserted.

Modular plug-in construction is used in the simulator to permit testing of different radar systems and for use as a target simulator. One group of modulars is capable of introducing various radar transmissions and radar-set effects on a simulated target-echo signal. These units have variable controls to adjust for any practical combination of prf, pulse width, antenna beam pattern, nutation and range.

The modulars can also simulate antenna nutation. Nutation is a conical scanning motion of the beam, normally obtained by rotation of the radiating dipole relative to the dish or vice versa.

Another group of modulars generates target motion simulating aircraft flight or arbitrary motions for specialized tests.

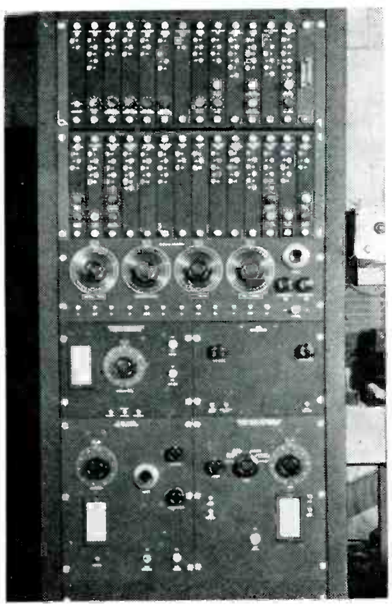
In most applications, a simulator does not replace all the physical radar equipment, but only that portion which cannot conveniently be made operational on the bench.

Typical Application

A typical arrangement of a radar and the simulator components is shown in Fig. 1. Simulated target motion generated by the motion modular is converted to a realistic video signal in the video modulars. This signal is inserted directly into the early video stages of the radar set for activating the video amplifiers, range and angle tracking circuits and indicator.

To utilize all of the receiver components, the video signal is transformed to 30 or 60 mc in the i-f modular. The i-f modular consists of a 15-mc Hartley oscillator 100-percent modulated by the video signal. This 15-mc signal is mixed with a 45-mc signal produced by a similar oscillator circuit and the sum and difference frequencies of 30 and 60 mc are fed to the i-f strip, which selects the proper frequency. This permits full utilization of the radar i-f strip which will include effects of i-f bandwidth, manual and automatic gain control, fast time constants and similar circuits.

In the tracking system shown, receiver output controls the operational antenna position through the pedestal servos. With the antenna position fed back to the video modulars, the tracking loop is closed. Since in an actual system the tracking information may be fed to a computer, the present target position of the computer may be compared with the simulator target-motion modulator output (the true target position) in a simple d-c deviation indicator or recorder.



Complete test simulator is rack-mounted. Modular units are at top

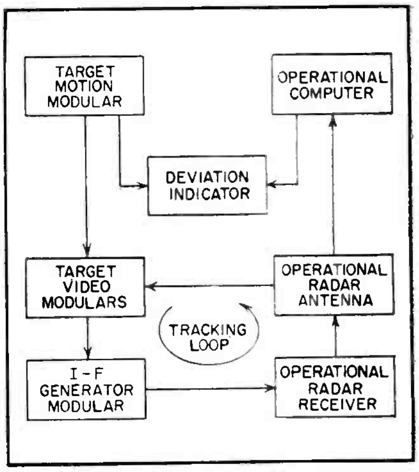


FIG. 1—Typical arrangement for testing radar system

The target maneuvers produced by the motion modular are generated electromechanically and electronically and are not limited by any structural considerations as would be those of a real aircraft. Since they are reproducible, it is possible to insert arbitrary motions into the radar tracking loop from which the transient and frequency response of the servos and tracking elements can be computed. For example, a ramp or step motion of the target in range, or a sinusoidal target motion in either range or angle can be injected. The sinusoidal motion may be adjusted in amplitude and frequency about any center value by means of accurately calibrated and stable controls. These sinusoids, after conversion into video and i-f by the appropriate modulars, are injected into the radar receiver-antenna pedestal loop, permiting preparation of Bode or Nyquist plots from which the transfer function and stability of the networks can be determined.

Range Programming

Range programming of targets is accomplished by means of simple d-c circuits, consisting of combinations of potentiometers and other electromechanical computing elements activated by a precision variable-speed drive consisting of a synchronous motor and ball-and-disk integrator. As an example, constant velocity slant range is generated by constant angular velocity of a potentiometer connected to a regulated d-c voltage source. Constant acceleration is accomplished by means of two potentiometers ganged together in a squaring circuit, computing the slant-range voltage in accordance with the equation $S = \frac{1}{2} at^2$.

Tracking-Radar Testing

A typical arrangement of video modulars for use with a tracking radar set is shown in Fig. 2. A trigger pulse is obtained from the radar set in order to slave the prf of the simulator to the radar. The motion modular is used to program a d-c voltage for target motion in range. The d-c slant range voltage is compared in amplitude with a sawtooth voltage of proper prf and slope in a conventional type pick-off circuit and a range-delayed pulse generated at coincidence. The range-delayed pulse is then shaped to provide proper rise time and pulse width to simulate radar-set parameters.

The motion modulars also program target angle in azimuth and elevation relative to the radar set. The angle information is usually in the form of 1-kc sine and cosine signals which are added in quadrature to obtain a sinusoidal signal which shifts in phase as the target moves. This signal is converted to a short duration pulse which is locked to the 1-kc time base.

Antenna position must then be converted to the same time base to obtain coincidence. This can be accomplished by mounting two resolvers to the antenna for use as angle pick-off devices. The resolvers are excited by a 1-kc signal and the outputs fed into quadrature circuits

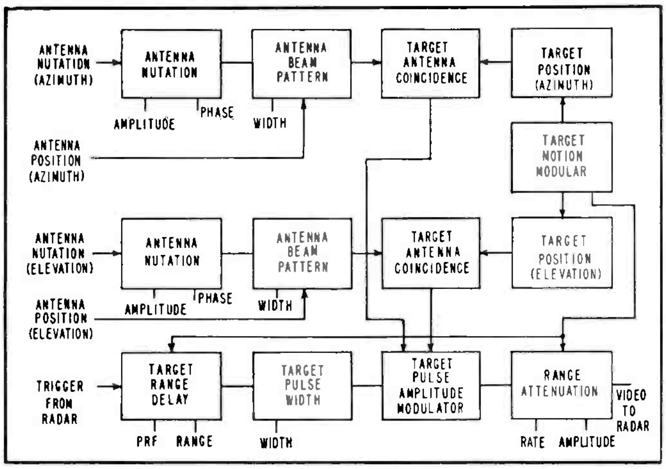


FIG. 2—Test arrangement for a tracking radar. Antenna information is derived from simulator modulars

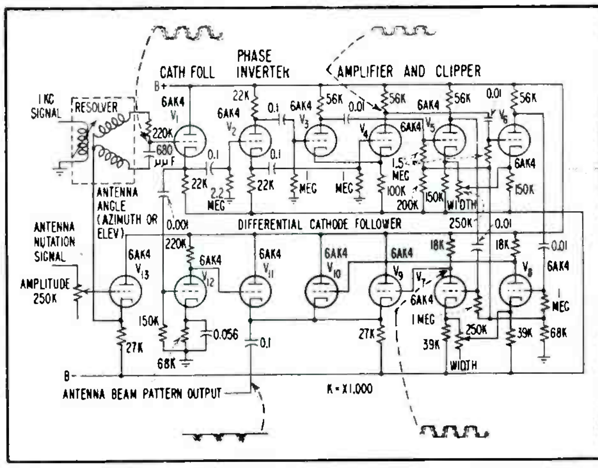


FIG. 3—Echo-pulse simulator uses differential cathode follower output to select most positive of three signals

to produce 1-kc signals phase shifted by an amount proportional to antenna motion. The signals are then converted and shaped to parabolic voltages which accurately simulate the profile of the antenna main lobe in the azimuth and elevation planes.

The radar set used in the illustration utilizes a nutating antenna. The two-phase output of the radar antenna-nutation generator is fed into the antenna-nutation modulars. These signals position modulate the simulated antenna beam pattern in a manner directly analogous to the spatial motion of the actual antenna beam.

The antenna beam patterns in azimuth and elevation are then compared with the appropriate target-position pulses and coincidence voltages generated. The amplitude of these coincidence voltages depend on the position of the target in the antenna beam.

Range Information

The target-range delayed pulse is amplitude modulated by the combination of the azimuth and elevation coincidence voltages properly added in quadrature. The resultant is a pulse whose amplitude is dependent on the target position in the nutating antenna beam. The target amplitude is further attenuated as a function of range to simulate effects of transmission attenuation.

The output of the modular may then be fed into the video circuits of the radar set or may be converted to an intermediate or radio frequency for injection into earlier stages of the radar.

Echo-Pulse Simulator

The method of converting antenna-angle motion into an antenna beam pattern voltage to amplitude modulate the simulated target echo pulse is detailed in Fig. 3. A resolver mounted on the antenna is excited by a 1-kc signal. The sine and cosine amplitude signal outputs from the stators are added in quadrature giving a constant-amplitude variable-phase signal at the grid of V_1. A single-phase signal from the radar-set nutation generator is fed into V_{13} to introduce nutation effects. This low-frequency signal mixes with the 1-kc signal and advances or retards the time at which the higher-frequency signal passes through zero voltage, dependent on the instantaneous amplitudes of the two signals.

The mixed signals appear at the output of cathode follower V_1. These are fed into phase inverter V_2, having equal cathode and plate load resistors and equal amplitude push-pull signal outputs are obtained. These signals are coupled to overdriven push-pull amplifiers V_3 and V_4. The output has the form of push-pull clipped 1-kc nutated sine waves. The clipped sine waves are further amplified and clipped by V_5, V_6, V_7 and V_8 operating as overdriven push-pull amplifiers.

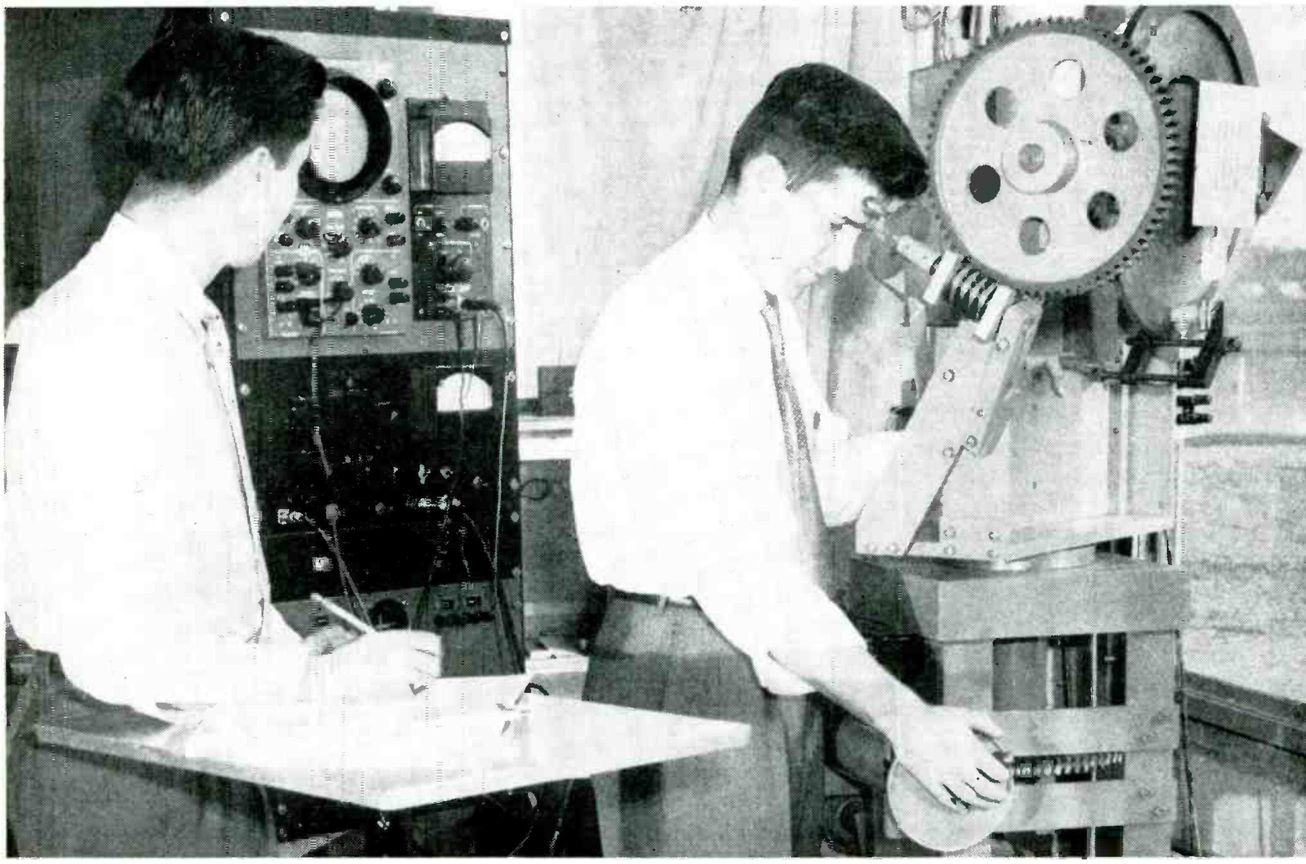
The output of V_7 and V_8 becomes push-pull trapezoidally shaped signals whose slopes may be varied over a limited range by the two common cathode width control potentiometers. These adjustments permit variation of effective antenna beam width. The push-pull trapezoidal signals are fed to V_9 and V_{10} which together with V_{11} form a differential cathode follower whose output is determined by the more positive of the three inputs. Normally V_{11} is cut off and has no effect on the output.

Output Circuit

The output remains at a positive voltage until near crossover of the trapezoid occurs and then decreases linearly to a lower positive voltage until crossover and then increases linearly back to the original steady state value. This forms a V-shaped voltage whose slope is dependent on the slope of the trapezoid signals and is repetitive at a 1-kc rate. The 1-kc sine wave of correct phase is obtained from V_1 and fed to the grid of V_{12}. This causes V_{12} to conduct for every other trapezoid crossover and eliminates the ambiguous pulse that would otherwise be formed.

The target position in angle is also converted to the same 1-kc time base but is represented by a short-duration pulse of 1 microsecond. Circuits compare this pulse in time coincidence with the antenna V-shaped voltage and produce a d-c coupled signal with an amplitude dependent on the degree of coincidence. This signal is further shaped to accurately reproduce the parabolic shape of the antenna beam. The parabolic shaped coincidence voltage amplitude modulates the target-echo signal.

Photoetched Antennas



Checking radiation pattern of four-by-four slot array shown in Fig. 1

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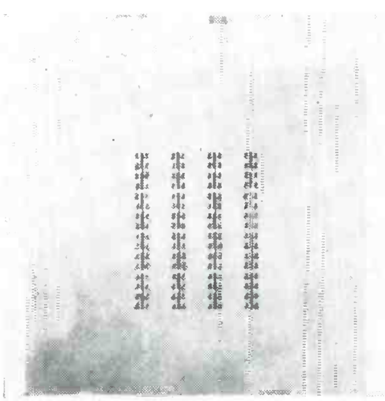

FIG. 1—Four-by-four slot array made from copper-clad Teflon three-plate line

MICROWAVE printed-circuit techniques are readily adapted to the construction of compact antennas ideal for flush mounting on high-speed aircraft.

This article describes the development of a two-dimensional X-band array consisting of 16 slots fed by photoetched Tri-plate transmission line. The design of a unity-coupled series slot and the resulting mode purity problems are also discussed.

The construction of a four-slot E-plane, a four-slot H-plane and the combination 4×4 E-H plane are shown.

Tri-plate is a three-plate shielded strip transmission line in which the center strip is photoetched on the inside faces of two dielectric sheets each of which has copper foil bonded to both surfaces.

The X-band antenna to be described consists of a 4×4 array of slots etched in one of the two outer faces of the transmission line. Such antenna arrays can be flush-mounted on the skin of a high-speed aircraft. The 4×4 X-band slot array is shown in Fig. 1. The composite antenna array has a 4 in. square aperture and a total thickness of only ⅛ in. Such a device can be mounted by drilling a small hole in the aircraft's skin, just large enough to allow the passage of a coaxial fitting or waveguide flange.

Principal objective in this work has been the development of a 4×4 slot array with in-phase signals of equal power fed to each slot. The 4×4 array was selected because its size is about the minimum

for Supersonic Aircraft

SUMMARY — Slot array etched in outer face of triple-plate transmission line provides an antenna suitable for flush mounting in the skin of high-speed aircraft. Technique is useful from 500 to 10,000 mc with significant saving in weight for lower-frequency applications

with which pattern asymmetry is distinguishable and because power splitters having an equal number of arms can be used. Power splitters having an odd number of arms are less convenient to use because the arms are not of equal length, which upsets the in-phase excitation of the slots they feed.

Teflon fiberglass laminate was chosen as the dielectric. It is a commercially available copper-clad dielectric with suitable electrical properties at microwave frequencies and has an adequate dielectric constant.

The ideal antenna for optimum broadside signal and minimum end-fire would have its slots spaced ½ wavelength apart in air and fed from a power divider whose arms are one wavelength apart in the dielectric. This ideal condition cannot be realized unless the dielectric constant equals four, because, since the principal mode of operation is TEM, the wavelength varies as the square root of the dielectric constant. The dielectric constant of Teflon fiberglass laminate—approximately 2.40—was satisfactory for maintaining the proper phase relationship both in air and in the dielectric. A frequency of 9,375 mc was selected for the study, because of the availability of test equipment.

Slot Design

First step was to design a satisfactory radiating element. A series slot, such as the one shown in Fig. 2 appeared to be the simplest to excite. It was not sufficient, however, to etch the slot in one of the outside faces of the line. Excitation could be accomplished in this manner because of the interruption of currents in the outer plate, but at the same time undesirable modes were set up as a result of the voltage unbalance introduced between the two outer plates by this asymmetrical device.

The first slot used in experiments —$\frac{1}{2}\lambda_0$ long and $(1/20)\lambda_0$ wide— showed appreciable lateral leakage from between the outer plates. The parallel plate mode was present and suppression of this mode is essential to the proper operation of the radiating element. It was determined that shorting pins along the center strip in the regions of the slot's input and output would maintain the proper voltage balance between the outer plates. Figure 2 shows a typical shorting pattern.

While these pins effectively suppressed undesirable modes, they had considerable effect on the impedance of the slot. Because of the time involved in separating the true slot impedance from the parameters which affect it, it was decided to match this unity-coupled slot solely by experimental means. The final radiating element designed was a slot $\frac{3}{8}\lambda_0$ long and $(1/20)\lambda_0$ wide in series with a 90-ohm line which terminated in an open circuit $(1/10)\lambda_L$ from the slot center. Quantity λ_0 is the wavelength in air and λ_L the wavelength in the transmission line.

The small tab in the center of each slot of the 4 × 4 array of Fig. 1 adds capacitance to the slot. Tuning is accomplished by trimming it to its proper length.

Figure 3 illustrates transition from waveguide to three-plate line

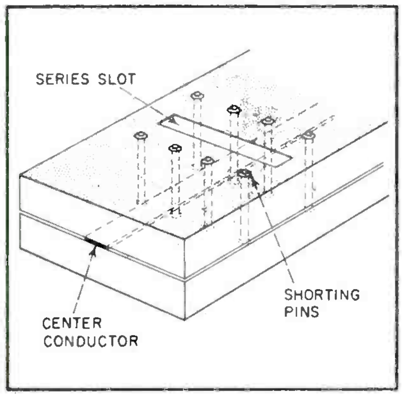

FIG. 2—Series-slot radiating element showing use of shorting pins

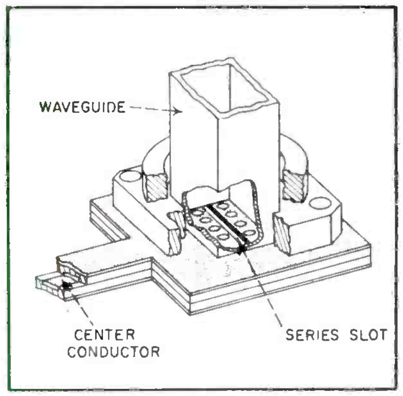

FIG. 3—Etched plate-to-waveguide transition using series slot as a transformer

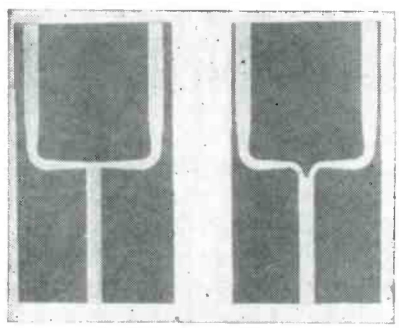

FIG. 4—Two-to-one power divider using T junction (left) and in-line junction (right) which affords smoother transition

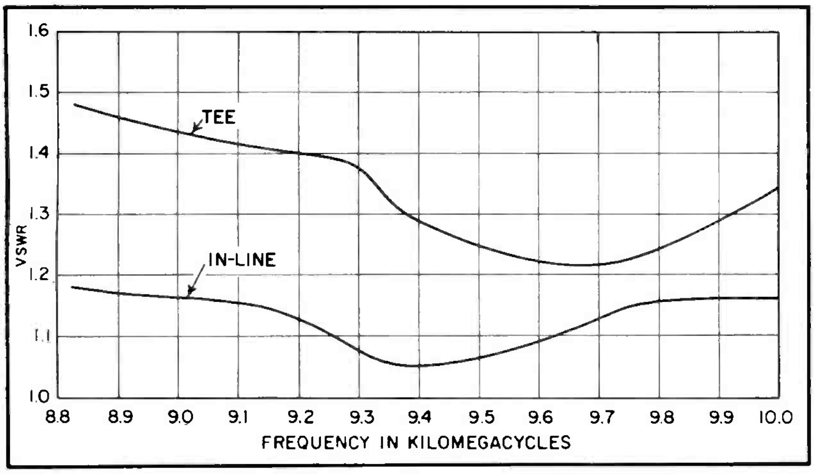

FIG. 5—Frequency versus vswr characteristics of in-line and T junctions

using a series slot transformer. A slot matched with a vswr of less than 1.1 at 9,375 mc has a vswr of 1.6 when coupled to a section of 1-in. × 1½-in. waveguide with a matched termination. This is the same as the ratio of their characteristic impedances: 377 ohms for air and 235 ohms for waveguide at 9,375 mc.

Feed Systems

The simplest power divider is a junction at which a line of characteristic impedance Z_0 divides into two parallel lines each having a characteristic impedance of $2Z_0$. Two possible configurations of this type are shown in Fig. 4. At the left is a T junction which is the three plate counterpart of the coaxial T. Figure 4, right, illustrates an in-line junction. The in-line type affords smoother transition than the T. This is borne out by the curves of Fig. 5, which are plots of vswr against frequency over a 12-percent band centered at 9,375 mc. The match of the in-line divider is under 1.10 vswr over a 5-percent band and under 1.18 over the entire 12-percent band. The best match obtained with the T is only 1.22. The dips in the center of both curves are due to the fact that the loads are best matched in the center-frequency region. However, the load vswr's were less than 1.12 over the range covered.

A combination of three of these two-way in-line junctions can be used to feed equal amounts of in-phase power to four separate lines. Figure 6, left, shows such a device. Further steps in this power-splitting pattern should be made in multiples of two to preserve the power divider's equiphase characteristic.

A three-way equal power split can be accomplished by splitting a line of characteristic impedance Z_0 into three lines each having a characteristic impedance of $3Z_0$. The three-way power divider illustrated in Fig. 6, right, shows that the center arm is shorter than the outer two. This asymmetry, which upsets the equiphase characteristic of the junction, can be overcome by curving the center arm to make its length equal to that of the others. The power splitter shown in Fig. 6, right, has less than 0.3-db variation in power between the arms when measured over a 10-percent frequency band centered at 9,375 mc.

A progressive power splitter is illustrated at the left of Fig. 7 alongside the slot array which it was designed to feed. This unit has been used successfully as an H-plane feed system for both the four-element H-plane array and the composite 4 × 4 array shown in Fig. 1. The input line has a characteristic impedance of 22.5 ohms and feeds, through a three-to-one power division, two lines whose characteristic impedances are 30 and 90 ohms. This 30-ohm line divides into a 45-ohm line and a second 90-ohm line, giving a two-to-one power split. The power in the 45-ohm line divides equally into two more 90-ohm lines. All junctions were designed to satisfy the fundamental parallel circuit equation: $1/Z_1 = 1/Z_2 + 1/Z_3$. Measurements showed a maximum deviation of 0.6 db over a 10-percent frequency band centered at 9,375 mc.

The power divider shown at the left in Fig. 8 is a nonfrequency sensitive device which excites with in-phase signals all slots of the E-plane array shown beside it. All signals must travel along paths of equal length from the junction of the power divider to the slots which they feed. Equiphase excitation in the H-plane, using the power divider of Fig. 7, will occur only at the frequency where λ_L equals the

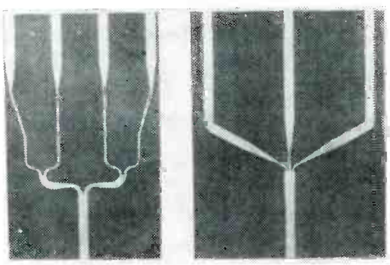

FIG. 6—Four-way power divider (left) and three-way power divider (right)

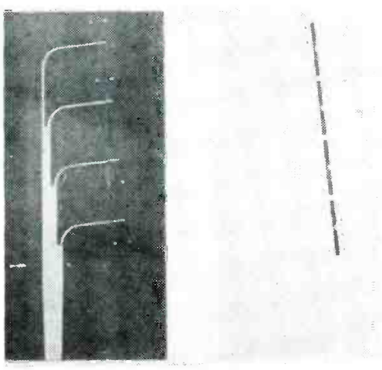

FIG. 7—Progressive power divider (left) and H-plane slot array which it was designed to feed (right)

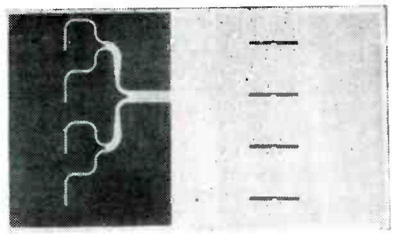

FIG. 8—Nonfrequency-sensitive power divider (left) and E-plane array which it feeds (right)

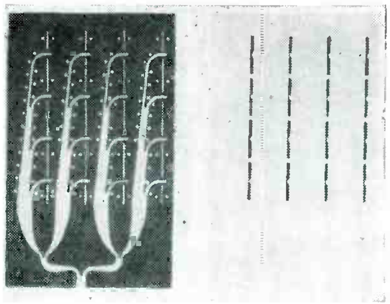

FIG. 9—Combination power-divider feed system (left) and its corresponding four-by-four array (right)

distance between the 90-ohm arms. This distance was constructed to equal λ_L at 9,375 mc.

The power divider used to feed the final 4 × 4 slot array is shown at the left in Fig. 9 along with the slot array which it is designed to feed. The feed system is a combination of the power dividers shown in Fig. 7 and 8. It is an assembly of four progessive power dividers, each of which feeds four H-plane coupled slots. Each of these progressive power dividers is coupled in phase to an arm of a four-way power splitter.

Radiation Patterns

Radiation patterns of the three antennas shown in Fig. 7, 8 and 9 were measured at the design frequency and are plotted in Fig. 10A, 10B and 10C. The individual four-slot H-plane and four-slot E-plane arrays, each of which comprises a side of the two-dimensional array, were constructed first and individually tested to make a more complete analysis of the composite 4 × 4 array. The half-power beamwidth values for both of the four-slot linear arrays are close to the predicted values. The H-plane array, with $1.92\lambda_0$ spacing between outside slot centers, has a 20-deg beamwidth, and the E-plane array, with $1.8\lambda_0$ spacing between slot centers, has a 23.5-deg beamwidth. The lower side lobes in the H-plane can be attributed to the voltage tapers at the ends of the array.

Comparing the E and H-plane patterns of the composite 4 × 4 array (Fig. 10C and 10D) with the corresponding individual array patterns (Fig. 10A and 10B), the main lobes of both plots seem to be identical. However, the side lobes in both planes of the 4 × 4 array are appreciably larger. The E-plane side lobe increased from approximately −12.5 db to −9.0 db, while the H-plane side lobe increased from approximately −15.2 db to −13.3 db. These higher side-lobe intensities are due to mutual coupling between diagonal slots. Diagonal slots are not present in the individual arrays.

These could be used in place of conventional waveguide slot arrays and horns for receiving and low-power transmitting applications from 500 to 10,000 mc, where fixed-beam antennas are required.

Studies which have led to the development of the techniques and equipment discussed were sponsored by the Navy Bureau of Aeronautics, industrial planning division; Cambridge Air Force Research Center and the National Bureau of Standards.

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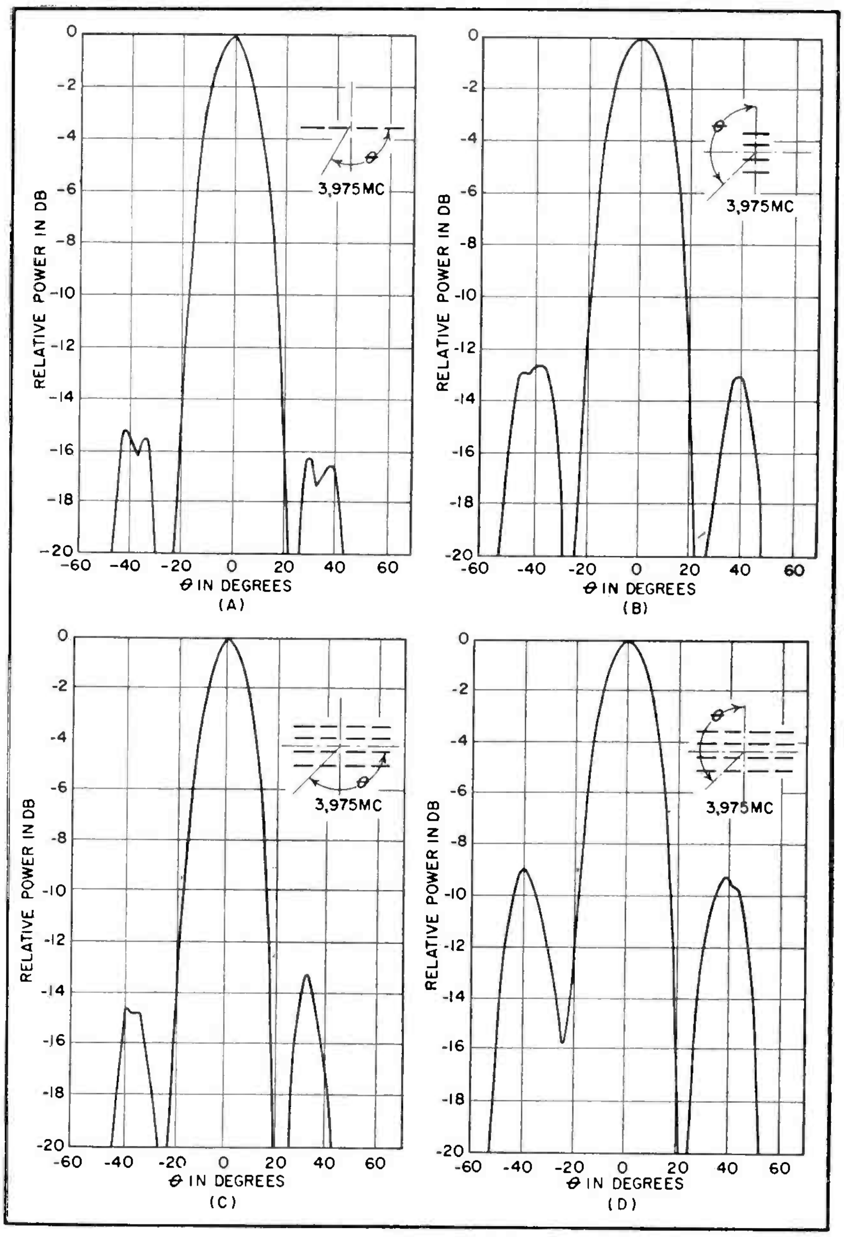
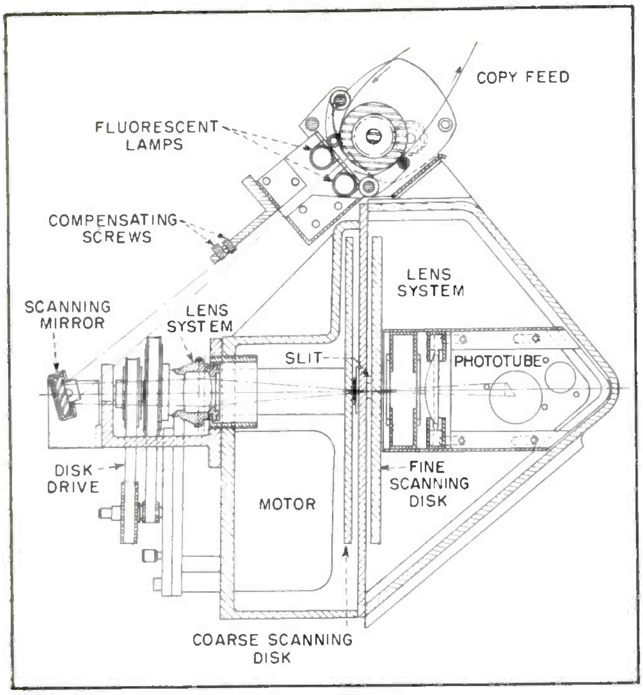
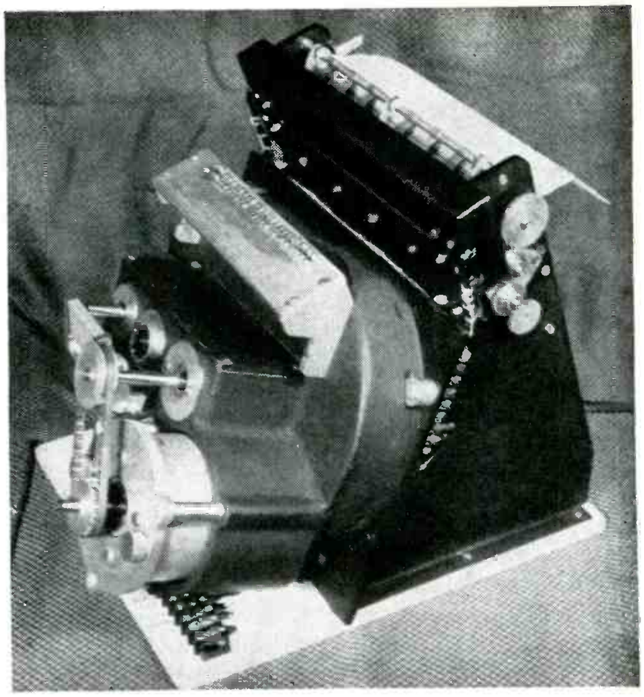


FIG. 10—Radiation patterns for H-plane array (A), E-plane array (B), E-plane pattern of composite array (C) and H-plane pattern of composite array (D)



Scanning mirror picks up image from brightly lighted line of copy. Compensating screws equalize effective illumination



Transmitter-scanner must be solidly constructed to reduce vibration from high-speed operation. Continuous copy at upper right

Facsimile Speedup

SUMMARY — Telecasting's demand for quick news photographs has shifted emphasis to continuous-feed devices that do not require photographic processing techniques. Transmitter-receiver setup produces 180 8.2-inch lines per minute with 105-line definition over wire lines or microwave

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FACSIMILE EQUIPMENT design in the past decade has been directed[1,2] toward the utilization of moderately wide-band transmission lines.

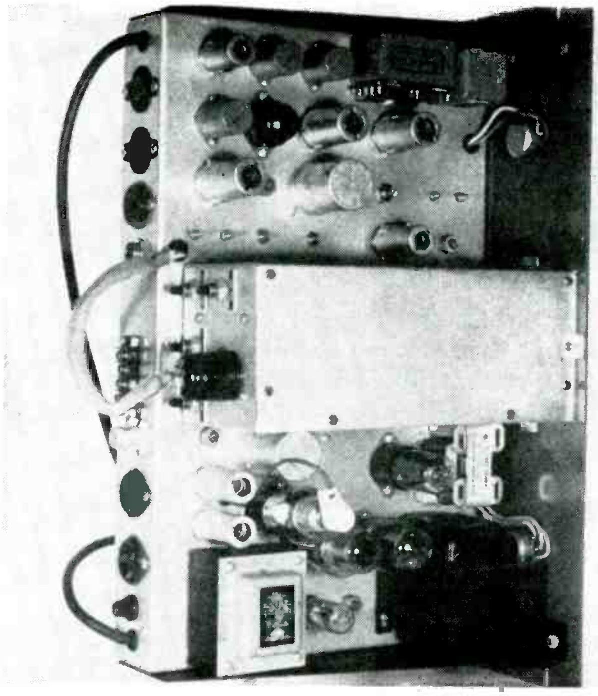
Owing to current emphasis on direct facsimile recording of pictures and text by the press services[3] and their newspicture distribution units together with the continued demands of other groups for facsimile equipment to operate over existing telephone company circuits, the design and packaging of a moderate-speed facsimile system has been undertaken.

A modern, two-way facsimile system for continuous operation of both transmitters and receivers is described below. The operating standards of the system are determined by optimum use of Schedule II telephotograph circuits as furnished by the American Telephone & Telegraph Co. to the military and press services throughout the United States. Since the system is for use over facilities with equalization of attenuation and envelope delay from about 1,200 to 2,600 cycles, the traffic handling capacity of this equipment is necessarily tailored for the intended transmission facility. Nevertheless, the units, having a chart speed of about fourteen square inches a minute, will process average typewriter characters at a rate of better than 150 words per minute.

The continuous scanner and continuous recorder transmit and receive copy of nominal page width.

Optimum use of telephotograph lines dictates a facsimile system having a useful scanned and recorded line across the page of 8.2 inches. The equipment outlined in Fig. 1 operates at 180 scanning lines a minute with a definition of 105 lines an inch. A 100-percent amplitude-modulated carrier of 2,400 cycles is fed through special insertion-loss type linear-phase ves-

Receiver-recorder will reproduce typed copy, weather maps, charts, photographs or similar illustrated material



Compact scanner amplifier showing vestigial sideband filter (top) monitor oscilloscope (center) and power supply

Enhances Usefulness

tigial-sideband filters to the telephone line terminals.

A pilot carrier is used for automatic control of start-stop and phasing of receivers. This same pilot carrier can also furnish power-frequency reference information from the transmitter to remote receivers for speed control of synchronous motors.

A continuous facsimile system delivering copies of 8½ by 11½-inch scanned pages in less than seven minutes comprises a continuous facsimile scanner, an automatic continuous facsimile recorder and associated electronic units. Letter-size sheets of 8½-in. maximum and originals of equal or narrower width, but without any restriction as to length, can be fed into the scanner mechanism in a continuous manner. This feature obviates the starting and stopping associated with reloading of earlier drum-type noncontinuous scanners. The automatic recorder mechanism is continuous to the limit of the 400-foot paper supply roll, which in this system lasts for over 48 hours of operating time. The design standards are listed in Table I.

Power Synchronization

Synchronous motors in the recorders will not run at the same speed as the synchronous motors in the scanner if power lines in the areas of the scanner and remote recorder are not locked together. These motors must run at exactly the same speed to maintain constant scanning alignment.

For synchronized remote operation of recorders, a motor-speed reference signal is sent from the originating point along with the facsimile intelligence. Ths synchronizing signal, determined by the exact frequency of the nominal 60-cycle power at the originating point, is transmitted as a double-sideband amplitude-modulated subcarrier. After detection, the demodulated 60-cycle signal controls the output power frequency of a motor-drive amplifier that turns the recorder motor in exact synchronism with the scanner motor.

Continuous scanning[4] is achieved with an optical system that forms a reduced real image of the copy at the intersection of an Archimedes spiral slot and a straight slit. The intersection of the spiral and

Table I—Design Characteristics of System

Line-use ratio	7/8
Facsimile signal	315 deg
Blank	45 deg
Phasing pulse	15 deg
Index of cooperation	(IRE) 984 (CCIR) 313.1
Required bandwidth	950–2,700 cycles
Carrier frequency	2,400 cycles
Maximum picture element frequency	1,500 cycles
Type of transmission	Vestigial sideband a-m
VSB filter	Linear phase through cutoff
Sense of modulation	Maximum on black
Recording medium	linear electrochemical recording paper 20-db dynamic range

the slit forms an aperture that sweeps across the copy at a constant speed when the spiral is driven by a synchronous motor. Lenses collect the light from the sweep aperture into a multiplier phototube.

The copy to be scanned is fed past two fluorescent lamps. The illuminated area of the copy beneath the lamps is viewed by an objective lens. For convenience the optical path is folded so that the lens actually views the copy via a mirror. The image of the copy is only 2.75 inches wide, hence the sweep distance required for the turning spiral is 2.75 inches.

The spiral slot is made photomechanically, the actual cleared aperture being only 0.0023 inch in width to provide some 1,000 resolvable elements over the 2.75-inch sweep with a minimum of aperture distortion. The horizontal slit also is made photographically and is placed next to the flat surface of the revolving spiral disk.

Behind the slit and spiral slot is a condensing lens system of wide aperture, which forms an image of the objective lens aperture stop on the multiplier phototube cathode. Since the objective lens does not move, neither does its image on the phototube, even though the intervening light rays pass through a constantly moving aperture (the slit-spiral slot intersection).

The disk containing the spiral slot is mounted on a shaft driven by a synchronous motor. Control signals are generated by means analogous to mounting a commutator and brush assembly on the disk shaft.

The recording unit in the continuous facsimile system uses a helix and linear electrode construction. A linear marking electrode, formed by a spring mounted, continuously moving, stainless steel tape,[5] is presented to the marking point in a manner that gives a smooth and accurate marking combination for operation at high rotational speeds.

Equipment including facsimile scanner, amplifier and modulator is shown in Fig. 3. Picture elements picked up by the spiral slot continuous scanner are veiwed by an electron-multiplier type phototube with log-compression output circuit. Carrier at 2,400 cycles and phototube output are fed into the double balanced ring modulator. Modulated output is passed through an insertion-loss type of linear-phase vestigial sideband filter.

Pilot control carrier at 450 cycles with added power-frequency modulation for start, stop, phasing and synchronizing control is mixed with picture signal in the primary of the output transformer. The amplitude of the signal subcarrier output is proportional to the optical density of the subject copy scanned.

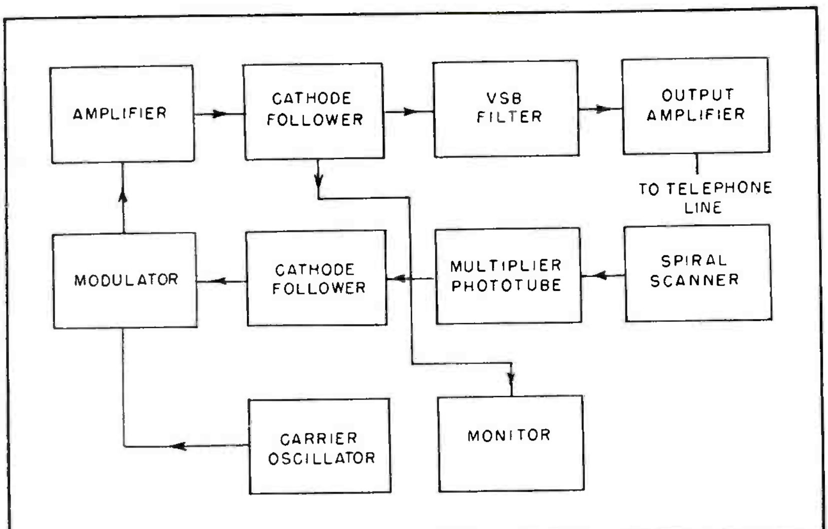


FIG. 1—Elements of the continuous-feed facsimile scanner-transmitter

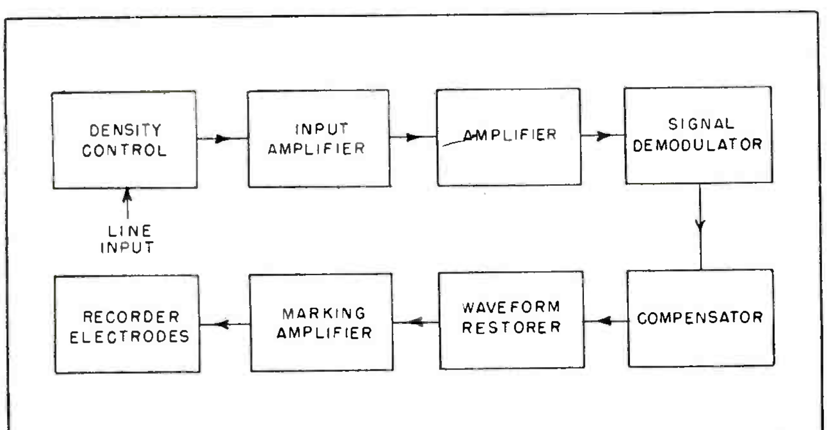


FIG. 2—Elementary facsimile receiver-recorder used on narrow-band lines

Recorder Amplifier

Processing incoming facsimile signals and production of correct marking currents is the function of the recorder shown in the circuit diagram of Fig. 4. It provides sufficient sensitivity for proper operation at input levels as low as −20 dbm. Besides the gain control that allows adjustment of density a standby-record switch permits gain adjustments being made in the standby position. Recording current is shown directly on a vu meter.

The high-impedance constant-current source represented by the output of the marking amplifier to the recording paper insures that the quality of recorded copy will be unaffected by variations in paper moisture or paper impedance. A Thyrite overload protective circuit prevents the transmission of excessive currents through the recording paper.

An inductor and capacitor combination between detector and marking amplifier comprise a snap-up circuit responsive near element frequency. The circuit tends to restore waveform and definition lost in transmission links

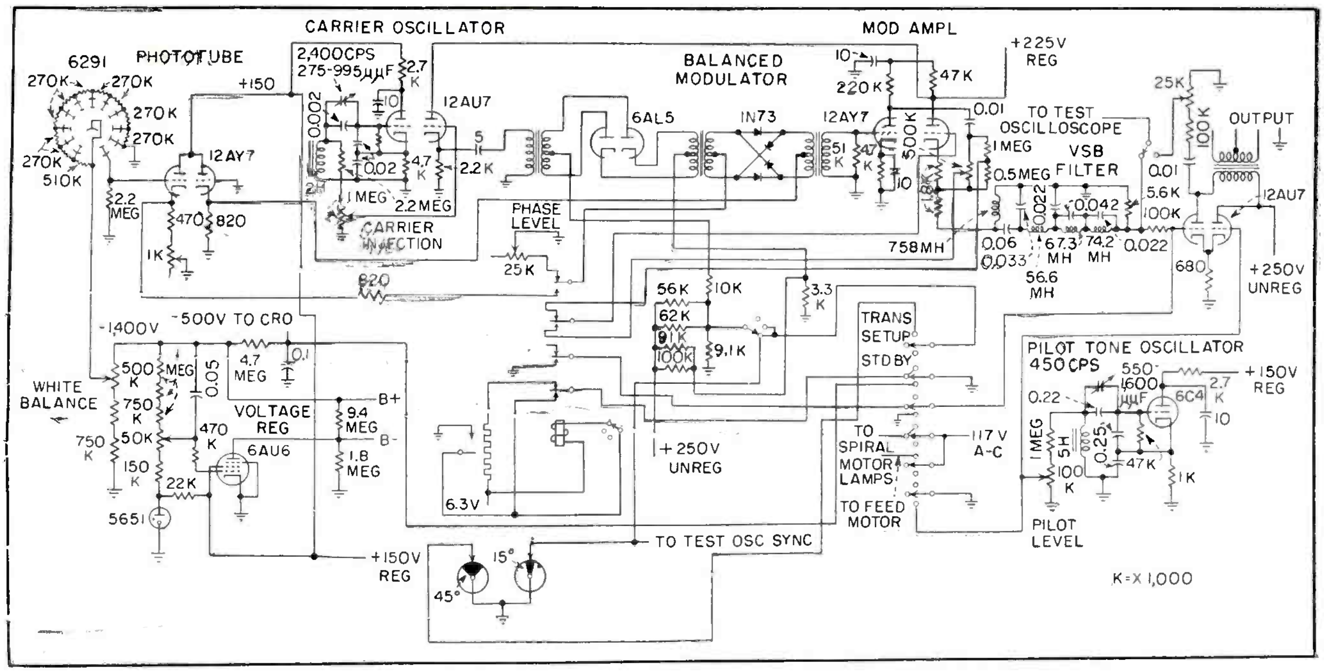


FIG. 3—Scanner amplifier used in system with common power synchronization. Additional subcarrier modulation can be added for remote locations using pilot tone oscillator like that shown to right

with restricted frequency range. An automatic phasing and phasing lock-out system, using tubes and thermal relays allows the recorder to phase automatically upon receipt of the phasing signal, but locks the circuit out of operation to avoid malfunctions caused by noise.

Communications Use

A transmitting terminal equipment of this type, besides being connected to telephone lines, can also be used as input to a-m and f-m radiotelephone transmitters. For use involving frequency shift keying of radiotelegraph transmitters, provision is made for the addition of tuning-fork frequency standards for control of power frequency. Converters for fsk are required at both the transmitters and receivers. An extensive facsimile project recently completed for the U. S. Signal Corps has resulted in a pair of fsk converters using modern techniques.

The facsimile system described has the ability to reproduce graphic material of practically any kind such as handwriting, typewritten copy, pictures, graphs, forms and maps. Such copy of normal page width or less and of any length emerges from the recorders in final form and is presented as a permanent image in black or varying shades of gray on a clean white record sheet. A built-in heater completes the electrolytic printing process and insures dry copy.

The transmitter monitor oscilloscope allows precise adjustment of signal levels during operation without stopping the equipment for readjustment. Transmission is possible from radiotelephone transmitters and over microwave links having a nominal 3,000-cycle bandwidth.

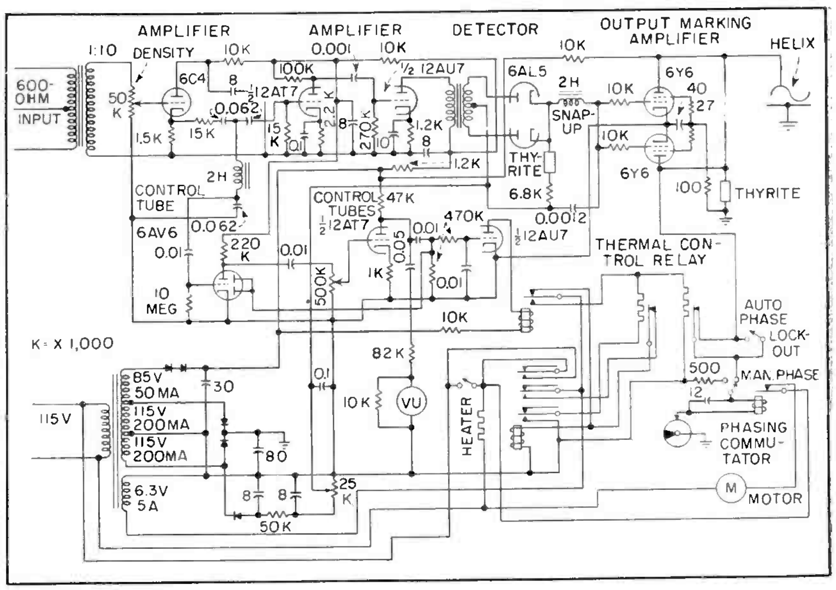


FIG. 4—Receiver-recorder employing special paper prints with output of marking amplifier

The author acknowledges assistance from all members of the engineering staff of Hogan Laboratories whose efforts and developments led to the system described in this paper.

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Transistors Generate

SUMMARY —— Sine, square or saw-tooth waves are obtained from same oscillator by changing value of one resistor. One stage operates as nonlinear element capable of phase inversion or noninversion depending on small-signal changes in operating point

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MANY new circuit applications result from the utilization of transistors as nonlinear networks as opposed to their more usual use as power-gain devices.

In the junction-transistor collector characteristics illustrated in Fig. 1, the linear region is characterized by an a-c collector resistance which is very high and fairly constant. However, in the range where V_c, the collector voltage, is nearly equal to zero, the collector resistance changes drastically from a very high value to a very low value.

When V_c is small, the a-c collector resistance is

$$r_c = \frac{\partial V_c}{\partial I_e} = \frac{1}{I_{co}}\,\frac{kT}{q}\,\exp\left(\frac{-qV_c}{kT}\right) \quad (1)$$

where I_{co} is the d-c collector current for zero emitter current, k is Boltzmann's constant, q is electronic charge and T is temperature in degrees Kelvin. From Eq. 1, it can be seen that large changes in r_c can take place for small changes in V_c around the value $V_c = 0$.

In a standard grounded-emitter amplifier circuit the current transfer function i_c/i_b is

$$A_i = \frac{i_c}{i_b} = -\frac{ar_c - (r_e + R_2)}{r_c(1-a) + r_e + R_2 + R_L} \quad (2)$$

where r_e is the a-c emitter resistance of the transistor and a is the a-c current-amplification factor.

From Eq. 2, it may be seen that if the transistor is operated in a region where the value ar_c is of the same order of magnitude as $r_e + R_2$, the phase reversal of the transistor will depend upon whether ar_c is greater than or less than $r_e + R_2$. Hence, if $ar_c > r_e + R_2$, the collector current will be 180 degrees out of phase with the base current. If $ar_c < r_e + R_2$, the collector current will be in phase with the base current.

If the transistor is operated with a d-c collector voltage that is nearly equal to zero, the magnitude of r_c will depend critically upon the input signal. A d-c operating point of this sort will be in the nonlinear operating region of the characteristics shown in Fig. 1. By very small changes in the input signal, the current or voltage transfer function associated with such a circuit can be made positive or negative.

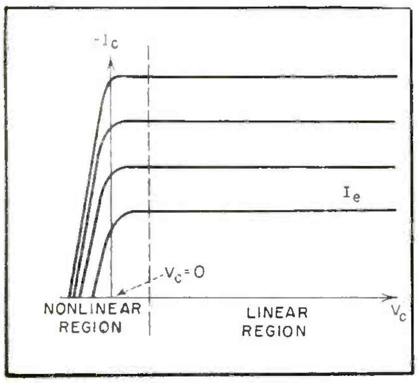


FIG. 1—Nonlinear and linear regions of junction-transistor characteristics

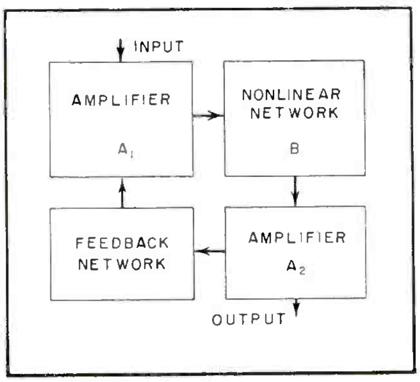


FIG. 2—Waveform generator consists of nonlinear stage and two amplifiers

Nonlinear Oscillator

In the block diagram, Fig. 2, A_1 and A_2 represent linear amplifiers of the phase-inverting type whereas B represents a nonlinear grounded-emitter stage. A negative signal at the input will appear as either a negative or positive signal at the output, depending upon the operating point of B. If feedback is applied from the output to the input, the system of Fig. 2 will be either regenerative or degenerative, again depending upon the operating point of B.

Suppose that the initial operating point of B is such that the voltage transfer through B is not phase inverting. A negative signal at the input of A_1 will then be regenerated due to the 360-degree phase shift between the circuit input and output. If, in the process of regeneration, the operating point of B shifts so that its transfer function becomes phase inverting, the negative signal at the input terminal of A_1 will be caused to degenerate.

If, for some reason (to be discussed later), degeneration of the input signal shifts the operating

Multiwaveforms

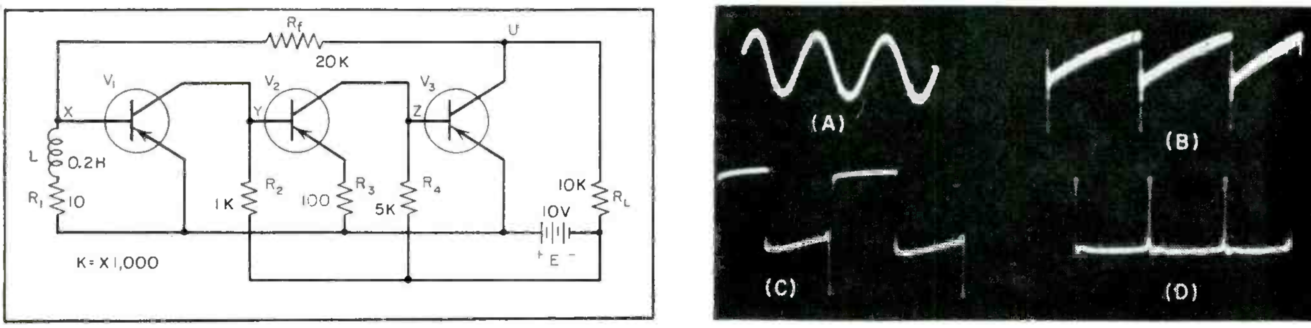


FIG. 3—Laboratory model of oscillator uses experimental *pnp* junction transistors similar to 2N45. Circuit values may have to be adjusted for transistors used. Waveforms *A, B* and *C* were obtained with R_3 = 100, 50 and 10 ohms. For *D*, R_3 = 10 ohms and R_2 = 600 ohms

point of *B* back to its original state, the regenerative-degenerative cycle becomes repetitive and the system operates as a regenerative-degenerative oscillator.

The circuit diagram of the oscillator, using three experimental *pnp* junction transistors, is shown in Fig. 3. Resistances R_2, R_3 and R_4 are adjusted so that transistor V_2 is at a d-c operating point just to the right of $V_c = 0$ in Fig. 1 in the phase-inverting region. When battery *E* is connected a transient voltage, negative with respect to ground, will appear at point *X*. Because V_2 is operating in the phase inverting region, this negative transient will appear as an amplified positive potential at the output *U*.

Due to the degenerative-feedback effect, point *X* becomes positive. However, as *X* becomes positive, the base voltage of V_2 at *Y* becomes negative and the second transistor is driven into the non-phase-inverting region. The network becomes regenerative and the positive potential at *X* builds up rapidly until V_1 is cut off or the circuit gain drops below unity. Inductance *L* then discharges the stored energy through R_f, R_1 and R_L until the potential at *X* has dropped enough for V_1 to become sufficiently conductive again. At this moment V_2 is still not phase inverting and so a negative potential is regenerated at *U*. This causes the generation of a sharp negative pulse at *X* which drives *Y* at the base of V_2 positive.

When *Y* is driven positive, V_2 becomes phase inverting causing the entire circuit to become degenerative. However, degeneration of the negative potential at *X* causes *Y* to swing negative again, which in turn, causes the system to become regenerative.

Thus, the mode of oscillation is controlled by the changes in the operating point of V_2.

The voltage required at the base of V_2 to swing the circuit into regenerative and degenerative action is of the order of 50 millivolts.

Circuit Variations

The circuit of Fig. 3 can be operated as an R-C regenerative-degenerative oscillator by replacing *L* with a resistor and by placing a capacitor in series with R_f. Several circuit variations are possible, but in all of these configurations, the value of resistance R_3 is the most critical. This may be expected since R_3, in combination with R_2 and R_4, controls the operating point of transistor V_2. If R_3 is made too small, point *Y* can never become negative enough, with respect to the collector, to switch V_2 into the non-phase-inverting region. If R_3 is made too large, *Y* may never become positive enough to switch V_2 into the phase-inverting region.

A basic difference between this waveform generator and the more usual relaxation or blocking types is that the former is controlled by small-signal changes in the d-c operating point of an essentially nonlinear network whereas the latter types depend upon large excursions in the dynamic characteristics of their active elements.

Thus, the multivibrator is basically a regenerative circuit which becomes degenerative only as a consequence of the loss in amplification when one of the active elements cuts off. However, in the regenerative-degenerative oscillator, the overall circuit amplification need not change for degeneration.

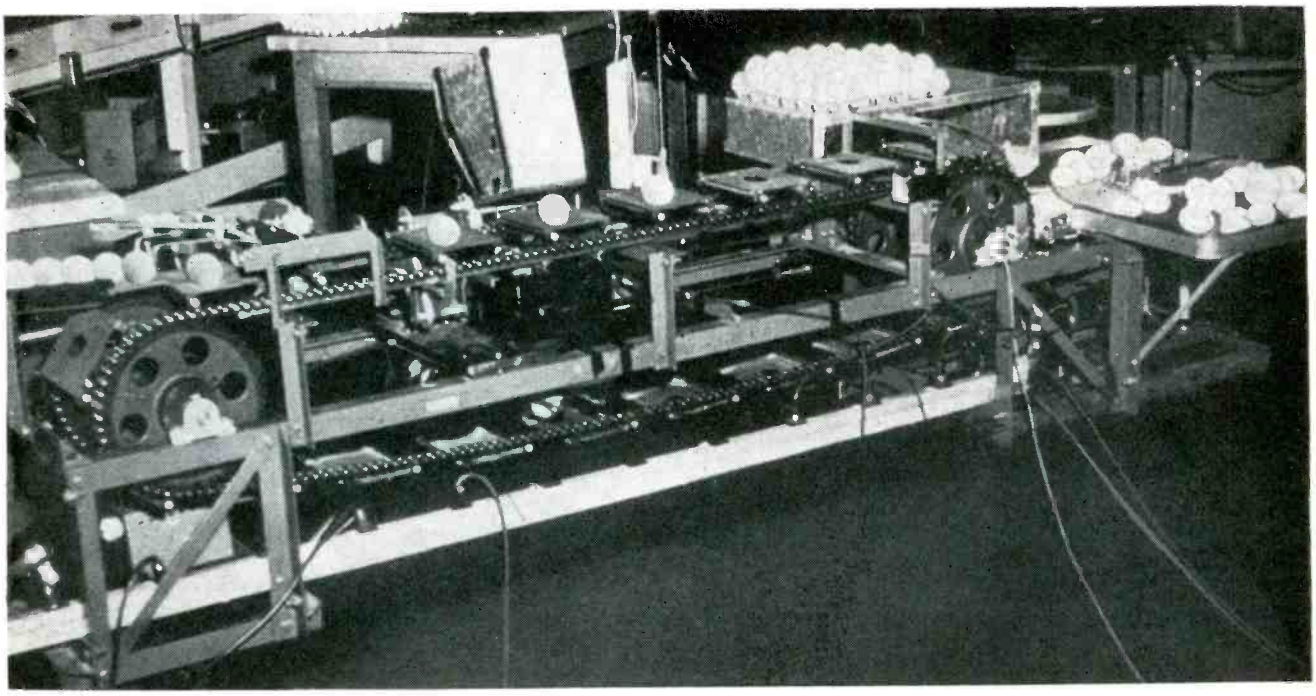
For example, the circuit shown in Fig. 3 can function in a manner analagous to a blocking oscillator. By adjustment of R_2 to change the operating point of transistor V_2 the damped oscillation of the circuit can be sustained to yield an output which is substantially a pulse-modulated sine wave. By adjustment of R_2 in the opposite direction, the output becomes a series of pulses.

If R_3 is adjusted so that V_2 is never phase inverting the oscillator becomes a relaxation-type circuit capable of generating sine, sawtooth or square waves.

If R_3 is adjusted so that V_2 is always phase inverting, the circuit is transformed into a degenerative-feedback-stabilized d-c amplifier.

The basic repetition rate of the pulses and the envelope oscillations depend upon the discharge time constants of the inductance, L/R_1 and $L/(R_f + R_L + R_1)$.

The cooperation of J. S. Schaffner of the General Electric Co. Electronics Laboratory, in the preparation of this article, is acknowledged.



Egg candler detects infected eggs by measuring internal fluorescence with two phototubes in housing at center. Housing is lowered over egg to produce light-tight seal during measurement

Photoelectric Inspector

SUMMARY — Ultraviolet light detected by two multiplier phototubes measures fluorescence of bacterial spoilage inside eggs at rates up to 500 eggs per minute. Use of response ratio at two wavelengths makes measurements independent of density and color of shell

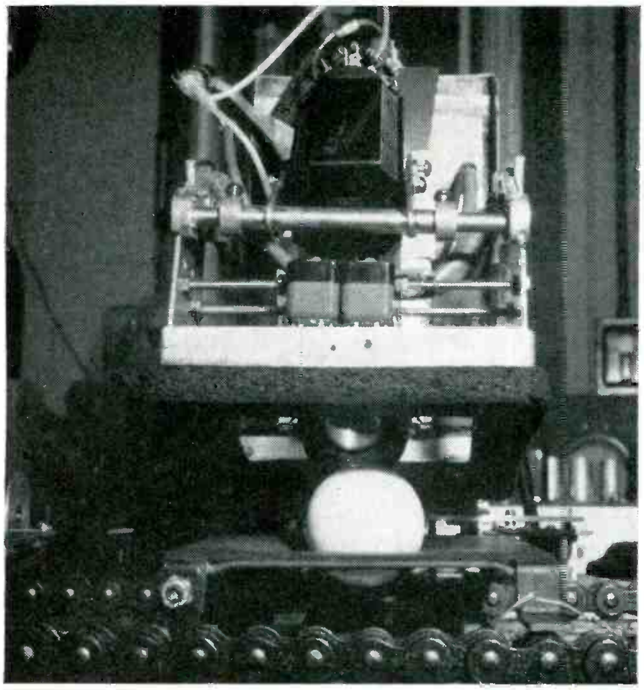
FLUORESCENCE caused by the presence of green rot, or bacterial spoilage of the white of an egg, can be used to detect infected eggs on an automatic candling basis. Normal, noninfected white-shell eggs have a weak fluorescence peaked at about 540 mμ (1 mμ = 10 Angstroms) and normal brown-shell eggs have a weaker fluorescence in the red region of the spectrum. Infection with green rot will cause a strong fluorescence at 525 mμ in white-shell eggs and a weaker fluorescence at 550 mμ in brown-shell eggs as shown in Fig. 1. The slopes of curves in this region are the best measure of presence or absence of infection. A filter ratio measurement was chosen to indicate these slopes. To handle eggs of all normal shell colors it was found that the best combination of filters was a 490, 510 mμ pair having transmittance curves as shown in Fig. 1.

The egg shells have very low transmittance in the ultraviolet, and as a result the best wavelengths for exciting the fluorescence inside the egg are in the 400 to 440 mμ region.

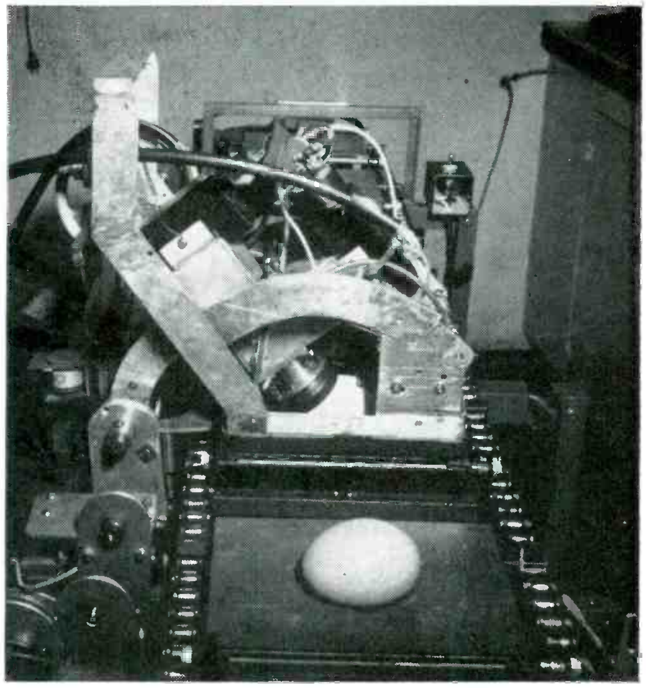
A type CH-4 mercury-arc lamp was chosen because of its relatively high output at 405 and 436 mμ with very low radiation in the 500 mμ region. The light output is filtered to eliminate wavelengths

Table 1—Accuracy of Green-Rot Candling Machine

Egg Classification	Number of Eggs	Machine Classification: Correct	Incorrect	Accuracy
Clear eggs	694	678	16	97.6%
Green-rot eggs	12	12	—	100.0%
All eggs	706	690	16	97.7%



Phototube housing in raised position with cover removed to show placement of components



In lowered position, rubber cup on phototube housing rests on egg shell to eliminate outside light

Detects Green Rot in Eggs

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that are longer than 500 $m\mu$.

Since an egg-handling mechanism was available, the measuring unit was adapted to it. This mechanism transports the eggs in individual rubber trays along a table by means of an endless belt. The belt is moved by a Geneva motion permitting the eggs to spend a large portion of the cycle at rest in a given position.

Optical System

The optical arrangement for the detection unit is shown in Fig. 2. The excitation energy strikes the underside of the egg and is restricted by the aperture to the small end of the egg to avoid the yolk as much as possible. The fluorescence energy is collected from the top of the egg near the small end and is divided by the dichroic beam-splitter. Part of the beam is transmitted to the 510 $m\mu$ filter and the other part is reflected to the 490 $m\mu$ filter. A lens system focuses the beams on the cathode of each of the phototubes. For the 490 $m\mu$ beam, a 1P28 multiplier phototube was used and for the 510 $m\mu$ beam, a 1P21 was used. The particular choice of tubes is not critical except that low-noise tubes are needed if low levels of infection are to be detected.

Stray light is excluded from the phototubes by enclosing the optical elements in a metal housing.

The wide range of energy level

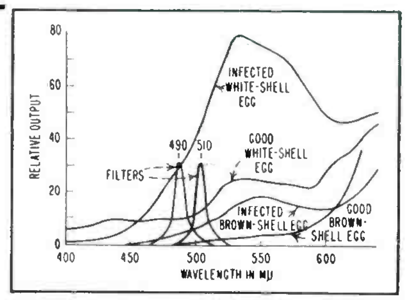

FIG. 1—Spectral response curves of good and infected eggs, with response curves of filters used on phototubes

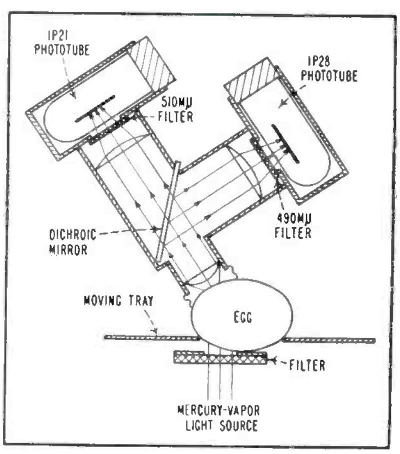

FIG. 2—Fluorescence from egg is split by dichroic mirror for transmission to two filtered phototubes

of the fluorescence obtained from different eggs places stringent requirements on the system for measuring the ratio of two adjacent wavelengths. This level has been found to vary as much as 10,000 to 1 from white-shell eggs to very dark brown-shell eggs. The method adopted for making the ratio measurement is similar to that used for direct-recording spectrophotometry. One phototube is used in a feedback circuit to control the accelerating voltage for both phototubes. Thus, the phototube with the 490 mμ filter is maintained at a constant anode current, and the anode current of the 510 mμ phototube is measured to give the ratio of the two currents.

The detection units is illustrated in block form in Fig. 3. For the first model constructed, a commercial power supply was modified to provide the necessary elements for the feedback loop. The grid of the first amplifier tube of the power supply was disconnected from the bleeder resistor chain and connected to the anode of the 490 mμ phototube with a 50-megohm load resistor. The high-voltage output was connected to the dynode resistor chains of each of the phototubes to complete the feedback loop. An adjustable reference voltage permits adjustment of the anode current. For optimum operation, anode current should be as small as possible. However, the minimum current is limited by the phototube dark current. This was found to be 0.04 microamperes for the 1P28 tube used in this application.

The fluorescence at 510 mμ is measured using the 1P21 phototube with a direct-coupled amplifier to drive a meter and operate an accept-reject solenoid. The circuit for this amplifier is shown in Fig. 4. The phototube signal developed across the input resistor is amplified in one-half of the 12AX7 and applied to the grid of the 12AU7 cathode follower to drive the meter and fire the 2D21 thyratron if the signal is large enough. The screen voltage of the 2D21 is variable to permit setting of the reject point at the desired level. The other half of the 12AX7 is used to compensate for variations in the color of the egg shell.

It was found experimentally that the darker shell colors caused a steeper slope of the fluorescence curve in the 500 mμ region, even though the eggs contained no green rot. Therefore, for maximum sensitivity in detecting green rot in eggs of all shell colors, it was necessary to apply a correction to the ratio measurements. Darker shell colors also caused higher accelerating voltages, and it has been possible to use this for correction. The accelerating voltage is applied through the cathode-follower circuit to control the bias in the amplifier. The adjustable resistors in the grid and cathode circuits of the cathode follower permit setting the level of compensation. The setting of these controls is determined experimentally using noninfected eggs of various colors.

Meter readings on a relative scale for normal eggs vary from 1.5 to 3.0 for white-shell eggs and from 0 to 5.0 for brown-shell eggs. Lightly infected eggs read from 4.0 to 10.0, and badly infected eggs read greater than 10.

If an egg is to be rejected, the accept-reject solenoid shifts the position of the egg-carrying tray laterally across the transport belt about ⅜ of an inch. At the end of the belt the position of the tray is detected by a snap-action switch which controls the solenoid-operated accept-reject gate.

The completed machine has been tested with eggs varying widely in interior quality, shell color and degree of cleanliness. Table I shows the results obtained on a total of 706 eggs. The overall accuracy was 97.7 per cent.

The errors occurred on eggs with very dense brown shells where the fluorescence energy was so small that the system was responding to the dark current of the phototubes rather than the fluorescence energy. This type of error could be reduced or eliminated by increasing the intensity of the incident light and by selecting phototubes with lower dark currents. However, the performance of the machine under the present conditions is far superior to that of the present method of visual fluorescence candling for green-rot. The present machine operates at a speed of 1,000 eggs per hour, but the measuring unit could be designed for a speed of 500 per minute.

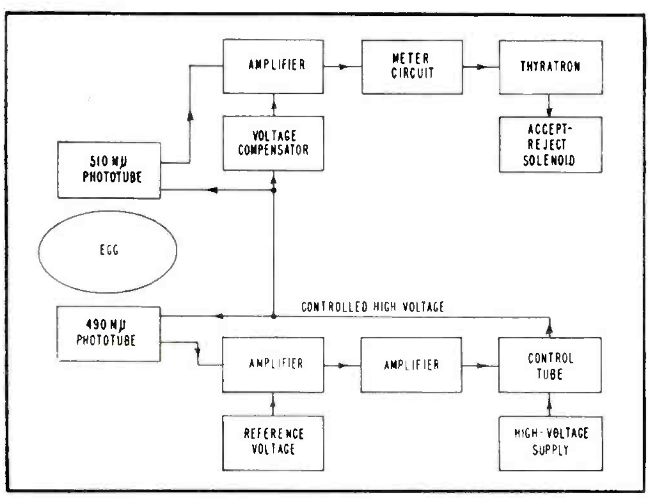

FIG. 3—Feedback from 490 mμ phototube is used to control accelerating voltage for both phototubes

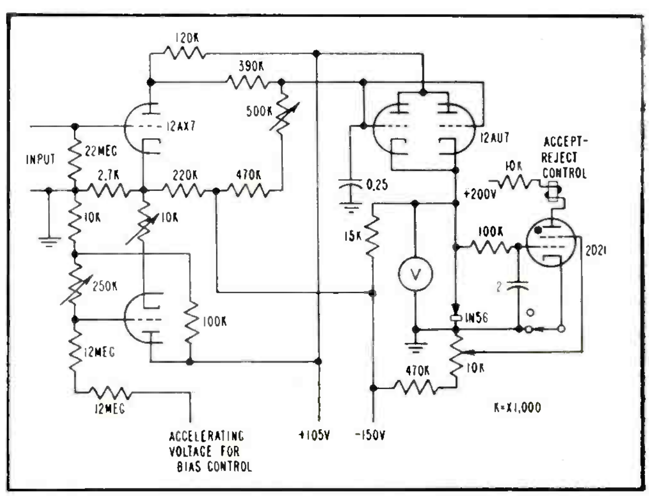

FIG. 4—Direct-coupled amplifier triggers thyratron to reject if ratio of phototube outputs is increased by presence of green rot

Compensated Squelch for Mobile Radio Receivers

SUMMARY —— Squelch circuit, needed to shut off annoying hiss from mobile receiver loudspeaker during no-signal periods, sometimes clips speech, particularly from older transmitters without modulation control. New deviation-compensated squelch uses recovered audio to hold off muting action when transmitter is overmodulated

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PRACTICALLY ALL of today's two-way mobile radio equipment is of the f-m type. Many of the first f-m units put on the market over 12 years ago are still in use. These older models were designed to occupy a channel of ±15 kc but there were no circuits employed to limit the channel width to this figure.

Increase in the use of two-way communication systems produced exceedingly crowded channels until it became necessary for the FCC to limit channel width to ±15 kc—now, in some cases, to ±7 kc—with correspondingly closer spacing between channels. Circuits to prevent exceeding the maximum channel width must be incorporated in all new sets.

Older equipment that lacks modulation-limiting circuits poses a problem in the design of new narrow-channel equipment, for should the new and the old be used in the same system, as is often the case, a phenomenon known as squelch clipping takes place.

A squelch circuit is employed in the receiver to mute the speaker and thus eliminate the annoying hiss generated by the receiver during the absence of signal.

However, should a narrow-band receiver with a passband of ±15 kc be used to receive a signal from a transmitter that does not employ a modulation-limiting circuit, there may be times during a transmission when the deviation is as much ±20 or 25 kc from center frequency.

During a carrier excursion of 25 kc the receiver is no longer capable of receiving this signal since it is out of the receiver's frequency acceptance range and therefore the receiver mutes. It may awaken

Squelch of audio background hiss in absence of signal is particularly necessary in police radio communications. New squelch avoids muting if deviation limit of transmitting station is exceeded

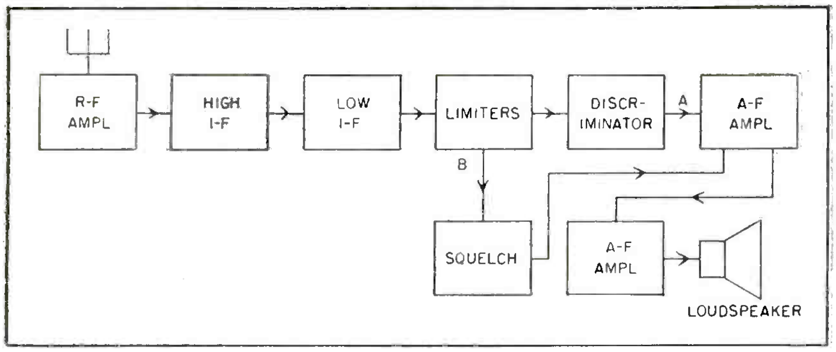


FIG. 1—Conventional squelch operation uses output from limiter circuit to bias off audio in the absence of signal

again on the next syllable or two, then mute again. This appears as clipping or chopping up of the speech at the receiver and is called squelch clipping.

Compensation Need

It is the purpose of the new squelch circuit to allow uninterrupted reception of signals that are deviating in excess of the passband of the receiver, for example, greater than ±15 kc, as may happen when receiving signals from a transmitter not employing deviation-limiting devices. The circuit also eliminates the need for stagger-tuned circuits and eliminates the need for swamping of tuned circuits.

With normal squelch action it is required that the squelch circuit mute the receiver during the absence of a signal to eliminate the objectionable background hiss generated by the high-gain tubes in the front end of the receiver.

In the presence of signal, this hiss is automatically suppressed by the normal operation of the front-end tubes. The stronger the received signal, the greater the hiss suppression. The squelch circuit utilizes this fact. The receiver is muted during maximum hiss and will awaken when a carrier of at least 0.1 microvolt causes at least 1.7 db of hiss suppression.

When no signals are being received, front-end hiss is developed at points *A* and *B* on the block diagram in Fig. 1. The hiss at *B* causes the squelch circuit to bias the first audio stage to cutoff, which prevents the hiss at point *A* from reaching the speaker and the set is muted. The reception of a carrier will cause a reduction in hiss at point *B*, which allows the squelch circuit to activate the first audio stage and the signal is heard at the speaker.

When no signals are being received, front-end noise in the receiver shown in Fig. 2 is developed across C_1, which has sufficient reactance at the hiss frequency of approximately 50 kc to produce about 4.5 volts a-c. However, the intermediate frequency of 455 kc is sufficiently bypassed by C_1. The noise is applied through C_2 to V_{1A}, the noise rectifier, and appears across R_2. Any audio developed across C_1 is attenuated by C_2, which offers a high reactance to these frequencies and as a result little audio reaches V_{1A}.

Improved Circuit

This tube rectifies the hiss and a positive direct voltage is developed across R_4, the diode load resistor. Capacitor C_3 filters the direct voltage and charges to about +4.5 volts d-c. This positive voltage is applied to the grid of squelch control tube V_{2B} through an *RC* filter comprising R_6 and C_6. The cathode of V_{2B} is positive with respect to ground owing to the voltage-dividing action of R_9, R_{10}, R_{11}, R_{12} and the squelch control.

Increasing the resistance of either R_{12} or the squelch control will increase the voltage at the cathode of V_{2B}. The grid-to-cathode voltage of V_{2B} is the net value of the rectified noise voltage and the cathode-to-ground voltage. The conduction of V_{2B} is determined by this bias. The amount of conduction will determine the voltage drop developed across the plate load resistor R_7. This *IR* drop is also in series with the grid-to-cathode circuit of V_{2A}, the first audio amplifier.

When the squelch control is adjusted so that V_{2B} is conducting just enough to cut off V_{2A}, the receiver is muted and the squelch control is said to be at threshold. Any reduction in noise resulting from reception of a carrier will cause V_{2B} to lessen its conduction, which in turn allows V_{2A} to pass the audio and the receiver is awakened. At the cessation of the carrier, the original noise level is resumed and the receiver becomes muted again. Control R_{12} is adjusted so the threshold setting is at the center of the squelch-control range.

Deviation Compensation

The unmuting of the receiver is dependent upon the suppression of the noise by the carrier. A receiver having a selectivity of ±15 kc at the half-power points will have a curve as shown in Fig. 3. When a carrier of frequency *A* is received, maximum gain in the receiver is realized, maximum noise suppression is achieved and the receiver unmutes. However, when the transmitter is modulated and the carrier deviates to frequency *B* the gain of the receiver is less at this point and therefore the noise suppression is not as great as at frequency *A*. When the carrier takes an excursion to frequency *C*, which can occur on peaks when receiving signals from transmitters that are overdeviating or do not employ modulation-limiting circuits, the receiver is practically unaware of any signal, the noise resumes and the receiver mutes.

During deviation, when the carrier is taking excursions beyond the passband of the receiver, recovered audio (Fig. 2) is being developed across R_5 and C_4. The audio voltage developed across C_4 is applied via C_5 to V_{1B}, the deviation compensator, and developed across R_{13}. Recovered audio is rectified in V_{1B} and a direct voltage is developed across R_4. This common resistor is shared by both the noise rectifier and the deviation compensator. The net resultant voltage across R_4 is dependent upon which diode is conducting the greater amount. Thus, during a peak carrier excursion when the voltage across R_4 would normally tend to go positive due to a rise in hiss, the rectification of the recovered audio compensates for this and actually causes the voltage to become less positive and on strong signals even becomes negative. This action keeps V_{2B} cut off or conducting little enough that V_{2A} is unsquelched and the receiver remains unmuted.

Squelch Tail

At the termination of a transmission, the hiss is immediately rectified and C_3 is charged positively again. However, owing to the RC time action of C_8 and R_6, a fraction of a second is required for C_8 to charge sufficiently to cause squelch action. This permits a small amount of hiss to get through the first audio amplifier before the squelch circuit can mute the receiver. This squelch tail indicates to the operator that transmission is over and the receiver is ready for the next transmission.

The RC action of R_6 and C_8 also serves to prevent the squelch circuit from causing a fluttering in the muting owing to rapid variation in signal levels such as when receiving a signal while passing under bridges or between high buildings at high speeds.

Decreasing the resistance of the squelch control past the threshold position will cause the receiver to awaken only to a stronger carrier. Increasing the resistance past the threshold will awaken the set, noise will be heard and no squelch action will be available.

The voltage divider consisting of R_5 and C_4 also serves as a de-emphasis network. The hiss frequencies above the audio range are readily attenuated by C_4, thereby minimizing the canceling action that occurs owing to the fact that both V_{1A} and V_{1B} tend to rectify hiss when no carrier is being received. During reception, any recovered audio appearing across R_5 and C_4 will cause a greater audio signal than hiss voltage to be developed across C_4 since the capacitor appears as a higher reactance at these lower frequencies. Hence, much more audio than hiss is available at V_{1B}, which now compensates easily for the rise in hiss at V_{1A} during deviation.

Awakening Voltage

During reception of a carrier the first limiter draws grid current producing a negative voltage across R_1. This negative voltage increases with carrier strength. The purpose of R_3 is to permit a portion of this negative voltage to be developed across R_4 during reception of a carrier of 1.2 microvolts or more. This allows the setting of R_{12} to determine the carrier strength required to awaken the receiver when the squelch control knob is set at the extreme counterclockwise position.

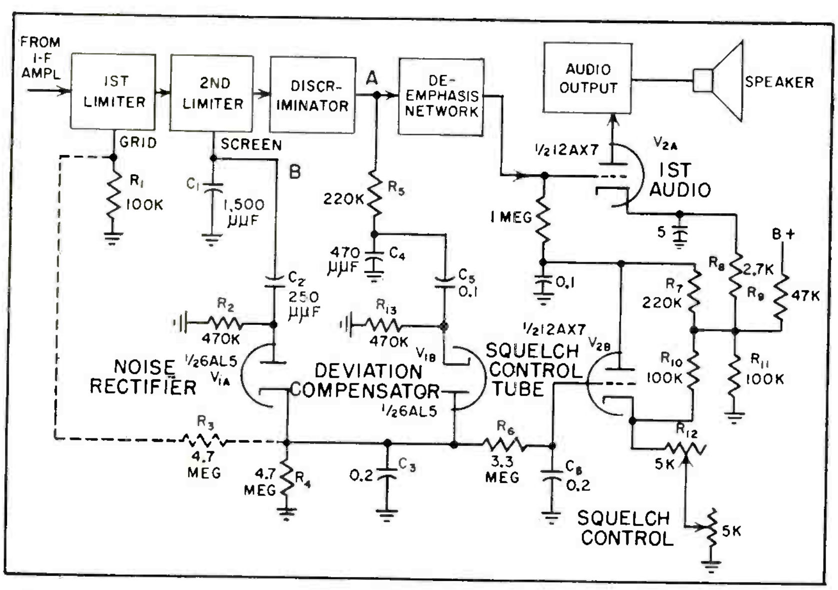


FIG. 2—Deviation-compensated squelch circuit uses audio output from discriminator to prevent muting during wide excursions of signal

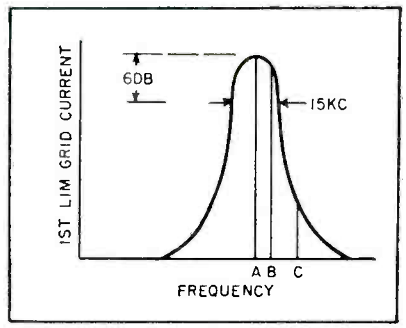


FIG. 3—Loss-of-signal effect encountered when unhindered deviation resulting from high modulation moves signal out of receiver passband

tion. Settings from 0.5 to 7.5 microvolts are easily achieved. Without R_3, settings from 0.5 to 1.1 microvolts are available.

With the new circuit no squelch clipping occurs up to ±30 kc deviation when operating at threshhold. The threshhold setting itself is independent of battery-voltage variations up to ±10 percent of normal voltage. The squelch circuit is unaffected by atmospheric, man-made or ignition noise; the receiver will not awaken in the presence of such noise. There must be a quieting action resulting from reception of a carrier.

Fail-Safe Operation

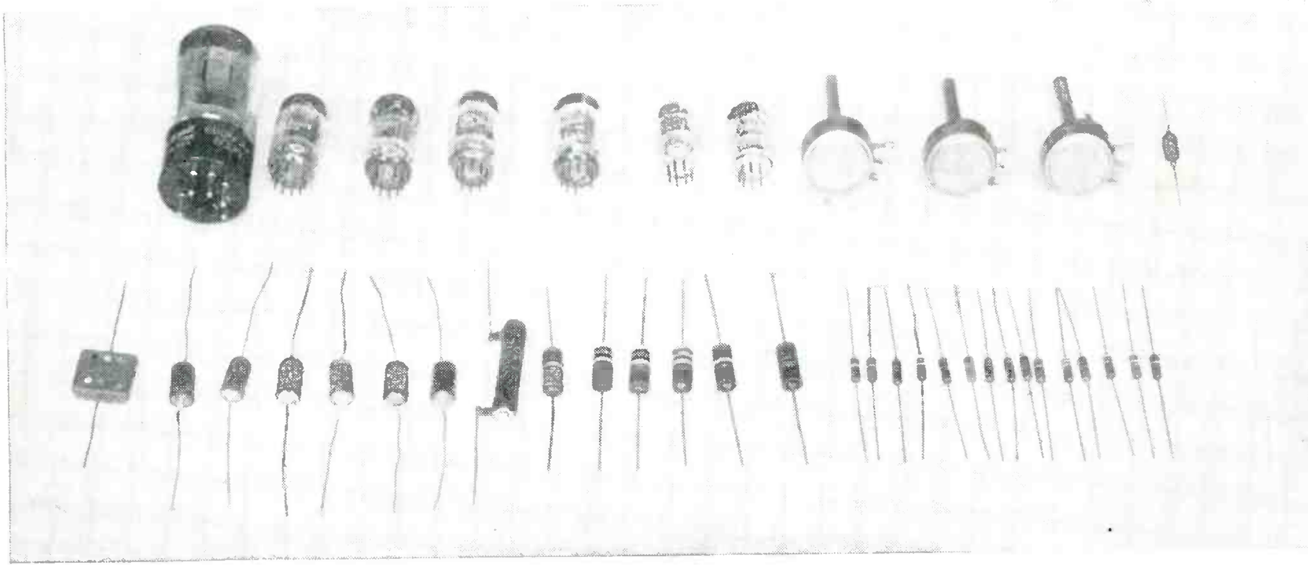
Should V_1 develop an open filament, the receiver will awaken permitting use of the set until serviced.

Squelch sensitivity is such that at threshhold it requires only 0.09 to 0.1 microvolt of carrier to awaken the receiver. At the extreme counterclockwise position of the squelch control it requires only 0.5 microvolt of carrier to awaken the receiver. By adjusting R_{12}, values from 0.2 microvolt to 1.1 microvolts can be achieved with at least 90-deg rotation available on the squelch control.

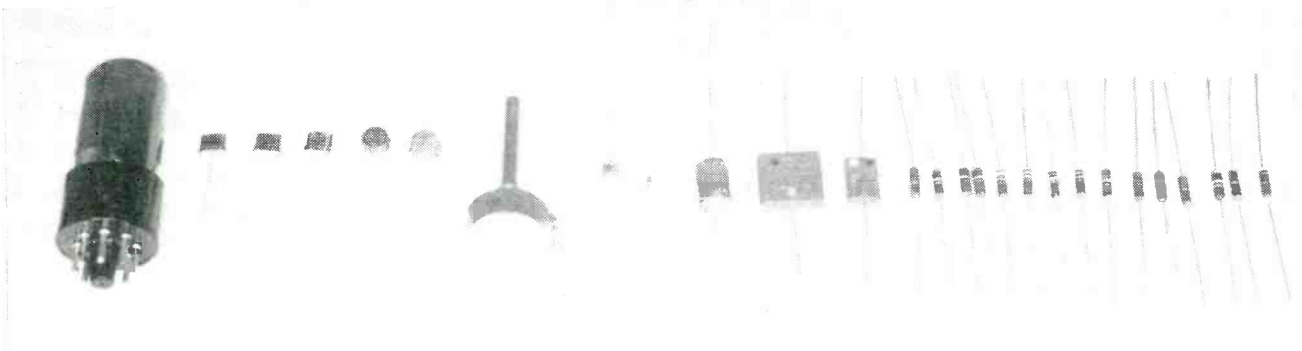
At threshhold, with signal strengths of at least 0.1 microvolt input, the receiver remains awake up to ±30 kc deviation at 1,000 cps.

At the extreme counterclockwise position of the squelch control (with R_{12} set for 1.1 microvolts) the receiver will remain awake up to ±25 kc deviation at 1,000 cps with signal strengths of at least 1.2 microvolts.

Simplified Circuit Design Results when..



the 40 components of an electron-tube crt deflection system........



are replaced by 27 smaller components in circuits using transistors

Transistor C-R Tube

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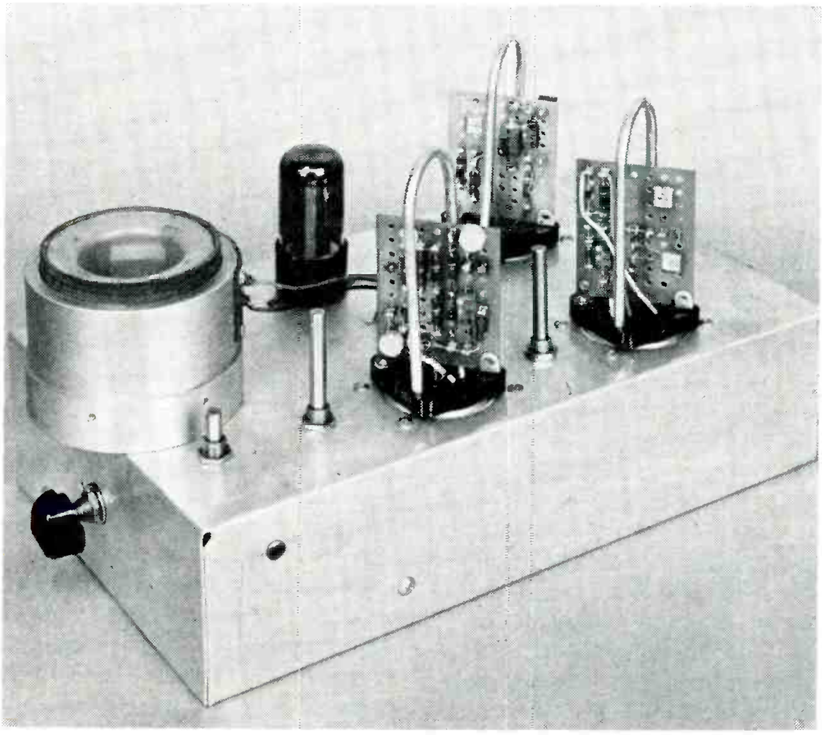
RESULTS can be discouraging if transistors are substituted in electron-tube circuits which have been changed only in component values. Such circuits have been optimized to fit the peculiarities of electron tubes while transistors have their own distinctive quirks.

The cathode-ray-tube deflection circuit to be described illustrates the design approach to using transistors. First a commonly used electron-tube circuit will be described and the unsuitability of directly substituting transistors demonstrated. Then the circuit designed specifically for transistors will be discussed. Characteristics desired in the deflection system which served as a target in the design work are listed in Table I.

Electron-Tube Circuit

A commonly used electron-tube deflection circuit is shown in Fig. 1. The initiating and terminating triggers control a bootstrap generator whose output is a highly linear saw tooth. The deflection yoke

SUMMARY — Five transistors and one electron tube form sweep circuit that produces 100-v peak-to-peak saw tooth from square-wave input. Design techniques avoid or reduce limitations of circuits based on prior electron-tube sweep circuits



Complete transistor sweep system including yoke, yoke driver, error amplifier, clamp and gate circuits

Deflection Circuit

current, which is proportional to the angle of beam deflection, is sampled by a resistor in the cathode of the yoke driver. The similar waveforms are compared. Their discrepancies are amplified and used as the grid signal for the yoke driver. The linearity of deflection is dependent upon the linearity of the bootstrap waveform itself and upon the gain of the feedback loop.

Referring to Fig. 2A, the operation commences with the switch closed and the full supply voltage appearing across R_1. When the switch is opened, C_1 starts to charge. As the capacitor voltage builds up, the cathode follower and coupling capacitor C_2 cause the voltage across R_1 to be increased by a nearly equal amount, maintaining constant current flow through R_1. During this period, the diode is disconnected and the current for R_1 supplied by C_2. At end of the sweep the switch closes and the diode supplies the current to recharge C_2.

The linearity of the voltage waveform on C_1 is equal to the constancy of the charging current. During the sweep, the grid-to-cathode voltage of the cathode follower changes and C_2 accumulates some charge. Expressed as a percentage of the supply voltage, the sum of these voltages represents the nonuniformity of current flow through R_1. Not all this current is supplied to C_1. Some is required by the imperfect switch and the grid of the cathode follower.

Perfect linearity would require unity-voltage-gain feedback including cathode follower and capacitor, infinite power gain in the cathode follower and zero or constant switch current during the sweep.

It is convenient to consider imperfections as the degree to which their associated impedences differ from infinity. Feedback having a voltage gain K results in the apparent impedance of R_1 being increased to $R_1/(1\text{-}K)$. This apparent source impedance is shunted by the input impedances of the cathode follower R_{CF} and the switch R_S which for electron-tube circuits are extremely high. The equivalent circuit is shown in Fig. 2B.

Since the output is taken from the cathode follower, its nonlinearity also must be included. This nonlinearity, being a small fraction of the grid-to-cathode voltage swing, is small and generally subtracts from the more dominant forms.

Saw-Tooth Waveforms

A transistor bootstrap circuit can be constructed having elements identical to those of the electron tube circuit. However, the power gain of a grounded-collector stage is severely limited. Cascading is necessary to achieve adequate power gain although this results in sacrifice of voltage gain. No system of cascading can make the input impedance of the first stage exceed its collector-to-base resistance, a maximum of about one megohm for germanium transistors. A similar limitation applies to the impedance of the electronic switch.

These impedance limitations could be tolerated if the impedance level of the whole circuit could be lowered sufficiently, that is, if charging current and capacitor size could be increased. Unfortunately, the current required to recharge C_2 quickly for high-duty-cycle operation must be furnished by the grounded-collector stage.

The alternate direct approach, furnishing a constant-current source by utilizing a voltage source more than a hundred times the saw-tooth amplitude, is inefficient and suffers from the same impedance limitations as the bootstrap. However, the absence of the bootstrap emitter follower does allow some decrease in impedance level.

Comparison of Waveforms

The most prevalent difficulty encountered in waveform comparison is the drift in operating point with temperature.

All transistor characteristics are to some extent affected by temperature. In most circuits, however, the changes are not sufficient to be troublesome with the exception of the temperature sensitivity of the base current. Although base current is small, it is large compared to the grid current of a vacuum tube and it can change several hundred percent over the usual ambient temperature range. Therefore, just as it is necessary to maintain a d-c return on the grid of an electron tube, the base of a transistor should look back into a d-c resistance of less than 10,000 ohms. Failure to do this will result in the base voltage drifting with temperature to such an extent that the transistor may saturate. This problem arises repeatedly in attempting to utilize a waveform already generated.

Yoke Drive

Amplification of the error signal between saw-tooth voltage and yoke current can be achieved using transistors but driving a magnetic yoke is beyond the capabilities of transistors. Neither sufficient voltage nor sufficient power can be obtained

Figure 3 shows the voltage waveform required by the combination of yoke and feedback resistances. It is made up of a step voltage to create the desired rate of flux build-up in the yoke ($L\ di/dt$), a saw-tooth voltage created by current flow in the yoke and feedback resistances (IR) and a spike to recover the initial flux condition.

The supply voltage must exceed the sum of $L\ di/dt$ and IR in all cases. During slow sweeps, $L\ di/dt$ is reduced and the excess voltage must be absorbed by the driver. The voltage required for a 50-microsecond sweep causes a dissipation of about ten watts on the slower sweeps.

Present power transistors obtain their higher dissipation rating by sacrificing the speed of response of the lower power units. Consequently, they offer no solution to a circuit which can concede nothing in response time. New techniques of manufacture offer hope that this relationship of power and frequency response may be eliminated in the future, but for the present an election tube offers the only solution to this problem.

The voltage that transistors will tolerate is generally limited to less than 60 volts. Use of a transistor as a yoke driver would require some protective device to limit the spike in yoke voltage to within this transistor rating. This hampers rapid recovery. Where operation at high duty cycle is required, the electron tube is irreplaceable because of its ability to withstand a large spike.

It should not be inferred that a transistor yoke drive is impractical in all cases. If a single slow sweep speed is adequate and if the duty cycle is of the order of 50 percent or less, a transistor appears feasible.

The driver must be chosen on the basis of the small grid voltage swing required since the output voltage of the transistor driving it is limited. No feedback resistor in the cathode is permissible because this directly adds to the required grid swing. Yoke current must be sampled in the plate circuit rather than in the cathode.

System Employing Transistors

In the transistor c-r tube deflection system a single electron tube drives the deflection yoke. However, the circuit configuration has been altered considerably so that this element may solve not only the yoke drive problems but also some of the other voltage difficulties. The circuit is illustrated in Fig. 4.

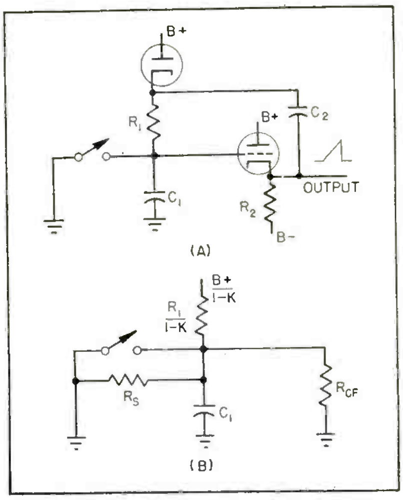


FIG. 2—Bootstrap circuit: schematic (A), equivalent circuit (B)

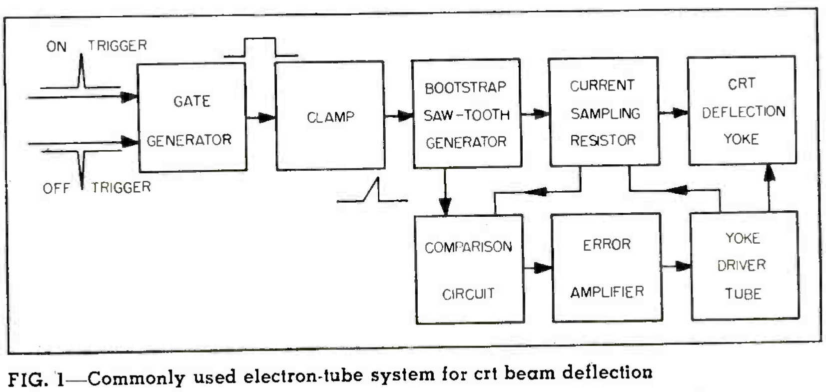


FIG. 1—Commonly used electron-tube system for crt beam deflection

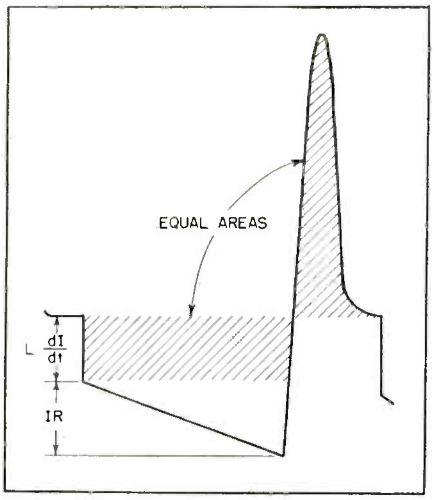


FIG. 3—Voltage waveform required by yoke and feedback resistances

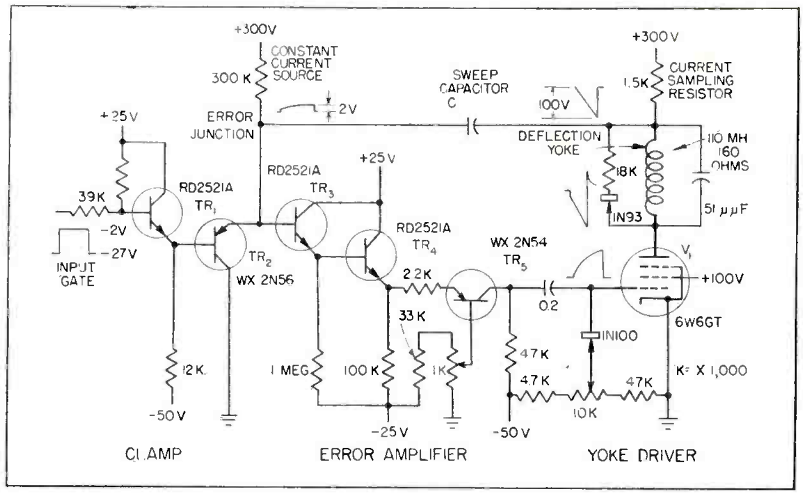


FIG. 4—Cathode-ray-tube deflection system employing transistors. Value of C in μf is equal to 10× sweep duration in seconds

The yoke driver tube is fed by an error amplifier which requires little change in input voltage to drive the yoke. This error signal is the difference between a voltage saw tooth and the yoke current. Since the voltage swing at the input of the error amplifier is small, it is easy to achieve a source of constant current. This current flows through the clamp until the gate opens and diverts the flow into the sweep capacitor. The charging of the sweep capacitor would cause a rapid increase in voltage at the input of the error amplifier but for the fact that the other end of the capacitor is attached to the resistor which measures yoke current.

Any increase in input voltage causes an increase in yoke current which counteracts the charge accumulated by the sweep capacitor. Although this input voltage actually is the error between a capacitor voltage saw tooth and yoke current, the capacitor voltage saw tooth is never generated with respect to ground and never appears across a transistor.

The waveform of yoke current is generated by a resistor in series with the yoke, both in the plate circuit of the driver tube. Compared to a cathode resistor, this has the advantage that the amplitude can be large without unduly increasing the grid drive. Screen current of the driver tube is not detected and does not distort the feedback. The one disadvantage is the sensitivity of the feedback to power supply ripple. The feedback resistor must tie to a well filtered source.

Table I—Characteristics of Desired Deflection System

Deflection rate R	Controllable between 50 and 3,750 microseconds per radius
Delay in starting following an initiating trigger	Less than 0.01 R or 2 microseconds whichever is greater
Delay in acceleration up to 50 per cent of nominal speed	Less than 0.02 R or 3 microseconds whichever is greater
Nonlinearity	Less than 1 percent of tube radius except for distortion due to starting delay
Recovery following a terminating trigger	Less than 0.1 R or 125 microseconds whichever is greater
Operating temperature range	0 to 50 C

When the gate turns on the clamp at the end of the sweep, the yoke driver tube is turned off and the sweep capacitor starts to discharge. The current sampling resistor limits the peak current that the clamp must carry to the peak current that the yoke was conducting at the preceding instant. This reduces clamping problems without hindering recovery appreciably.

Advantages

This system of sweep deflection has avoided or reduced the disadvantages which arise when transistors are used in a circuit based upon prior electron-tube systems: low voltage output, relatively low input impedance and temperature instability of base current.

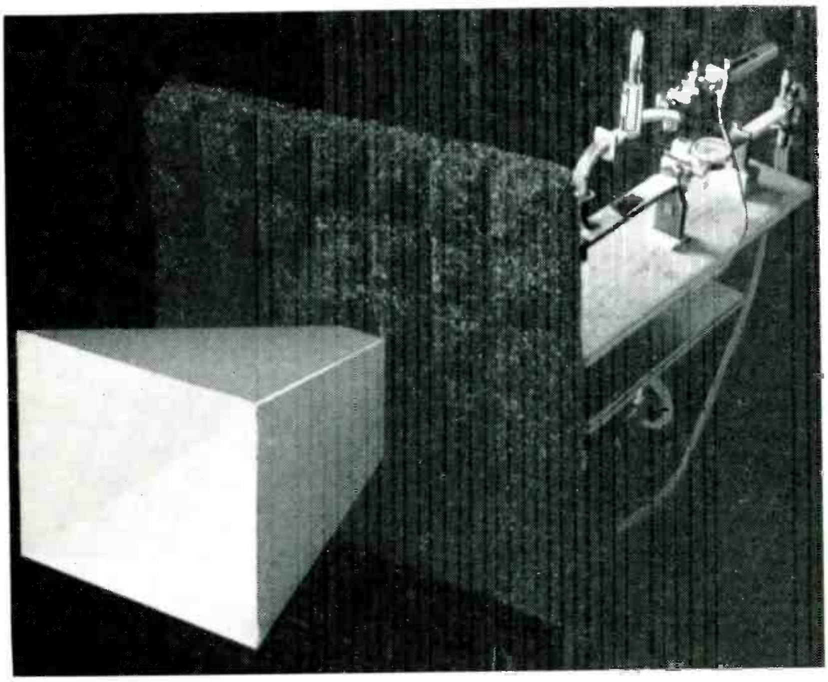
The two waveforms to be compared do not appear on the transistors; 100-volt amplitudes are available yet only their difference (about 2 volts) appears at the error junction. Therefore, the transistors do not limit the saw-tooth amplitude.

Generation of the saw tooth is simply achieved. A current source of sufficient constancy is no longer a problem when it is supplying the error junction, a point of limited voltage swing. For the same reason, the impedances of the error amplifier and the supposedly open clamp will bypass proportionately less current from its intended task of charging the sweep capacitor. Consequently, a linearity of saw-tooth reference waveform is achieved which is inconceivable were the waveform to be generated with respect to ground.

The problem of temperature instability when a transistor's base is connected to a high resistance is completely eliminated by this system. A change in d-c base current of transistor TR_3 is equivalent merely to a change in the constant-current source. It slows or speeds the sweep rate to an unimportant degree. The base of the transistor is clamped to ground to stabilize the operating point. It cannot drift with temperature.

Design of Microwave

SUMMARY — Electromagnetic horns for the microwave region from 0.77 cm to 31.5 cm have been built and calibration techniques perfected. Resulting designs are easily and accurately duplicated and have been adopted as standards by the Inter-Service Antenna Group



Horn and transmitter on adjustable mount. Microwave absorbent material reduces wave reflections inside horn

SOME time ago a program was initiated at the Naval Research Laboratory to design and calibrate a series of gain-standards covering the microwave region from a wavelength of 0.77 cm to 31.5 cm. The present paper is based on an NRL report.

The series of gain-standards consists of eleven broadband horns having gains ranging from 24.7 db to 13.7 db. The horns can be easily and accurately duplicated.

Criteria

Electromagnetic horns were considered well suited as gain-standard antennas because they are broadband, rugged and easily duplicated. However, previous attempts to obtain accurate horn calibrations had shown marked discrepancies in the measured gain obtained at various horn-separation distances.

The usual criterion for minimum horn-separation distance had been $2D^2/\lambda$ where D is the larger aperture dimension of the horn and λ is the wavelength. This criterion was shown to be invalid. A new criterion was developed[2] which resolved previous inconsistencies and formed the basis for a set of curves correcting for finite separation between horns.

Three general requirements were considered of prime importance in the design: a useful gain figure; a simple construction; and accuracy of calibration. Because of size and weight considerations, the horns were not scaled from band to band throughout the range. Instead, five basic designs were used and the horns for each of the other bands were scaled from one of these.

Design

A nearly optimum horn was desirable to obtain the maximum gain consistent with size limitations. An optimum horn has aperture dimensions chosen to give maximum gain for a fixed slant height. This is the case when $a^2 \cong 3.18\ \lambda l_H$ and $b^2 \cong 2.08\ \lambda l_E$ where a, b, l_H and l_E refer to dimensions shown in Fig. 1. Approximately equal half-power beamwidths for the radiation patterns in the two planes was another desirable characteristic. The theoretical criterion for equal beamwidths is that $a = 1.35b$. This assumes an in-phase aperture with the electric field intensity constant in the E-plane and varying cosinusoidally in the H-plane.

Schelkunoff's gain curves[3,4] were used in determining the horn dimensions for the desired gain, equal beamwidth and optimum horn requirements. A final determination of the calculated gain was obtained by using the formulas from which the Schelkunoff curves were plotted.

The fabricated type of pyramidal horn shown in Fig. 1 was chosen as the best means of satisfying the requirements. For simplicity a simple butt-joint between horn and waveguide was adopted. Most of the horns are made of flat brass sheets. Exceptions are the 8-mm electroformed horn and the 15, 23, and 30-cm horns which are made of welded aluminum sheets.

A typical horn construction drawing is shown in Fig. 2. Design and

Gain-Standard Horns

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construction data are given in Table 1.

Calibration

Using the setup shown in Fig. 3, experimental primary gain measurements were made to check the accuracy of the calculated gain. The formula for the experimental determination of gain is

$$G = \frac{4\pi R}{\lambda} \sqrt{\frac{P_R}{P_T}}$$

where R is the separation distance between horns, λ is the wavelength and P_R/P_T is the ratio of power received to power transmitted. Two identical matched horns separated by a distance R were used, one acting as the transmitting antenna and the other as the receiving antenna.

The r-f source was a reflex klystron with 1,000 cycle square-wave modulation. Attached to the receiving horn at point A' in Fig. 3, was a matched bolometer-detector which delivered the detected voltage to a linear amplifier connected to a vacuum-tube voltmeter.

The horn and associated r-f components at both the transmitting and receiving ends were mounted on tripods so that each horn could be peaked in azimuth and elevation for maximum received power.

The voltmeter reading was proportional to the received power P_R, for this measurement since a bolometer-detector is a square-law device. To obtain a voltage reading proportional to the transmitted power P_T, the transmitting horn was removed and the receiving detector connected at A in Fig. 3.

Unusual care was necessary in making these measurements. The separation distance R was varied frequently and the measuring procedure was repeated several times at each new distance. The horns and the bolometer were carefully matched at each frequency.

Microwave absorbent material[6], shown in the photograph, was used to minimize the reflections. At longer wavelengths difficulties were encountered because of reflections and the large separation distances required. True Fraunhofer field (far-field) conditions which are assumed in deriving the gain formula, do not exist until a horn-separation-distance of many times the magni-

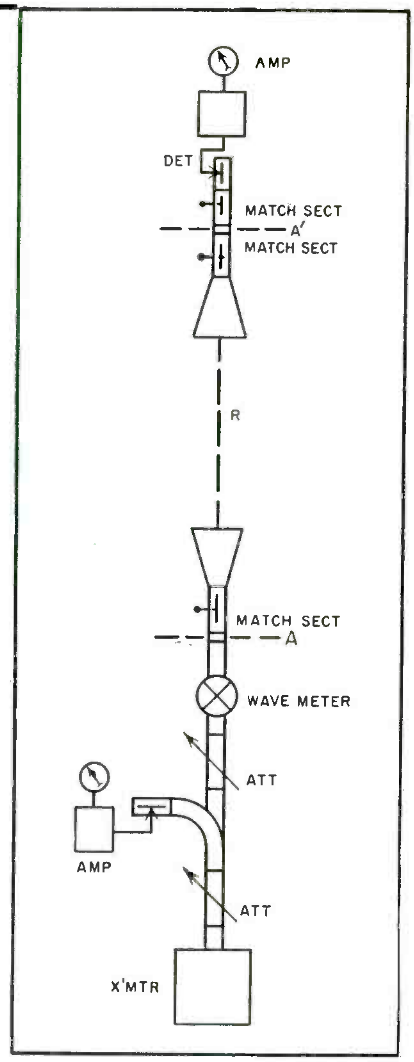

FIG. 3—Experimental setup for gain measurements

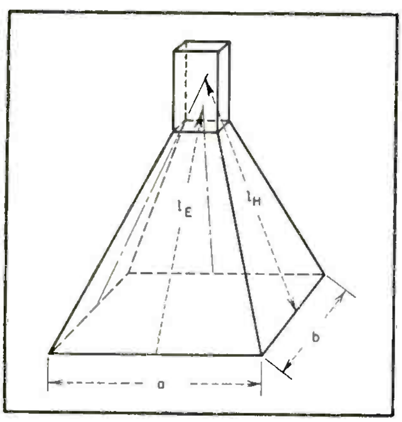

FIG. 1—Physical dimensions of horn used for calculating gain. Butt joint is used between horn and waveguide

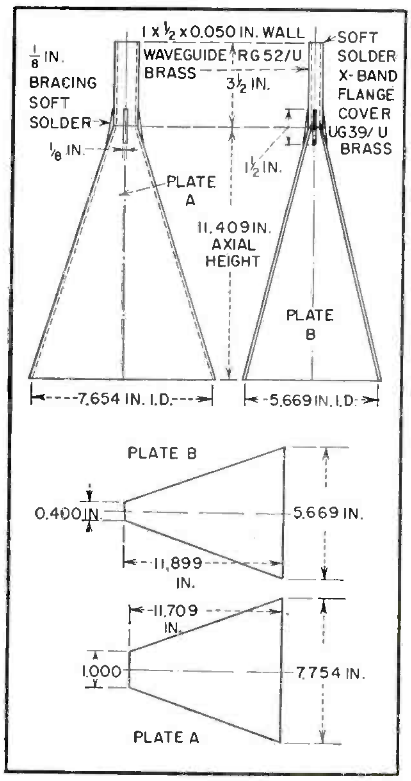

FIG. 2—Typical construction drawing for a gain-standard horn. Plates are made from 0.50 in. sheet brass

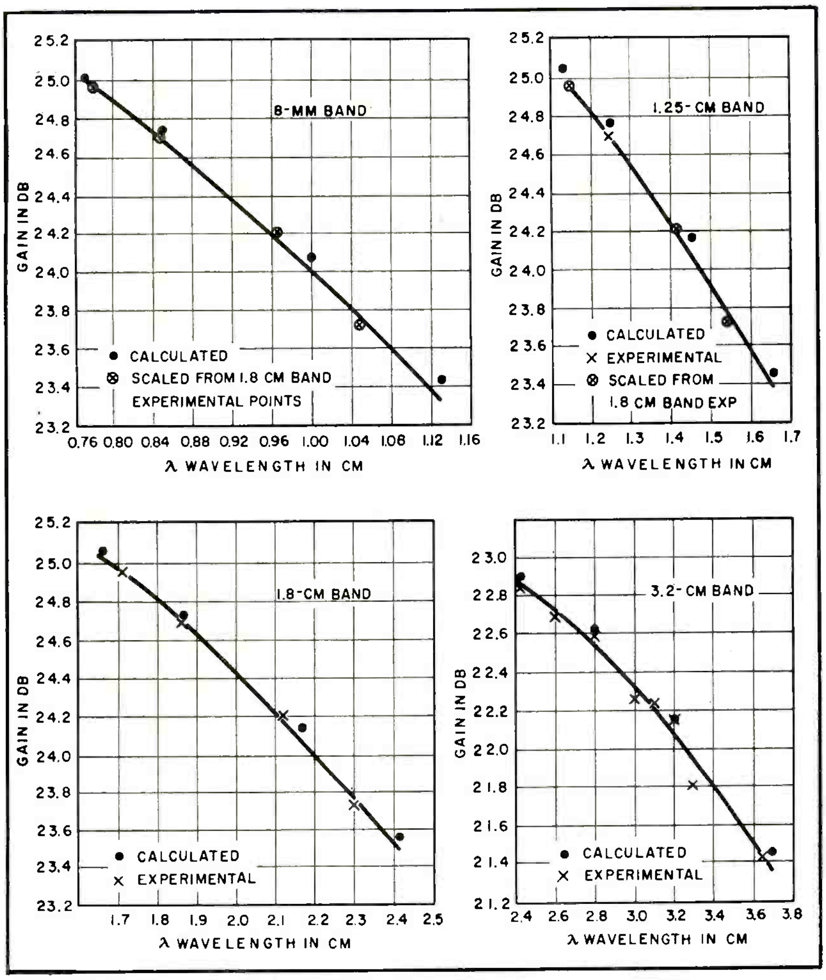

FIG. 4—Gain curves for gain-standard horns in the 8-mm, 1.25-cm, 1.8-cm and 3.2-cm bands. Comparisons of measured gain for hours scaled from one band to another show good agreement

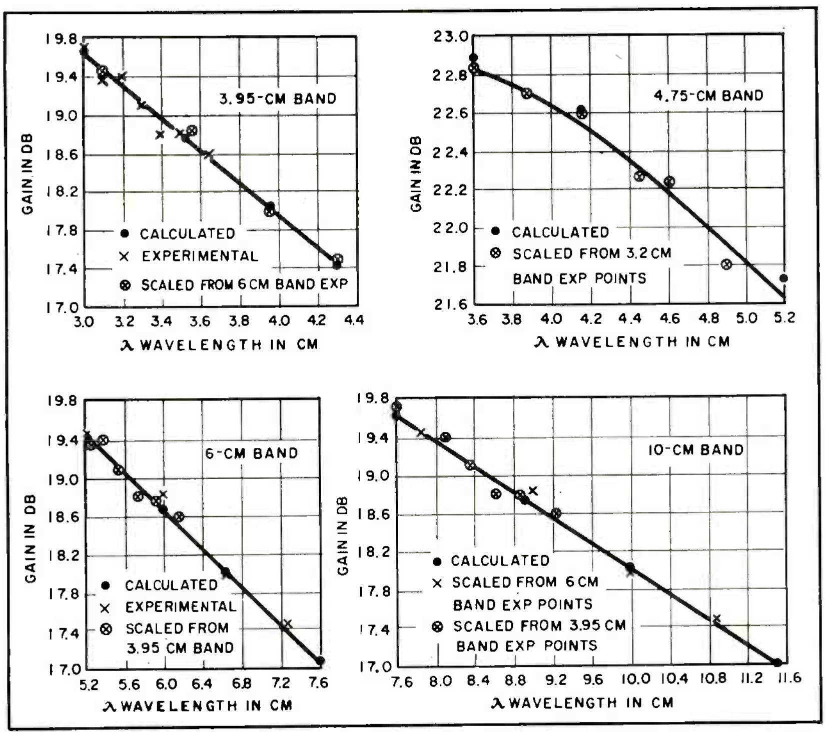

FIG. 5—Gain curves for gain-standard horns in the 3.95-cm, 4.75-cm, 6-cm and 10-cm bands. Variations in curves are not due to experimental difficulties

tude of $2D^2/\lambda$ is attained[2].

The effectiveness of the absorbent material is a function of wavelength, the absorbing power diminishing as the wavelength is increased. At wavelengths longer than in the 6-cm band there is sufficient reflection to virtually preclude making accurate gain measurements. The absorption is still adequate for most other purposes at considerably longer wavelengths.

Because of the difficulties mentioned, experimental gain measurements at 10 cm and longer wavelengths were abandoned. The 10-cm horn calibration was obtained from that of the 3.95-cm and 6-cm horns. The latter were scaled from the 10-cm horn to obtain reliable measurements at the shorter wavelengths.

Measurements were made over the range of the band for the 1.8-cm, 3.2-cm and 6-cm horns, since these represent the three basic horn designs from 8 mm to 10 cm inclusive (see Table 1). Several measurements were also made at the 3.95-cm band, taking advantage of the scaling to get a cross-check on the 6-cm horn calibration. Similarly, a measurement was made at 1.25 cm as a check on the 1.8-cm horn at the scaled wavelength of 1.87 cm. These comparisons of the measured gain for horns scaled from one band to another showed good agreement (see Fig. 4 and 5).

Accuracy

At any one wavelength the measured points showed a dispersion of less than 0.1 db. As a function of wavelength, the gain curve is not monotonic as would be predicted from the theory, but shows small periodic variations, as in Fig. 5. After exhaustive checking it is felt that these variations, of the order of ±0.1 to 0.2 db, are actually present and not due to experimental difficulties. This effect can probably be attributed to higher modes in the aperture, and currents on the outside of the horn, both of which are neglected in the theory. Taking into account all possible deviations from the true gain over each band, the maximum possible error was less than ±0.3 db up to and including the 10-cm horns.

At wavelengths longer than 10 cm, where no experimental measurements have been feasible, the gain has been calculated by means of Schelkunoff's formula. Below 10 cm the greatest discrepancy between the average measured gain (using Braun's correction curves for near-field conditions) and the gain calculated from Schelkunoff's formula was of the order of 0.2 db. In general the difference was much less. Because of the infeasibility of making experimental checks a maximum tolerance of ±0.5 db is reasonable for all horns above the 10-cm band (see Fig. 6).

VSWR

The greatest voltage-standing wave ratio encountered in horn measurements made over the band at four representative bands was 1.25. In any event the vswr should be measured at the wavelength used. For accurate measurements the horns should either be carefully matched or allowance should be made for any mismatch. In either case the bolometer must be well-matched.

Error Sources

Obtaining an accurate gain measurement requires that a number of precautions be observed. Instability is one of the greatest problems. The r-f source should be carefully selected for stability of both frequency and power output. The bolometer amplifiers and vacuum-tube voltmeters must also be very stable. Rigid waveguide, rather than flexible cables, should be used in the r-f transmission line. Adjustable bolometer holders and variable attenuators should have a stable adjustment.

Flange-to-flange connections rather than choke-to-flange, should be used, since chokes may introduce considerable mismatch at some wavelengths. The bolometer amplifiers should be checked for linearity throughout the range used and both the amplifiers and the voltmeters should be accurately calibrated.

Power Level

The power level was kept low enough to maintain amplifier linearity. This restriction limited the maximum horn-separation distance, so that measurements were made at distances of three or four times D^2/λ. Corrections were required be-

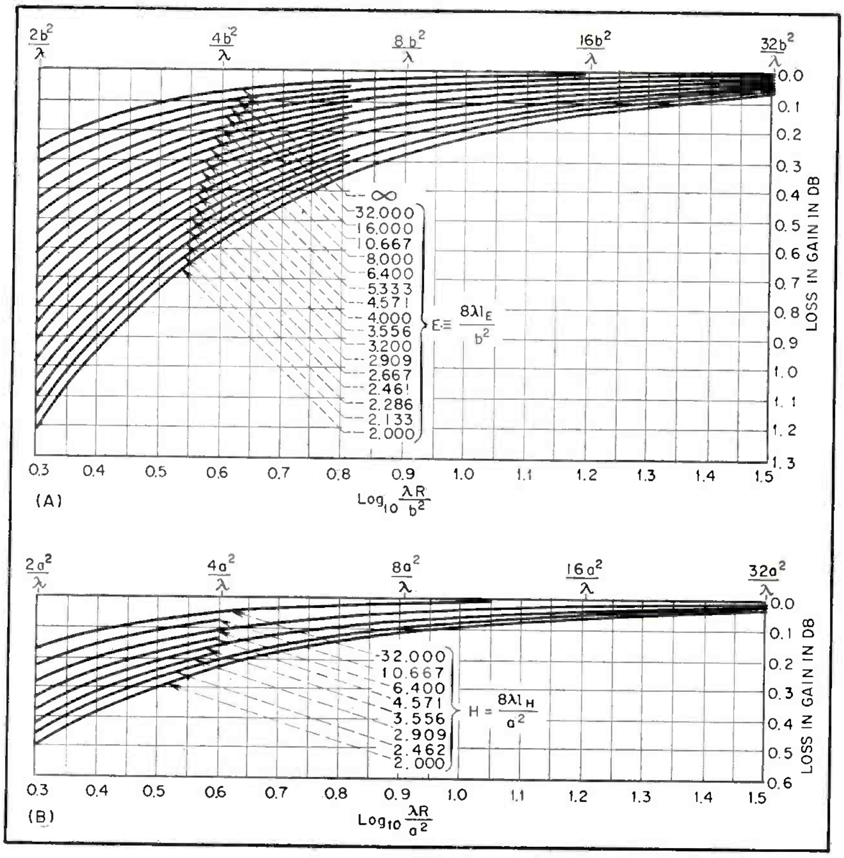

FIG. 7—Braun's E- and H-plane correction curves

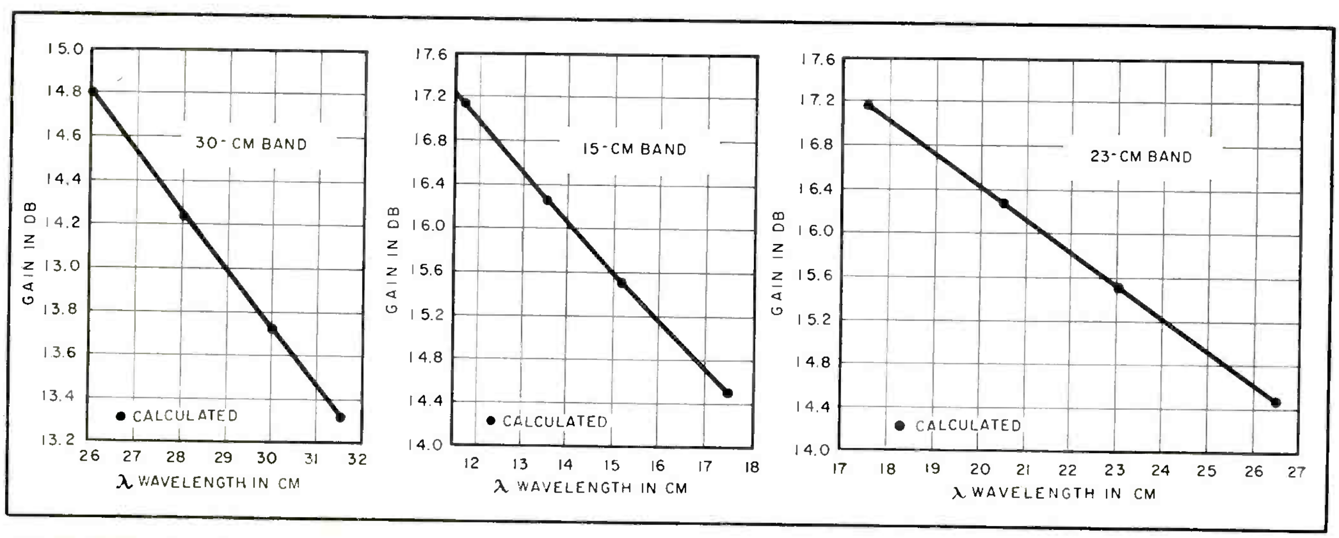

FIG. 6—Gain curves for gain-standard horns in the 15-cm, 23-cm and 30-cm bands

Table I—Summary of Gain-Standard Horn Data

Band	Dimensions (I. D.) See Fig. 1	Plate Data: Plate	Plate Data: Large End	Plate Data: Small End	Plate Data: Length	Plate Data: Material	Waveguide: Size (O.D.)	Waveguide: Flange	Axial Length to Wave-guide	Over-all Length	Design Point Frequency	Gain at Design Point (db)
8 mm	$a = 2.720$ $b = 2.231$	......	......	......	......	......	0.360×0.220	UG-381/U	....	6.46	0.85 cm	24.7
	$l_H = 6.513$ $l_E = 6.197$	Electroformed; details not shown					RG-96/U				35,290 mc	
1.25 cm	$a = 4.000$ $b = 3.281$	A	4.080	0.500	8.641	0.040	0.500×0.250	UG-117/U	8.500	11.2	1.25 cm	24.7
	$l_H = 9.706$ $l_E = 9.113$	B	3.281	0.170	8.688	Brass	RG-53/U				24,000 mc	
1.8 cm	$a = 5.984$ $b = 4.908$	A	6.064	0.702	12.769	0.040	0.702×0.391	UG-420/U	12.560	15.6	1.87 cm	24.7
	$l_H = 14.333$ $l_E = 13.633$	B	4.908	0.311	12.843	Brass	RG-91/U				16,040 mc	
3.2 cm	$a = 7.654$ $b = 5.669$	A	7.754	1.000	11.709	0.050	1.000×0.500	UG-39/U	11.409	14.9	3.20 cm	22.1
	$l_H = 13.484$ $l_E = 12.598$	B	5.669	0.400	11.899	Brass	RG-52/U				9,375 mc	
4.75 cm	$a = 11.360$ $b = 8.415$	A	11.485	1.497	17.318	1/16	1.500×0.750	UG-344/U	16.874	20.4	4.75 cm	22.1
	$l_H = 20.014$ $l_E = 18.700$	B	8.415	0.622	17.597	Brass	RG-50/U				6,315 mc	
3.95 cm	$a = 5.011$ $b = 3.733$	A	5.166	1.247	5.682	1/16	1.250×0.625	UG-51/U	5.447	9.45	3.95 cm	18.0
	$l_H = 7.447$ $l_E = 6.555$	B	3.733	0.497	5.789	Brass	RG-51/U				7,595 mc	
6 cm	$a = 8.507$ $b = 6.300$	A	8.632	1.997	9.531	1/16	2.000×1.000	UG-149A/U	9.136	13.1	6.67 cm	18.0
	$l_H = 12.462$ $l_E = 11.062$	B	6.300	0.872	9.720	Brass	RG-49/U				4,500 mc	
10 cm	$a = 12.760$ $b = 9.450$	A	12.95	3.00	14.24	3/32	3.000×1.500	UG-214/U	13.65	20.7	10.00 cm	18.0
	$l_H = 18.682$ $l_E = 16.593$	B	9.45	1.34	14.52	Brass	RG-48/U				3,000 mc	
15 cm	$a = 14.508$ $b = 10.747$	A	14.508	4.300	11.285	3/32	4.460×2.310	UG-437/U	10.43	14.4	15.22 cm	15.5
	$l_H = 16.508$ $l_E = 14.107$	B	10.747	2.150	11.616	Alum.	RG-105/U				1,970 mc	
23 cm	$a = 21.931$ $b = 16.245$	A	21.931	6.500	17.059	1/8	6.660×3.410	UG-418/U	15.77	21.8	23.00 cm	15.5
	$l_H = 24.955$ $l_E = 21.325$	B	16.245	3.250	17.559	Alum.	RG-103/U				1,300 mc	
30 cm	$a = 21.931$ $b = 16.245$	A	21.931	7.700	18.312	1/8	7.950×4.100	10"x6"x3/8"	17.23	23.2	30.00 cm	13.7
	$l_H = 28.730$ $l_E = 24.000$	B	16.245	3.850	18.643	Alum.	RETMA WR-770				1,000 mc	

Horns in each bracket have essentially same design in terms of wavelengths

Plate tolerances

1.25–6 cm: ±0.005 in.

10–30 cm: ±0.015 in.

All dimensions in inches

cause of the near-field conditions.

The procedure for determining the true Fraunhofer (far-field) gain from the primary gain test data, using Braun's near-field correction curves, Fig. 7A and B is shown in the following example: See Fig. 1 and Table I

3.2-cm band horn dimensions:

$a = 7.654$ in. $\quad l_H = 13.484$ in.

$b = 5.669$ in. $\quad l_E = 12.598$ in.

Parameters for using the gain formula:

$$\lambda = 3.20 \text{ cm} = 1.2598 \text{ in.}$$

$$R(\text{distance between horns}) = 140.25 \text{ in.}$$

$$\frac{4\pi R}{\lambda} = \frac{(12.566)(140.25)}{1.2598} = 1398.94$$

From test data:

$$\frac{P_T}{P_R} = \frac{11.3}{0.123} = 91.87; \quad \sqrt{\frac{P_T}{P_R}} = 9.585$$

$$\text{Uncorrected Gain} = \frac{4\pi R}{\lambda} \Big/ \sqrt{\frac{P_T}{P_R}} = \frac{1398.94}{9.585} = 145.95$$

$$10 \log 145.95 = 21.64 \text{ db}$$

Parameters for using the correction curves:

E-plane, Fig. 7A

$$\frac{8l_E}{b^2} = \frac{(8)(12.598)}{32.1376} = 3.1360$$

$$\left.\begin{aligned} E &= \left(\frac{8l_E}{b^2}\right)\lambda \\ &= (3.1360)(1.2598) \\ &= 3.951 \\ \log\frac{\lambda R}{b^2} &= \log\frac{(1.2598)(140.25)}{32.1376} \\ &= \log 5.498 = 0.740 \end{aligned}\right\} \text{0.22 db correction}$$

H-plane (Fig. 7B):

$$\frac{8l_H}{a^2} = \frac{(8)(13.484)}{58.5837} = 1.8413$$

$$\left.\begin{aligned} H &= \left(\frac{8l_H}{a^2}\right)\lambda \\ &= (1.8413)(1.2598) \\ &= 2.320 \\ \log\frac{\lambda R}{a^2} &= \log\frac{(1.2598)(140.25)}{58.5837} \\ &= \log 3.016 = 0.479 \end{aligned}\right\} \text{0.28 db correction}$$

Reading from the correction curves as detailed above:

E-plane correction	0.22 db
H-plane correction	0.28 db
Total correction	0.50 db
Uncorrected gain	21.64 db
Corrected gain	22.14 db

The calculated gain, using Schelkunoff's gain formula, in this case was the same. Note that the separation distance R, was approximately $3D^2/\lambda$, and the required correction at this distance was not small.

Consistently good agreement was obtained between measurements made at different distances using the correction curves.

A series of microwave gain-standard horns has now been built which incorporates the following desired characteristics: a useful value of gain; broad-band coverage; accurate calibration; reasonable size; ease of duplication.

Improved techniques have resulted in an accuracy of gain measurement which was not possible previously.

The author wishes to express his appreciation to E. H. Braun for his advice and cooperation and to F. W. Lashway for his suggestions and drawings

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All-Pass Amplifier

SUMMARY — Five-stage 10 to 70-mc amplifier uses parasitic capacitances of tubes as transmission elements beyond useful amplification range of tubes. Arbitrarily large gain-bandwidth products can be obtained by cascading a sufficient number of tubes

By HARRY J. WOLL
Optics, Sound and Special Engineering
Radio Corporation of America
Camden, N. J.

SHORTER PULSES with faster rise times have engendered a need for equipment to amplify these pulses. This requires wide-band amplifiers since the limiting rise time of an amplified pulse is inversely proportional to the bandwidth of the amplifier.

High-frequency attenuation through a tandem connection of stages can be reduced by allowing the signal to be transmitted through the parasitic capacitances rather than being attenuated by them. In a conventional amplifier the bandwidth is limited because the parasitic capacitances shunt the interstage coupling impedance and attenuate the signal at high frequencies.

In this amplifier the parasitic capacitances are incorporated into a high-pass filter which allows transmission of signal frequencies beyond the band of useful amplification. The stage amplifies in a manner similar to a conventional amplifier at the lower frequencies. By suitable combination of stages or band-pass equivalents of them, amplification can be obtained over bandwidths beyond the limits of conventional amplifiers.

An all-pass amplifier stage will be defined as a network which has an input impedance equal to R at all frequencies if the output of the stage is terminated with the nominal load resistance R, and a voltage transfer ratio

$$\frac{E_3}{E_1} = \frac{p - \omega_o}{p + \frac{\omega_o}{A}} \qquad (1)$$

or its band-pass equivalent.

$$\frac{E_3}{E_1} = \frac{p + \frac{\omega_1^2}{p} - \omega_o}{p + \frac{\omega_1^2}{p} + \frac{\omega_o}{A}} \qquad (2)$$

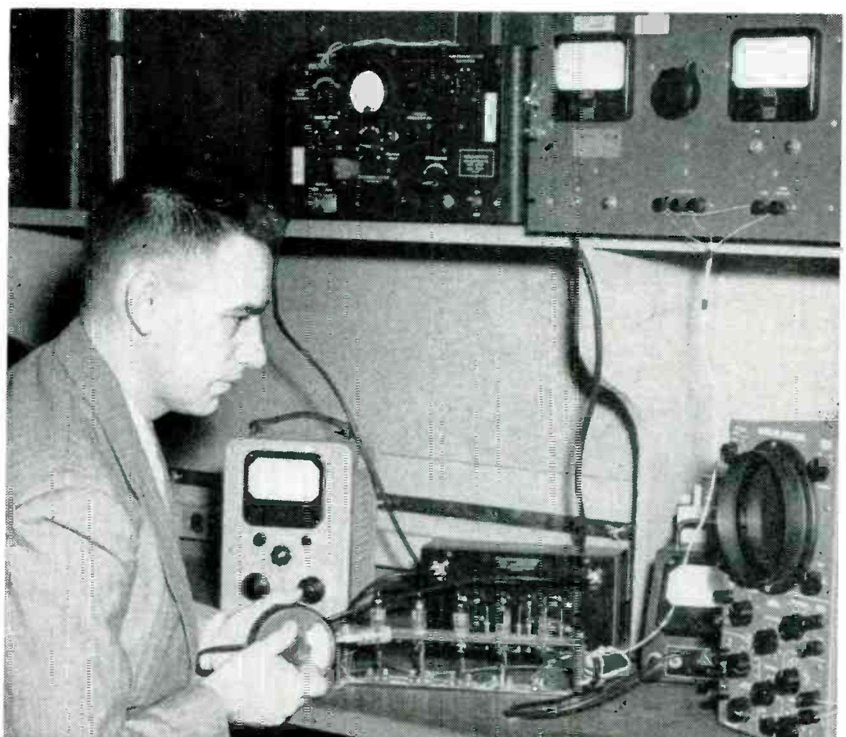
where p is the complex-frequency variable, R is the load resistance, A is the maximum stage gain, ω_0 is a measure of bandwidth and ω_1 is the angular frequency of maximum gain.

Stages which have their maximum gain at zero frequency will be called low-pass stages; others will be called band-pass stages.

Since the input impedance of a properly terminated all-pass amplifier stage is equal to R at all frequencies, the stages in a tandem connection are matched on an iterative basis. Each stage contributes to the response independently of the rest of the amplifier.

Typical Amplifier

An all-pass amplifier stage is shown in Fig. 1, where C_1 is the grid-to-cathode capacitance and C_2 is the grid-to-plate capacitance. At



Experimental five-stage 10 to 70-mc all-pass amplifier test setup. Amplifier is shown immediately to right of author's hands

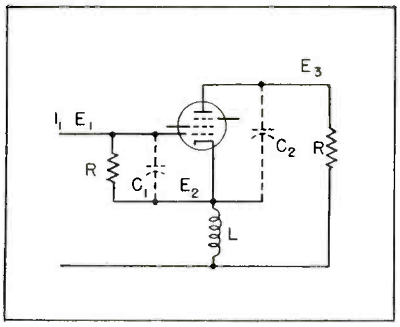


FIG. 1—All-pass amplifier stage is equivalent to conventional amplifier stage and high-pass filter

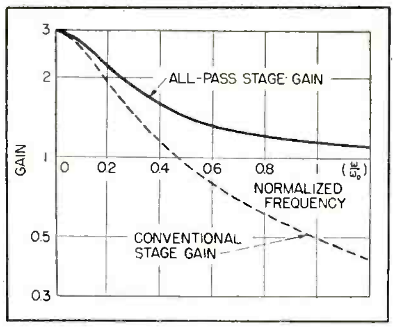


FIG. 2—Gain per stage of conventional amplifier compared with all-pass amplifier

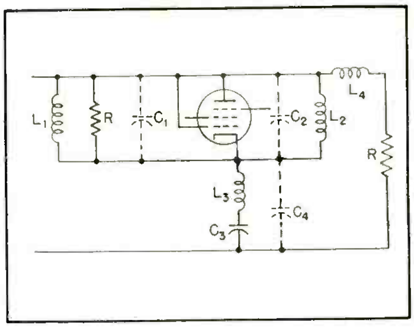


FIG. 3—All-pass amplifier stage, showing stray capacitance to ground with inductance L_4 inserted in output

low frequencies the cathode-to-ground impedance is small, the interelectrode capacitances have a negligible effect and the tube amplifies in a conventional manner having a voltage gain of $A = g_mR$. At high frequencies the input current flows directly into the load through the tube capacitances since they are low impedances.

The cathode-to-ground inductance can be neglected at these frequencies because it is a high impedance. An all-pass amplifier stage can then be considered a combination of a conventional amplifier stage and a high-pass filter with each controlling the characteristics of the stage over part of the frequency spectrum.

The equations that define the network of Fig. 1 reduce to a voltage transfer ratio

$$\frac{E_3}{E_1} = \frac{pRC_2 - 1}{pRC_2 + \dfrac{1}{g_mR}} \qquad (3)$$

and an input impedance equal to R when

$$g_mR = \frac{C_1}{C_2} \qquad (4)$$

$$L = \frac{R^2C_1}{1 + g_mR} \qquad (5)$$

Stage gain is equal to the ratio of the input capacitance to the output capacitance. This restriction can be eliminated through the use of an autotransformer.

Figure 2 compares the gain versus frequency curve of an all-pass amplifier stage with that of a conventional amplifier using the same tube and having a two-terminal interstage. Both were adjusted to a low-frequency gain of three.

The preceding showed a method of circumventing the gain-bandwidth limitations imposed upon amplifiers by the parasitic capacitances of the tubes. A circuit composed of simple lumped ideal elements was assumed. In actual practice this is not the case.

Nonideal Components

The most troublesome circuit element is stray capacitance of the circuit to ground. It consists of the capacitance to ground of the tube, wiring and components. All these can be lumped as a capacitance from cathode to ground.

At frequencies above the band of amplification the amplifier becomes a high-pass filter. At these frequencies, the total capacitance shunting the load is the stray capacitance to ground per stage times the number of stages. In a multistage amplifier this capacitance would severely limit the bandwidth capabilities of the amplifier.

If, in Fig. 3, C_4 is the stray capacitance to ground per stage and R is the load resistance, inductance

$$L_4 = R^2C_4 \qquad (6)$$

can be inserted in the output circuit of the stage. At high frequencies, series inductance L_4, in conjunction with shunt capacitance C_4 forms a section of a constant-k low-pass filter of impedance R.

In the center of the band of useful amplification, L_4 and C_4 do not affect the stage gain since C_4 is shunted by series-resonant circuit L_3 - C_3. Inductance L_4 is in series with parallel-resonant circuit L_2 - C_2. The input impedance of the stage is not affected since it is determined by the grid-to-cathode impedance at the center of the band.

Outside the band of amplification L_4 and C_4 function as a lumped-constant line of impedance R. The capacitances of the individual stages are isolated and the limiting bandwidth is determined by the load impedance R and the capacitance to ground C_4 of one stage.

The high-frequency limit due to C_4 is inversely proportional to the line impedance.

The line impedance can be reduced, raising the high-frequency limit imposed by C_4, by paralleling tubes in a stage. Another means for reducing line impedance is the use of tapped coils at the input and output.

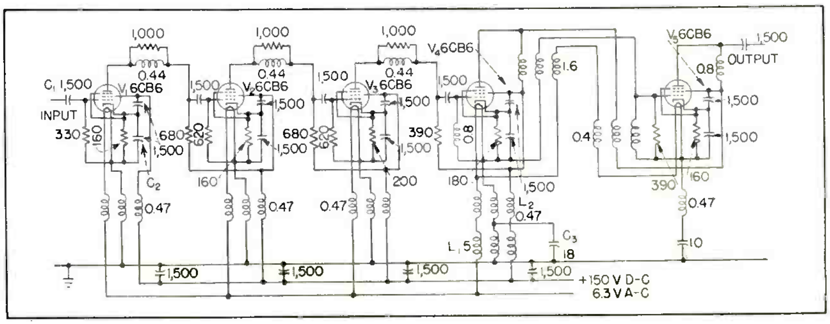


FIG. 4—Five-stage 10 to 70-mc amplifier. Heater and plate voltages are supplied to the tubes through trifilar coils. Capacitances are in $\mu\mu$F and inductances in μH

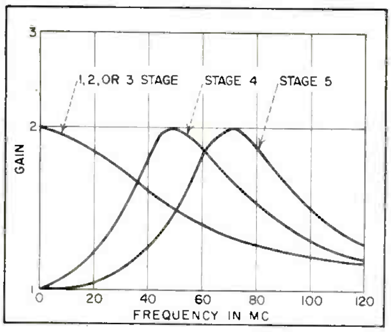


FIG. 5—Individual stage response of 10 to 70-mc all-pass amplifier

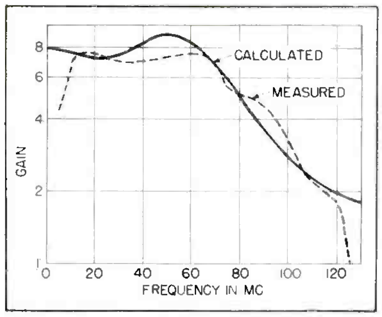


FIG. 6—Overall response characteristic of 10 to 70-mc all-pass amplifier

A schematic of an experimental amplifier is shown in Fig. 4. The grid-input stage was chosen as the basic building block. Using a 6CB6 the input capacitance was 13 $\mu\mu$f and the output capacitance was 6.5 $\mu\mu$f. These figures include capacitance of the socket, components and wiring.

Five-Stage Amplifier

The cathode resistors were individually adjusted to operate the tubes at a transconductance of 6,100 micromhos so that any deviation between calculated and experimental results would not be due to variations in tubes. From Eq. 3, 4 and 5, stage gain $= C_1/C_2 = 13.5/6.5 = 2$, $g_m R = C_1/C_2 = 2$, or $R = 2/g_m = 330$ ohms, L (inductance from cathode to ground) $= R_2 C_1/(1 + g_m R) = 0.47$ μh and $f_o = 1/(2\pi R C_2) = 74$ mc

The response curve of a low-pass stage, where f is in mc, is then

$$\left|\frac{E_3}{E_1}\right| = \frac{\left(\frac{f}{f_o}\right)^2 + 1}{\left(\frac{f}{f_o}\right)^2 + \left(\frac{1}{g_m R}\right)^2} = \frac{f^2 + 74^2}{f^2 + 37^2} \quad (7)$$

This is plotted in Fig. 5.

Using the low-pass to band-pass transformation, response curves of equivalent band-pass stages can be calculated. By shifting templates that correspond to the response curves of band-pass stages it was determined that three low-pass stages plus two band-pass stages tuned to 50 and 70 mc respectively would give a response out to 70 mc, as plotted in Fig. 6.

The band-pass stages have the same cathode-to-ground inductance as the low-pass stages. A capacitor is added to series-resonate this inductance at the center frequency of the passband. This capacitance includes the equivalent stray capacitance from the low end of the cathode coil to ground, but does not include the capacitance from the tube to ground. Coils are added to parallel-resonate the input and output capacitances of the tube at the center frequency of the passband.

The shunt capacitance to ground was 4 $\mu\mu$f per stage. Series coils were added to compensate for the effect of the shunt capacitance. The value of this inductance is $L = R^2 C = (330)^2 \times 4 \times 10^{-12} = 0.44$ μh.

Compensating coils are not put in the plate circuits of V_4 and V_5 because these tubes are operate as amplifiers at high frequencies. Their cathode-to-ground impedances are low and the 4-$\mu\mu$f shunt capacitance has only a slight effect. The 1,000-ohm resistors were shunted across the series chokes to eliminate resonant peaks in response at and above the cutoff frequency of the constant-k filter formed by the shunt capacitances and the series inductances.

Insufficient cathode-bypass capacitance limits the response below 5 mc. The major limitation on low-frequency response is the low impedance of L_1. The cathode-to-ground impedance of V_4 should be high at low frequencies. In the ideal case C_3 would not be shunted by an inductance. However, L_1 supplies plate and heater voltage to V_4 and V_5 and is necessary. For best low-frequency response it should have high inductance with a distributed capacitance less than 21.5 $\mu\mu$f. At high frequencies L_1 and C_3 in parallel should be equivalent to the 21.4 $\mu\mu$f required to series-resonate L_2 at 50 mc. A considerably larger inductance is practical for L_1. The 5-μh coil that is used has a distributed capacitance of only 2 or 3 $\mu\mu$f.

The measured response of the amplifier is compared with the calculated response in Fig. 6. The low-frequency cutoff is at about 10 mc. The measured response was made somewhat flatter than the calculated value by misaligning the band-pass stages. This added an inflection to the response curve between 80 and 90 mc. The sharp cutoff at 120 mc is due to the constant-k filter

Advantages

Theoretically, an all-pass amplifier has at least 1.6 times the log-gain-bandwidth per tube of a distributed amplifier or of a divided-band amplifier with two-terminal interstages and at least $\frac{2}{3}$ the log-gain-bandwidth per tube of a divided-band amplifier with four-terminal interstages. Practically, log-gain-bandwidths per tube about equal to those of distributed amplifiers have been obtained.

General-purpose divided-band amplifiers are not available commercially because of the difficulty of realizing accurately matched phase and amplitude characteristics in the different channels. Since all-pass amplifiers do not require this adjustment, they are superior to divided-band amplifiers.

Because of the difficulty in supplying heater and plate voltages to the tubes, the all-pass amplifier is inferior to the distributed amplifier.

All-pass and divided-band amplifiers have the disadvantage that variations in tube transconductance directly affect their amplitude response. In the distributed amplifier, tube transconductance has only a second-order effect on response.

The author is grateful for the guidance of W. H. Boghosian of the University of Pennsylvania and the encouragement of L. H. Good of the Radio Corporation of America.

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How to Design Overstaggered Doublets

SUMMARY—Stagger-tuned amplifiers can be peaked to give response curves similar to overcoupled transformers. Advantages include increased gain and skirt selectivity. Curves provide a useful aid in designing the tuned circuits

By **HAROLD D. WEBB** *University of Illinois Urbana, Illinois*

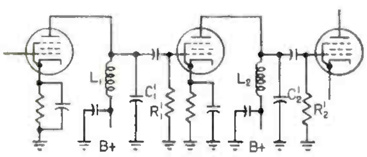

FIG. 1—Staggered doublet

DESIGN PROBLEMS

To select components for an overstaggered doublet, the designer must first determine the Q and resonant frequency of each tuned circuit. He begins by knowing only the desired center frequency, f_o, bandwidth B and permissible dip in db d.

The Q's are to be equal for both tuned circuits. The resonant frequencies are related by α. If the frequencies are f_{o1} and f_{o2}

$$f_{o1} = f_o/\alpha$$
$$f_{o2} = f_o\alpha$$

Should the designer want to work from equations, he would determine first the quantity γ

$$d = 20 \log_{10} [1/\sqrt{1 - (\gamma^2 - 1)^2}]$$

from which $\gamma^2 - 1$ must be negative for overstaggering. This quantity is used to solve for q

$$q = 1/b \sqrt{(1-\gamma^2) + \sqrt{1-(\gamma^2-1)^2}}$$

where b is defined by $b = f_o/B$.

The designer may now evaluate the Q of the tuned circuits

$$Q^2 = [4 + q^2 + \sqrt{(4+q^2)^2 - 8q^2\gamma^2}]/4q^2\gamma^2$$

Now α is found in terms of Q, q and γ

$$\alpha^2 = q^2\gamma^2Q^2 - 1 + \sqrt{(q^2\gamma^2Q^2-1)^2 - 1}$$

The OVERSTAGGERED doublet gives an amplitude response with a dip resembling that for an overcoupled transformer. Its advantages include increased peak and center-frequency gain, increased skirt selectivity and less critical adjustment. The desired type of output can be obtained only in the absence of regeneration or any other type of feedback that affects the shape of the response characteristic. A staggered doublet is shown in Fig. 1.

Curve family I shows Q plotted against b for various values of dip d. Curve II plots α versus b. Quantity b is the ratio of center frequency to half-power bandwidth, and α is used to find the resonant frequencies. The values of α versus b are so nearly the same for various amounts of dip that only one curve for α versus b is given. This is the curve for the maximally flat case, $d = 0$. Also plotted are γ^2 versus d, curve III; peak gain improvement in db versus d, curve IV; center-frequency gain improvement in db versus d, curve V; and skirt selectivity versus d, curve VI. Skirt selectivity is the ratio of bandwidth 10 db down to bandwidth 3 db down.

From curves I the value of Q may be read directly. The stage resonant frequencies are found using the value of α read from curve II. For a given value of C, L is found from $L = 1/C\omega^2$ and R is found for each stage from $R = Q/C\omega$.

For the curves the value of b is limited between 0.5 and 10. When the value of b is too large to be represented on the graph, find Q for $b = 8$, divide this value by 8 and multiply the result by the given value of b. To find f_{01} and f_{02} for values of b greater than 10 use $f_{01} = f_0 - B/2\sqrt{2}$ and $f_{02} = f_0 + B/2\sqrt{2}$; B is half-power bandwidth.

Example

Design a staggered doublet with center frequency 20 mc, bandwidth 5 mc at the half-power points and 1-db dip. Let C_1 and C_2, the total shunt capacitances for each stage of the doublet, each be 12 $\mu\mu$f.

First, $b = f_0/B = 20/5 = 4$. From the 1-db dip curve I for $b = 4$, $Q = 8.9$.

From curve II for $b = 4$, $\alpha = 1.093$. The center frequencies are $f_{01} = f_o/\alpha = 20/1.093 = 18.3$ mc and $f_{02} = f_0\alpha = 21.9$ mc.

(Continued on p 160)

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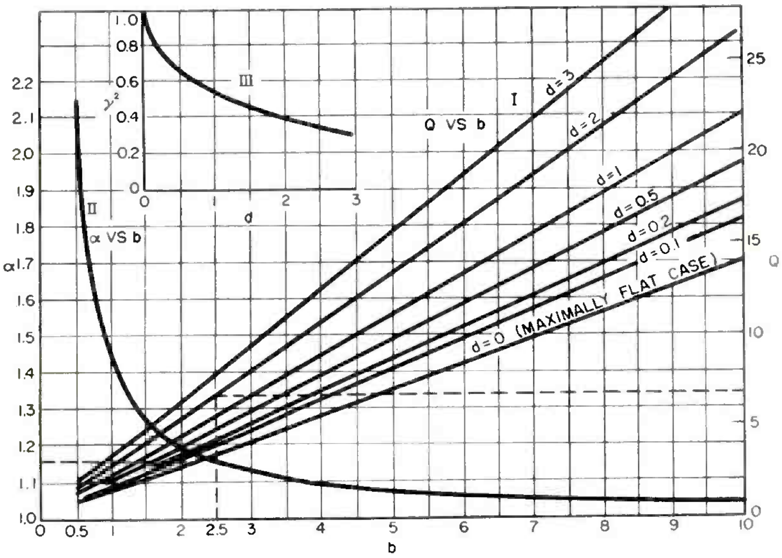
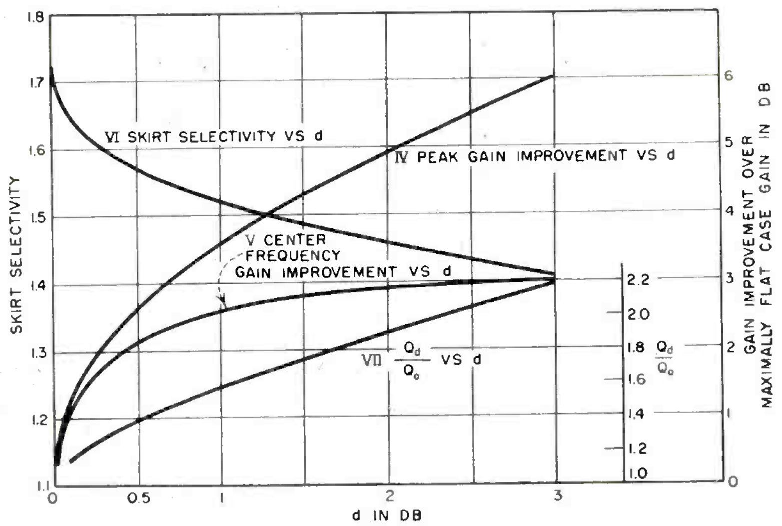
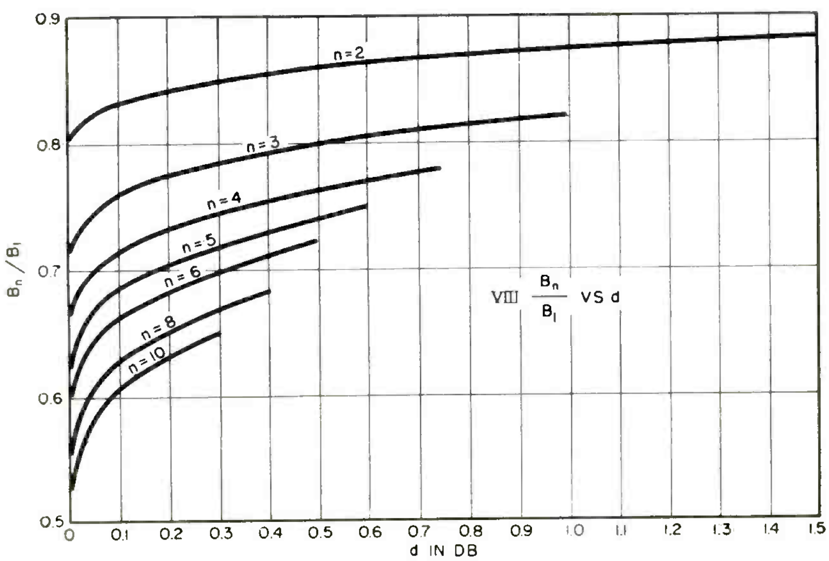
Overstaggered Doublets (Continued from p 158)







Two stages are used having center frequencies of 18.3 and 21.9 mc and effective Q's of 8.9.

The effective parallel resistance for the stage at 18.3 mc is $R_1 = Q/C_1\omega_{01} = 6{,}450$ ohms and for the stage at 21.9 mc $R_2 = Q/C_2\omega_{02} = 5{,}390$ ohms. The inductances are $L_1 = 1/C_1\omega_{01}^2 = 6.3 \times 10^{-6}$ henrys and $L_2 = 1/C_2\omega_{02}^2 = 4.4 \times 10^{-6}$ henrys.

The gain at the center frequency is $G = g_m/2\pi CB$, and the gain at the peaks is 1 db greater. From curves IV and V the peak and center-frequency gain improvements over a maximally flat stage are 3.6 and 2.6 db. The 10-db-down to 3-db-down skirt selectivity from curve VI is 1.52.

An alternate method is to determine Q from the 0-db-dip curve I, from which $Q_0 = 5.7$ for $b = 4$, and multiply this Q by the Q ratio obtained from curve VII for $d = 1$ db, which is 1.57. The Q used in the design is then $5.7 \times 1.57 = 8.95$.

Cascaded Pairs

In the design of overstaggered pairs for wide bandwidth response it is frequently necessary to use more than two stages. It may be desired to use two or more overstaggered pairs that are alike in design rather than to use a staggered quadruplet or sextuplet. The designer will be concerned with the overall bandwidth 3 db down from the peaks as compared to the bandwidth 3 db down from the peaks for one staggered pair. This information can be read from curve VIII, which is the ratio of the bandwidth 3 db down from the peaks to that of one pair versus d for various values of n where n is the number of like pairs that are cascaded. For n cascaded pairs the db dip for the overall response is n times the dip for one pair, if the pairs are all alike.

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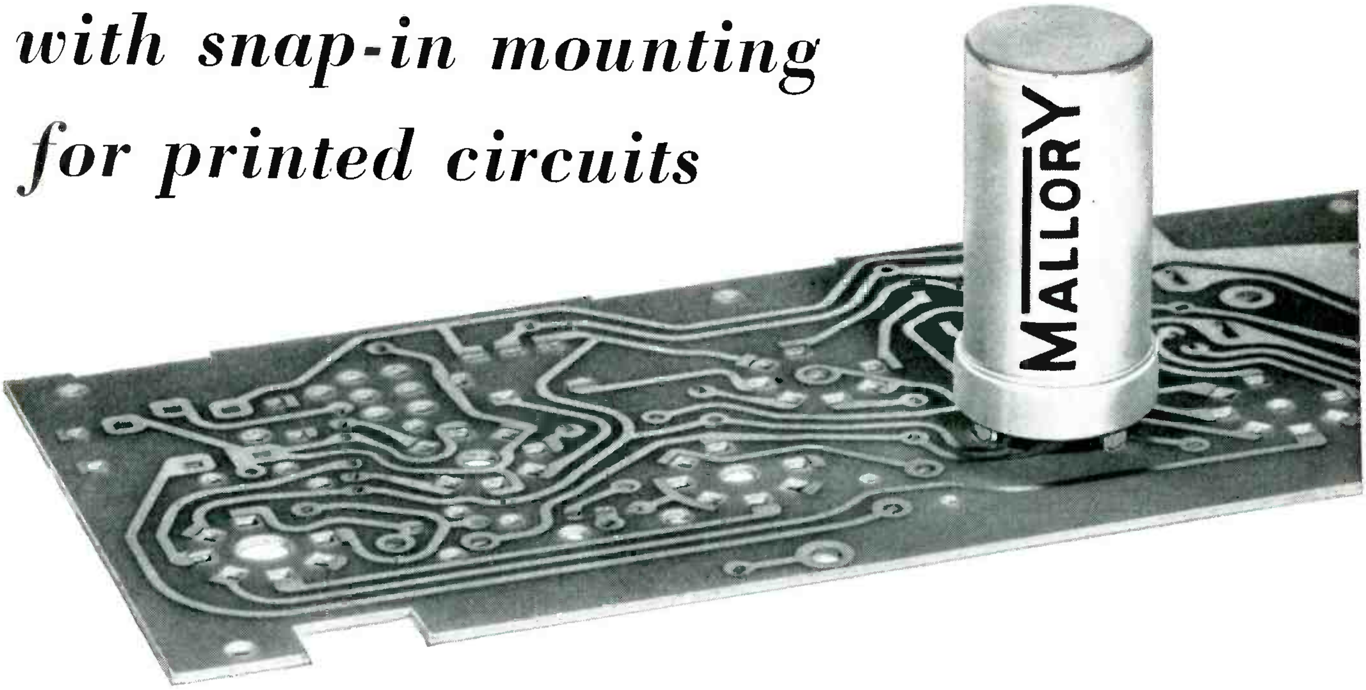

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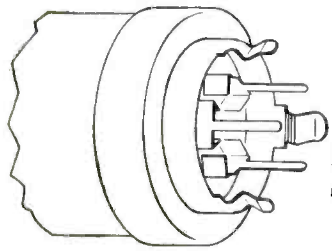
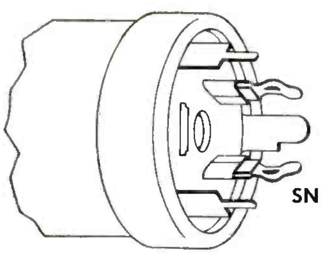


SNAP-IN MOUNTING TABS



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Electrons At Work

Edited by ALEXANDER A. McKENZIE

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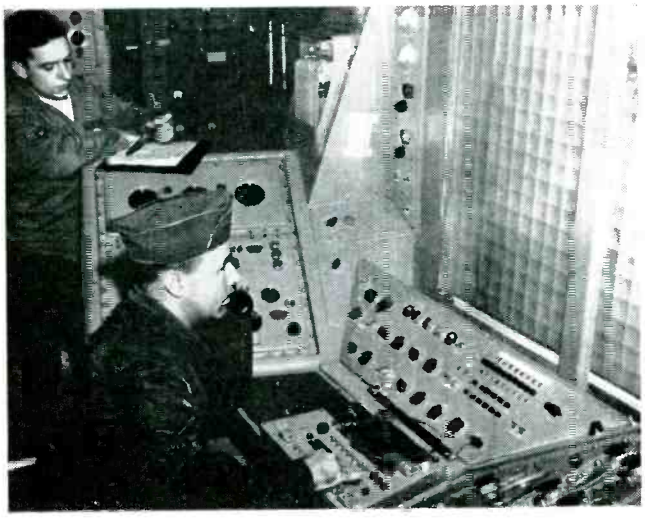
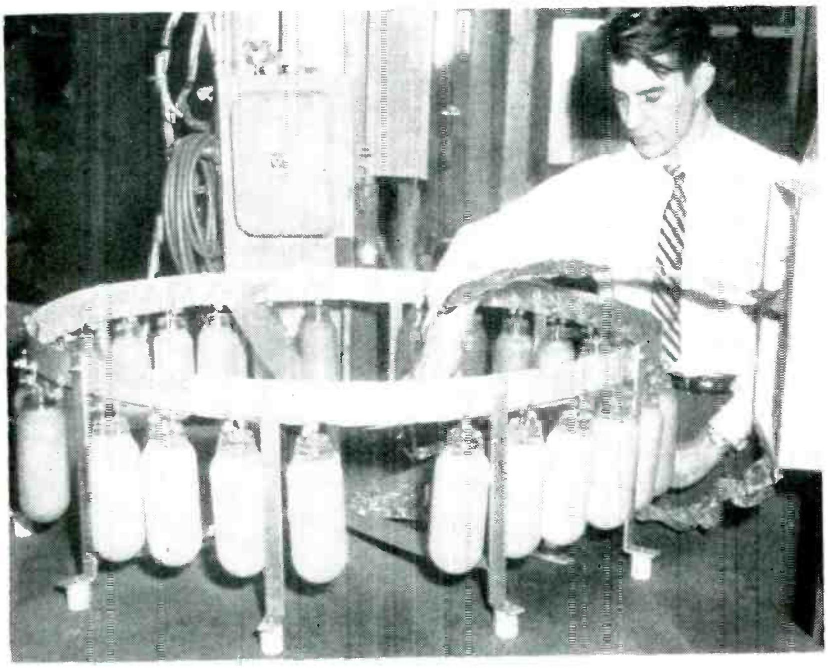


Interior of radar control station (left) from which pilotless jets are made to traverse desired target area. Alternatively, the QF-80 (right photograph) can be flown off the runway by the controller and then command taken over by a DT-33 director aircraft in the rear. Robot command guidance systems built by Sperry Gyroscope Co. were used in recent Air Force tests with the AEC

Paralleled Beacon Lamps Serve as Dummy Load



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- Superior Regulation.
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- Low Ripple.
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- Fast Recovery Time, Suitable for Square Wave Pulsed Loading.
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- Guarantee One Year.

To include 3" Current and Voltage Meters, Add M to Model number (e.g. KR 1-M) and Add $30.00 to the Price.
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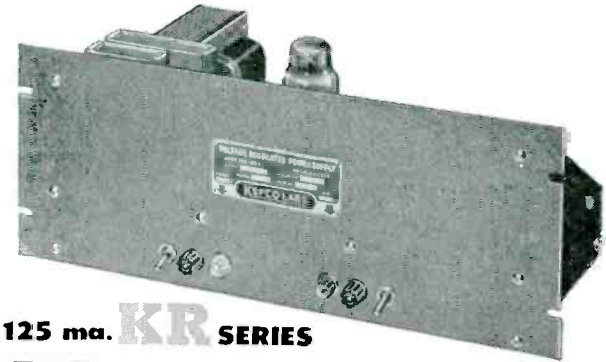
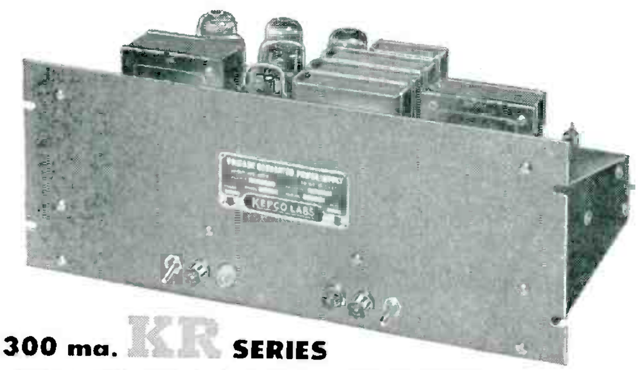


125 ma. KR SERIES

MODEL	OUTPUT	VOLTS	CURRENT	REGULATION line 105-125V	REGULATION load 0-max	RIPPLE (RMS)	19" Rack Mount W	H	D
KR1 $90.	1 2	100-200 6.3 AC	0-125 ma. 3 amp.	0.3 volts *	0.3 volts *	3 mv.	19"	7"	7½"
KR2 $90.	1 2	200-325 6.3 AC	0-125 ma. 3 amp.	0.2 volts *	0.2 volts *	3 mv.	19"	7"	7½"

*AC Voltages unregulated.



300 ma. KR SERIES

MODEL	OUTPUT	VOLTS	CURRENT	REGULATION line 105-125V	REGULATION load 0-max	RIPPLE (RMS)	19" Rack Mount W	H	D
KR3 $180.	1 2 3	100-200 6.3AC 6.3AC	0-300 ma. 5 amp. 5 amp.	0.3 volts * *	0.3 volts * *	3 mv.	19"	7"	11"
KR4 $180.	1 2 3	200-325 6.3AC 6.3AC	0-300 ma. 5 amp. 5 amp.	0.2 volts * *	0.2 volts * *	3 mv.	19"	7"	11"

*AC Voltages unregulated.

600 ma. KR SERIES

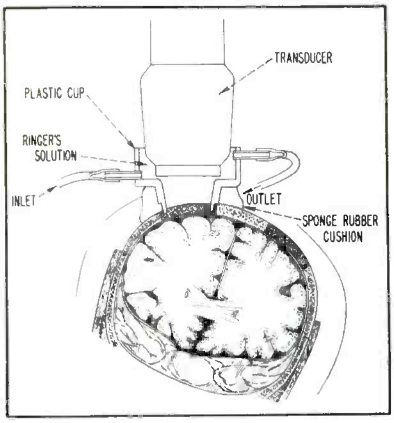
MODEL	OUTPUT	VOLTS	CURRENT	REGULATION line 105-125V	REGULATION load 0-max	RIPPLE (RMS)	19" Rack Mount W	H	D
KR5 $240.	1 2 3	100-200 6.3 AC 6.3 AC	0-600 ma. 10 amp. 10 amp.	0.3 volts * *	0.3 volts * *	5 mv.	19"	10½"	13"
KR6 $240.	1 2 3	195-305 6.3 AC 6.3 AC	0-600 ma. 10 amp. 10 amp.	0.2 volts * *	0.2 volts * *	5 mv.	19"	10½"	13"
KR7 $250.	1 2 3	295-405 6.3 AC 6.3 AC	0-600 ma. 10 amp. 10 amp.	0.2 volts * *	0.2 volts * *	5 mv.	19"	10½"	13"

*AC Voltages unregulated.

resistance for the test.

Vacuum capacitors inside the circle of lamps are connected in required combinations to the dummy load for simulating the capacitance of the actual load and tuning the generator. Flexible metal strips connect load and generator.

Ultrasonic Irradiation Substitutes for Lobotomy



Method of transmitting ultrasound to the brain after removal of bone button over each prefrontal area

SMALLER PARTS of the human brain are sometimes destroyed for therapeutic purposes, as, for example, to ease intense pain or depression resulting from malignant tumors. A sharp instrument, aspiration needle or electrocautery have been generally used to cause such localized destruction.

Serious complications may follow because of unpredictable hemmorhages, scars or degeneration that may develop. Inertia, stupor, incontinence or personality changes can result.

Experiments showed that graded, controllable lesions extending deep into the white matter with comparatively little damage to the cortex of the exposed animal brain could be produced by a single beam of ultrasound without noticeable ill effects on animals.

Based upon animal experiments, it was decided to apply sound to human patients through opening made in the calvaria, the dome-like upper part of the cranium. Bilateral circular trephine openings $1\frac{1}{4}$ to $1\frac{1}{2}$ in. in diameter were made over the frontal areas. The patient was placed in a sitting position so that dorsal surface of the pre-

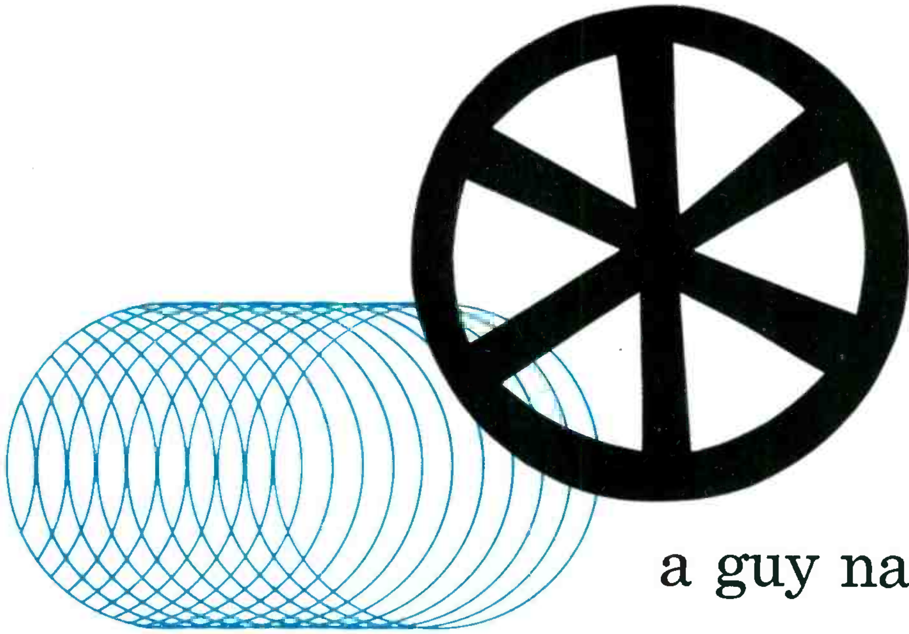
Guardian Picket Ship

Latest addition to northern hemisphere defense is the radar picket ship that can pick up signals reflected from aircraft far off the shores of the continent. First ship to be commissioned for this service is the USS Guardian, YAGR-1, shown at left. First official photographs of the vessel indicate no details of the extensive radar and electronics installations in this floating laboratory

Overseas Radiotelephone Service Links Most of World's Telephones

That about 96 percent of all the telephones in the world can be interconnected depends in no small part on the use of radio. On the east coast of the United States, transmitters of the American Telephone and Telegraph Co. located at Lawrenceville, N. J.

(left) relay to Europe, Africa and South America. One of the high-frequency receiving stations is located at Manahawkin, N. J. Adjustments and co-ordination depend upon the technical operators (right) in New York City



a guy named Og

Once your name was Og. You tired of shouldering mastodon steaks...of dragging your mate by her hair. You invented the wheel.

Later, your name was Watt. Steam made your kettle-lid dance...and the Industrial Revolution was on.

Yesterday, you were a bicycle mechanic named Henry...today, your brainchild's descendants are counted in millions.

Your name is legion. You created every linkage... every device...every system.

You're an engineer.

You make things work better...faster...more accurately ...more economically.

Next week...next month...next year...some system will need a better, faster, more accurate or more economical means of recording...or indicating...or computing...or controlling a process.

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THE FRONT COVER

DURING an experimental production run, thousands of noise and vibration checks are made upon the performance of new aircraft tires and associated wheels and brakes.

Using a vibration pickup and Magnecord tape recorder, a record can be quickly made of performance. The reduced data may be played back to the executive upon whose decision the direction of the program may be continued or changed.

The airplane brake testing machine shown is installed in the B. F. Goodrich plant at Troy, Ohio. It has a top speed of 246 mph and the wheel can be loaded to 70,000 pounds.

frontal lobes was slanting about 10 to 15 degrees forward. With the sound head fixed vertically, the beam was aimed at the anterior tip of the lateral ventricle.

Ringer's solution at room temperature, degassed by 20 minutes of boiling and continuously exchanged, acted as the coupling agent between the tissue and the transducer.

A frequency of 1,000 kc was employed, intensity averaging about 7 watts per square centimeter close to the crystal. Exposure time varied from 4 to 14 minutes for a series of 20 patients who were generally given only a local anesthetic.

Judged from a layman's viewpoint, the method would appear to be successful in a majority of cases. In the more careful phrasing of the physician, it is indicated that the ultrasonic substitute for surgical lobotomy is comparatively simple, carries a minimal risk and has, with a limited number of patients, given clinical results that compare favorably with those of surgical lobotomies in similar cases.

On fifty-five patients treated there have been no complications and a satisfactory lobotomy effect has been, in general, obtained. A cerebral localizer facilitates aiming the ultrasonic beam.

This report is abstracted from two technical papers by Dr. P. A. Lindstrom, Veterans Administration, Pittsburgh, Pa.

Automobile Reflection in VHF-TV

By J. C. GEIST
Electronics Engineer
Silver Spring, Md.

TELEVISION SIGNAL reflection from objects such as high buildings, water towers and aircraft is quite common. The resulting picture ghosts and airplane-flutter are well known. Reflections from railroad trains have also been observed. However, television-signal reflection difficulties directly traceable to automobile reflections are rare.

Such a situation was recently encountered in a television installa-

Car shown in location where reflection from car roof interfered with reception of channel 9 signals

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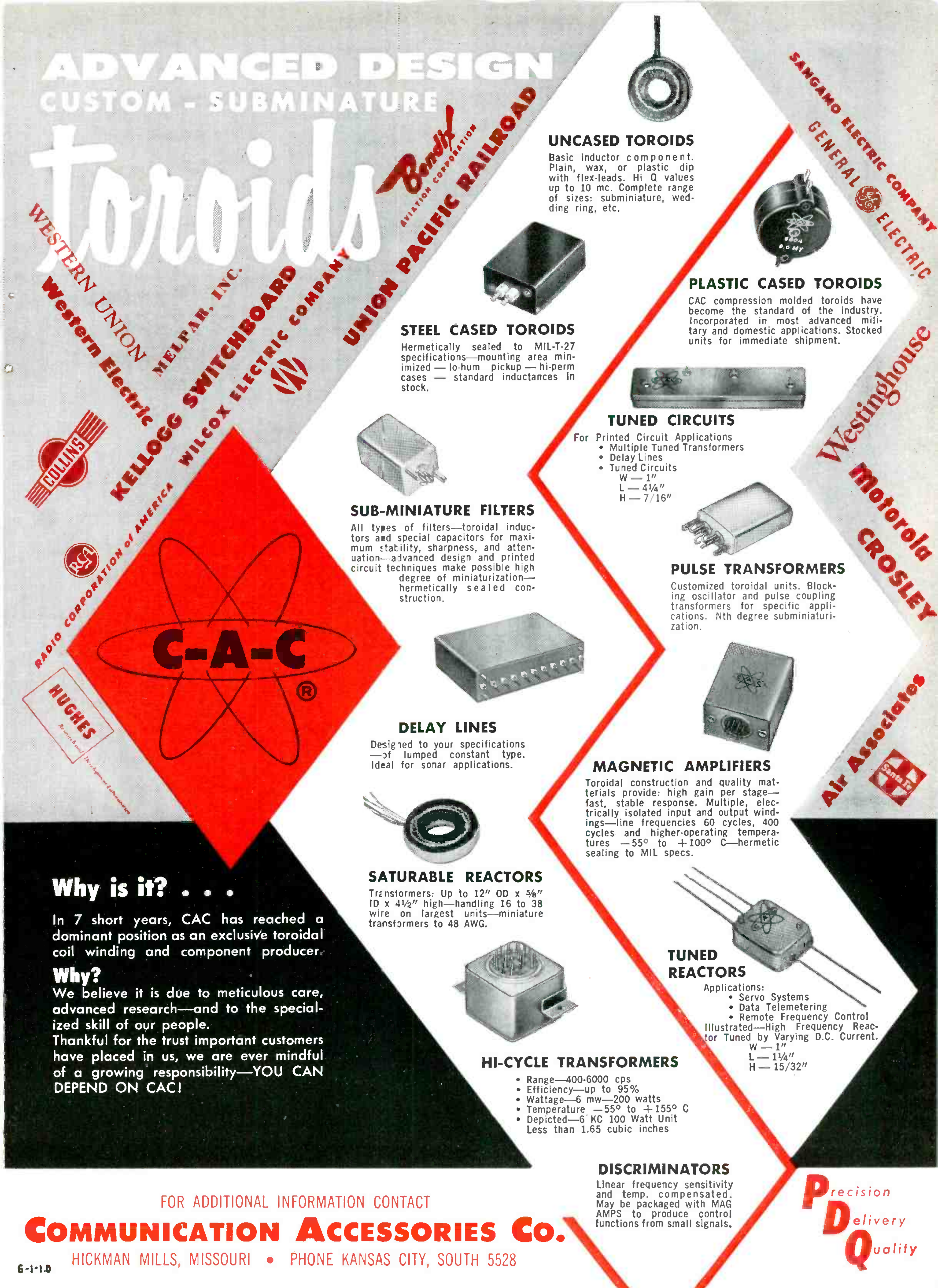
tion in a normally good receiving neighborhood. Local stations on channels 4 and 5, seven and ten miles distant respectively, were received well, but the antenna could not be oriented to receive local high-band stations on channels 7 and 9—both only about six miles from the receiving location.

Orientation for a good picture on either of these channels provided an unusable picture on the other even though the angular bearings to the two stations were within five degrees. The situation was further characterized by unusual high-band signal variations from day to day and sometimes even over a few hours. Not only did signal strength vary, but at times numerous ghosts and poor horizontal sync were evident. In the spring of the year, after determining that the receiver was operating properly by obtaining excellent operation in another location, it was decided to replace the antenna with one of a somewhat broader horizontal pattern and smaller side and rear lobe pattern. This new antenna gave excellent results. Throughout the summer and early fall all four local stations provided excellent picture quality.

In late October (when the trees had lost nearly all their leaves) poor reception was again reported; but this time all channels were degraded with only channel 4 being at all usable. Receiver performance was found to be at a generally low level. Again, after tube replacement and circuit alignment, excel-

VHF Direction Finder

Compact indicator suitable for small airports tunes vhf aircraft radio bands and furnishes bearings even when voice signals are unintelligible. Built by Olympic Radio and Television, Inc., it was described in technical article on p 184 of June 1955 issue of this magazine but without company designation



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Transformers: Up to 12″ OD x ⅝″ ID x 4½″ high—handling 16 to 38 wire on largest units—miniature transformers to 48 AWG.
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Applications:
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Illustrated—High Frequency Reactor Tuned by Varying D.C. Current.
W — 1″
L — 1¼″
H — 15/32″
HI-CYCLE TRANSFORMERS
• Range—400-6000 cps
• Efficiency—up to 95%
• Wattage—6 mw—200 watts
• Temperature —55° to +155° C
• Depicted—6 KC 100 Watt Unit Less than 1.65 cubic inches
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lent performance was obtained in another location. Good pictures were obtained on channels 4 and 5 but again the high-band channels were unsatisfactory.

Since there is a group of large trees about 150 to 200 feet from the antenna in the direction of the stations, difference in reception conditions between leafy trees and bare trees was considered as possibly contributing to the difficulty. Significant differences in summer and winter reception had not, however, been noted at other tv installations in the neighborhood.

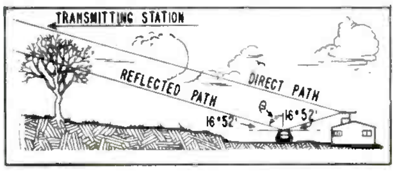

FIG. 1—Paths of direct and reflected television signals to receiving antenna

At this point the antenna installation was checked and reoriented. It was thought that a recent hurricane might have damaged or moved the antenna. No damage was found, but it was discovered that the original conditions again existed in which no antenna orientation could be found to provide satisfactory reception of both channels 7 and 9. Over a period of a few days it was found that the previous condition of widely varying high-band reception was also present. Reception on channel 9, particularly, varied widely from night to night and every automobile that passed the house seemed to affect the picture on channel 9.

Further investigation revealed that every car passing on the near side of the street caused a picture fluctuation similar to a short burst of airplane flutter. Those moving in the opposite direction on the far side of the street caused no picture variation. It was further found that an automobile parked directly in front of the antenna in an area extending from the curb to near the center of the street, and about one car length long would reflect the channel 9 signal in such a manner as to completely ruin its usefulness. The photograph shows an automobile parked in the critical location in front of the house. The chimney-mounted antenna is also

revolutionary ALUMINUM CORE BOX† *construction*

withstands HIGH TEMPERATURE • VACUUM IMPREGNATION
HEAVY WINDING STRESSES • SHOCK and VIBRATION

This is a development which calls for immediate changes in purchasing specifications for Tape Wound Cores, because introduction of the Aluminum Core Box means designing your toroids around four important new advantages:

1. Use of an aluminum core box means the new Magnetics, Inc. tape wound cores will withstand temperatures of *at least* 450° F.
2. Because of the unusual seal provided by forming the aluminum over the silicone glass seal, true vacuum impregnation of your coils is now possible. Varnish cannot penetrate the core box and affect magnetic properties of the tape.
3. The strong aluminum construction absolutely prevents deflection of the core box when coils are wound—a distortion-free construction which means no change of magnetic properties.
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Because of the many advantages of these new Magnetics, Inc. Tape Wound Cores, it will pay you many times over to specify "Aluminum Core Boxes" on your next order.

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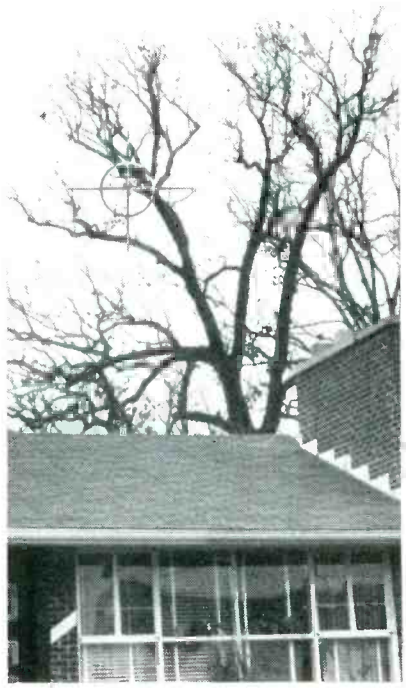
shown in the photograph.

While puzzling, this automobile reflection explained some of the extreme variations from one evening to the next, reception for a particular period depending on whether or not an automobile was left parked in the critical location. Consideration of elementary vhf propagation behavior at first added to the puzzle but finally offered a



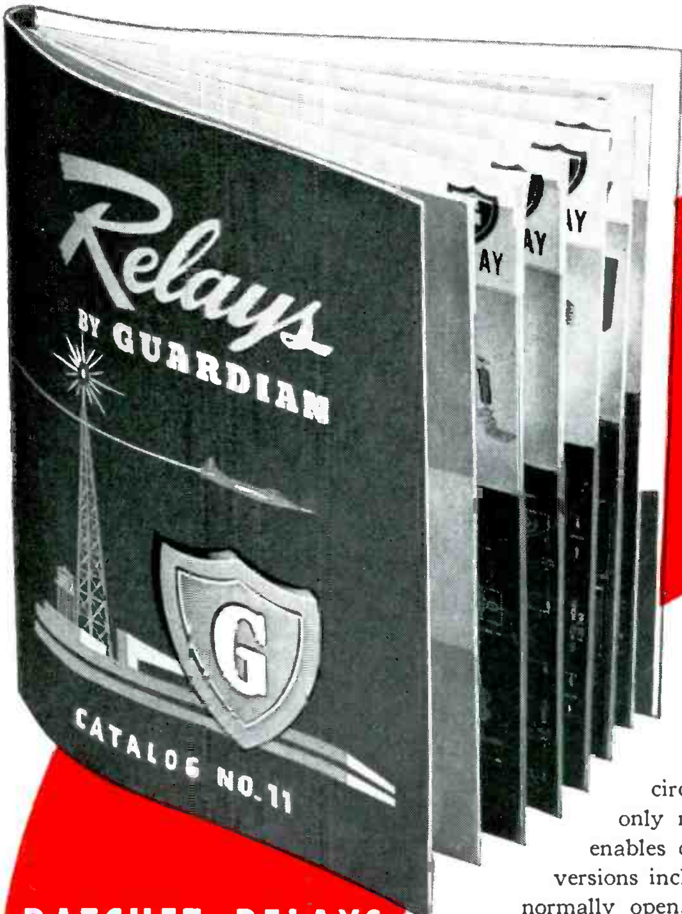
Sighting through surveyor's transit toward transmitting antenna showed tree branch acting as reflector of tv signal

clue to the phenomenon.

Figure 1 is the profile of an vhf communication path showing the direct and reflected path. In order for the angle of incidence to equal the angle of reflection, the point on the earth's surface at which reflection takes place must be approximately (depending on relative antenna heights) midway between the transmitting and receiving location. Reflection from an object close to the receiving antenna as in the present case would be at a large angle β.

A transit was set up directly in front of the antenna at car-top height on the angular bearing to the transmitter and pointed toward the receiving antenna. The instrument was then elevated until the cross hairs were centered on the forward end of the antenna sup-

reduce internal wiring—simplify the circuit!



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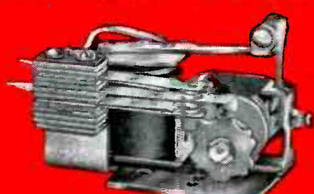
The GUARDIAN® 32 POLE SERIES 805 D. C. RELAY

The most flexible, dependable, long lasting unit for isolating circuits, this new Guardian Series 805 D.C. 32-pole Relay not only reduces the required amount of internal wiring, but also enables designers to simplify auxiliary control components. Three versions include: (a) 32-pole shorting relay; (b) 32-pole, single throw, normally open, 1½ amperes, non-inductive; (c) 32-pole, single throw, normally closed, 1½ amperes, non-inductive load. With contacts completely enclosed by an aluminum cover, unit is virtually dust-proof.

A fourth version, also 32-pole, however with *double throw* contact combination, is in the development stage now.

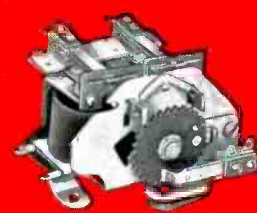
RATCHET RELAYS



GUARDIAN S-120

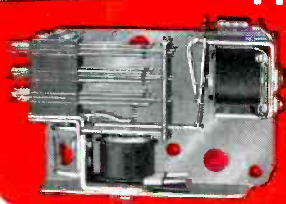
GUARDIAN S-520

STEPPERS



GUARDIAN MAS STEPPER

INTERLOCK RELAYS



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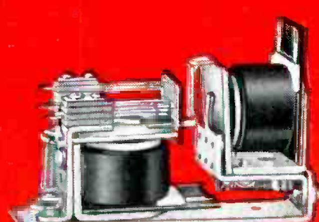

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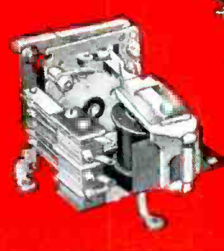
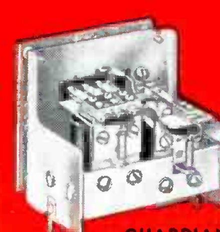


GUARDIAN M-120 STEPPER



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port rod. The elevation angle to this point was 16 deg 52 minutes as shown.

The transit was then rotated through a horizontal angle of 180 deg keeping the previous elevation angle fixed. The instrument was then on the same angular bearing, and pointed toward the transmitting station. An observation through the transit in this position showed the cross hairs to be resting on a clump of branches on a tree about 150 feet away. The line-of-sight of this transit shot is shown in the photograph. The position of the transit cross-hairs is indicated.

The information obtained with the transit provides a basis for an explanation of the reflection mechanism. Evidently during the summer the leaf-covered tree in the signal path, while causing some signal attenuation, did not constitute sharply defined reflecting surfaces. This probably explains why the new antenna installed in the spring of the year provided satisfactory operation until the next fall.

However, without the leaves, the branches of the tree act as sharply defined objects. In this particular case, a branch acting as a good reflector for the frequency of channel 9 happens to be in just the correct geometrical relation to reflect the signal downward to be re-reflected

Private Flyer Tacan

Production of a civilian version of military tactical air navigation transmitter-receiver is scheduled to start in October if the system is finally adopted for civil airways. The mechanical mockup shown above was built by Federal Telecommunication Labs., in Nutley, N. J. Tacan provides both distance and bearing information from appropriate beacons located on the ground (or on an aircraft carrier)

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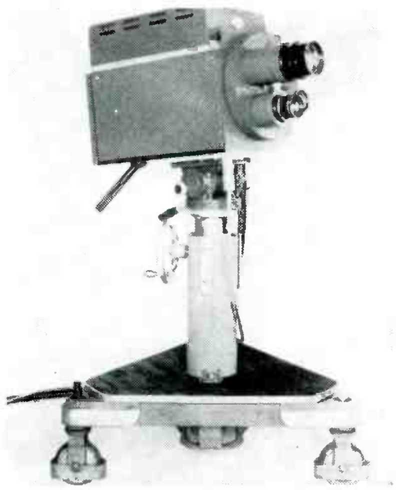
from the automobile metal body.

The solution to this problem was to move the antenna out of the path of the reflected signal. Moving the antenna about 35 feet to the other side of the house provided a signal path that did not pass through the tree. With this new location good pictures were obtained on all four local channels, and the automobile reflection was completely eliminated.

Reverse TV Program Pickup

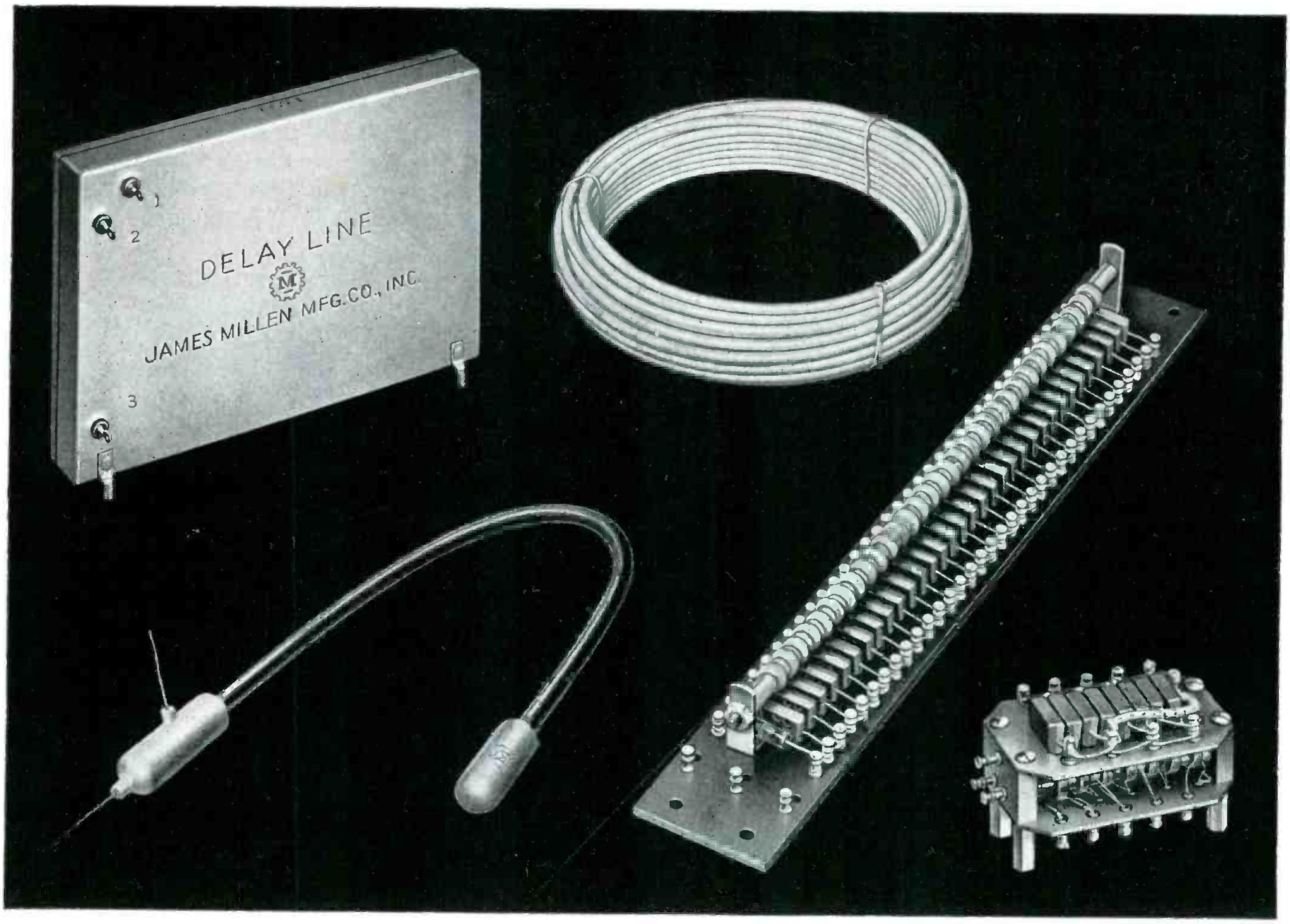
CONVENTIONAL television uses an illuminated scene and, by means of a camera tube and associated sweep circuits, electronically scans the image to produce standard television picture signals. For color tv, three cameras, or the equivalent thereof, are necessary.



Mobile light source generates a scanning beam that is directed towards the scene to be televised

In the Vitascan system proposed by Allen B. Du Mont Laboratories, Inc., a dark scene is scanned by a moving light and that which is reflected is picked up by a multiplier phototube. Since the system may have its greatest use in color tv, groups of four phototubes are provided with color filters. The primary source of illumination has a lesser red component than blue and green, so two tubes in each group are used for red pickup.

The pulsed light source, aimed like a camera, is a flying-spot cathode-ray tube. Light from the



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Millen distributed constant line is available as bulk line for laboratory use and in either flexible or metallic hermetically sealed units adjusted to exact time delay for use in production equipment. Lump constant delay networks may be preferred for some specialized applications and can be furnished in open or hermetically sealed construction. The above illustrates several typical lines of both types. Our engineers are available to assist you in your delay line problems.

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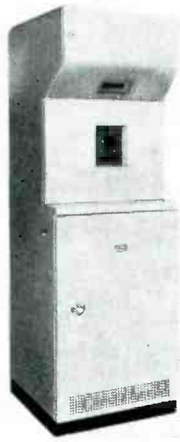
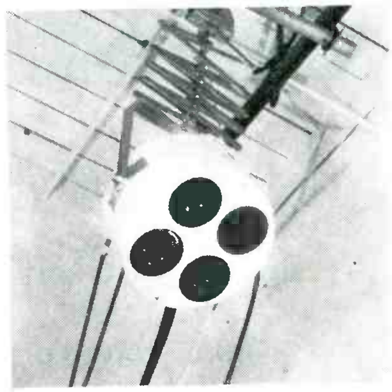
tube is directed by mirror and lens onto the scene being televised.

Electrical signals from the separate phototubes pass to conventional color transmitting equipment. Because the light source has already performed the scanning function,



Stationary light source for Du Mont Vitascan system. Upper part of cabinet houses equipment for scanning transparencies with the same flying-spot scanner



Multiplier phototube cluster picks up reflected light from objects hit by scanning beam. Two tubes have red filters; others pick up green and blue

before the reflected light is picked up in the color-filtered phototubes, there is no problem of color registration.

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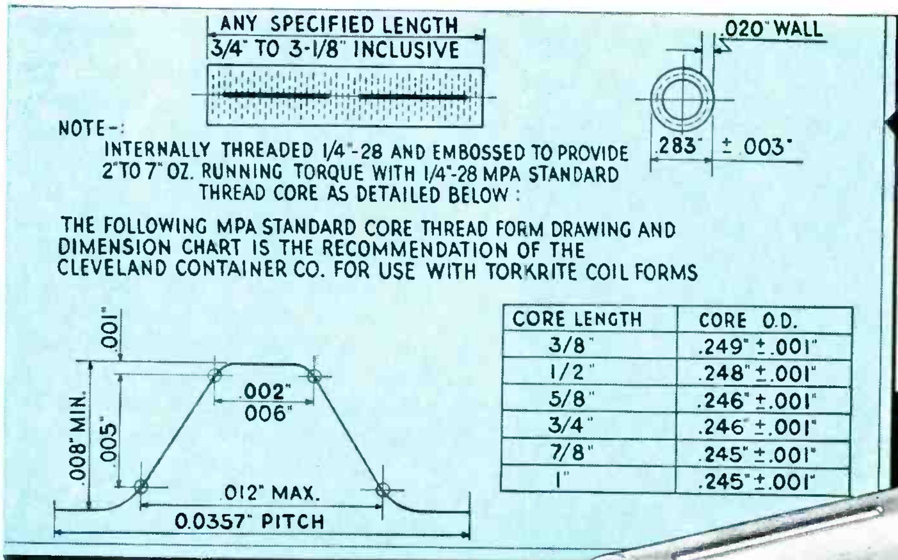

CORE LENGTH	CORE O.D.
3/8"	.249" ± .001"
1/2"	.248" ± .001"
5/8"	.246" ± .001"
3/4"	.246" ± .001"
7/8"	.245" ± .001"
1"	.245" ± .001"

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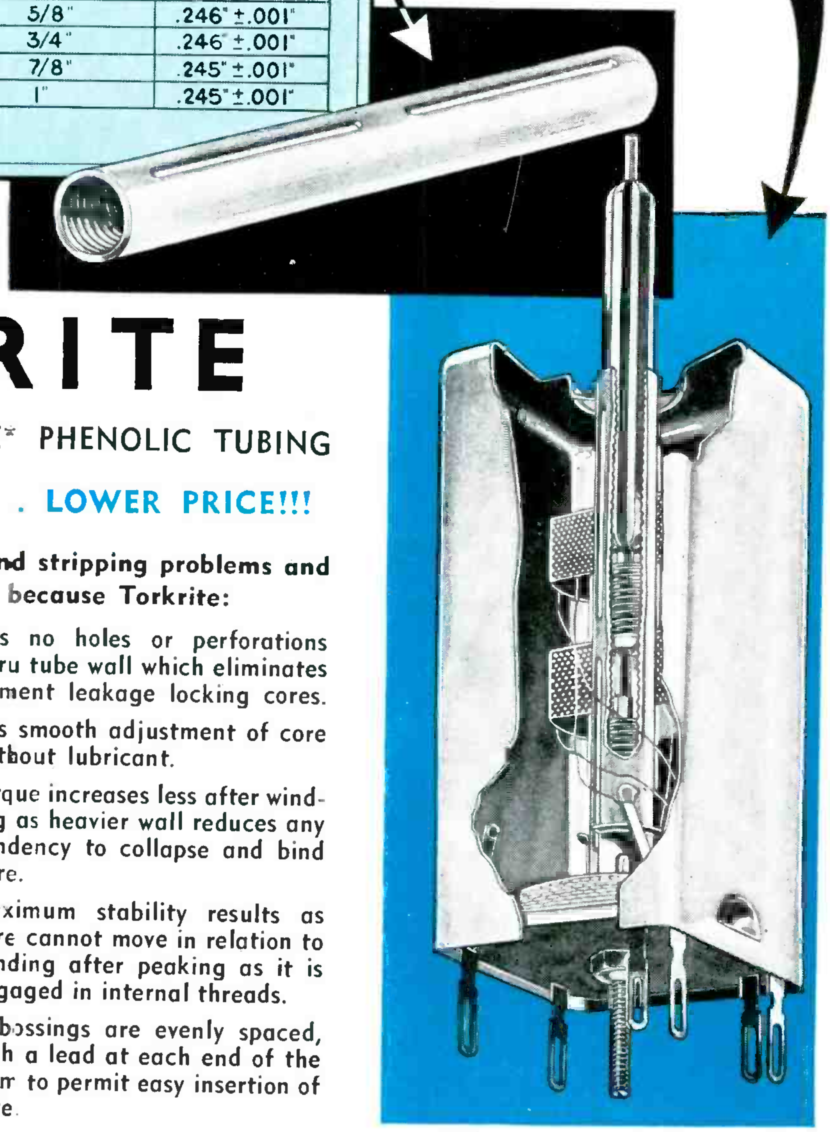

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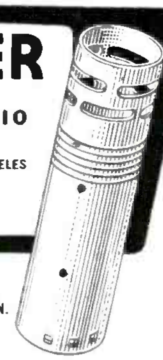

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the retrace blanking interval for the scanning beam. Illumination is synchronized with the scanning and recurs sixty times a second. At such a recurrence rate, the eye, owing to the phenomenon of persistence of vision, sees this stroboscopic flash as a continuous light.

Different camera shots may be obtained by providing one or more mobile scanning sources in addition to the stationary source used in the basic system. Additional clusters of phototubes can be located appropriately to catch the reflected light from the alternative source.

Equipment Reliability

OF HIGH IMPORTANCE to military users is a knowledge of how reliable vital electronic equipment may be and why. Reliability of industrial or communications equipment is likewise important, grading from operations that affect the safety of life or property down to a degree of annoyance or commercial rejection.

A preliminary study performed by Aeronautical Radio, Inc. (commonly denominated Arinc) entitled "Electronic Equipment Reliability As Affected by Electron Tubes" has recently been issued, copies of which may be obtained by qualified agencies from Arinc at 1520 New Hampshire Ave., N. W., Washington 6, D. C.

The report draws upon data from several military bases as well as information from four commercial airlines. Seven types of equipment

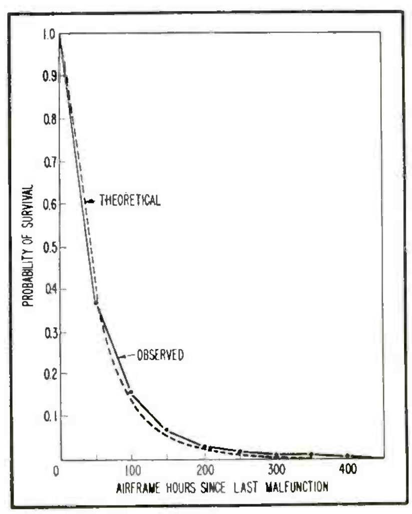
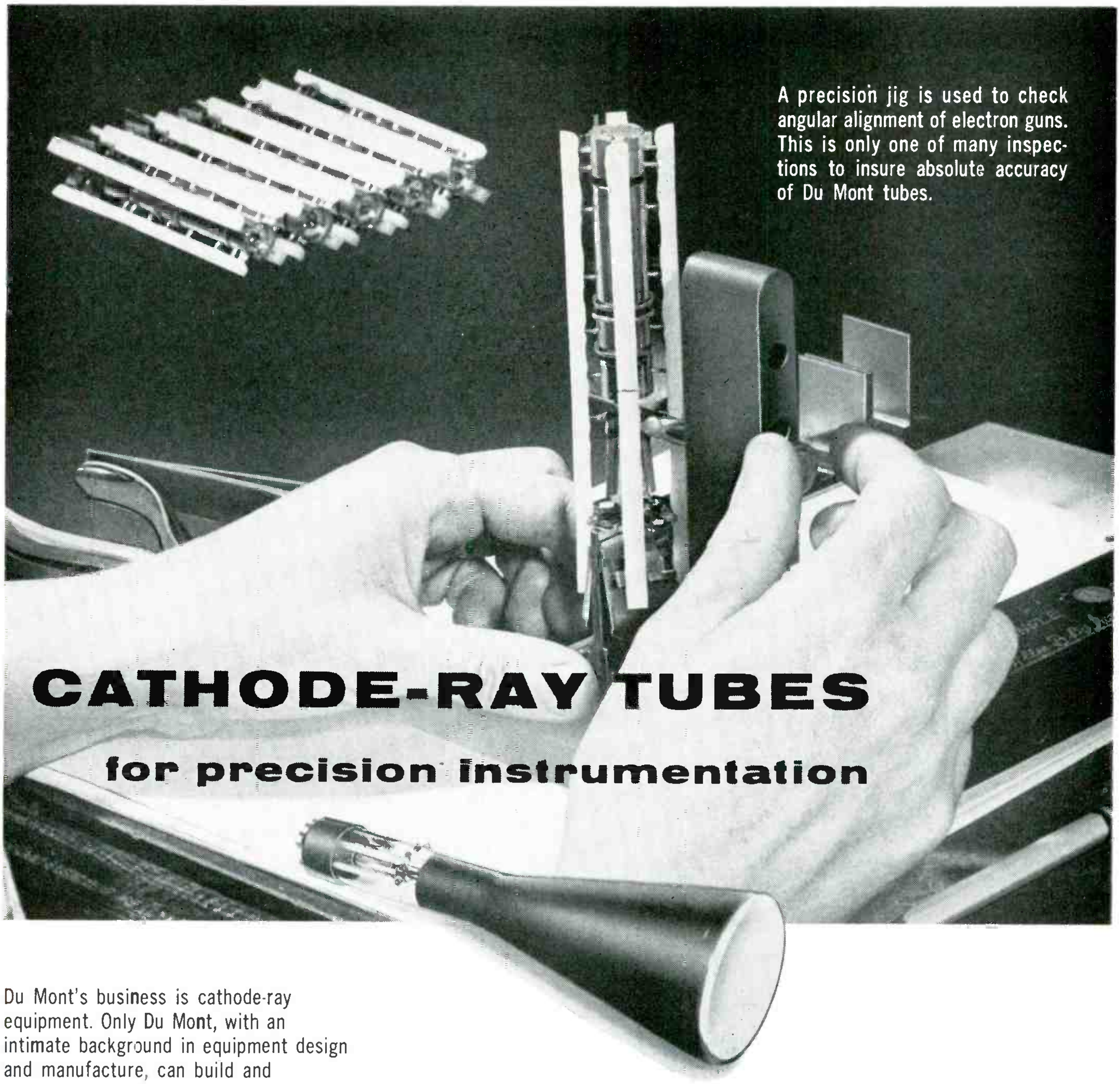


FIG. 1—Theoretical and observed reliability of airborne equipments



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Cathode-ray Tubes

TYPE	DEFLECTION FACTOR*		DEFLECTION UNIFORMITY	LINE WIDTH*	ANGULAR ALIGNMENT BETWEEN PLATES	P1 LIGHT OUTPUT*
	D1 D2	D3 D4				
3JP-A	150 dcv/in	111 dcv/in	3%	.03" max.	90° ± 1°	25 ft. L. Min.
3WP-	69 dcv/in	47.5 dcv/in	2%	.026" max.	90° ± 1°	7 ft. L. Min.
5ADP-	45 dcv/in	35 dcv/in	2%	.03" max.	90° ± 1°	15 ft. L. Min.
5AMP-	45 dcv/in	22.5 dcv/in	1%	.032" max.	90° ± 1°	15 ft. L. Min.
5AQP-	45 dcv/in	35 dcv/in	1%	.030" max.	90° ± 1°	15 ft. L. Min.
5ARP-	dual beam mono-accelerator — each gun equivalent to Type 5AQP — (see above)					
5ATP-	104 dcv/in	38 dcv/in	1%	.035" max.	90° ± 1°	170 ft. L. Min.

*Under typical operating conditions (7-inch versions of the five inch tubes will be considered on request.)

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are covered in this report.

Reliability criteria have been converted to mathematical terms that are based upon the time between equipment malfunctions. In general, equipments seem to attain a stability of the probability of malfunction at an early stage and thereafter show an exponential distribution for time between malfunctions.

This effect is illustrated in the figures. In Fig. 1 is shown the behavior of a type of 55-tube airborne equipment based at a particular airfield where it remained in service until malfunction occurred. Another type of ground equipment at another location uses 19 tubes. Its reliability function is shown in Fig. 2. Periodic overhaul and preventive maintenance are frequently performed upon it thus considerably changing the curve compared to Fig. 1.—A. A. McK.

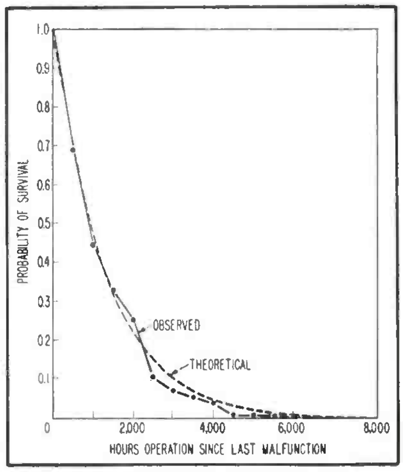

FIG. 2—Theoretical curve fitted to observed reliability of ground equipments

Feedback Clamp Circuit for TV

By K. R. Wendt and W. K. Squires

*Sylvania Electric Products Co.
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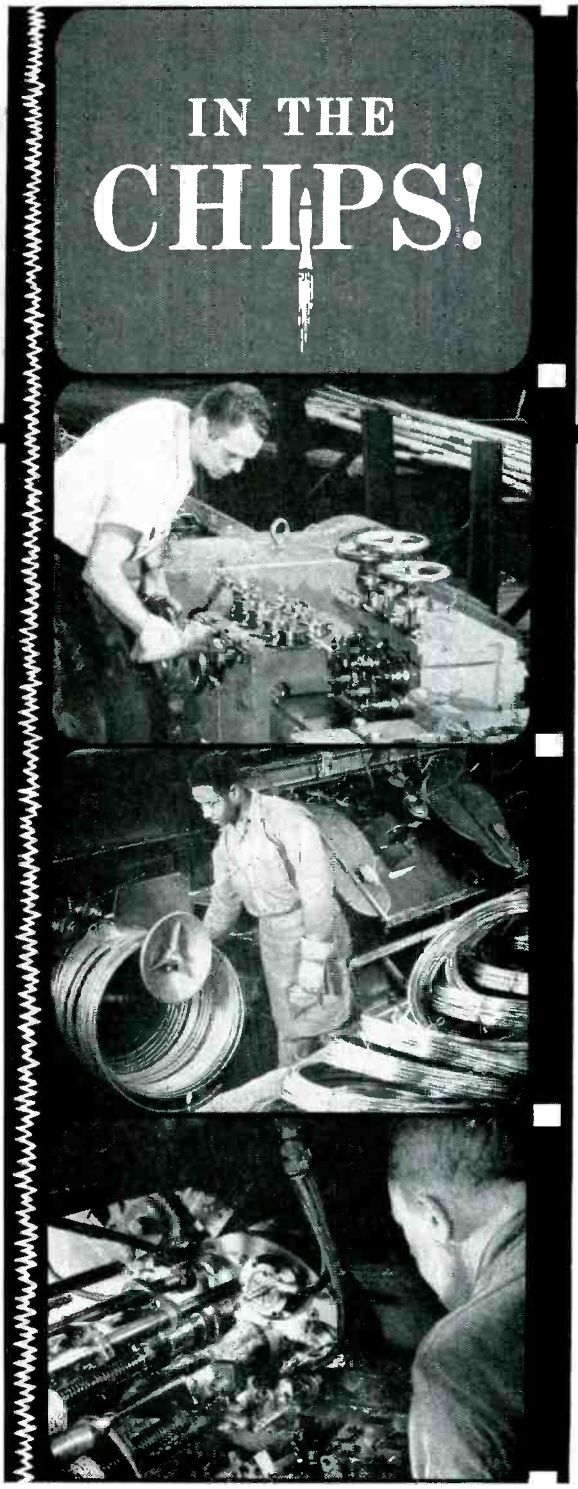
Buffalo, N. Y.*

Clamp circuits, are used for restoration of the d-c component, correction of low-frequency errors such as tilt and reduction or elimination of low-frequency noise, microphonics and switching transients. All of these operations are quite similar and involve comparison of the video signal to some



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constant reference during horizontal blanking time.

The operation of double-diode keyed clamps has been described in the literature[1]. While the circuit permits considerable correction of video signal faults, it has several definite weaknesses. The circuit applies all of the required correction at the time the clamp is keyed, so that the corrections appear as abrupt steps in the video output.

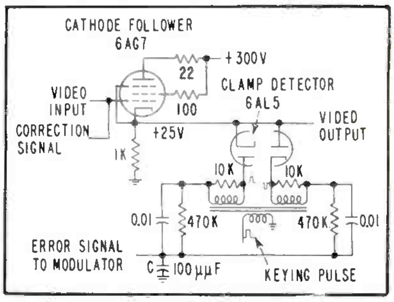

FIG. 1—Diode clamp detector operates from low-impedance source minimizing effect of unbalance between diodes

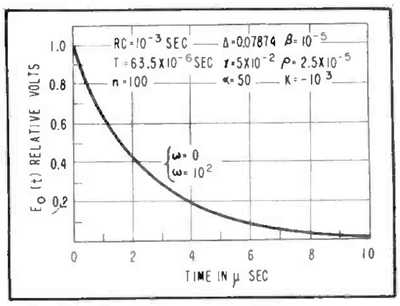

FIG. 2—Response of clamp circuit to cosinusoidal input

The time-constant of the circuit must be short if accurate or complete correction is to be made, but the use of a short time-constant makes the circuit highly susceptible to noise. Also, in most stabilizing-amplifier clamp circuits the keying pulse is obtained by shaping of the incoming sync signal with the result that slight errors in pulse timing cause substantial errors in clamp operation.

The circuit shown in Fig. 1 overcomes most of the difficulties of the conventional keyed clamp through the use of a feedback system. The double-diode circuit itself applies no correction, but only measures the error in the video signal. This error is amplified and subtracted from the video signal to provide correction. This ap-

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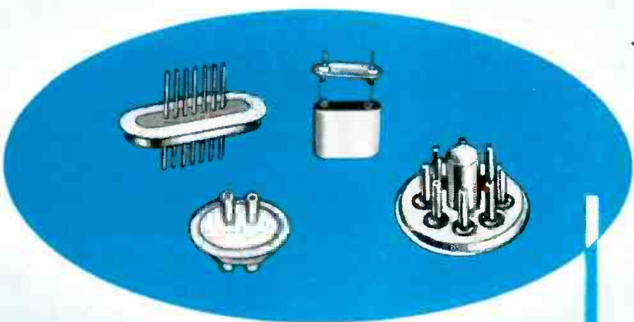

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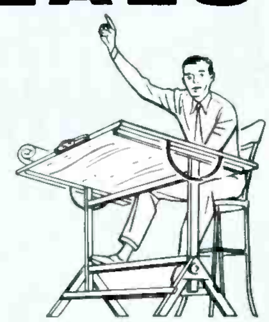

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Division of Amperex Electronics Corporation • 44 SUMMER AVENUE, NEWARK 4, NEW JERSEY proach permits a short time-constant for the sampling clamp circuit, while the time-constants of the feedback-loop amplifier can be such that integration of the error signal results. Consequently, noise susceptibility is reduced and the correction, rather than appearing in abrupt steps, is applied slowly and smoothly.

The response of the circuit to a step function is of particular interest as this will be essentially the response to a switching transient and will also give the response envelope for hum and noise. This is shown in Fig. 2. For the constants chosen the error is reduced to 12.5 percent in 5 microseconds. The error is essentially well before the end of a scanning line. Although the feedback gain was made 10^3, no tendency toward oscillation or overshoot is observed.

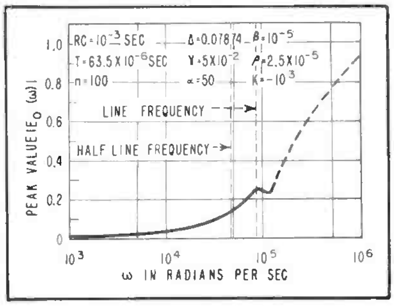
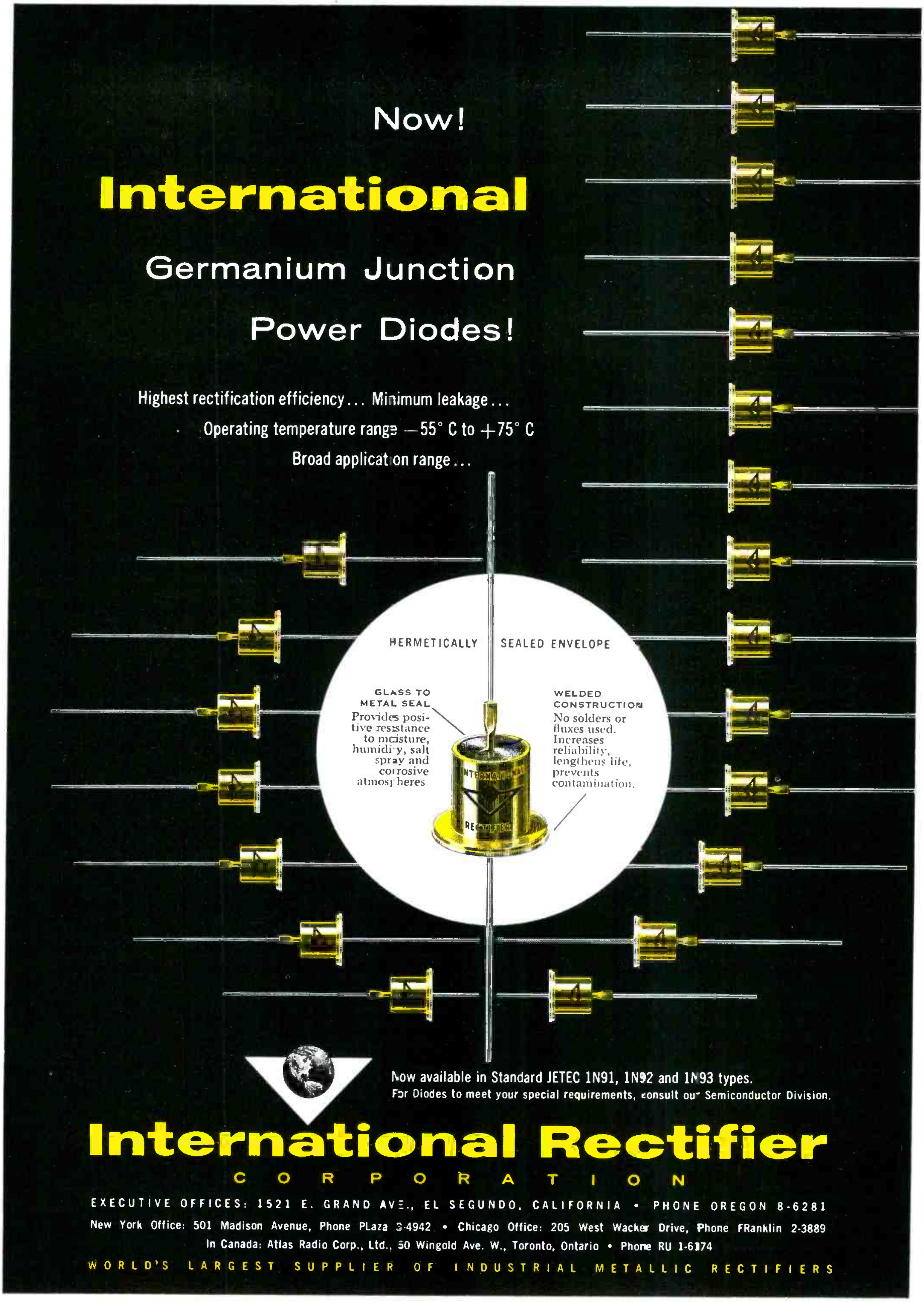


FIG. 3—Clamp circuit response to cosinusoidal signal after initial transient

By applying a cosinusoidal input of variable frequency the plot of Fig. 3 is obtained. This curve gives the fractional output for inputs such as hum and microphonics. As the frequency increases, the correction of such errors decreases. The correction is virtually complete to a frequency of about 1,500 cps. At line frequency and at half line frequency a discontinuity occurs because of the sampling action of the keyed clamp. The latter discontinuity is practically zero width on this curve and so does not show.

The double-diode keyed clamp is placed across a cathode-follower output as an error detector as shown in Fig. 1. A voltage equal to the error in the video signal is developed across C. Unlike conventional clamp circuits, this clamp operates from a low-impedance source of about 100 ohms; as a re-



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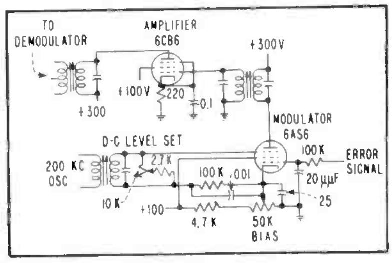


FIG. 4—Carrier-type modulator and amplifier used with clamp circuit

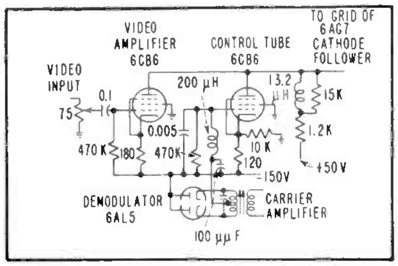


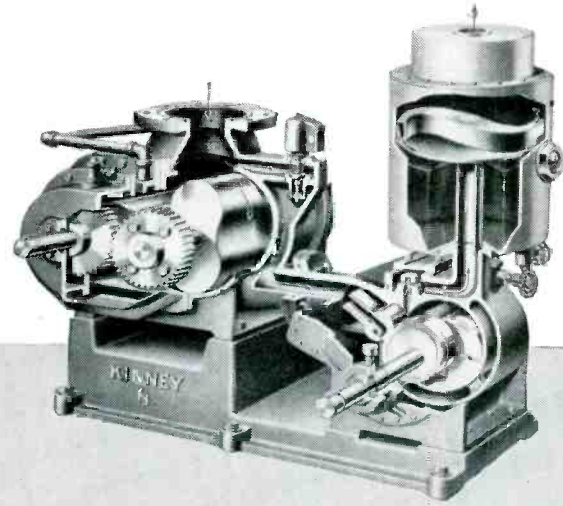
FIG. 5—Demodulator and control tube circuit

sult, if there is any unbalance between the two diodes or the pulses keying them, very little of the unbalance pulse voltage will appear in the video output.

As it is necessary to amplify the direct voltage across *C* and apply it to the grid of the cathode follower even though the two points are at practically the same direct voltage, a carrier-type d-c amplifier was used. The circuit of the carrier modulator and amplifier is shown in Fig. 4. A 6AS6 with a 200-kc carrier applied to the suppressor and the error signal applied to the control grid was used as modulator. One stage of 200-kc amplification was employed. The R-C integrator in the control-grid circuit of the 6AS6 was necessary to reduce the pulse feedthrough from the clamp circuit. The d-c reference level for the system is determined by the amplitude of the suppressor voltage.

The remainder of the circuit is shown in Fig. 5. A 6AL5 is used to demodulate the carrier. The demodulator output is applied to the 6CB6 control tube to complete the feedback loop. The integration time constants are almost entirely determined by the demodulator filter, although the carrier-amplifier bandwidth sets a lower limit at about 0.1 millisecond.

To avoid errors in pulse timing and to permit placing the keying pulse at any point during blanking,



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Model KS-13	½ HP Single Stage Simplex Pump	13.0 CFM
Model KS-27	1½ HP Single Stage Simplex Pump	27.0 CFM
Model KS-47	2 HP Single Stage Simplex Pump	46.8 CFM
Model KDH-130	5 HP Single Stage Duplex Pump	131 CFM
Model KD-220	10 HP Single Stage Duplex Pump	218 CFM
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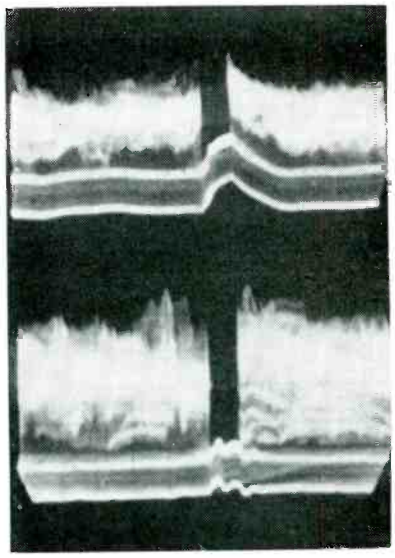


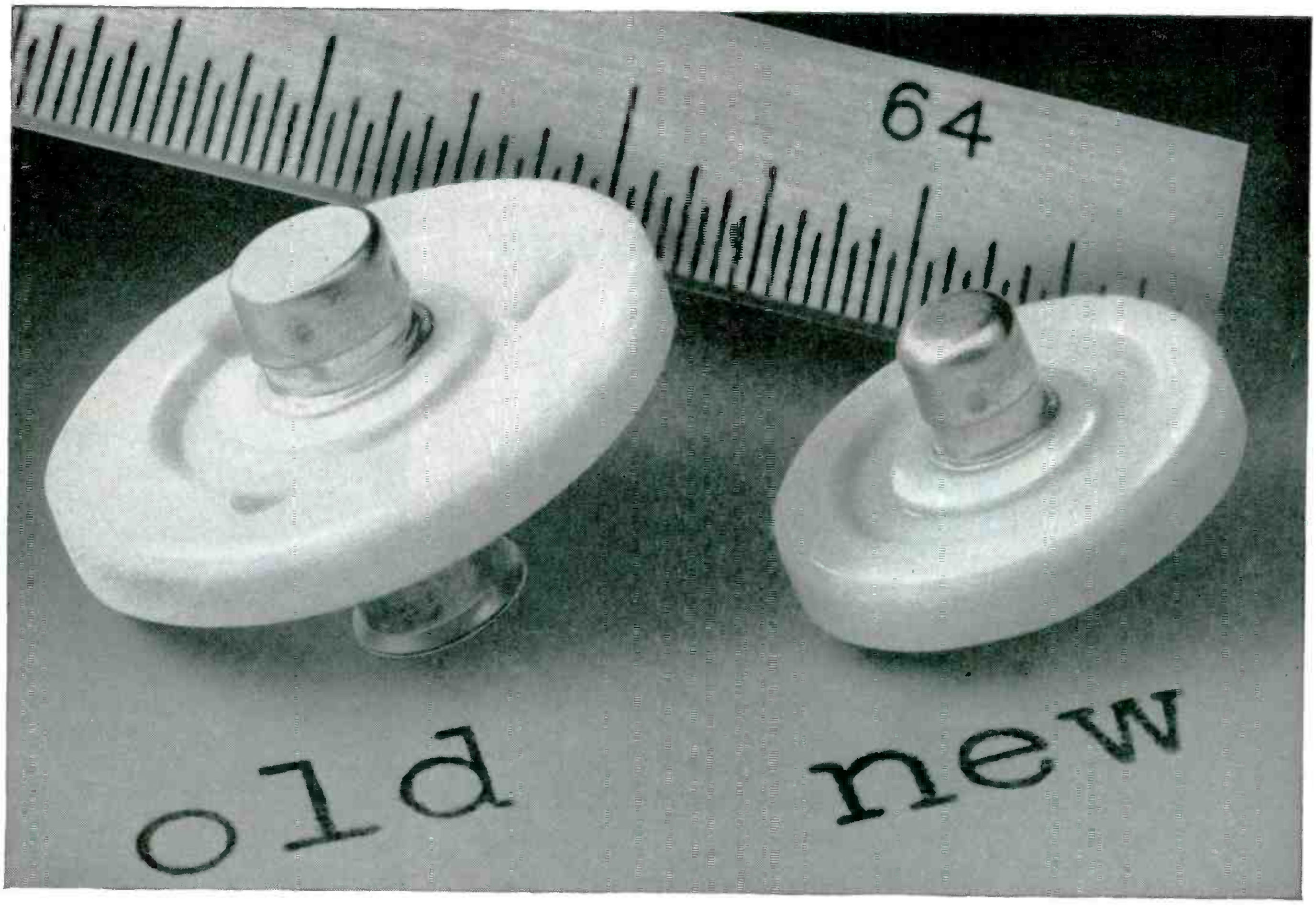
FIG. 6—Input and output signals for a video signal deficient in low frequencies

an afc circuit was used to generate the local keying pulses. A sync separator was operated directly from the cathode follower and the separated sync applied to an afc circuit. The output from the afc circuit was used to trigger a fast multivibrator to produce one to two microsecond keying pulses. The use of afc completely eliminates all vertical information from the keying pulses as well as providing excellent noise immunity.

To avoid producing an incorrect error signal during the vertical sync period, it is necessary to place the keying pulse on the first half of the horizontal sync pulse. No difficulty then occurs with the doubles during vertical sync. Because of this strict requirement on timing and the existence of two feedback loops, one in the clamp and one in the afc, the circuit must be adjusted much like keyed agc. The output signal is poor until the timing is adjusted to the correct point, when the output settles down to a clean signal. Once adjusted, the hold-in characteristics result in stable operation over as much as 15 db variation in input amplitude.

Figure 6 shows input and output voltages for an input signal highly deficient in lows. The only limitation on the amount of correction attainable is the linear dynamic range of the feedback system, particularly the modulator.

Figures 7A and 7B show the in-



New miniature disc cathode shank diameter and length are reduced by approximately 25% from the previous model. Ceramic also is about 25% smaller. Concentric groove in ceramic inhibits leakage from sublimation deposits. Magnification 8x.

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Think what this means: Tri-gun color TV tubes can have more slender necks. So also can multi-gun special purpose cathode ray tubes. Cost can be saved in the glass, the base, and the socket. Even single gun tubes can benefit. Less metal and ceramic means a lower heater power requirement.

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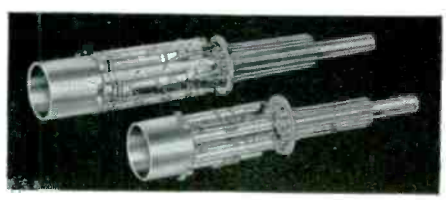

Size Comparison of Color TV Guns. Note how much more compact gun can be with miniature disc cathodes. Permits more slender tube neck.

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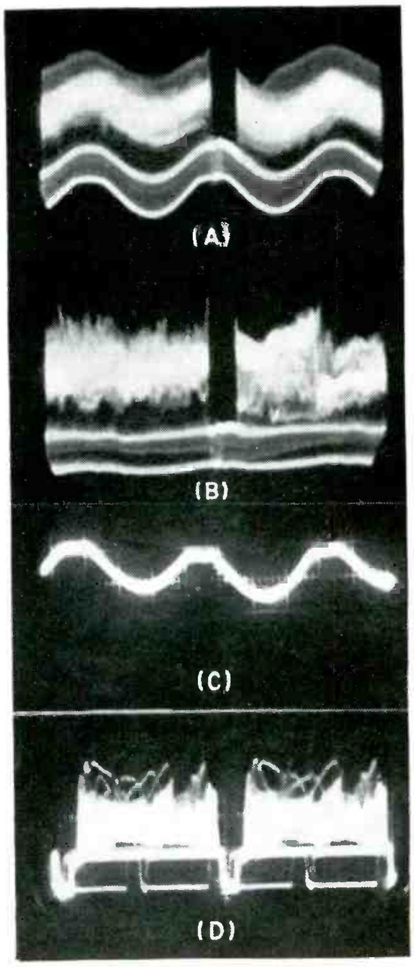


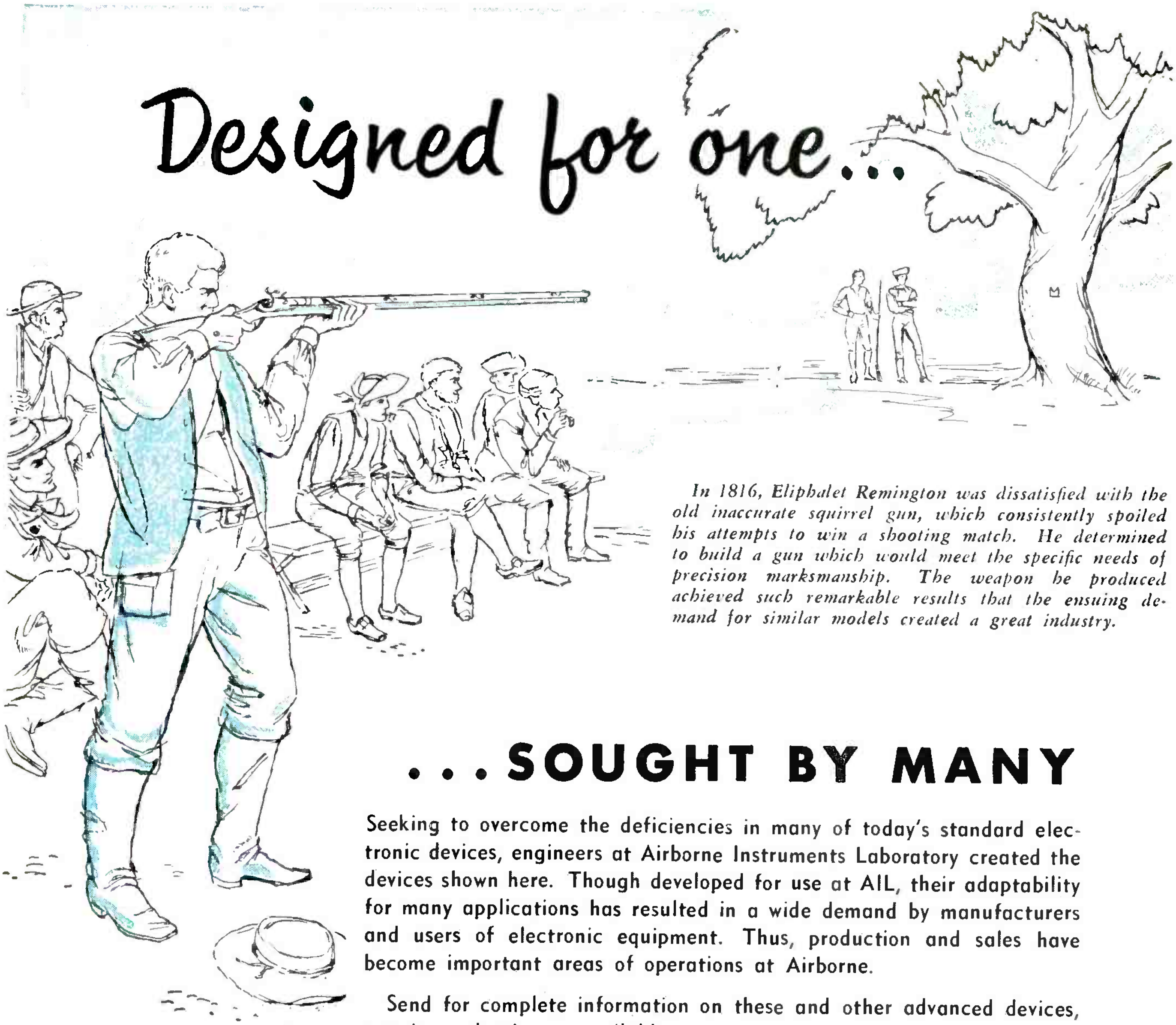
FIG. 7—Input (A) and output (B) signals for video signal with 20-percent sinusoidal voltage added. Error voltage (C) and waveform at 6AG7 cathode (D) are shown for the same condition

put and output voltages for an input video signal with 20-percent sinusoidal voltage at 150 cps added. The sinusoidal variation is reduced to about 2 percent, which checks well with the theoretical circuit performance, considering that the practical circuit falls somewhat short of ideal.

Figure 7C shows the error signal in the feedback loop. The error voltage is not perfectly linear; improving the modulation and demodulation linearity is one avenue of improvement for further practical circuits. The video waveform at the 6AG7 cathode is shown in Fig. 7D. The oscilloscope sweep is about 100 microseconds. The unbalance and capacitance leakage of the clamp permits some of the keying pulse to appear. On close inspection, the pulse can be seen at the top, first-half of sync.

Some variations of the circuit operation are possible. By remov-

Designed for one...



In 1816, Eliphalet Remington was dissatisfied with the old inaccurate squirrel gun, which consistently spoiled his attempts to win a shooting match. He determined to build a gun which would meet the specific needs of precision marksmanship. The weapon he produced achieved such remarkable results that the ensuing demand for similar models created a great industry.

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ing the color burst from the back porch, the keying pulse could be placed there so that d-c would be set at black level rather than sync tips, consequently aiding sync stretching operations. To avoid misinformation during vertical, the vertical sync could be keyed out. A local color subcarrier source would then be synchronized with the incoming burst and a new color sync burst keyed into the video output. As an alternative the keying pulse could be placed on the back-porch so that no change would be made in the burst waveform except for its d-c level.

The authors wish to express their appreciation of the assistance given by L. H. Hardy on the preparation of this paper.

REFERENCE

(1) K. R. Wendt, Television D.C. Component, *RCA Rev*, Mar. 1948.

Geodimeter Determines Precise Baselines

SURVEYING of land areas has gone on since early time with increasing improvements towards greater accuracy. A need for quick and accurate base lines without the necessity of clearing areas, leveling and making several measurements with tapes has resulted in the development of a new instrument.

Developed by Erik Bergstrand, a Swedish geodesist, and manufactured by AGA Gasaccumulator Co. of Stockholm, Sweden, the geodimeter utilizing optical and electronic techniques has been undergoing tests by the Army Corps of Engineers.

Basis of the instrument is the Fizeau method for determining the velocity of light. As shown in Fig. 1, if the tooth and space dimensions, wheel rotation speed and distance from wheel to mirror are known,

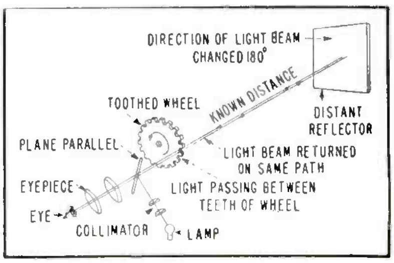

FIG. 1—Fizeau's toothed wheel for measuring speed of light

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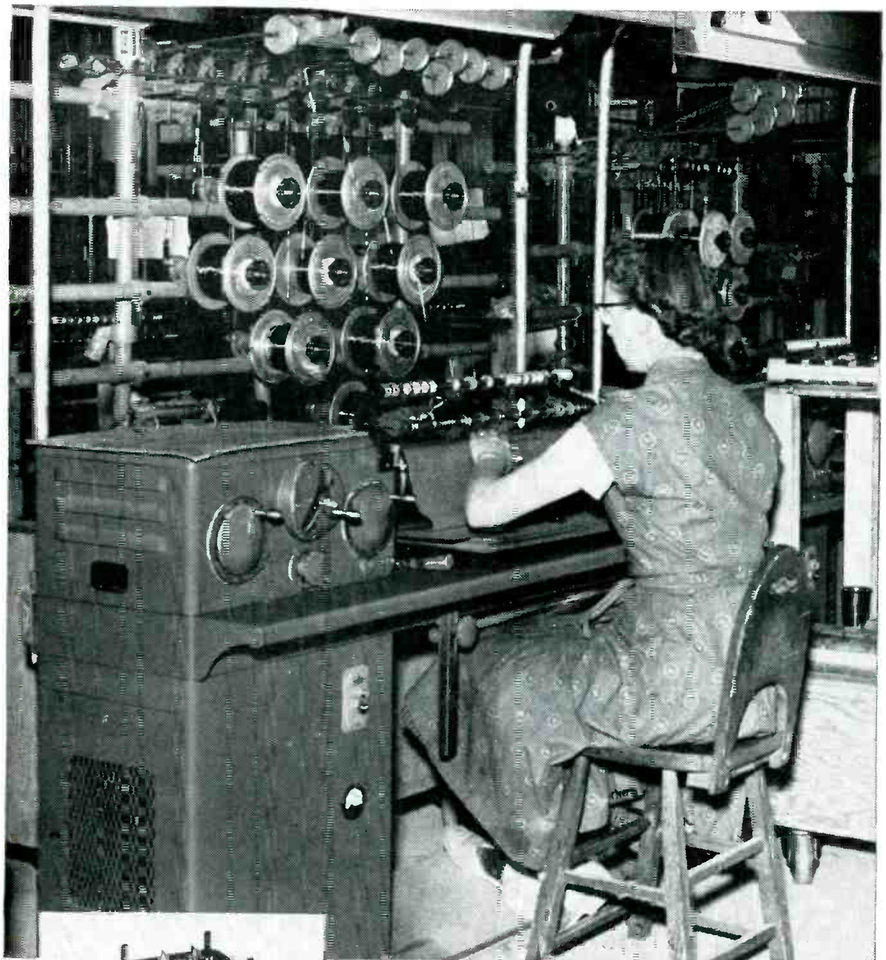

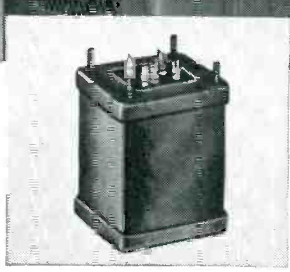

One Of The Leesona No. 108 Hand-Feed Coil Winders installed by the Freed Transformer Company of Brooklyn, N. Y. Note the convenient location of controls for quick set-up change. Many other features make this the fastest, easiest to operate, most advanced hand-feed coil winder ever designed. Inset shows a Hi-Fidelity Transformer, a typical Freed component in which precision-wound coil structures are vital to high performance and reliability.

At the Freed Transformer Company, well known manufacturers of electronics components, Leesona No. 108 Hand-Feed Coil Winders have replaced obsolete winding equipment. Here's what the president of Freed reports about the new installation:

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the velocity of light can be computed by observing the wheel rotation speed when the reflex appears bright or dark.

The gross outlines of the geodimeter are shown in Fig. 2, wherein Fizeau's toothed wheel is replaced by a Kerr cell modulated at 10 mc and two crossed polarizers. Whereas the human eye observed the reflection in the early experiment, a multiplier phototube is used in the geodimeter.

Distance measurement by radar depends upon measurement of time lapse between transmission and reception of a pulse. Similarly, distance determined with the geodimeter depends upon accurate measurement employing a phase-comparison technique.

The high-frequency signal that modulates the light wave passes through an electrical delay line that can be continuously adjusted to provide the same time delay that the modulated light encounters in its trip between the instrument and the remote reflector.

When the electrical delay has been properly adjusted, the null detector indicates a zero meter reading. Calibration of the electrical delay is accomplished positively by means of a built-in continuously variable light path, indicated in the diagram. A distance comparable to that under measurement is not required in the variable light-delay

Continuous Weather Map Recorder

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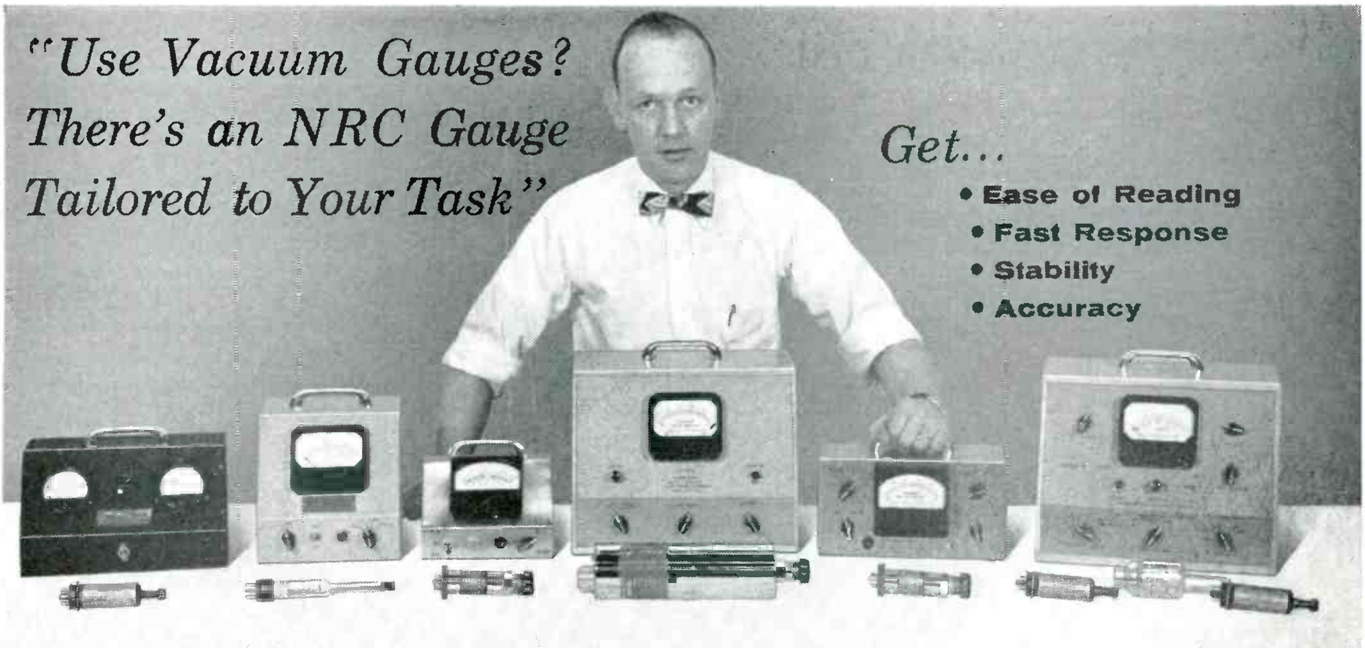

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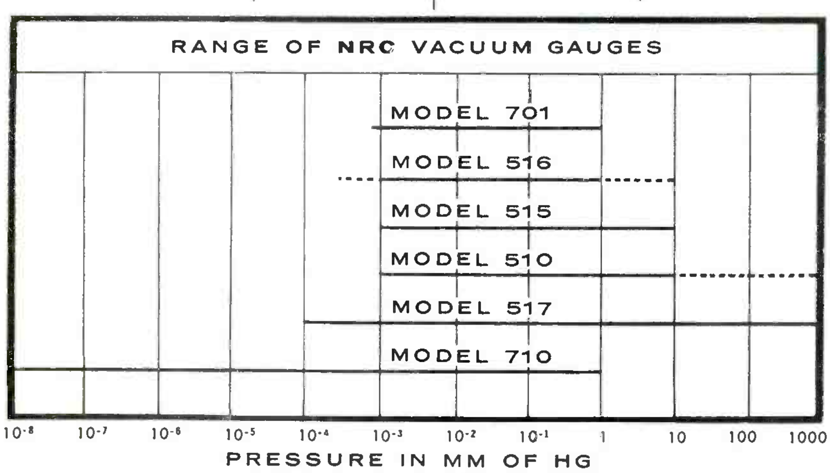

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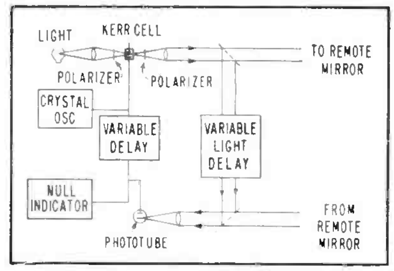

FIG. 2—Diagram shows use of the Kerr cell shutter and variable delay units

path because the light modulation is continuous. The requirement is merely for a line slightly longer than a quarter wavelength of the modulating frequency—7.5 meters.

Although this system has great accuracy, there is ambiguity unless the approximate distance is known within ±7.5 meters. However, a second frequency of 10.1 mc is likewise used and a vernier effect is obtained in space such that the distance need only be known initially to ±750 meters or about ± a half mile. Knowledge of distance to the nearest mile is generally available from the roughest maps, so this does not constitute a limitation on the usefulness of the geodimeter.

Because measurements are made in the atmosphere with changing conditions of temperature, pressure and humidity, the new instrument does not realize its inherent accuracy. Measurements conducted thus far have a probable error ranging from 1/500,000 to 1/4,000,000. This material has been abstracted from a report by Milton E. Compton, Jr., Engineer Research and Development Laboratories, Ft. Belvoir, Va.

PERTINENT PATENTS

By NORMAN L. CHALFIN
Hughes Aircraft Co.
Culver City, Calif.

ABSTRACTS published this month include a method of inserting beep tone to warn that a telephone conversation is being recorded, a development looking toward flat tv tubes and two low-drift d-c amplifiers.

Beep Tone Generator

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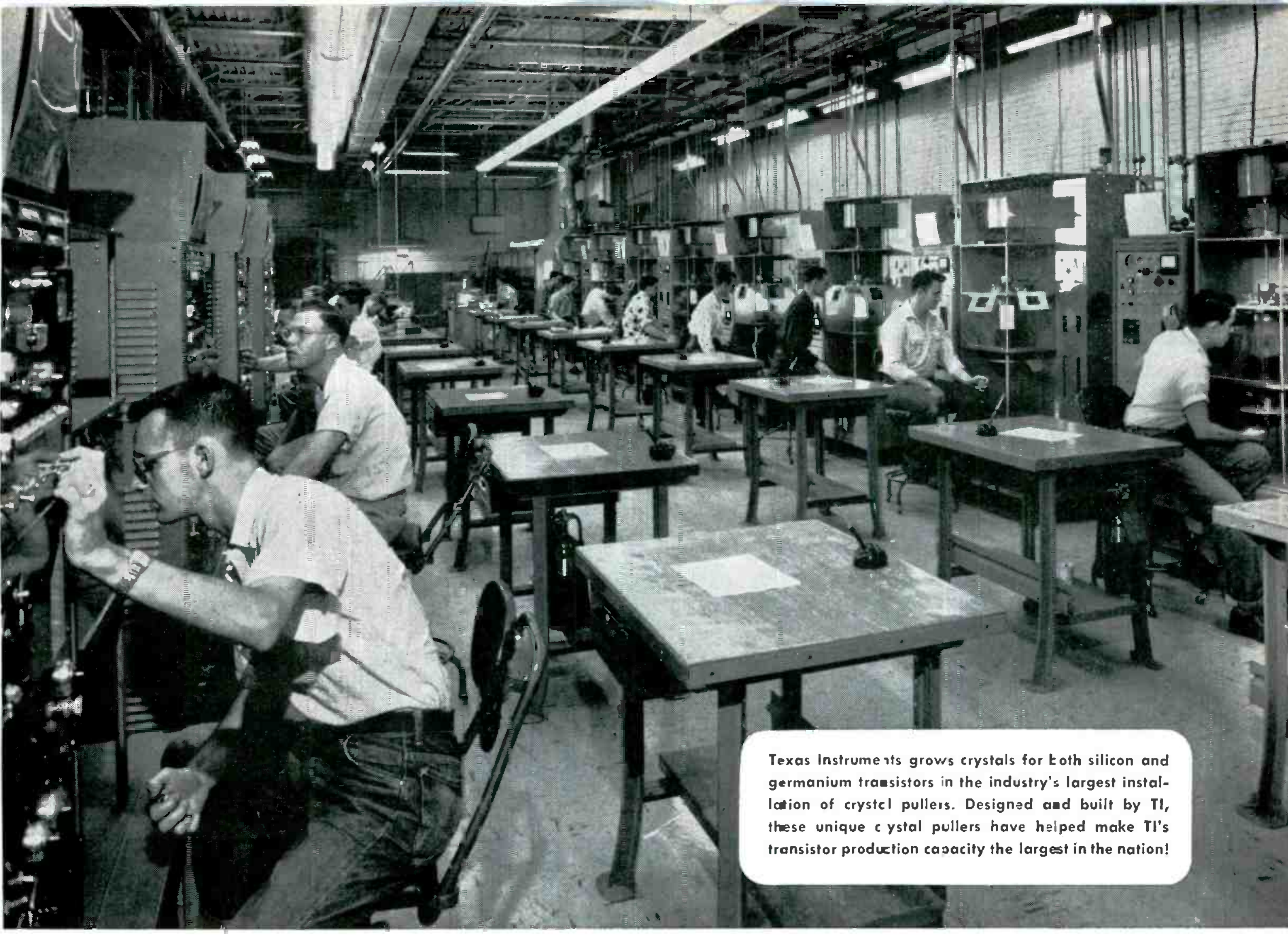

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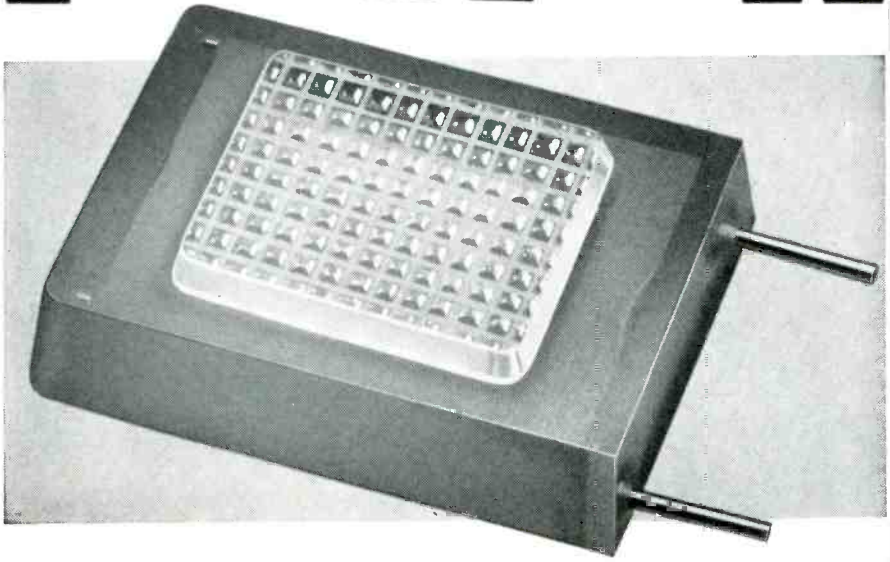

tion deemed wholly or partly inoperative or invalid, by reason of a defective specification or drawing, or by a patentee claiming more or less than he had a right to claim in the patent, the Commissioner (of Patents) shall on surrender of such patent and the payment of the fee required by law, reissue the patent for the invention disclosed in the original patent for the unexpired part of the term of the original patent. No new matter shall be introduced into the application for reissue."

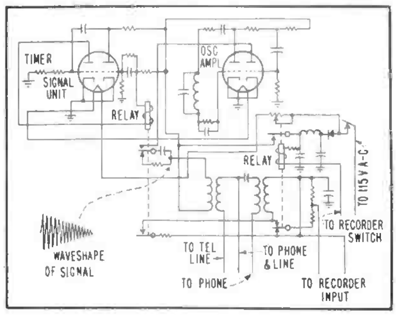

FIG. 1—Beep tone unit for attachment to tapped telephones

The above quotation from the Patent Codification Act of 1952, 35 U.S.C. 251 is by way of introducing the invention of one S. E. Peterson of Elwood Park, Ill., which went through this process to be granted reissue patent Re23,855. The invention is "Signal Unit for Telephone Conversation Recorders". The patent is assigned to Automatic Electric Laboratories, Inc., Chicago, Ill. The circuit of the telephone recording signal unit is in Fig. 1.

The invention describes a means of generating, timing and controlling the occurrence of a telephone recording beep-tone and applying the tone to the telephone line during a recorded telephone conversation so the parties may know that the conversation is being recorded. This is a requirement of the regulations promulgated by the FCC regarding the recording of telephone conversations.

The recording signal tone is generated by a Hartley oscillator combined in a double triode with a buffer amplifier. Another double triode is connected as a multivibrator to operate a timing relay. Power for the unit is supplied

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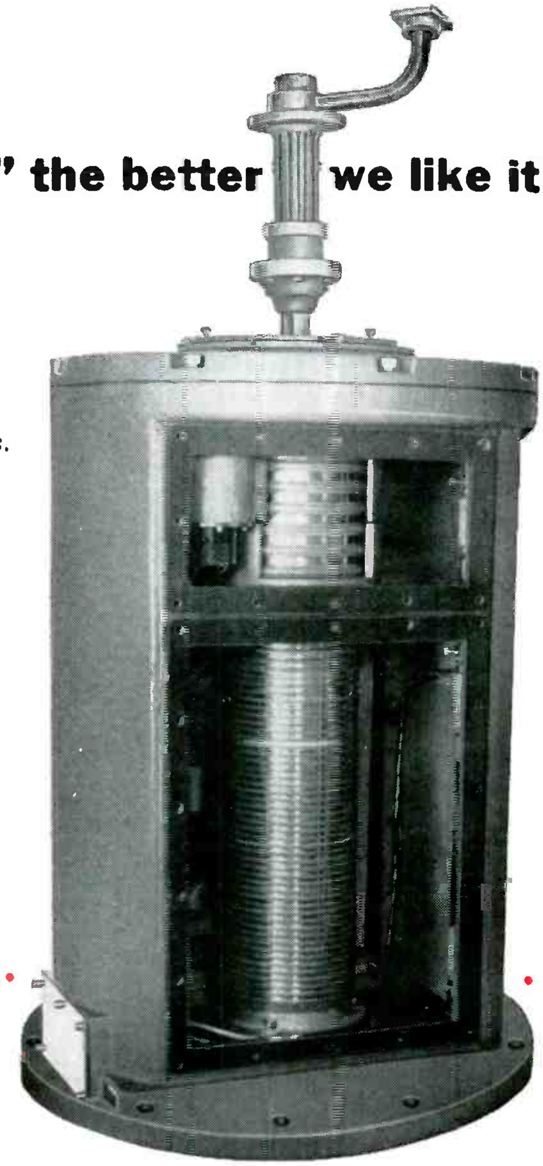

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through a half-wave a-c line rectifier power supply.

Picture Screen

Patent 2,698,915 was issued to W. W. Piper for a "Phosphor Screen". The patent is assigned to General Electric.

The particular importance of this patent is that it sets the stage for a type of flat tv tube. While the illustrations shown in Fig. 2 and 3 do not indicate dimensionally the relationships of the components, they do show the mechanical and electrical relationships.

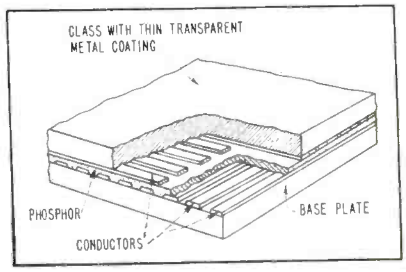


FIG. 2—Construction of phosphor screen

This invention is based upon the theoretical principle of electroluminescence. The devices exhibiting the phenomenon are generally called luminescent capacitors.

As shown in Fig. 3 the cell consists of a base plate, a first series of conductors on the base plate, a phosphor of the electroluminescent type and on top of the phosphor a second series of conductors at right angles to the first series.

As illustrated in Fig. 3 horizontal and vertical switches are provided to apply potential at the same time to one horizontal and one vertical conductor. At the point where the conductors cross the phosphor becomes luminescent. There is but little imagination necessary to see

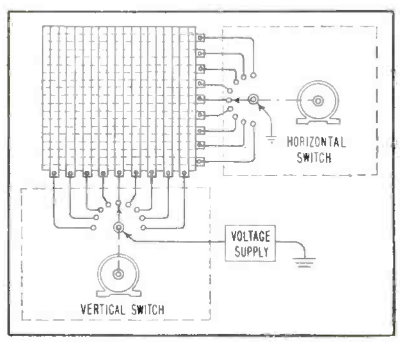
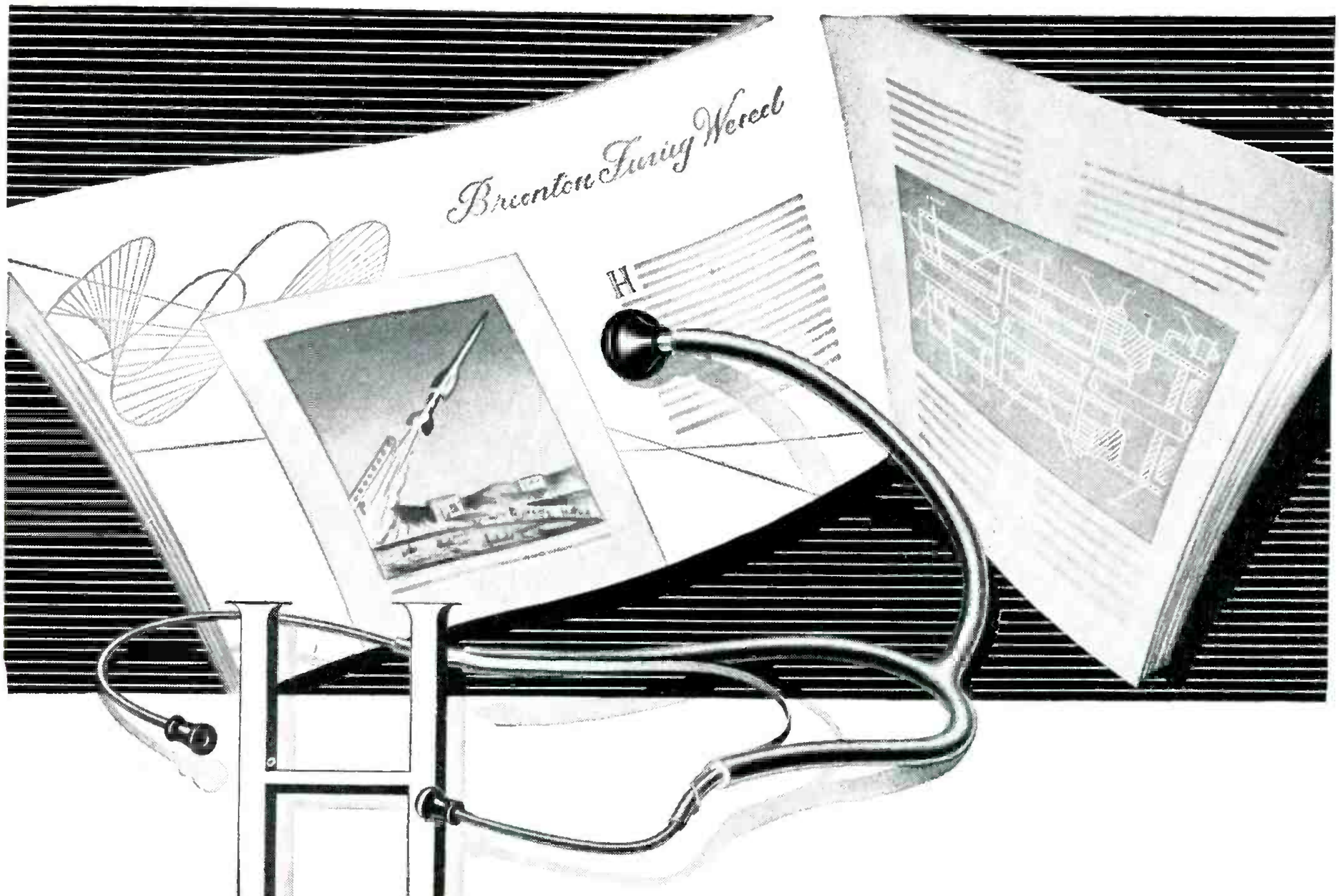


FIG. 3—Method of exciting light pattern



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how the horizontal and vertical switch may each be a rapidly operated electronic device with concurrent variation of the voltage supply to provide the necessary elements of a television scanning and video signal system. The luminescence at the cross over points of the conductors varies in brightness as the intensity of the voltage supply.

D-C Amplifiers

"A Stabilized Direct Current Amplifier" is the subject of a patent

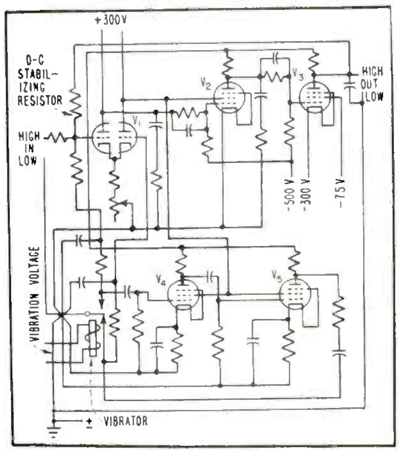

FIG. 4—Stabilized d-c amplifier

2,685,000 award A. W. Vance, of Cranbury, N. J. The patent is assigned to RCA.

The zero drift of d-c amplifiers is one of the problems that electronics engineers have tried to eliminate for some time. Generally, feedback techniques have been employed to stabilize d-c amplifiers so that the zero condition is reliably zero at all times. Normally, manual adjustments have been provided to effect this stabilization. The adjustments do not hold and must be repeatedly checked and corrected.

The present invention provides automatic stabilization adjustment continuously. Both zero drift and gain are stabilized. The gain is controlled by overall feedback. Zero drift is controlled by using a chopper device to break up the error voltage into an a-c component that is amplified, rectified and applied to the d-c amplifier to correct the zero drift at the point where the zero setting is normally adjusted.

The circuit of the invention is shown in Fig. 4. Tubes V_1, V_2 and

V_3 are the three stages of a d-c amplifier. Tubes V_4 and V_5 comprise a two-stage a-c amplifier. An overall d-c stabilizing resistor is shown connected between the output of V_3 and the first grid of V_1. This is the gain stabilizing circuit.

Through an isolation resistor the slowly varying input signal and the error signal (in phase opposition) are applied to a vibrator chopper and the resulting alternating signal amplified by V_4 and V_5 in cascade.

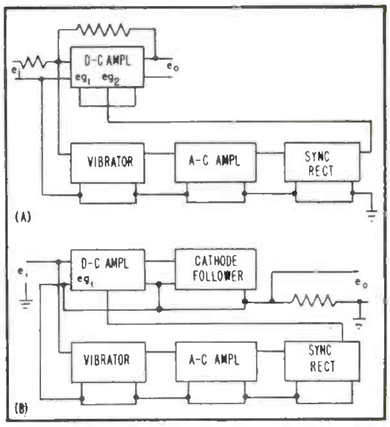

FIG. 5—Alternative stabilized d-c amplifier elements

The chopper is so connected that in one position the error and input signal are grounded and the other permits the error signal and input to be applied across a capacitor to the grid of V_4.

When the input and error signal are grounded the output signal of the a-c amplifier is applied to the second half of tube V_1 which results in a gain variation of the first half of V_1 by virtue of the common cathode connection. The action nullifies the effect of the feedback voltage applied to the first half of V_1 and so maintains the zero setting.

In Fig. 5A and 5B block diagrams are shown of very similar circuit arrangements of a "Stabilized Direct Current Amplifier", which is the subject of patent 2,684,999 issued to E. A. Goldberg and J. Lehmann. This patent is also assigned to RCA.

The vibrator and synchronous rectifiers of the block diagrams are the important features of the invention largely different from the system described above in the discussion of patent 2,685,000.

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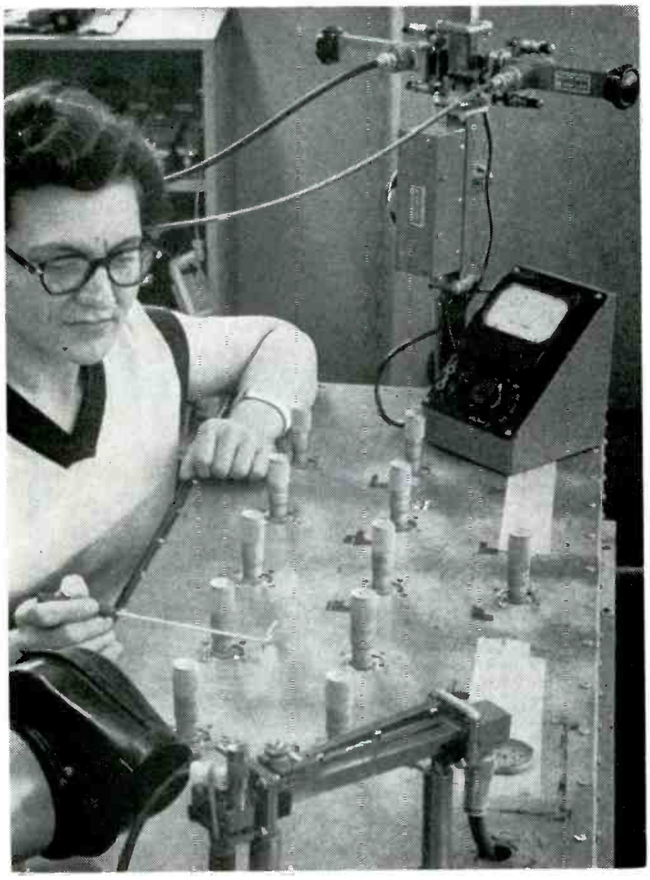
Production Techniques

Edited by JOHN MARKUS

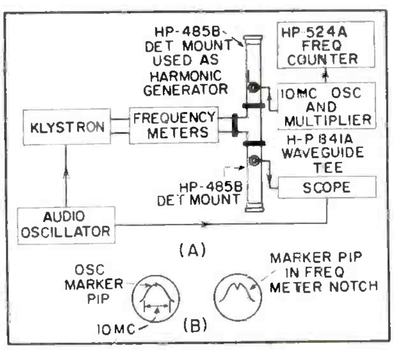
Calibrating Waveguide Frequency Meters in Batches of Eleven



Using dental-type mirror to read each frequency meter in turn on mass-calibrating setup. Metal table is hinged and lifts up clear of meters for unloading and reloading after each batch is calibrated

Changing frequency setting of variable oscillator in preparation for checking another point on each of the eleven frequency meters. Frequency counter, scope and other equipment are on table at rear

IN THE Palo Alto plant of Hewlett-Packard Co., a frequency counter is used in a production setup to calibrate waveguide frequency meters over a range from 5,850 to 12,400 mc. The frequency meter to be calibrated is inserted between the klystron signal source and the waveguide tee, as shown in the diagram. One arm of the tee connects to a detector mount which provides a rectified signal for presentation on the oscilloscope. The second arm of the tee connects to a multiplier chain driven by the variable oscillator. The oscillator is provided with a high-ratio gear drive that varies the frequency over a range of a few hundred kilocycles on each side of 10 mc. The harmonic-generating system provides marker frequencies throughout the desired shf range.

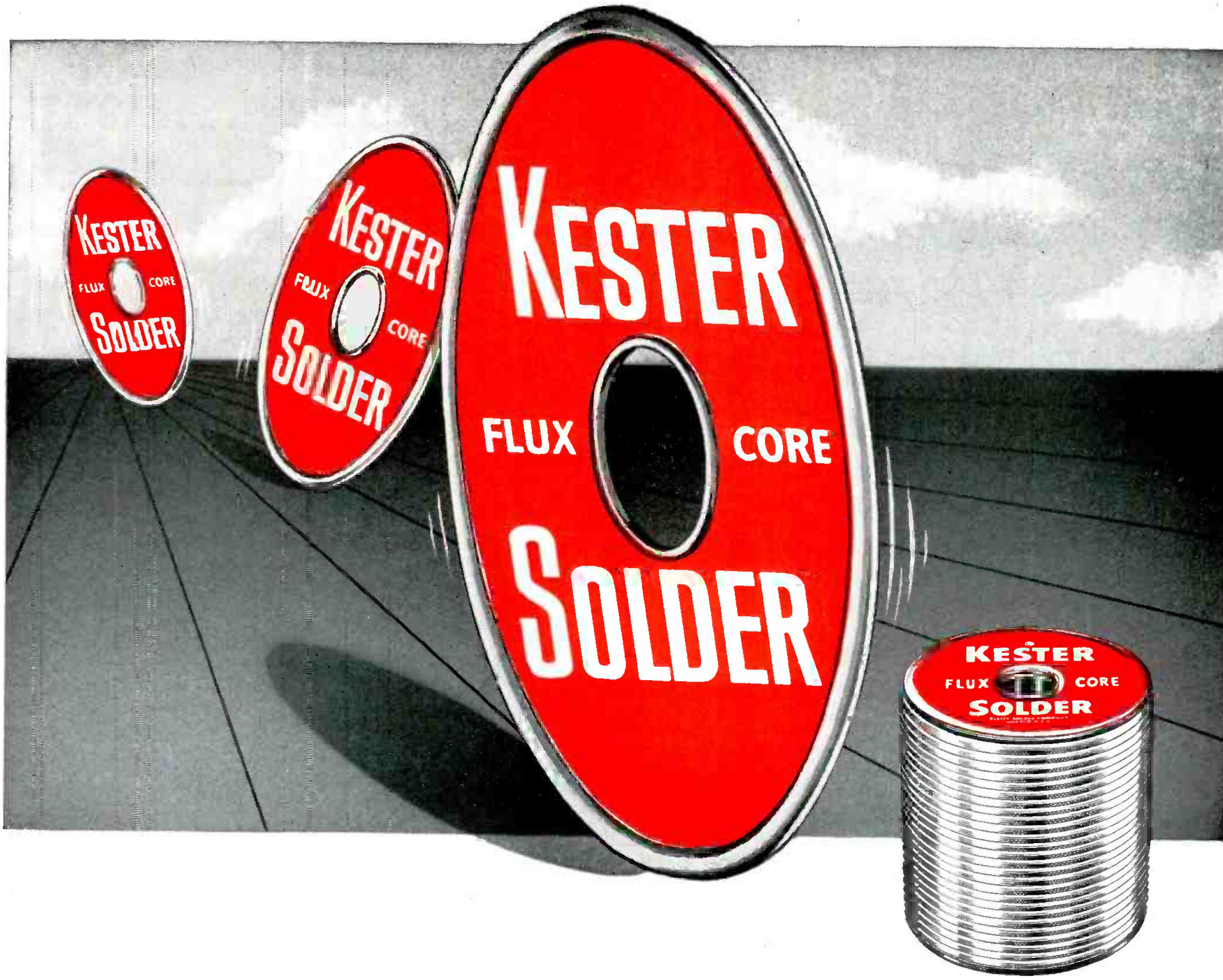


Calibrating setup (A), with waveforms seen on oscilloscope (B)

In operation, the signal source is tuned to the desired region and is frequency-modulated to have a frequency swing of several megacycles. When the 10-mc oscillator is suitably tuned, a marker pip from the multiplier appears atop the klystron output curve as shown on the diagram.

When the frequency meter is approximately tuned to the marker pip frequency, a notch will appear on the oscilloscope presentation. When the frequency meter is precisely tuned, the marker pip will drop into the notch, giving an accurate indication of the frequency meter tuning.

The 10-mc oscillator can be



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slowly tuned through a range corresponding to the range of the frequency meter, pausing at desired intervals to establish the calibration. Throughout this process, the frequency of the klystron is changed to accommodate the marker pip.

Besides simplifying the calibration of the frequency meters, this test setup allows convenient checks on drift caused by temperature changes and on shifts in resonant frequency caused by mechanical inaccuracies such as looseness of threads in the frequency meter drive system. Production tests on the frequency meters are simplified because a number of frequency meters can be connected in series. These are all connected between the klystron and the tee in the mass-calibrating arrangement shown.

Since the notch is a plot of the resonance curve of the frequency meter, the Q can be quickly determined by measuring the frequency interval between the half-amplitude points of the notch. This is easily done by varying the 10-mc oscillator and recording the readings of the decade-type frequency counter on the rack at the rear.

Spraying Counterelectrodes On Selenium Rectifier Plates

A SOLDER POT ingeniously combined with an air gun serves for spraying a molten bismuth-cadmium alloy over the selenium coating of rectifier plates in the Selenium Rectifier Division of Radio Receptor Co., Brooklyn, N. Y.

The molten-spray gun is suspended from the ceiling by a steel cable, directly over a metal pan resting on the bench. An opening at the left side of the pan is large enough to permit insertion and removal of the plates. A false bottom fits into the pan about half-way up and has a square central opening through which the metal is sprayed downward.

The rectifier plate is slipped into a masking fixture mounted on the bench directly below the square opening. The mask serves to leave an uncoated edge around the plate, to prevent the counterelectrode from shorting around the edges of the plate to the base. If the plate has a central mounting hole, a cone-shaped plug is inserted before spraying to mask its edges.

Spraying counterelectrode on 6-inch-square selenium rectifier cell. Mushroom plug covers center hole to mask its edges. Operator wears glove on left hand to keep plates clean and protect hand. Flexible air line and line cord for heater in pot are taped to steel supporting cable

When the plate is in position, the operator squeezes the air valve on the handle of the gun. This pulls a pin slug out from the solder pot, allowing the molten metal to run into the air stream where it is atomized and sprayed downward. The ceiling suspension makes it easy to swing the gun over the entire area of the plate for complete coating. Small ingots of alloy are added from time to time to keep the pot full, thereby maintaining a uniform pressure of the molten metal. The setup produces a uniform coating that definitely improves product quality.

Automatic Turntable Tests Selenium Cells for H-V Breakdown

SELENIUM CELLS for instrument rectifiers are automatically checked for shorts at increasingly higher voltages with a self-indexing turntable setup in the Selenium Rectifier Division of Radio Receptor Co. in Brooklyn, N. Y. The operator merely loads and unloads the individual cells as the turntable rotates past him. Air jets blow good cells into one container and shorted cells into another, while mechanical counters keep the tally of each.

Turntable indexing is achieved with a pawl arrangement operated

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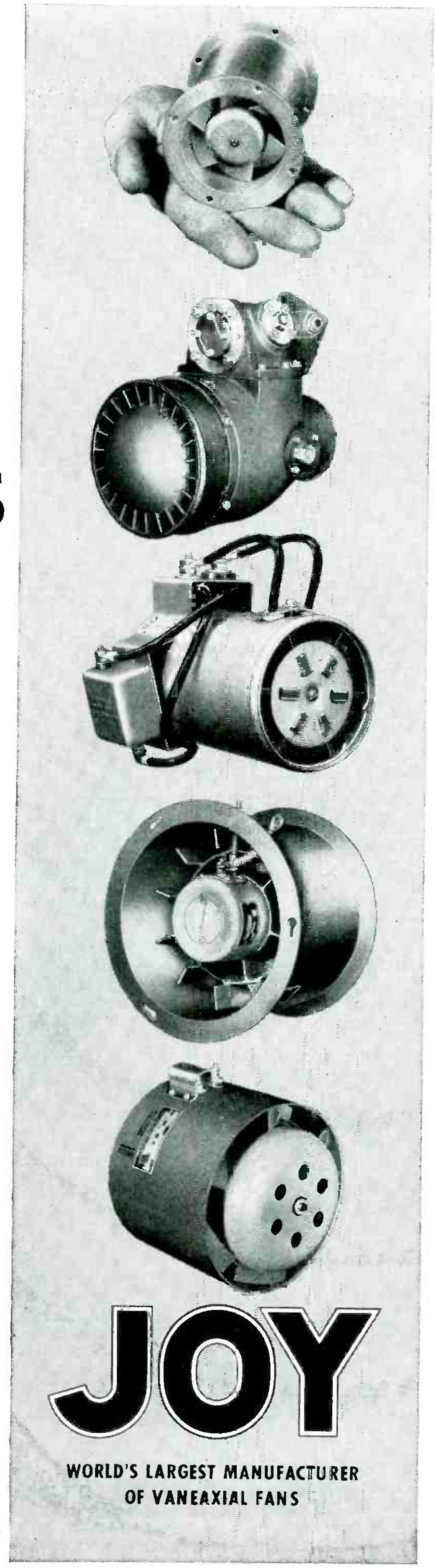

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The inherent compactness of vaneaxial design permits easy installation in any location. True airfoil-design blades and straightener vanes impart a smooth, direct airflow, with efficiencies above 85%, giving high-capacity performance with low horsepower expenditure.

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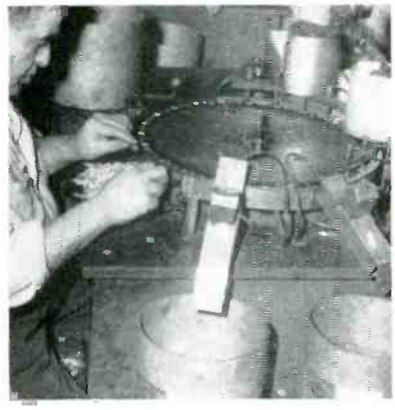
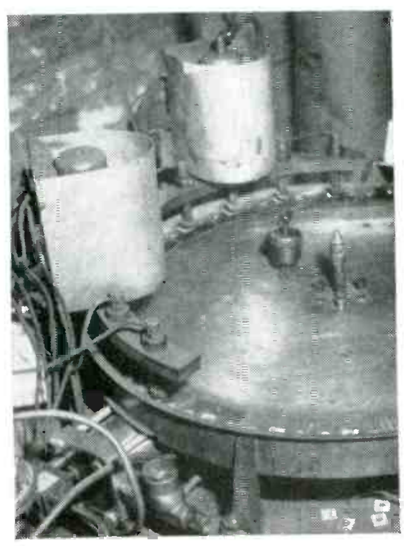


Automatic shorts tester for selenium rectifier cells. Good cells are blown into container at right of operator. Turntable rotates clockwise

by a master air cylinder having an adjustable air pressure regulator in its input line to permit changing the speed of automatic stepping. Two other air cylinders, mounted above the turntable, serve to lower and raise the banks of brass electrodes that make contact with the cells. Each bank has five electrodes and generally each electrode is connected to a different test voltage. The cells thus get increasingly higher test voltages as they move around. For some applications, only one bank of electrodes is used. Interconnections with the master air cylinder make the electrode banks move down after each indexing of the turntable.

At the position immediately following the highest-voltage test



Air cylinders on top of turntable move the electrode banks up and down after turntable is advanced by air cylinder at lower left. First electrode bank is not in use here electrode is an output chute and air blast tube for ejecting shorted or bad cells. If a cell is not shorted, there is no blast at this position and the cell is blown into the accept chute three steps later by another blast of air. The accept blast occurs at every step, since any cell which is acceptable is not removed from its nest at the reject station. A memory circuit is employed for the reject blast, which follows one station after the last test station.

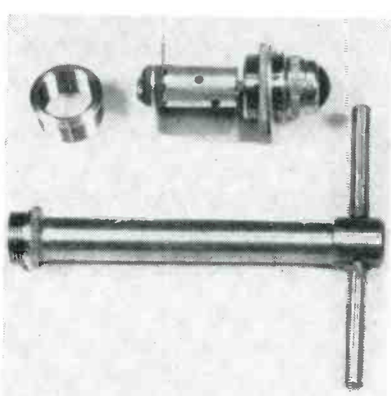
The high operating speed of the turntable necessitated special lubricating. The supporting bearing for the turntable is a somewhat smaller metal disk underneath. A grease cup on the turntable serves to force grease between the mating disks.

Ferrule Wrench Aids Mounting of Panel Lamps

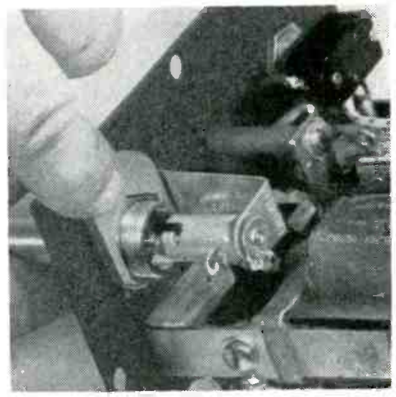
By Ronald L. Ives

Mounting small indicator lamp sockets on panels tightly is quite difficult because of lack of suitable standard tools for tightening the mounting ferrule. In consequence, many such sockets are loose on the panels or are badly chewed up by attempts to tighten them with pliers.

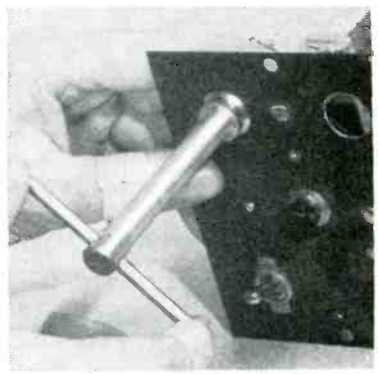
This recurrent difficulty can be eliminated quickly and cheaply by use of a T-handled threaded mandrel, an open-end wrench cut down to clear the indicator light frame and a small pair of pliers. The threaded mandrel consists of the



T-handled threaded mandrel used as ferrule wrench, with lamp socket assembly at upper right and the ferrule itself at upper left. Ferrule has flange that bears against front of panel when installed; knurled part of bezel on mandrel tool bears against this flange when tool is installed



Using filed-down open-end wrench to hold mounting nut behind panel



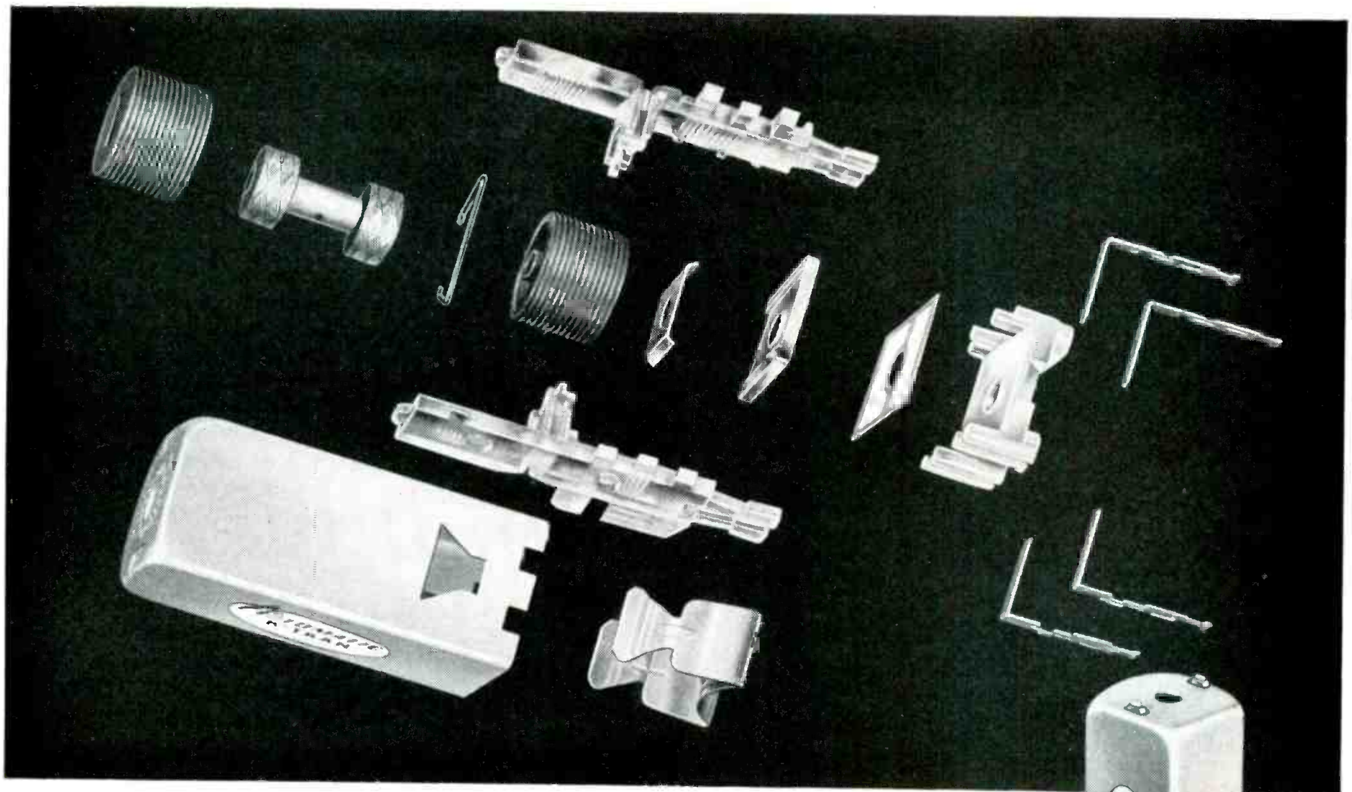
Using ferrule wrench to tighten ferrule of socket

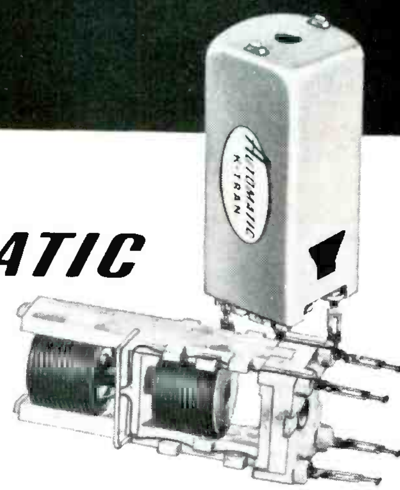
metallic part of a light bezel, soldered onto a shaft which is terminated by a T-handle.

The open-end wrench is a thin wrench of suitable size, with the jaws filed down so that they will just fit between the ferrule nut and the socket frame. This wrench not only holds the nut from turning, but also permits orientation of the lamp frame by the technician.

In operation, the mandrel tool is threaded into the mounting ferrule of the socket, and this in turn is passed through the panel and the socket frame into its holding nut. With the nut and socket frame held in position by the filed-down wrench, the ferrule is tightened firmly by turning the mandrel tool. Then, with the threads of the ferrule held gently with a pair of pliers to prevent turning, the mandrel is unscrewed. Some care is needed with the pliers to preserve appearances even though the thread on the ferrule is never used again. Taping of the plier jaws will help.

Using these tools, mounting time for indicator lights runs about one minute each. Tightening of loose





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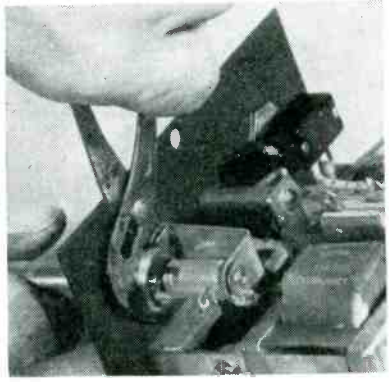


Holding ferrule thread with pliers while removing driving mandrel

indicators on old equipment takes slightly longer because of accessibility problems.

Quality Control Charts for Printed Wiring

By JAMES P. HEYWOOD

Supervisor, Quality Control Engineering Light Military Electronic Equipment Department General Electric Co. Utica, N. Y.

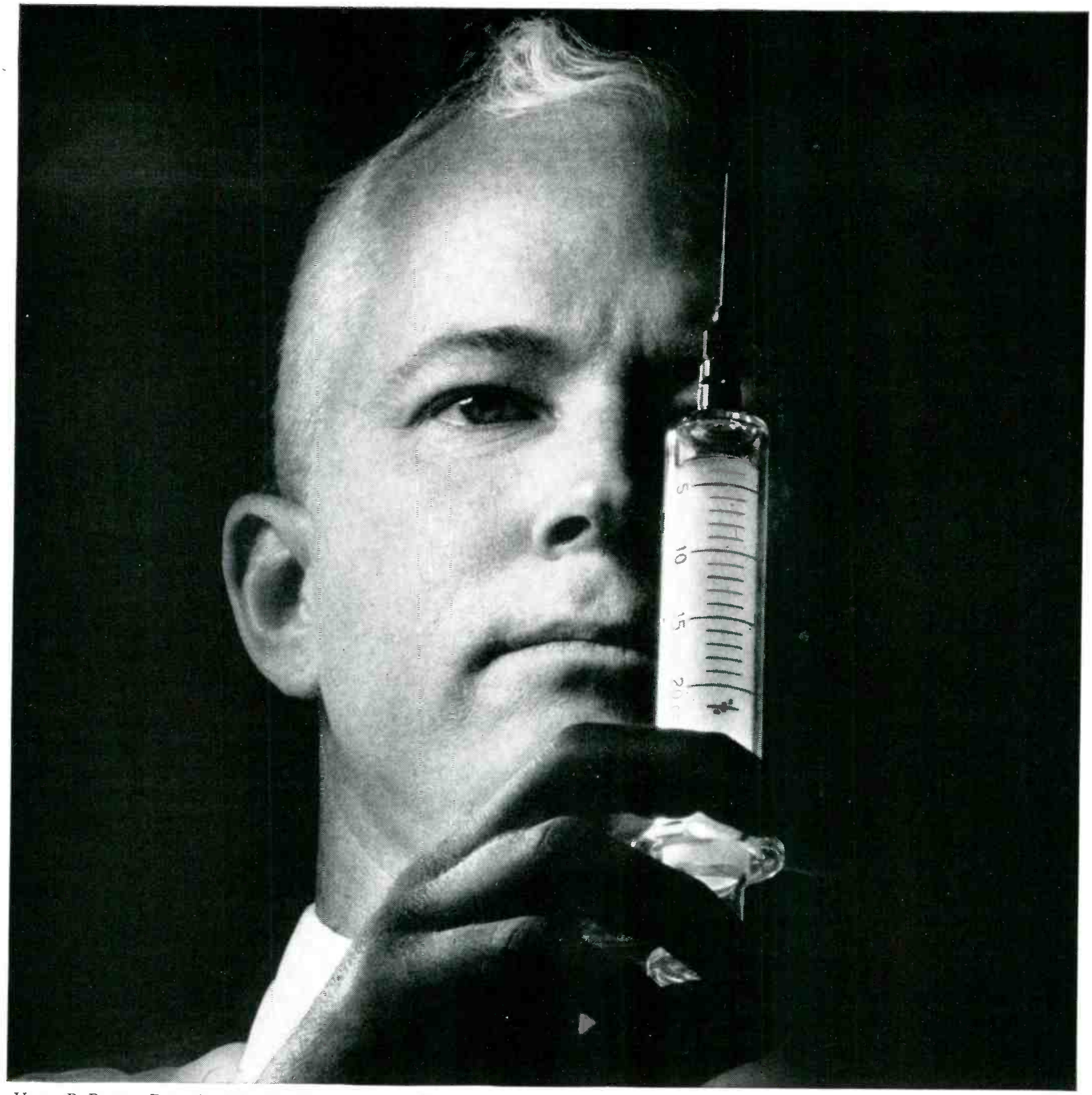
SOME PRINTED wiring boards are presented for inspection which contain only a few circuits and components. Other boards may contain several hundred circuits and a great many components. It is often important to discover whether the rate of making defects on one type of board is comparable with the number of defects occurring on another type.

It is not practical to count the number of defects per unit and make a comparison on this basis, since the complexities vary in a ratio of possibly 20 to 1. The common denominator of all the boards manufactured is planned hours of time, however. A small board could conceivable have less than an hour's total time expended on it, while a complex board would require 10-hours total labor.

Quality control charts indicate that printed wiring boards involve only about 10 defects for each hour of applied labor, whereas 20 defects per hour might be expected with the old method of assembly.

Figure 1 shows a typical control chart which is kept on the manufacturing floor as a running record of manufacturing quality, day by day.

The second column, headed in-



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DATE	INSP	DEF	%
1	172.4	28	16.2
2	146.1	13	8.9
3	150.5	20	13.3
6	191.7	10	5.2
7	189.6	25	13.2
8	145.5	24	16.5
9	192.9	25	13.0
10	182.6	20	11.0
13	164.2	11	6.7
14	165.8	18	10.9
15	171.5	21	12.2
16	184.2	17	9.2
17	185.3	20	10.8
20	169.3	22	13.0
21	179.8	16	8.9
22	152.3	8	5.3
23	168.7	13	7.7
24	174.6	9	5.2
27	175.9	16	9.1
28	163.1	3	1.8
29	184.6	15	8.1
30	181.4	9	5.0
31	179.2	13	7.3

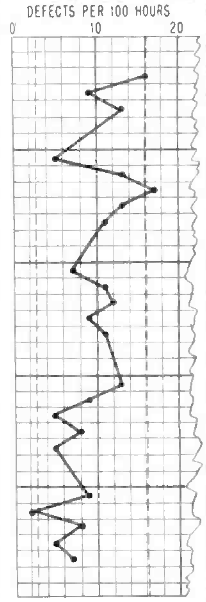

FIG. 1—Example of one-month quality control chart for printed wiring boards

spection, is the number of units inspected multiplied by their individual complexities as computed in planned hours of direct labor. The third column gives the number of defects found and the fourth column is defects per 100 hours or percentage.

The chart is complete for one month, in which a total of 3,971.2 hours were applied with 376 defects. This gave a process average of 9.5 for the month. This chart portrays the ideal condition, wherein each week shows an improvement over the previous one.

Since production of printed wiring boards is often relatively small quantities of each, with a great variety of types, it is impossible to apply a normal attribute sampling plan such as Mil Std 105-A. It is necessary, therefore, to devise a plan which is statistically sound and yet is applicable to as few as 5 or 6 pieces. Here again, the concept of complexity based on number of hours of applied labor is used.

An examination of a normal printed wiring board indicates that there are at least 100 inspection points for each hour of manufacturing time. A board which takes 5 hours to fabricate, therefore, would contain approximately 500 inspection points. If this is true, each such board may be considered as consisting of 500 pieces, so that a lot of 5 boards contains 2,500

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All manufacturers of metal clad stock for printed circuitry have made considerable progress in improving their product—a material with a metal foil surface bonded to a non-conducting base. How this has been done by one leading manufacturer, the Continental-Diamond Fibre Company, illustrates some of the problems involved in buying this type of material and in understanding its design potentials.

C-D-F CONSOLIDATED GRADES

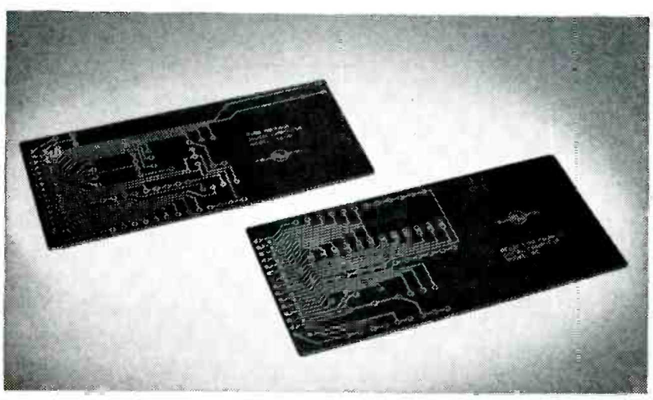
At first, small test lots of Dilecto laminated plastic with copper surfaces were made. Almost every core material was used. Finally the number of practical grades for printed circuit work narrowed down to these few grades which retained to a large degree the inherent electrical qualities of their base material and resin at high temperatures:

XXXP-26 COPPER CLAD—PAPER BASE WITH PHENOLIC RESIN
A laminate with excellent electrical and mechanical properties. High moisture resistance and dimensional stability. Recommended for applications where high heat and high insulation resistance plus low dielectric loss under high humidity is needed. Low cold flow characteristics. Can be hot punched to ⅛". Good flexural strength. Natural green color.

This is one of the *improved C-D-F Dilecto laminates*. Advances in resins and manufacturing techniques make this grade almost homogeneous, with improved impregnation of the filler. Thorough impregnation eliminates entrapped moisture and air, giving greater moisture resistance and better dielectric properties.

Any metal clad is no better than its base and the care taken in laminating. With the cost of material high, compared to labor and inspection, the purchase of a *uniform* metal clad material, like this C-D-F grade, becomes vital.

XXXP-24 COPPER CLAD—PAPER BASE PUNCHING GRADE WITH PHENOLIC RESIN
Similar to grade XXXP-26 in electrical and moisture resistance properties, but not quite as strong mechanically. Equal cold flow and punching characteristics. Natural brown.



GB-181E COPPER CLAD—GLASS FABRIC WITH EPOXY RESIN
The new C-D-F epoxy grade uses a glass fabric laminate with a copper foil surface on one or both sides. Epoxy resin laminates possess very high mechanical strength (tensile and flexural), along with good dielectric strength, both perpendicular and parallel to laminations. Used in government and commercial equipment, epoxy metal clads are superior to phenolic laminates in moisture absorption and temperature resistance. Both bond and hot solder tests are rated excellent.

GB-116T COPPER CLAD—GLASS FABRIC WITH TEFLON RESIN
A glass base laminate using duPont's tetrafluoroethylene resin, Teflon, for outstanding resistance to high heat with extremely low dielectric loss properties. A fine weave continuous filament glass fabric cloth is used for superior mechanical strength and good machining qualities. In spite of its high cost, this C-D-F grade has demonstrated that it can save money and do a job that no other single material can in microstrip high-voltage, high-frequency circuit elements. Remember, C-D-F is a major supplier of sheets, tapes, rods, tubes of Teflon, has valuable experience in its manufacture and fabrication. Write for samples.

C-D-F INCREASED BOND STRENGTH

By developing a special thermo-setting adhesive particularly suited for metal clads, C-D-F was able to increase the bond strength of their laminates considerably above their original figures. Bond or peel strength, the amount of pull required to separate the foil from the core material, is one of the most important physical properties. Therefore, the purchaser should compare his source of supply with these C-D-F average test values:

BONDING STRENGTH—FOIL TO LAMINATE

MATERIAL	Average or Typical Value Lbs. pull per 1" width of foil to separate
XXXP-24 or XXXP-26 plus 0.0014" copper	5 to 8
XXXP-24 or XXXP-26 plus 0.0028" copper	7 to 9
GB-181E plus 0.0014" copper	15 to 18
GB-116T plus 0.0014" copper	6 to 9

These values are based on tests at prevailing room temperature (20-30°C.)

C-D-F INCREASED HEAT RESISTANCE

Special efforts by C-D-F technicians to increase the heat resistance of all C-D-F Metal Clads have resulted in certain special grade variations able to withstand higher soldering temperatures without damage. As production methods change, C-D-F offers materials to meet your requirements.

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CONTINENTAL-DIAMOND FIBRE COMPANY
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pieces. The design of a sampling plan for any given assurance for a lot of 2,500 pieces is relatively simple. The operating characteristic curve of such a plan can be drawn in advance and the sample size and acceptance number derived therefrom.

As an example, lot size was set on a maximum of 6 pieces and sample size was frozen at 2.0. Curves for C drawn on a plan of lot size 6, sample size 2, acceptance number 0, show that AOQL (Average Outgoing Quality Limit) is 0.09 on the premise that 100 in-

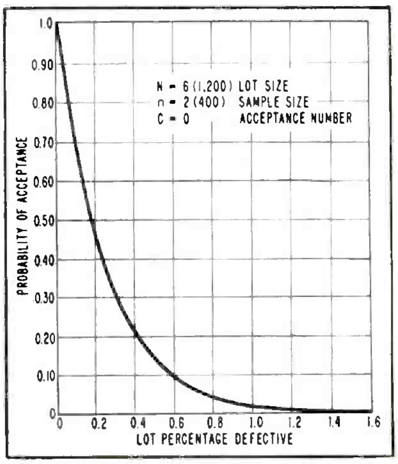

FIG. 2—Operating characteristic curve for typical small-lot production of printed wiring boards

spection points are contained in each hour's work and each board contains 2 hours work. Any lot which is examined and found to contain more defects than those allowed by the sampling plan is returned to the manufacturing department for reinspection.

The operating characteristic curve for a sampling plan where N equals 1,200, n equals 400 and C equals O is shown in Fig. 2.

The AOQL curve in Fig. 3 indicates that the worst condition exists when the percent defective in a lot equals 0.25 and the average outgoing quality level is 0.092. This concept of computing complexity is applicable only when all the inspection points are derived from the same process and form a homogenous universe. It would not be possible, for example, to add the number of rivets to the number of welds when inspecting a housing or cabinet, since these stem from

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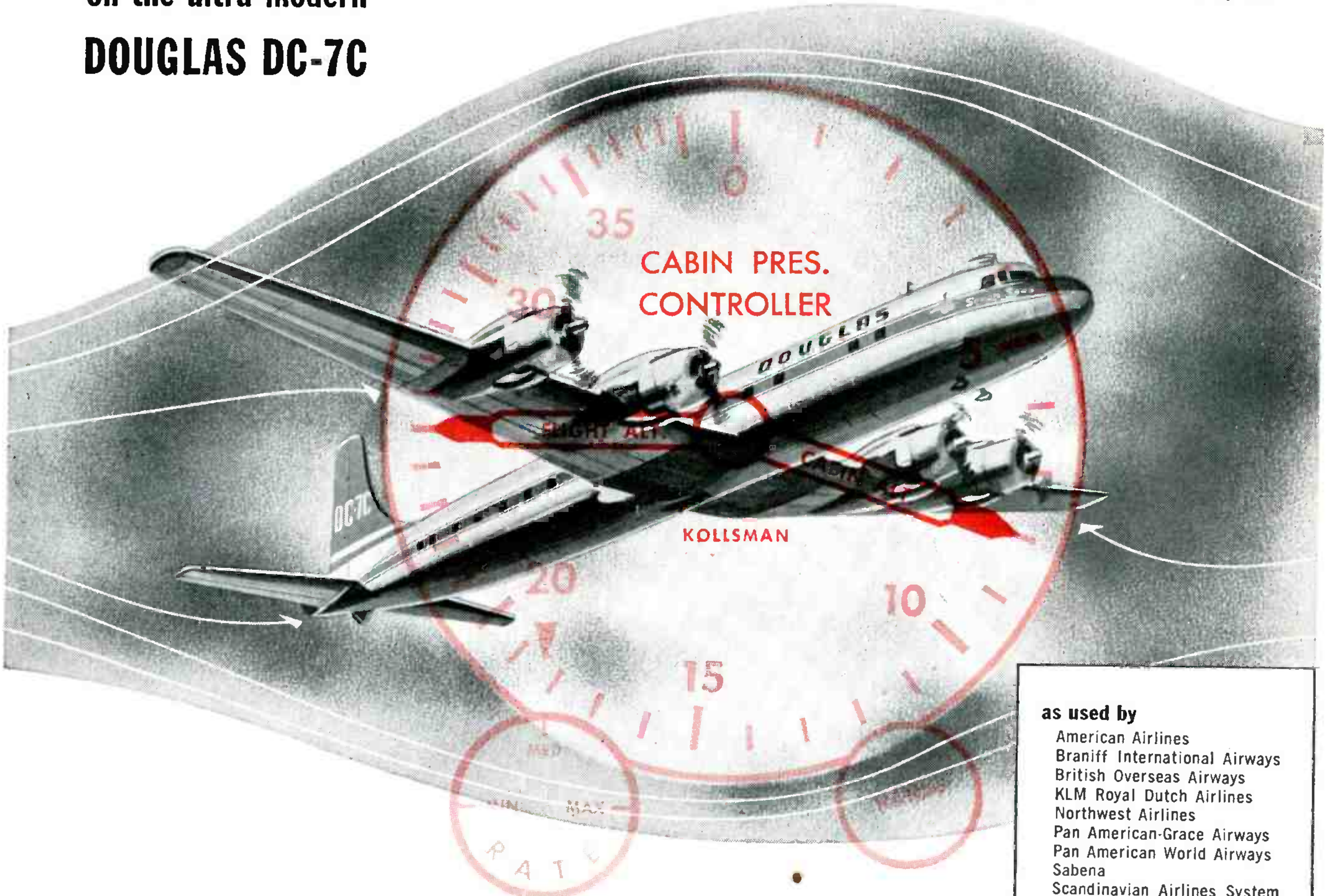

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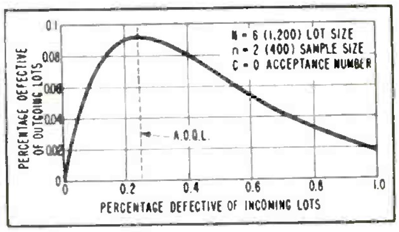

FIG. 3—Average outgoing quality curve

entirely different processes.

Increased ability of the operators, changes in manufacturing techniques and many other reasons can very easily lead to an improved standard of workmanship which was thought impossible of attainment when the original designs were first fabricated in the factory. Machining of the boards is a subject for continual review, since improvements in materials and changes in tools tend to considerably improve the results of a machine department's work. Improvements in the adhesion of the circuits to the board and the decreased range of thickness of the solder plate which is applied to the copper allow standards to be changed realistically.

The Quality Control department is therefore faced with a dynamic program of improvement in which it can play a very large part. Constant sampling of all the attributes listed above and many more which have not been mentioned enables this department to point the way toward improvement in quality of printed-wiring boards in all of these areas.

This material has been abstracted from a paper presented at the RETMA Symposium at the University of Pennsylvania early this year.

Die-Casting Cuts Cost Of Three-Coil Can

DIE-CASTING has reduced the cost of producing a radio chassis part, used on several models of a 1955 automobile, from 10 cents to 7 cents each. This 3-cent saving, when multiplied by half a million sets per year, amounts to the sizeable sum of $15,000. In addition, the single die-cast zinc part replaces four stampings, thus eliminating assembly time on these.

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OUTSIDE DIA.—2½"
LENGTH —2"

STANDARD SQUARE CASES

HU-709:
DIMEN. A—1"
LENGTH —2⅛"

HU-741:
DIMEN. A—1¾"
LENGTH —2-19/32"

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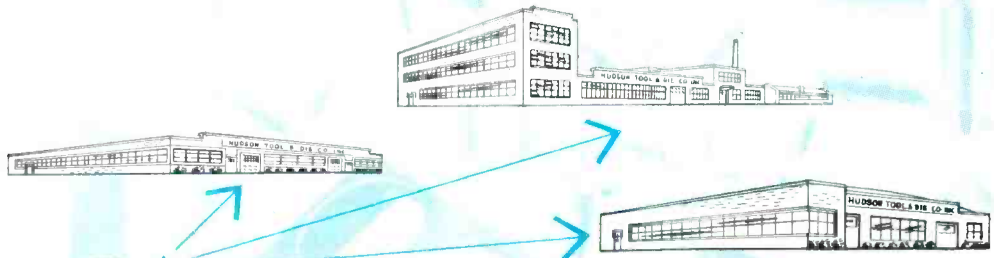

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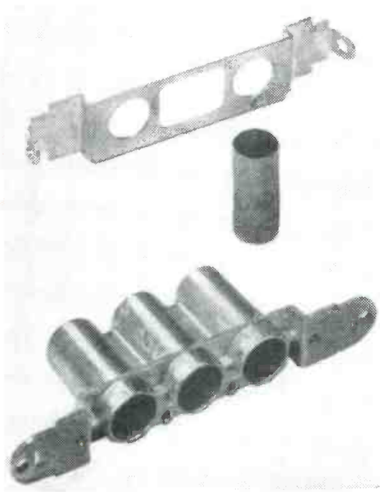


Die-cast coil can with examples of stamped strip and individual coil can shown above for comparison

production at the Chicago plant of the Precision Castings Co. It holds three coils—the antenna coil, an r-f coil and an oscillator coil—as used in pushbutton car radios.

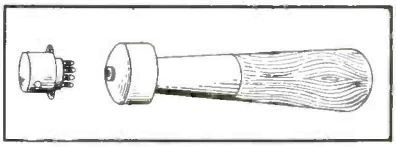
Under the old method of production, a steel strip was stamped out having three holes for the cans and a smaller hole at each end for bolting to the radio chassis. Three tubes of drawn sheet metal were inserted in these holes and crimped into place. Being of steel, the parts had to be plated for corrosion resistance.

With die-casting, the entire part is made automatically in one operation, and offers strength advantages over the stamping and crimping method.

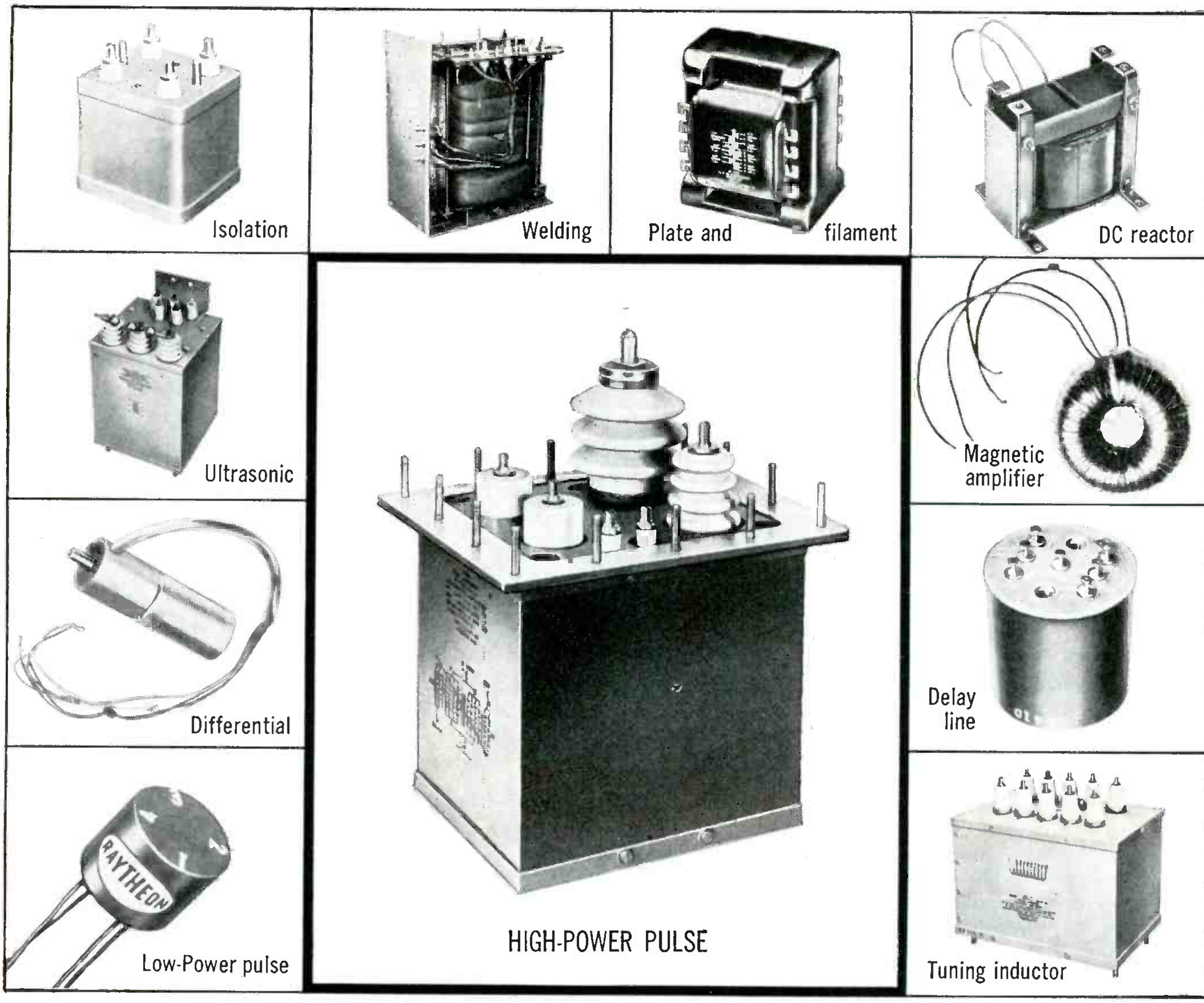
Tube Socket Spreaders

MINIATURE vacuum-tube sockets are usually received with the solder lugs straight and close together. When these sockets are wired, it is desirable to spread the solder lugs to provide clearance for soldering operations and prevent shorts between adjacent wires and lugs.

The lugs may be spread easily, quickly and in a uniform manner



Terminal-spreading tool for miniature sockets. Two sizes are needed, for 7-pin and for 9-pin sockets respectively



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designed for your specialized applications

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To meet your need for specialized electronic signal and power range transformers, Raytheon offers exceptional standard transformers and custom design facilities. An unusually large and widely experienced engineering staff is at your service to design and develop transformers that best fit your particular applications.

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Available to you are the resources of Raytheon's entire transformer engineering staff. Yet in order to best satisfy your needs, design, development and production of your transformers are turned over to an individual Raytheon engineer who sees your job through from start to finish.

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All types of winding, core processing, impregnation and baking equipment are available for model making or full production runs. Raytheon also offers complete facilities for testing.

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Raytheon has successfully custom engineered over 30,000 transformer designs and millions have been produced. Proof of Raytheon quality is this fact: *in 25 years less than ¼ of one percent of all Raytheon transformers have been returned from the field for any reason.*

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Equipment Marketing Division

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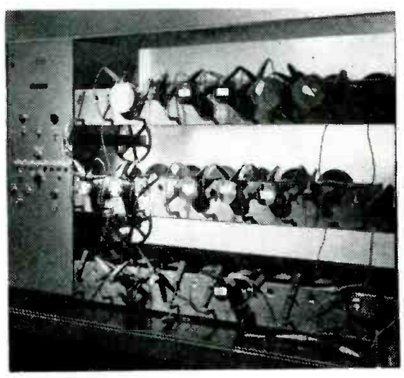
with the tube socket spreader tool shown. The center post on the tube socket should enter the recess in the tool smoothly. A steady direct pressure will separate the lugs to the full extent of the spreader tool. Do not rock or wiggle the tool handle, as this may bend the lugs too far and damage them.

For obstructed locations where the straight-handled tool cannot be used, right-angle offset spreaders can be made up. The lugs in a socket must float to permit ready tube pin alignment after the bending and soldering operations are completed. —Glenn L. Martin Co. training bulletin.

Life-Testers for Precision Potentiometers

A MECHANICAL life tester designed and built at Helipot Corp., South Pasadena, Calif. accommodates up to 24 precision potentiometers in any assortment of models and is adjustable for any number of revolutions from 1 to 40 per cycle. It will automatically shut off if the continuity through any unit breaks down; lights at the left will show which unit has failed. When used to test mechanical life only, no voltage is impressed upon the potentiometers; instead, they are connected through the bias circuit of a thyratron that serves to cut off all power when a unit fails.

A newer and larger rotational life tester for Helipots consists of three independent bays accommodating a total of 84 units. Fourteen units can be mounted on one of the doors,

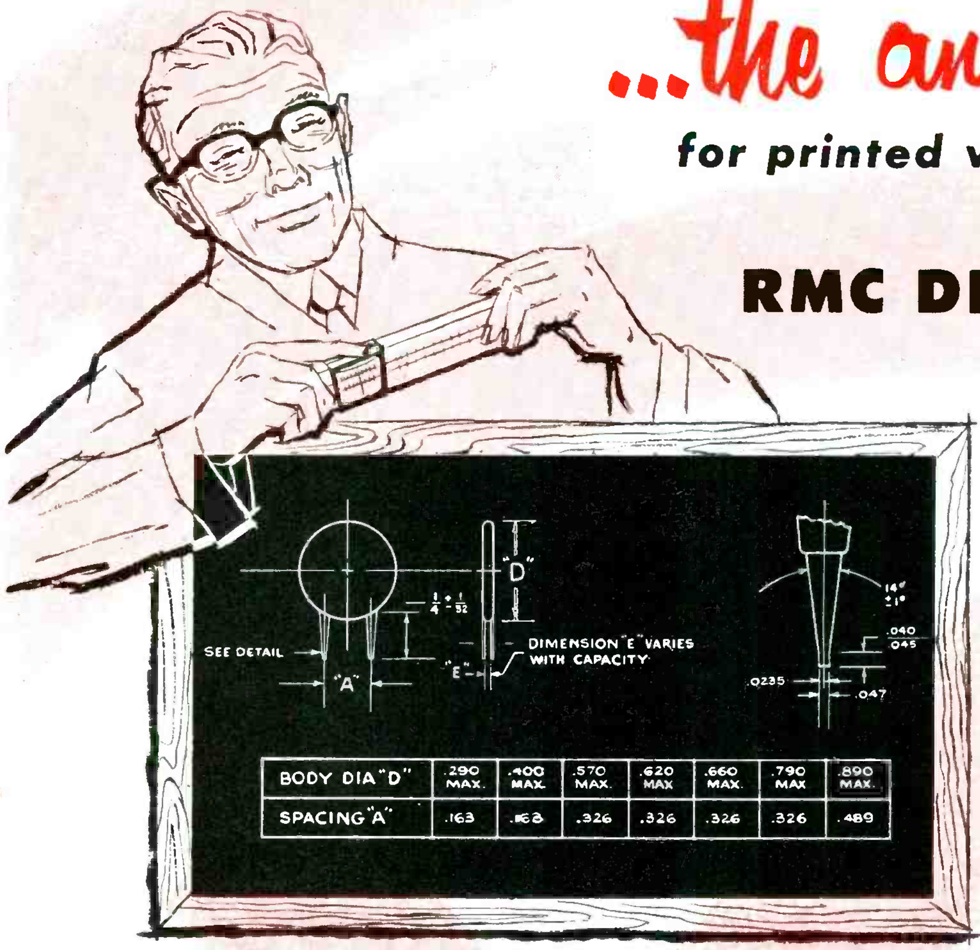


Gear-driven arrangement for testing 24 potentiometers at a time. Eight lamps combined with three-position selector switch permit quick determination of failed unit

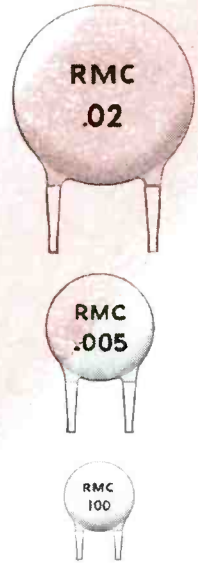
...the answer

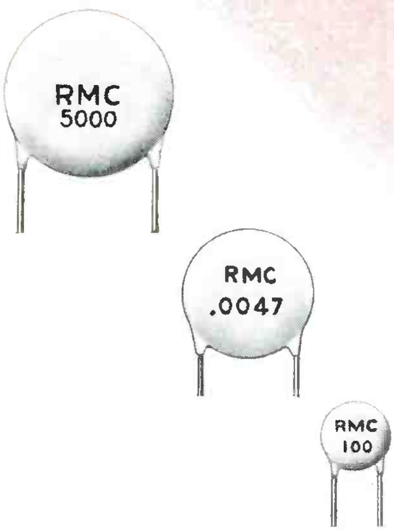
for printed wire circuits

RMC DISCAPS®



BODY DIA "D"	.290 MAX.	.400 MAX.	.570 MAX.	.620 MAX	.660 MAX.	.790 MAX	.890 MAX.
SPACING "A"	.163	.163	.326	.326	.326	.326	.489





Wedg-loc... The exclusive wedge leads on these DISCAPS lock securely in place on printed circuit assemblies prior to the soldering operation. There is no possibility of the capacitors becoming loose or falling out and the soldered connection is always uniform.

Available in capacities between 2 MMF and 20,000 MMF, Wedg-loc DISCAPS can be furnished in temperature compensating, by-pass, and stable capacity types. Suggested hole size is a .062 square.

Plug-in... RMC plug-in DISCAPS are designed to simplify production line problems on printed circuits. Leads are No. 20 tinned copper (.032 diameter) and are available up to 1½" in length. Plug-in DISCAPS are manufactured in temperature compensating, by-pass, and stable capacity types and include the mechanical and electrical features that have made standard DISCAPS the favorite of leading manufacturers.

Write today on your company letterhead for expert engineering help on any capacitor problem.

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS CORPORATION

GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Two RMC Plants Devoted Exclusively to Ceramic Capacitors

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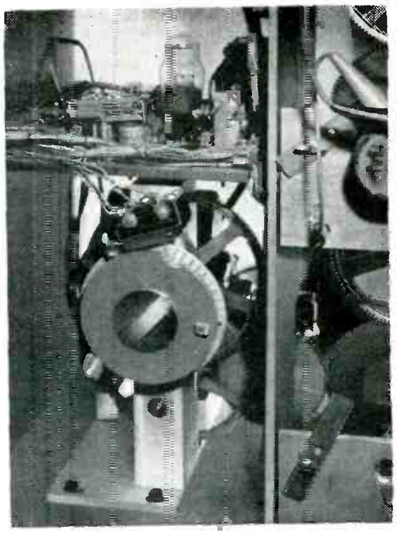
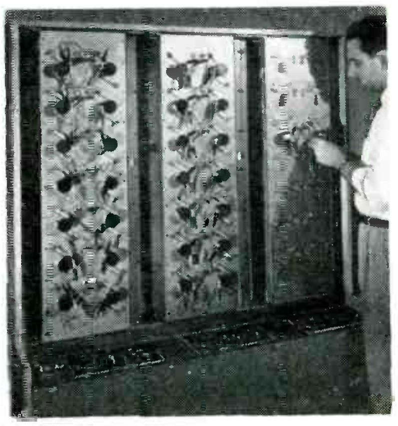


Cycling control unit in 24-unit tester. Cam in foreground can be rotated to provide from 1 to 40 turns before reversing to give an equal number of turns in opposite direction. Scale behind notch in cam indicates number of turns. Above cam are relays for reversing polarity and for cutting off power when a unit fails

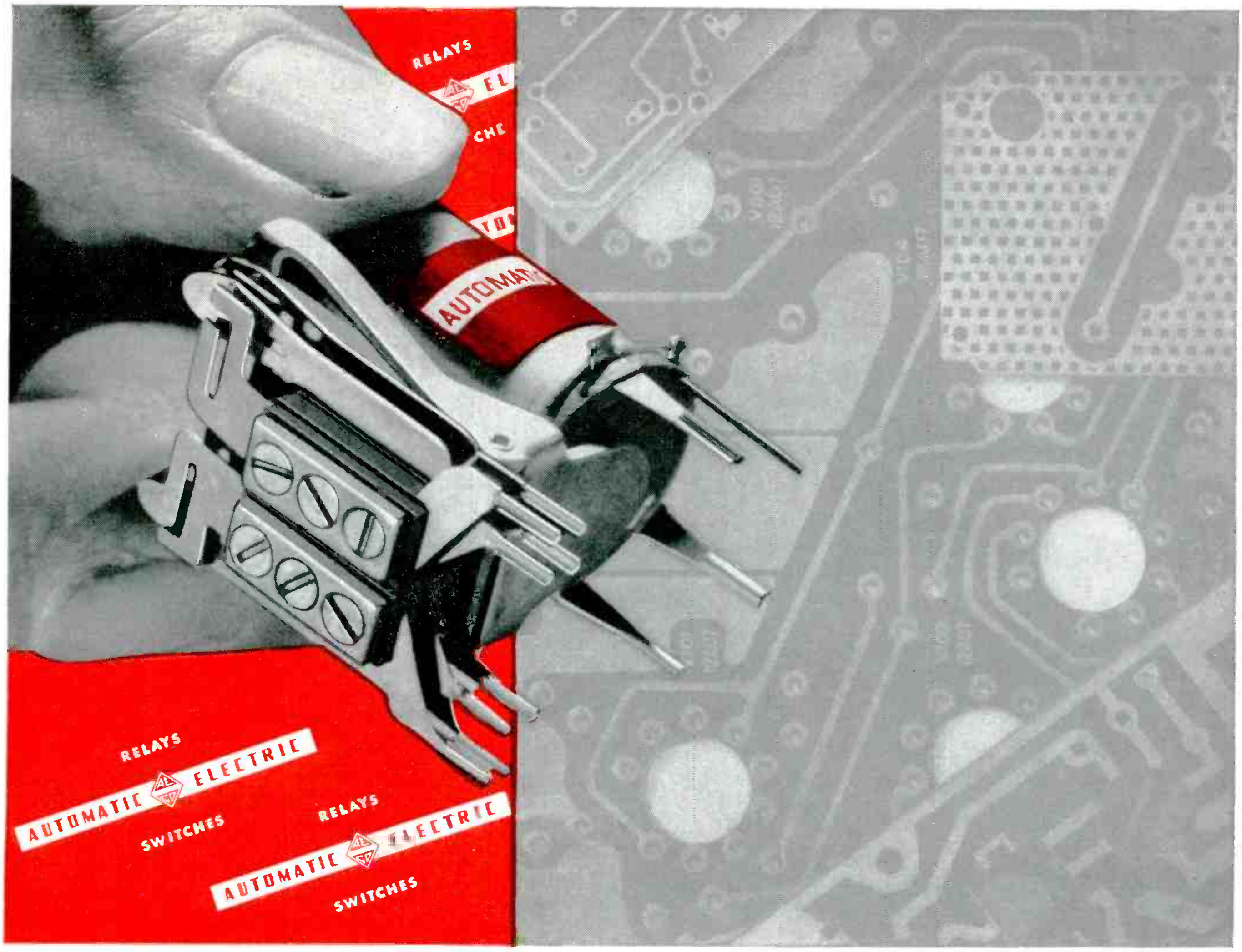
and 14 more on an identical door at the back of the tester, with all 28 units of the bay rotated by a single chain drive. The cycling in any bay can be different from the cycling in the other two bays.

To test electrical continuity through the coil when a unit is run until breakdown, alligator clips are connected to the end terminals and wired to a selfshorting jack. If a receptacle is not in use, the jack and clips are removed from the board. Above each jack is a signal lamp that lights if the unit breaks down.

Rotation of each potentiometer



Three-bay, six-door unit for testing 84 units at a time. Metal strips locked in position by wing nuts hold potentiometers in position on doors



NOW!

dependable relays for printed circuits

Maybe you, too, have been awaiting availability of a *good* relay for direct insertion into printed circuits. Now Automatic Electric can solve your problem with a miniature relay that is just right.

120 million operations, without a single readjustment or relubrication! That's what you get from this rugged, improved Series SQD Relay, because it features a special *heavy-duty* bearing and bearing pin. Also a recess in the bearing plate retains an adequate supply of lubricant for long-term lubrication of the bearing pin.

Consider these additional advantages:

1. The sections of the terminals that insert into the printed circuit board are NOT brazed or welded into place, but are integral parts of the coil terminals and contact springs—thus preventing internal loss in conductivity or continuity.
2. Terminal design permits direct plug-in of the relay into a printed circuit board, ready to be secured in place with any acceptable soldering technique.

Usually the desired contact spring combination, or pile-up, is sufficiently large so that additional mounting (support) of the relay is not necessary.

SQD Miniature Printed Circuit Relays are available with many different contact spring arrangements, and for a multitude of applications. Springs can be made of phosphor-bronze, "Bronco" metal, or other special-purpose materials, as required.

Of course the long life, heavy-duty features of the improved SQD Relay can be had in the conventional type of plug-in relay, if regular sockets are preferred for use, whether in printed circuitry or other applications.

To get complete details, write: Automatic Electric Sales Corporation, 1033 West Van Buren St., Chicago 7, Illinois. *In Canada:* Automatic Electric (Canada) Ltd., Toronto. *Offices in principal cities.*

RELAYS **SWITCHES**

PRODUCTS OF THE INDUSTRIAL DEPARTMENT OF

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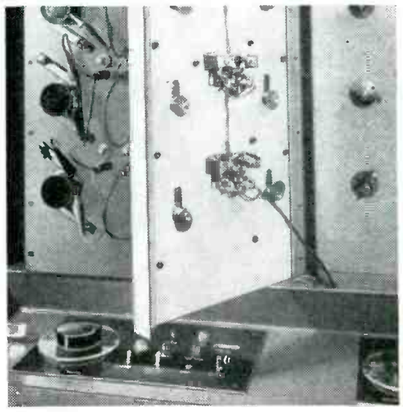
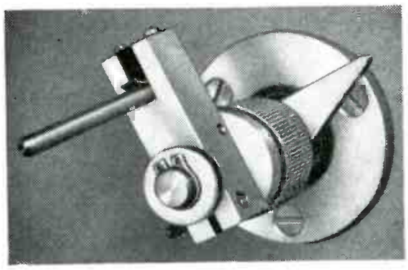
shaft is accomplished through an eccentric slotted disk behind the door and its matching adjustable slip clutch. The knurled nut of the clutch is threaded on a shaft which rotates with a sprocket wheel behind the panel. This nut can be set for desired friction on a cork washer and locked in position by the wing nut behind it. The cork washer bears against the smooth disk in front of it; the coupling



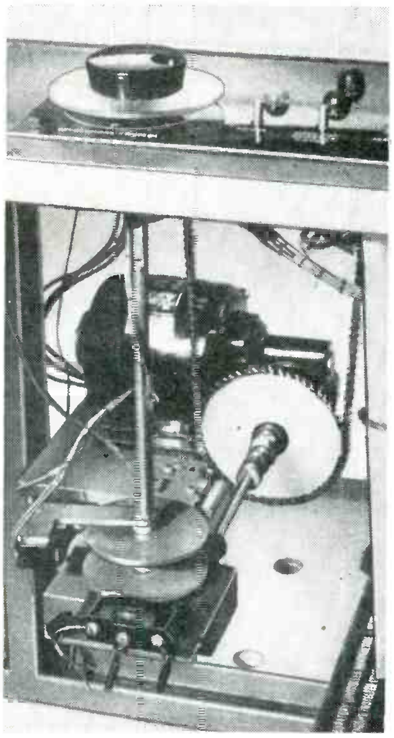
Door swung open to show eccentric slotted disks for each potentiometer. These mate with chain-driven slip clutches at right when door is closed



Slip clutch and drive pin

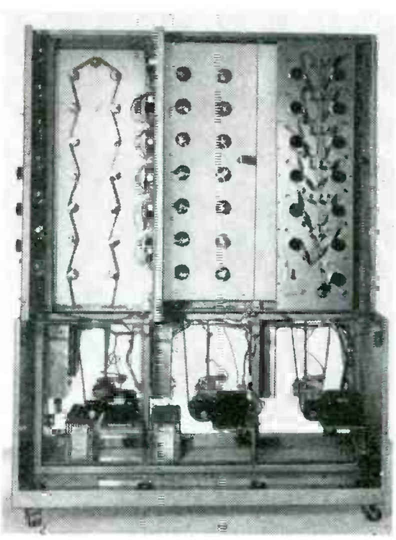
rotates integrally with this forward disk. Spring loading of this coupling eliminates any axial or angular misalignment which might put binding pressure on the bearing of a potentiometer being tested. Unique parabolic washers back-to-back between the coupling and the retaining washer provide flexibility in the plane perpendicular to the shaft. The spring-loaded pin projecting from the coupling engages the eccentric slotted disk.

Setting the number of revolutions per cycle is simple on the life tester. Directly below the horizontal knob on the control panel is a pair of cams. The lower cam activates a fixed snap-action switch to initiate a cycle of revolutions. The cam



Two cams at bottom control revolutions per cycle. Switch for lower cam is fixed, but switch for upper cam can be rotated around cam by knob on control panel at top

above it, which reverses rotation half-way through a cycle, is phased in relation to the lower cam. The control knob, rather than adjusting the position of the upper cam, rotates a floating snap-action switch. The cams are driven in phase with the potentiometers by a shaft extension from the motor which termi-



Three stages of undress in life tester. At right are units mounted on door. Center door is swung open to show clutches. At left, both door and inner panel are swung open to show chain drive for bay

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nates in a reduction worm gear.

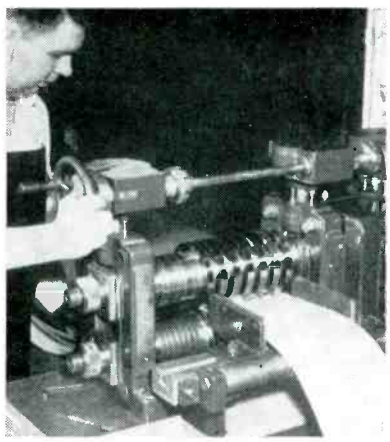
A chain drive connects the main sprocket gear on the motor with 14 small sprocket gears. Each of these small gears is mounted on a shaft which drives two adjustable slip clutches, one on each side.

Silicon-Steel Slitter Cuts Transformer Costs

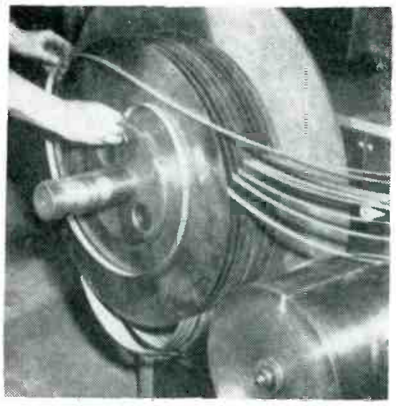
BECAUSE THE NARROW strip widths required for special wound-core transformers were not available from mills, Instruments & Accessories Co. of East Islip, N. Y., formerly had to use a costly outside slitting service. Now, using a standard production-model rotary gang slitter manufactured by the Stanat Mfg. Co., Long Island City, N. Y., the transformer producer has reduced silicon steel strip cost 60 percent, improved product quality, reduced inventory requirements and speeded production. It is estimated that the slitter will pay for itself in less than two years.

Incoming material in coils weighing up to 1,200 lb in varying gages is mounted on a pay-off, fed through the slitter and rewound on an automatic recoiler. The slitter permits production of samples within hours to accompany bids. Small orders can be filled in a few days. This speed contrasts with the previous time-consuming method of ordering wide stock, sending it out for slitting and waiting for delivery before transformer production could begin.

The Stanat slitter virtually



Input end of 12-inch rotary gang slitter as set up for cutting 7¾ inch wide 0.012-inch silicon steel into ⅝-inch strands



Core plate recoiler being set up for winding twelve ⅝-inch silicon-steel slit strands coming from slitter

eliminates burrs, improves the stacking factor and permits the steel to wrap closer together. Contamination of the strip from lubricants is also eliminated because no lubricant is required with the slitter. The inherent accuracy of the slitter, largely due to a special floating upper arbor which aligns the individual upper and lower arbor knives, regularly produces ⅝-inch-width strip with a tolerance not exceeding plus or minus 0.001 in.

Each core plate of the recoiler has two starting slots (one for thin stock) and three radial banding slots. On setting up the line, each slit strand is looped around the core plate and then inserted in a starting slot. Once the slitting operation is completed, the tightly wound slit coils are banded and removed with their respective core plates. All danger of coil telescoping or unwinding is thus eliminated.

Press-Driven Turntable Aids Printing of Selenium Rectifiers

A CHAIN-DRIVEN turntable on a Markem industrial printing machine boosted output and achieved greater uniformity in printing code numbers and ratings on radio stacks at Radio Receptor Co. in Brooklyn, N. Y.

A simple knockout bar bolted rigidly under the turntable serves to push each selenium rectifier unit out of the turntable slot and down the chute into the tote box after

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Selenium rectifier printing setup. Press operation and indexing are automatic, with speed being adjustable. Knockout bar has just pushed a stack out of turntable

printing. The operator thus only has to insert the stacks in the turntable slots, with terminals inward for uniform printing.

Color Transparencies Aid Assembly

COLOR TRANSPARENCIES serve as a visual aid in the assembly of complex electronic components at Bell Aircraft Corp. in Buffalo, N. Y. Use of the Ecktacolor process has already substantially reduced production time and costs.

One of the most encouraging aspects of this process is that it promises to reduce substantially the reams of drawings and blueprints necessary to build an established moderate-sized electronic unit.

One of the major problems stemmed from equivocal interpretations of drawings originating in various engineering groups. It was extremely difficult to show proportionately, and with clarity, the relationship of a particular cable to another component.

This was especially true in complicated instrumentation where personnel were required to maintain extreme conformity in regard to the various radii of wire bends, slack slopes on terminated wires and certain formations on component leads.

The problem of inspection became so arduous before the introduction of color transparencies that it was suggested a sample be maintained at all times of each of the hundreds of various units involved. The cost would have been exorbitant.

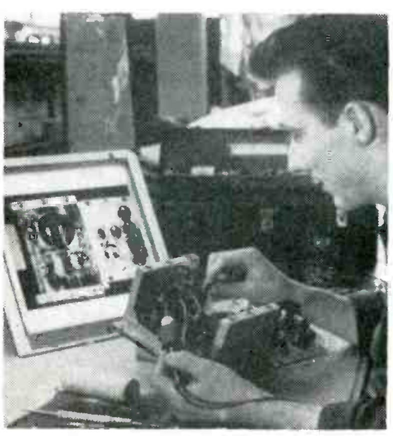
Previously, prototype models of each assembly were built and retained, serving as visual aids for wiring of subsequent units. This method alone tied up costly units which could have been consigned for shipment.

Assemblers, working from blueprints and schematic diagrams, often had to refer to the prototypes, which necessitated personnel constantly moving back and forth between their benches and the models on display.

The photo process resolved this problem by a click of the shutter and the printing of duplicate copies for each operator in the plant's photographic department.

Ecktacolor differs from other processes in that a color negative, from which any number of transparencies can be made, is used. It eliminates considerable expense and the risk of inferior quality that would be experienced in making enlargements from positive transparencies such as Ecktachrome.

The color transparency, a replica of the finished product, is placed in an inexpensive Kodak transparency illuminator (10 in. × 10 in. Model L viewer) or in a Plexiglas envelope under a bench light. This clearly shows the maze of wires the drawing was designed to display, each in its true identifying



Color transparency mounted in illuminator guides assembler by showing in true color the correct position of each lead and component

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color at exactly the desired position.

In a relatively short time a semi-skilled operator can begin to associate the various colors with the circuit functions of the wire colors. Thus, the problem of human error is minimized with this colored replica of the finished product before the operator at all times.

Color transparencies also answered the problem of extreme uniformity. Unlike the delicate and costly models which had to be kept in one location, the transparencies can be brought into the work area and easily handed from bench to bench. They can be filed away and afford a permanent record for future reference.

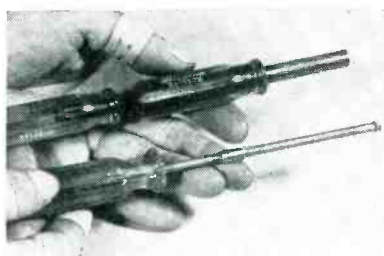
In the event of engineering changes, taking a new color photograph is less costly than the preparation and distribution of new drawings. Color prints of new models can be serviced to the department in a matter of hours.

As production demands increase, the Ecktacolor process can be developed to show the incremental stages in the manufacturing of a unit. The various stages can be placed in leaflet book form and each stage of progress flipped over the viewer.

Nut Starters

By RONALD L. IVES

TWO SPECIAL TYPES of nut starters have been found especially useful in modifying complicated electronic assemblies. One consists of a hex wrench operated by a lower handle, sliding over a threaded core that is operated by the upper handle, as shown in Fig. 1. In use, the nut is



Nut starters for work at close quarters. Upper starter is hex wrench with threaded core to hold nut during starting. Lower starter, having threaded stud inserted in coil spring, is shown with nut in position

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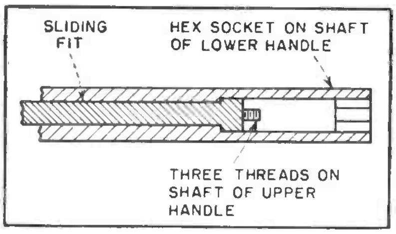

FIG. 1—Cross-section of two-handle starter for nuts

placed in the hex socket and engaged by the threaded core, then placed end-on to the screw. Both handles are turned together until the nut engages, the threaded core is retracted by turning the upper handle, and the nut then is screwed tight with the lower handle. The starter is then removed.

The other starter consists of a short threaded stud which is screwed into a length of coil spring (spring curtain rod) and held fast with soft solder. A handle is attached to the opposite end. In use, the nut is threaded onto the stud a few turns and brought against the screw. The handle is then turned until the nut engages. The nut is now held from turning by pressing against it with a screwdriver blade or other convenient tool and the starter is removed by unscrewing. The nut is then tightened with conventional tools. Because the shaft of this nut starter is flexible, it can be offset considerably, making it possible to start nuts in crowded locations.

Electrode-Centering Jig

TO PREVENT electrodes from scratching and deforming each other during tube assembly, sliding guides are used in connection with a bench-mounted holding fixture in Tung-Sol's Bloomfield, N. J. plant.

Assembly involves placing the base mica in the holding fixture, then inserting the cathode-heater assembly in the mica manually. The hinged slide is now brought up into position for sliding the grid down over the cathode without touching it. Other grids similarly ride down over the first grid with the aid of other grooves in the slide, and finally the plate is brought down. The guide is then pushed down out of the way and the top mica is put

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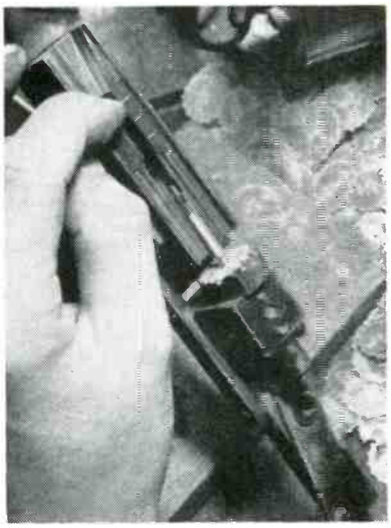


Method of sliding anode into position without touching grids of tube assembly

on to complete the assembly. This technique has greatly reduced assembly rejects.

Trenches Replace Pipes in Tube Plant

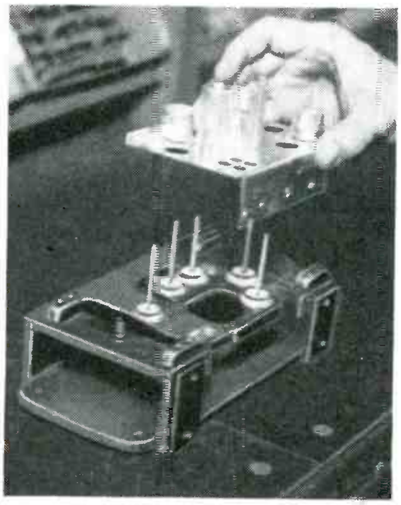
A SYSTEM of acid-proof brick trenches, pitched downward in the floor to a settling tank, is used to carry off acids in the chemical room of the new General Electric industrial and transmitting tube plant at Scranton, Pa. The hydrofluoric, chromic, sulphuric and other acids are used in cleaning and plating tube parts.

The trench system is used in lieu

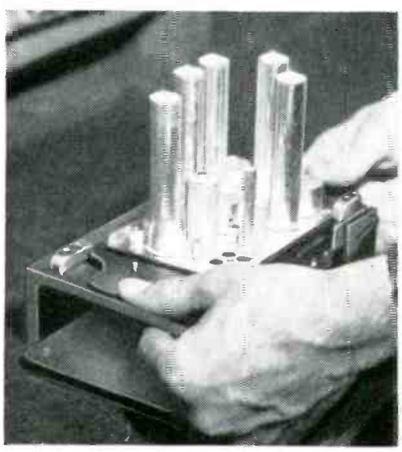
Acid-proof brick trench 15 inches deep carries away corrosive acids in plating room of tube plant of piping, and allows a large-capacity drainage system without the necessity for pipe replacements. Maple or cypress duckboard cover the floor to allow workers free movement about the room.

Metal Jig Aids Assembly of Coaxial Tuning Units

ASSEMBLY of the antenna, r-f and mixer stages for 144-174-mc com-



Placing chassis on jig after nuts of tuning elements have been set into recesses



Method of pressing side levers to pry chassis out of jig

munication receivers is done with the aid of a bench-mounted metal jig in Motorola's Chicago plant. The five silvered ceramic nuts are placed in the jig, the chassis is dropped down over these and a threaded wrench is used to tighten each in turn. Spring-loaded levers on the sides of the jig are then pushed down to pry out the chassis.

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New Products

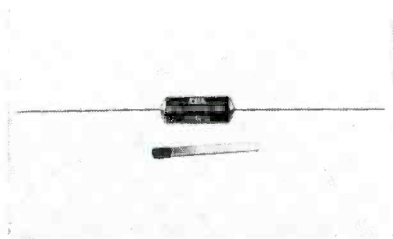
Edited by WILLIAM P. O'BRIEN

73 New Products and 54 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

TIME INTERVAL METER
and frequency standard

WESTPORT INDUSTRIES, 149 Lomita, El Segundo, Calif. The WE-210 is a small, lightweight, inexpensive, yet highly accurate time interval meter and frequency standard using glow-transfer tubes in the counter and a crystal-controlled oscillator as the time base. Time is displayed directly to the nearest 0.0001 sec by four easily read decades. Two ranges of 1 and 10 sec are provided; however, longer intervals are easily noted by watching the thousands decade, or through use of an auxiliary electromechanical register. The WE-210 can be used for timing high-speed electrical or mechanical devices such as: relays, actuators and camera shutters. The instrument also operates as an electronic counter having a maximum counting rate of 50,000 pps. One-kc and ten-kc front-panel outputs are provided for use as a frequency standard.

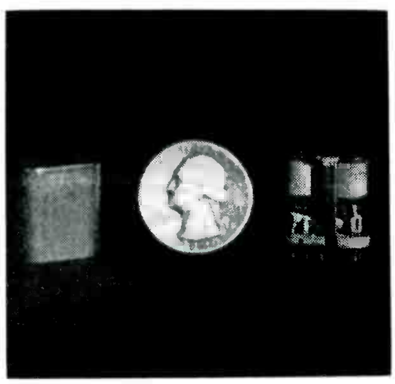
TINY RESISTOR
in glazed steatite jacket



RESISTANCE PRODUCTS CO., 914 S. 13th St., Harrisburg, Pa. Neither excessive humidity nor adverse climatic conditions have any effect upon the stability of type HSD miniature high megohm resistor which is hermetically sealed in a glazed steatite jacket. Measuring only $\frac{7}{8}$ in. long by $\frac{11}{32}$ in. diameter and being light in weight, permits this resistor to be soldered directly into the circuit with no support other than the wire leads. Noise level is extremely low. Maximum voltage is 2,500. Maximum resistance value is 10 million megohms. Standard tolerance is ±10 percent. It is also available in ±5 percent and ±3 percent.

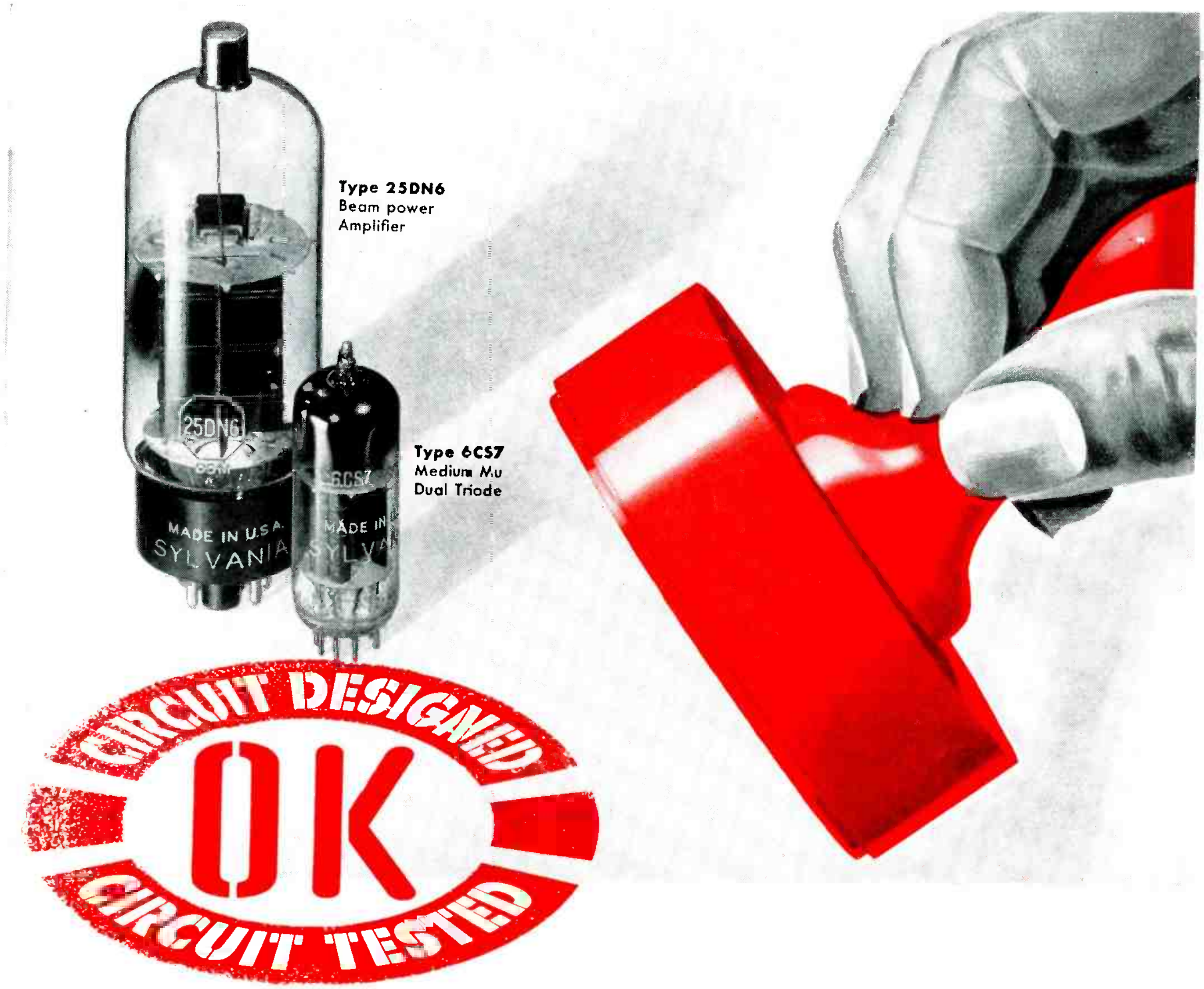
SMALL RELAY
for aircraft system use

GENERAL ELECTRIC CO., Schenectady 5, N. Y., has announced a new hermetically sealed microminiature relay that is less than an inch in height and weighs only 10 grams. For use in aircraft systems, the relay has a contact rating of 2 amperes resistive load at 30 v d-c or 115 v a-c. Simplicity of adjustment and extra assurance of reliability are achieved by a balanced armature design, which also gives high resistance to shock and vibration. Rated for operation at 1.5 milliseconds, the sealed relay has contact springs of beryllium copper, designed to hold their adjustment indefinitely during temperature cycling and storage. Shock rating is over 50 g, and vibration resistance is 10 to 55 cps at 0.12 in. maximum excursion and 55 to 500 cps at 20-g acceleration. Two models are available which can be supplied with a variety of terminal types and mounting brackets.



NOISE VOLTMETER
covers 20 cps to 200 kc

MILLIVAC INSTRUMENT CORP., 444 Second St., Schenectady 6, N. Y., has developed a new rms noise voltmeter which covers a frequency range of 20 cps to 200 kc with its internal rms voltage detector (crys-



"Circuit-designed and circuit-tested" to meet today's TV requirements

Add two more to Sylvania's long list of original tube developments. Typical of all Sylvania "Originals" these tubes fill timely and important applications for the equipment designer.

One meets the TV designer's need for a horizontal amplifier suitable for low B+ chassis applications. The other provides a dual-purpose tube combining a higher-rated vertical deflection amplifier and oscillator for normal B+ chassis. Each type is "circuit-designed and circuit-tested" for optimum performance in its application to the modern television receiver.

For complete information on the New Sylvania types 25DN6 and 6CS7, check the appropriate space. Or if you have interests in other equipment fields let us send you a complete listing of Sylvania "circuit-designed and circuit-tested" tubes.

Type 25DN6

"Circuit-designed" for horizontal amplifier use in *off-the-line* low B+ series-string TV applications; and to eliminate "snivet" problems.

"Circuit-tested"—to exhibit a low plate knee characteristic and deliver high peak currents which are necessary for proper deflection.

Type 6CS7

"Circuit-designed" to provide an oscillator combined with a vertical deflection amplifier with higher plate dissipation (6.5 watts).

"Circuit-tested" — to deliver optimum performance at higher ratings under the more stringent operating conditions of modern circuitry.

Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

☐ Please send complete data on the new 25DN6 and 6CS7

Please send information on other "circuit-designed and circuit-tested" types as indicated below.

☐ Other entertainment types ☐ Control equipment types
☐ Military equipment types ☐ Test equipment types
☐ Special-purpose types ☐ ______________types

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Address____________________________

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In Canada: Sylvania Electric (Canada) Ltd.,
University Tower Building, Montreal

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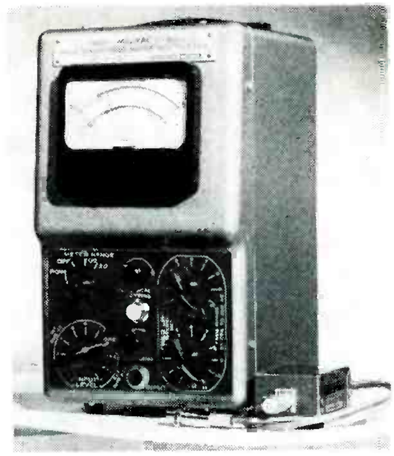
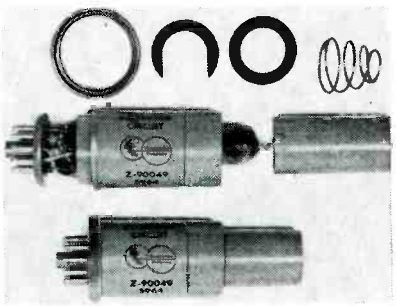
tal diode) and frequencies up to 200 mc with its external probe-style detector. The main advantage of the instrument and the noise measuring method upon which it is based is that measuring accuracy does not depend upon the frequency response of attenuators, the freqency spectrum of noise generators, nor upon the frequency response of oscilloscopes. Noise measurements are made by feeding into the amplifier under test reference signals from a calibrated signal generator. The MV-19A noise voltmeter measures the output of the amplifier. An adjustable meter-input-divider reduces amplified signals and amplified noise to a sufficiently low level at which the rms detectors of the instrument operate strictly in their square-law region. Millivac's high-impedance chopper-type d-c millivolt amplifier then converts the weak d-c signals from the rms diode into meter-deflections on a square-law-dial, making readings of the ratio between the calibration signal and the residual rms noise voltage possible.



SQUARING CIRCUIT
packaged as plug-in unit

EECO PRODUCTION CO., 827 South Vermont Ave., Los Angeles 5, Calif. Squaring circuit Z-90049, designed to operate from 0 to 1 mc, is intended to square input sine or complex waveforms. It is packaged as a plug-in unit with an 11-pin base. The plug-in unit has a 1½-in. overall diameter and an overall height of 4$\frac{5}{32}$ in. The unit weighs about 3.25 oz and is provided with a removable tube shield. It requires a peak-to-peak input signal of 25 v; +200 v d-c at 12 ma, −200 v d-c at 1 ma, and 6.3 v at 300 ma. The squaring circuit provides a 110-v peak-to-peak square or rectangular wave output up to 200 kc and 85 v at 1 mc. It has a negative-going rise time of 0.4 μsec or less and a positive-going decay time of 0.8 μsec or less. It has an output impedance of less than 10,000 ohms.

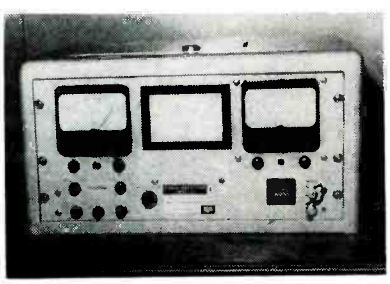


EPUT METER
counts to 100,000 in 1 sec

RANSOM RESEARCH, P. O. Box 382, SanPedro, Calif. Model 1005 is a 5-digit events-per-unit-time meter counting up to 100,000 in 1 sec with an accuracy of ±1 count. The instrument is intended for industrial, military and laboratory applications for measuring the rate of occurrence of mechanical or electrical phenomena during a 1-sec period. A crystal-controlled timing circuit, accurate to 0.001 percent at room temperatures, gates the second counter for a 1-sec time interval. The count is directly displayed on the faces of direct-reading decade scaler tubes. The instrument will operate at −20 dbm level from 60 cycles to 100 kc. Input impedance is 100,000 ohms. Price of the unit is $495.

NOISE METER
aids transistor users

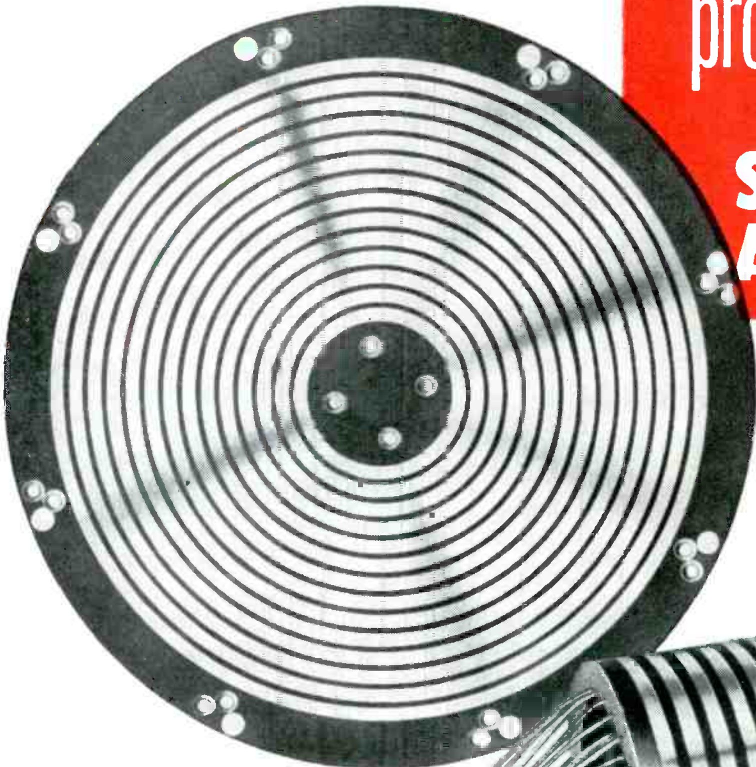
RADIO RECEPTOR CO., INC., 240 Wythe Ave., Brooklyn, N. Y. A new, simplified transistor noise meter, furnishes accurate information on the noise figure of a transistor in a single simple reading by simply inserting the transistor into a socket. The new device is useful for large-scale users of transistors, such as hearing-aid companies and manufacturers of radio receivers. The equipment is 21½ in. wide, 10⅞ in. high and 16¼ in. deep. It contains a novel, rapid-insertion transistor socket and provision so that the test set may be used in conjunction with other transistor test equipment with a single insertion of the transistor. The unit sells for $625.



TV PICTURE TUBES
with 90-deg deflection angle

CBS-HYTRON, A Division of Columbia Broadcasting System, Inc., Danvers, Mass., has announced two

Now available the revolutionary ELECTRO TEC process* for your LARGE SLIP RING ASSEMBLIES

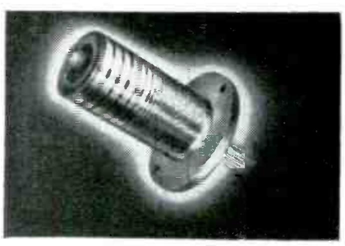


featuring

- LOWER COST
- CLOSER TOLERANCES
- ONE-PIECE CONSTRUCTION
- JEWEL-LIKE FINISH
- UNIFORM RING HARDNESS
- REDUCED WEIGHT

An assembly with 14 concentric, hard silver rings electro deposited into machined plastic blank. Dovetail locks rings in place. Machined blank insures accuracy. Diameter approx. 11", thickness approx. 5/16".

Cylindrical assembly with 25 rings. Three wide rings accommodate large contact area brushes for high current capacity. Length 14", O.D. approx. 5⅝".



An assembly with 30 rings of various widths to accommodate various current requirements. Unit is approx. 4-5/16" long, designed for flange mounting.

Cylinder type assembly approx. 3¾" long with 24 hard silver rings. 1⅝" O.D. with wall thickness less than ¼".

*PAT. NO. 2,696,570

Now a Complete Service in all sizes of Slip Ring Assemblies

ELECTRO TEC is now tooled up, with new expanded facilities for production of large Slip Ring Assemblies to exact customer specification. Sizes range up to 36" in diameter, either cylindrical or disc type.

The exclusive ELECTRO TEC PROCESS*—the electro-deposition of hard silver rings into an accurately machined plastic blank—consistently yields a high degree of dimensional accuracy, excellent concentricity, and a jewel-like ring finish. This process also eliminates expensive tooling and mold charges, frequently lowers costs to 30% of other methods of manufacture. The silver rings are uniformly hard for long life—70-95 Brinell.

ELECTRO TEC one-piece construction precludes dimensional variation due to accumulated errors. The plastic base is fully cured before rings are plated into it, thus preventing separation of base material from the rings.

ELECTRO TEC LARGE SLIP RING Assemblies are widely used in Radar Equipment, Fire Control Systems, Test Tables and many other critical applications. Light weight combined with rugged durability recommends their use in airborne applications.

Every user knows the ELECTRIC TEC reputation for quality and superiority in miniature and sub-miniature slip ring assemblies.

Our Engineering Department is available for consultation on any of your slip ring problems without obligation.

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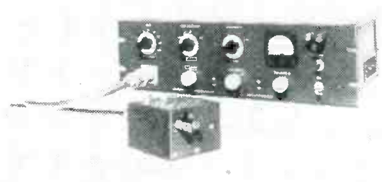
new tv picture tubes with a 90-deg deflection angle which provides a shorter overall tube length and thus cuts cabinet size. Types 17AVP4 and 17ATP4 differ mainly in that the first measures 15⅝ in. overall, and the second 16¼ in. Both are of all-glass, rectangular construction, with gray-glass spherical face plates that provide greater contrast under high ambient light conditions. Each employs an electron gun designed for use with a single-field external ion-trap magnet, and both have an outer conductive coating that, when grounded, serves as a high-voltage filter capacitor.

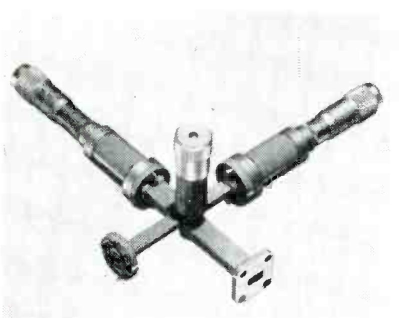
CALIBRATOR
for WWV transmissions

BROWNING LABORATORIES, INC., 750 Main St., Winchester, Mass. The RH-10A standard frequency calibrator is designed to receive WWV transmissions at 5 and 10 mc, and audio signals at 440 or 600 cycles. It has a sensitivity of better than 1 μv on all bands, image rejection of more than 50 db, and front-panel provision for coupling secondary standard and other r-f sources for comparison of fundamentals and harmonics. A built-in panel speaker enables audible monitoring. Price is $295.



D-C AMPLIFIER
a wide-band, high-gain unit

AMERICAN ELECTRONIC LABORATORIES INC., Philadelphia, Pa., has developed a d-c amplifier combining high gain, low noise and drift, and wide band-pass. Features include: push-pull input and output circuits with input impedance of 100 megohms and grid current of 10^{-8} amperes or less; band-pass flat to 50 kc minimum and usable to 100 kc; front-panel selectable bandwidth (down [illegible] at upper limit) of d-c to 100 cps, 400 cps, 1 kc and 4 kc. Sensitivity may be varied by a calibrated attenuator with maximum gain of 100 db (100,000). Drift obtainable is 5 μv per minute or less. In-phase signal rejection is adjustable to 50,000: 1. Noise level is held to 10 μv rms or less at full bandwidth.



CRYSTAL MULTIPLIER
for ultramicrowave research

DEMORNAY-BONARDI, 780 S. Arroyo Parkway, Pasadena, Calif., has announced a crystal multiplier designed to produce frequencies above the range of currently available tubes, and thus enable experimentation in the ultramicrowave region up to 90,000 mc. Designated DB-350, the multiplier is designed especially for harmonic power generation at the second, third, fourth or fifth harmonic. It consists of an input waveguide of a size appropriate to the input frequency, an output waveguide and a tunable crystal holder.

VARIABLE INDUCTORS
in 16 standard values

LEVINTHAL ELECTRONIC PRODUCTS, INC., 2760 Fair Oaks Ave., Redwood City, Calif. Carbonyl-iron cup-core units completely embedded in epoxy resin, the style B type 1 variable inductors are provided in 16 standard values from 56 μh to

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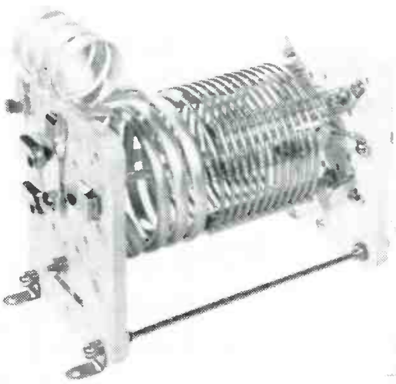
18 mh. Their construction makes them resistant to the effects of large amplitude vibration and shock, as well as moisture and chemical attack. Tunable over an inductance range of 2 to 1, these inductors have voltage ratings of 400 v and power-dissipation ratings of 5 w at 20 C temperature rise. On special order, these units can be provided in values up to approximately 200 mh, and in the form of complete sealed tuned circuits with shunt capacitors included to specification. The type 1 formula of the core material gives constant inductance characteristics free from nonlinear effects. The units are operable over a temperature range from −50 C to +100 C, with a temperature coefficient of inductance less than 50 ppm per deg C.

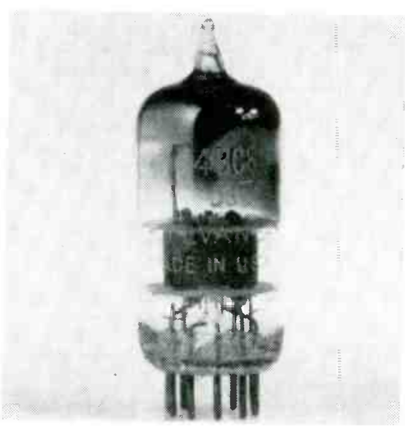


PI-NETWORK INDUCTOR with full bandswitching

BARKER & WILLIAMSON, INC., 237 Fairfield Ave., Upper Darby, Pa. A compact 1-kw pi-network tank coil with full bandswitching provides maximum efficiency operation from 80 through 10 meters for high-power pi-network final amplifiers. Designed for class C or linear operation using triodes or tetrodes in conventional or grounded grid circuits model 850 permits instant selection of the desired operating band through a positive-acting, high-current r-f switch. Stepped sectional coil windings, of extra heavy conductor at the higher frequencies, provide ample current carrying capacity and minimum Q of 300 across the entire operating range. Construction features assure high efficiency, minimum power loss and adequate safety factor. Bulletin 850 gives complete information.

SIGNAL GENERATOR
covers from 160 kc to 110 mc

TRIPLETT ELECTRICAL INSTRUMENT Co., Bluffton, Ohio. Model 3432-A signal generator has complete frequency coverage from 160 kc to 110 mc with no skips in frequency for a-m/f-m radio, monochrome or color tv servicing. The r-f circuits are double shielded with copper steel shields, and a cathode follower output provides good stability by acting as a buffer to the oscillator. Jacks are provided for either internal modulation or audio output, and both are controlled by audio control to provide variable modulation or a-f output. Model 3432-A has a large, easily read, etched aluminum dial, as well as a smooth planetary drive dial for ease and accuracy in adjustment.



TWIN TRIODE
is new miniature type

SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y. The 4BC8 is a medium mu, semi-

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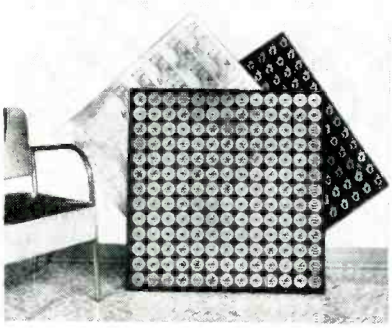
remote cutoff twin triode which offers more satisfactory performance in agc systems. It is intended for application as a vhf cascode amplifier in series string television receivers and features a 600 ma, 4.2 v heater, with controlled heater warmup time. Objectionable cross modulation effects are minimized under both strong and weak signal conditions.

BINARY MULTIRESISTOR
is highly accurate

JULIE RESEARCH LABORATORIES, 341 E. 149th St., New York 51, N. Y. The BMR-105 binary multiresistor is designed for general computer use, digital-analog conversion, and as a set of laboratory resistance standards. The 4 in. × 5 in. × 2½ in. sealed metal unit contains a number of highly accurate resistors having resistance values in a binary sequence. By suitable interconnection of individual resistors, resistance values between 0 and 131,070 ohms may be realized in 2-ohm increments. At maximum setting this amounts to a resistance accuracy of 0.0015 percent. Overall temperature coefficient of resistance is within ±5 parts per million per deg C at 20 C.

TIME INTERVAL METER
features versatility

SUNSHINE SCIENTIFIC INSTRUMENT, 1810 Grant Ave., Philadelphia 15, Pa. A direct reading electronic time interval meter accurately measures short time intervals from 1/10,000 sec to 3 sec. It will measure the duration of an electric pulse, the time between various combinations of positive and negatives impulses, the time between two impulses with an impulse from a second source intervening, signals actuated from one or two sources, and the time between various combinations of electric and light impulses. Accessories include a calibrator, which allows use of the instrument as an instantaneous frequency meter, a photoelectric receiver and a light source. Catalog No. 2, now available, describes the instrument in detail.



PRINTED CIRCUITS
by photoengraving method

CHEM-ETCHED CIRCUITS, INC., 121 S. Cowen St., Garrett, Ind., offers a new development in printed circuits produced by the photoengraving method. New type automatic equipment, turning out multiple-unit sheets as large as 36 in. square, gives high capacity production while holding critical accuracy. High-volume automatic production of photoengraved circuitry is now available. The method facilitates production of switch plates, control boards, coils, capacitors, commutators and code disks.

VHF TRANSMITTER
for aircraft use

DAYTON AVIATION RADIO AND EQUIPMENT CORP., Troy, Ohio, has available a 22-channel aircraft transmitter that may be employed on any vhf channel from 118.0 to 127.0 mc. A uniform power output

 For additional information on all items on this page, use post card on last page.

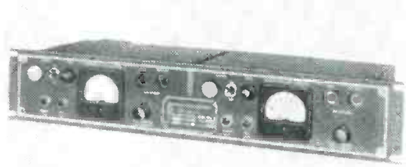
of 3 to 4 w is provided on any channel within the range. This uniformity is provided by a new capacitor tuning system in which rotation of the channel selector switch also rotates a ganged segmented capacitor, providing precise peaking for three tuned circuits. Each segment of the capacitor rotor is employed on three channels, with a frequency spacing of up to 2 mc for each group of channels. Crystal-controlled oscillator, plus temperature compensated components and precise tuning adjustments result in a frequency stability of 0.01 percent or better on all crystal channels. Measuring only $2\frac{1}{2}$ in $\times$ $3\frac{1}{2}$ in. $\times$ $7\frac{3}{4}$ in., the transmitter weighs 1 lb 6 oz.

DELAY LINE
is ±0.5 percent accurate

Advance Electronics Co., Inc., 451 Highland Ave., Passaic, N. J. Type 605 precision variable delay line consists of 60 sections of L-C m-derived networks and one 60-position rotary switch. The L-C m-derived networks are especially designed for fast rise time and negligible overshoot. The rotary switch is used to change the amount of time delay between the input and output by connecting the output terminal to any one of the 60 sections of L-C networks. The input impedance of the delay line is equal to the characteristic impedance. The output terminal should be connected to a high-impedance load, such as the grid circuit of the amplifier. Accuracy of time delay can be as high as ±0.5 percent of the time delay at any point. The device can be used for distant measurement in radar systems, phase and time-delay measurement of various signals, or time delay for pulse circuits.

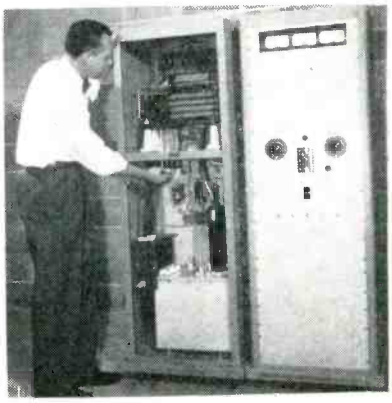
FREQUENCY STANDARD
is transistorized unit

ELDICO OF NEW YORK, INC., 72 E. Second St., Mineola, N. Y. The FS-100 is a precision transistorized, self-contained 100-kc frequency standard that is self-powered by a miniature battery. Due to the low current drain of the 2N38 transistor, shelf life of the battery is obtained. A miniature variable capacitor is provided to zero the frequency standard with WWV. Operation is simple. Just throw the switch and couple to the receiving antenna. The 100-kc transistor oscillator will give accurate frequency measurements every 100 kc's on the receiving dial. The FS-100, although intended for mobile operation, is not limited to mobile use.



HALF DUPLEX ADAPTER
has unique break circuit

NORTHERN RADIO CO., INC., 147 W. 22nd St., New York 11, N. Y. Type 181 dual half-duplex adapter couples a 4-wire full duplex tone telegraph system to a half-duplex 2-wire d-c teleprinter loop. This makes possible the half-duplex operation of the tone links, and in such a system a teleprinter in any d-c loop becomes a two-way nonsimultaneous system, with any other teleprinter in any other d-c loop associated with a remote tone station. In a half-duplex circuit, two-way communication cannot be carried on simultaneously and the stations have to take turns in the use of the circuit. Thus in the case of urgent messages, it must be possible for any teleprinter to break into the transmission of any other teleprinter and thereby show its need to take over the circuit. For this reason the adapter is provided with an exclusive break circuit which immediately recognizes a break signal and automatically switches the adapter from its transmit to its receive position. This permits a receiving operator to break into the circuit, bring the system closer to full-duplex operation. An automatic mark restoring circuit is built into the adapter.



LAB POWER SUPPLIES having 50-kv isolation

LEVINTHAL ELECTRONIC PRODUCTS, INC., 2960 Fair Oaks Ave., Redwood City, Calif. Developed to provide the flexibility of use necessary for experimental work with klystrons, t-w tubes and other microwave devices, a series of power supplies is available having 50-kv isolation from ground on both sides of the h-v circuit so that several units can be operated in series where desired. Two of the models have continuously-variable outputs from 0 to 1,000 v and from 0 to 2,000 v at 200 ma. Operable from inputs of 105 to 125-v single-phase 60-cps power, the supplies exhibit regulation to a maximum of 0.5 percent over that input range, and ripple of less than 0.5 v peak-to-peak at any output. Suitable metering with 1.0-percent accuracy is included. Units are completely protected by interlocks and automatic short-circuiting devices.

POWER TETRODE
is water and air-cooled

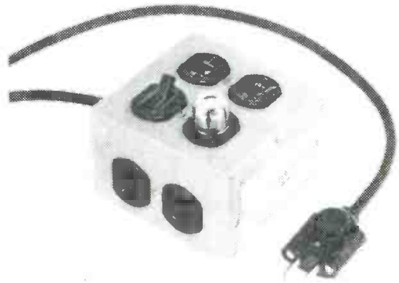
EITEL-MCCULLOUGH, INC., San Bruno, Calif. The 4W300B radial-beam power tetrode, designed for operation as an amplifier, oscillator or frequency multiplier into uhf, is a water and air-cooled version of the Eimac 4X150A. Rated at 300-w plate dissipation, the tube delivers 140 w of useful power output at 500 mc in a coaxial-cavity amplifier circuit. The Eimac 4X150A/4001 air-system socket is recommended for use with the new tetrode.

CRYSTAL HOLDER
is 2 in. long overall

SAGE LABORATORIES, INC., 38 Guinan St., Waltham 54, Mass., announces a new miniaturized crystal holder, the SL-101, designed for use with the new Sylvania tripolar crystal diode—types 1N358, 1N369 and 1N369A. It incorporates a

 For additional information on all items on this page, use post card on last page.

broadband bead, which provides a minimum bandwidth of 1 to 12.4 kmc. When the holder is terminated in a matched load, the maximum vswr is 1.6 over the specified frequency range. The input is a type N male connector, the output is a 50-ohm Microdot receptacle. The signal output from the mount is negative. The holder, with crystal inserted, can be used as a video detector or as part of a crystal mixer.

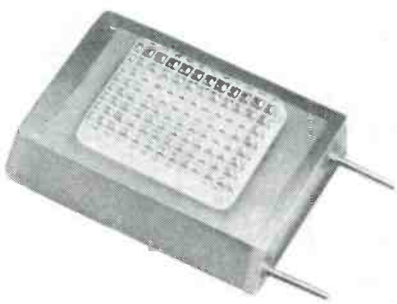


FUSED OUTLET BOX
prevents down time

THE KENRU CO., Box 121, Parsippany, N. J. A new type portable multiple electric output box is trade named Safcorde. Primary feature is that both wires are fused, eliminating the possibility of blown fuses at the switch box, thus preventing down time to other equipment and lighting circuits. One flick of the switch provides complete control without pulling individual cords. The unit consists of 6 heavy duty outlets, control switch, pilot light and fuses rated at 10 amperes on 115 v a-c or d-c.

PRECISION RESOLVER
is a boosterless unit

JOHN OSTER MFG. CO., Avionic Division, 1 Main St., Racine, Wisc. A new size 15 boosterless resolver, type 3D-2348, is now available. No associated amplifiers and compensators are necessary because of the small variation in transformer ratio and phase shift with varying input voltage. Axis misalignment is ±7 minutes and maximum angular error 0.12 percent. Input voltage ranges from 0 to 16 v, 400 cps. Input impedance is 740 at 79 deg. The unit is available with terminal connectors and is designed for phase shifting and interchanging rectangular and polar coordinates in computer applications.

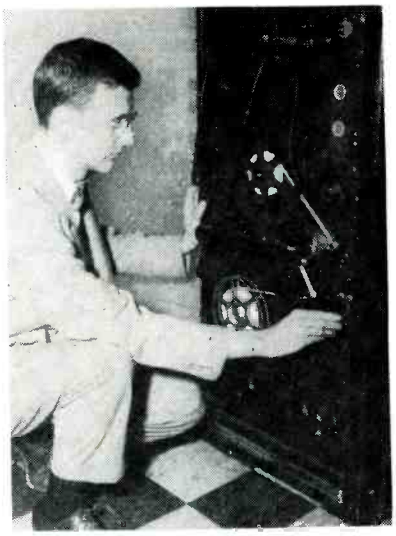


PHOTOCONDUCTIVE CELL
operates relays

CANADIAN MARCONI CO., 2442 Trenton Ave., Montreal 16, P. Q., Canada, announces a new photoconductive cell handling power up to 0.3 w. It eliminates the electronic amplifier, the vacuum photocell and the d-c power supply. The cell is designed to operate relays and other devices on voltages from 110 v to 1.5 v a-c or d-c with incident light values from daylight (1,000 ft candles) to moonlight (0.020 ft candles). Sensitivity is 0.40 ampere per lumen.

WHITE DOT GENERATOR
with vertical sync pulses

WINSTON ELECTRONICS, INC., 4312 Main St., Philadelphia 27, Pa. The Win-Tronix model 160 is a white dot linearity generator. The unit is compatible for black-and-white or color tv, and provides both large and small white dots for ease of color receiver convergence, plus vertical and horizontal bars for sweep circuit alignment. Internally generated vertical sync pulses and locked-to-line frequency give stable operation. The instrument has r-f carrier output and external modulation provisions.



CODE CONVERTER operates automatically

C. G. S. LABORATORIES, INC., 391 Ludlow St., Stamford, Conn. The Trak code converter receivers International Morse code and translates it automatically and accurately into teleprinter code signals for operating a standard teletypewriter and producing printed page copy. It may receive the code in the three following ways: (1) output of a radio receiver or tone line as a keyed audio tone; (2) hand keyed or automatic keying as a keyed d-c voltage; (3) an undulator inked tape fed past a photoelectric scanner which will deliver a keyed direct current. If a character is sent that is not recognized as a normal Morse code character of proper dots and dashes, or where it is unintelligible, the converter refuses to translate. Instead, it transmits a question mark character and the teleprinter will show such mark in place of the unintelligible character.

QUARTZ CRYSTAL is all-glass, military type

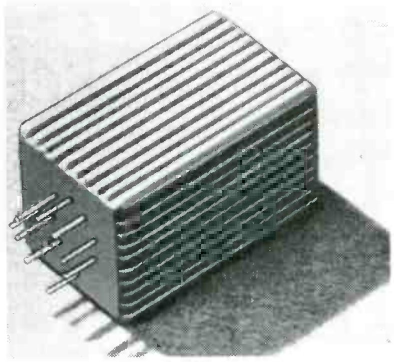
ROGERS MAJESTIC ELECTRONICS LTD., 11 Brentcliffe Road, Toronto, Ontario, Canada, has developed an all-glass, military type quartz crystal which will overcome electronic equipment failures due to crystal aging. The quartz crystal is contained in a high vacuum where it maintains its activity and frequency stability under external operating conditions which cause frequent failure to crystals in metal type containers. Installed in military type, portable radio transmitters, the new all-glass crystal was subjected to conditions simulating extremes of arctic and tropical weather. The new crystal is interchangeable mechanically and electrically with the most commonly used types of military crystals.

FASTENER
for tv focusing units

TINNERMAN PRODUCTS INC., P. O. Box 6688, Cleveland 1, Ohio, has developed a new Speed Nut which serves as both a fastener and a spacer on a tv focusing unit. Eliminating several auxiliary parts and providing extremely fast, simple assembly, the fastener incorporates a U-shaped portion which is merely slipped by hand over the flanged rim of the focusing unit's frame. Then the unit itself is positioned on the formed box section of the fastener, the clearance holes are aligned, and the screw is driven to provide a self-locking, self-retaining fastener and spacer all in one piece.

CLAMPED FLIP-FLOP
is transistorized

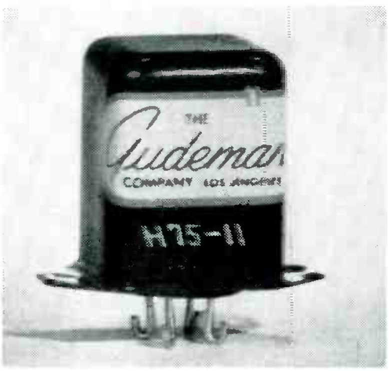
SPRAGUE ELECTRIC CO., 35 Marshall St., North Adams, Mass. Designed to meet a need for a subminiature plug-in binary element for computer applications, the encapsulated type 200C5 flip-flop uses a new concept of printed circuit design. Power



and space requirements are about $\frac{1}{3}$ less than conventionally wired tube flip-flop circuits. The 200C5 is a bistable circuit designed for high-reliability application. Entirely transistorized, the circuit includes two junction transistors, two input diodes, and four clamping diodes. The entire unit, encapsulated in a plastic jacket for humidity resistance, measures just $1\frac{5}{8}$ in. × $\frac{15}{16}$ in. and has a standard 7-pin miniature tube-type plug-in base. Complete information is provided in engineering bulletin 801.

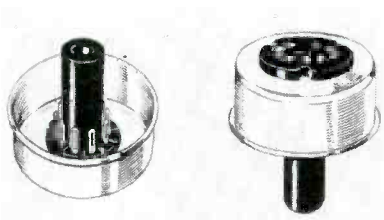
CRT BASING UNIT
is safe to handle

REICHERT BROS., Glen Rock, N. J. The Reicholder basing unit is designed to insure straight bases and to do this basing operation in a minimum length of time without blistering or damaging the glass neck or the Bakelite base. A specially designed heating unit with 110-w heater is used in the basing unit. This method of basing allows the Bakelite base to be heated by conduction and allows the heat to be concentrated in the required area. The basing operation takes 4 minutes and setting time is 2 minutes. The unit is safe to handle as no hot or current carrying parts have to be handled by the operator. The heating element is protected by a shield. Clamping actuator and handle are covered with a heat resisting material. The operator does not have to lift the tube for basing. The basing can be accomplished on the conveyor line or the basing unit can be suspended from above with a spring or a counterbalance and pulled down when needed. The unit can be built to almost every size crt.



PULSE TRANSFORMER
operates from - 70 C to 135 C

THE GUDEMAN CO. OF CALIFORNIA, INC., 9200 Exposition Blvd., Los Angeles 34, Calif., is offering a new two-winding, epoxy resin impregnated and hermetically sealed 75-μsec pulse transformer with a rise time of only 2 μsec. The new units, H75-11, meet MIL-T-27, grade 1, class A test specifications. Operating temperature range is from -70 C to 135 C. Size is $\frac{7}{8}$ in. $\times$ $\frac{7}{8}$ in. $\times$ $1\frac{1}{8}$ in. exclusive of terminals and mounting flange.



TUBE SOCKETS
are guaranteed anti-corona

NATIONAL FABRICATED PRODUCTS, INC., 2650 W. Belden Ave., Chicago 47, Ill., has available new high-voltage and anti-corona sockets for 1 $\times$ 2 type tubes. They meet UL requirements and are guaranteed

For additional information on all items on this page, use post card on last page.

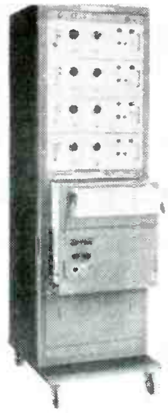
against tracking or carbonizing from corona. The sockets are designed to eliminate arcing when subjected to voltage between socket pins and screw extending $\frac{3}{8}$-in. in hole at bottom of post. Extremely compact in design, they are easily mounted to chassis with self-tapping screw. Diameter of cup is $1\frac{1}{2}$ in. or $1\frac{5}{16}$ in.; depth of cup, $\frac{1}{2}$ in. or $\frac{11}{16}$ in.; height of cup is $\frac{1}{2}$ in. or $\frac{11}{16}$ in.; height of post under socket is $1\frac{1}{8}$ in. or $1\frac{3}{8}$ in. or any combination required.

POWER TETRODE
immune to shock damage

EITEL-MCCULLOUGH, INC., San Bruno, Calif., announces the 4 × 5000A, a radial-beam power tetrode constructed entirely of ceramic and metal, thereby offering greater reliability and increased immunity to damage from thermal and physical shock. With a plate dissipation rating of 5,000 w and a power output of 16 kw in class C telegraphy service through 30 mc, it fills a power gap in the tetrode field. It is especially suitable for ssb operation. The simple coaxial structure allows low lead inductance and an integral finned anode permits improved cooling with low air pressure.

RECORDING SYSTEMS
used with analog computers

SANBORN Co., 195 Massachusetts Ave., Cambridge, Mass. Two new



oscillographic recording systems are now available, designed for 6 and 8-channel recording of analog computer output, or other applications involving sensitivity of 1 v per cm. The systems are complete, and comprised of model 150-2000 dual-channel d-c amplifiers and recorder assembly, housed in a metal mobile cabinet. The new systems have the 150 series operating features, including individual stylus temperature controls, 9 paper speeds, regulated power supplies, improved control of input signals by attenuator ratios of 1, 2, 5 and so on.

VTVM
operates automatically

BERGEN LABORATORIES, 22-02 Raphael St., Fair Lawn, N. J., announces the Voltohmatic automatic range switching vtvm. It features automatic a-c, d-c, ohms, range and (d-c) polarity selection. It selects the range where the pointer reads high, thus automatically obtaining greater accuracy. During the auto-

 For additional information on all items on this page, use post card on last page.

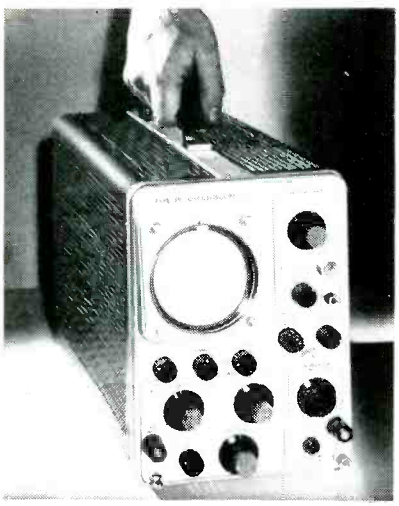
matic range selection, the meter movement is disconnected from the circuit, thus proecting the instrument from damage. When not being used automatically, the range switch may be operated manually as in a conventional vom. Chief features and specifications are listed in a recent data sheet. Price of the unit is $99.50.

VOM
incorporates 6 new features

TRIPLETT ELECTRICAL INSTRUMENT Co., Bluffton, Ohio. Model 630-NA volt-ohm-milliammeter incorporates 6 new features. It has meter protection against overloads; 70 ranges; and frequency compensation up to 20 kc, providing for accurate readings over the entire audio range. The meter has high accuracy on the same scale for a-c and d-c—1.5 percent d-c to 1,200 v, and 3 percent a-c to 1,200 v. It has temperature compensation, giving complete accuracy within a wide range of ambient temperatures. Finally, pressure contact switching is assured through the use of firm double contacts which always provide clean positive switch contact, and banana plugs, which provide for the best low resistance contacts for test leads, and hold firmly in the jacks under all conditions. Price is $69.50.

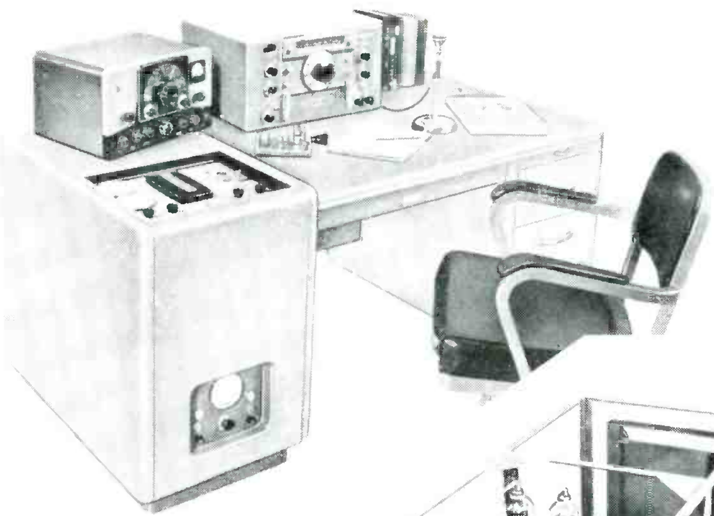
COLOR DOT GENERATOR
with vertical sync

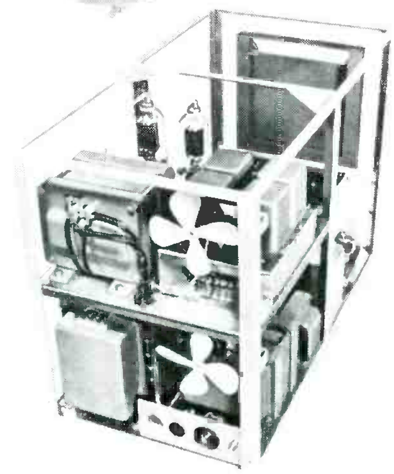
KAY ELECTRIC CO., 14 Maple Ave., Pine Brook, N. J., has announced the ChromaDot, a new combined color-bar dot generator with vertical sync and requiring only one connection to the r-f antenna or video amplifier. The color bar generator has a horizontal sync pulse signal. When a switch is depressed it provides a vertical sync pulse and varying pedestals throughout each frame to test linearity of color receiver circuits. The dot section provides signals which contain horizontal pulse, dot pulses and vertical sync, so that a stationary locked pattern is displayed without auxiliary signals. All these aforementioned signals are impressed as modulation on a picture carrier. The color bar pattern produces a display of 10 color bars with progressive 30-deg phase shifts from the color pulsed signal. Video output is −0.6 v peak-to-peak into 75 ohms, 10 v peak-to-peak into 5,000 ohms. Positive or negative polarity sync pulses are provided. Price is $395.



OSCILLOSCOPE
is portable, precision unit

TEKTRONIX, INC., P. O. Box 831, Portland 7, Oregon. Type 310 oscilloscope is a d-c to 4-mc portable precision instrument, designed for both field and laboratory applications. Size is 10 in. high × 6¾ in. wide × 17 in. deep. Weight is only 23½ lb. Wide-range sweep circuit is 0.5 μsec per div to 0.6 sec per div continuously variable with 18 calibrated steps from 0.5 μsec per div to 0.2 sec per div; accuracy within 3 percent, 5× magnifier, accurate on all ranges. Vertical amplifier rise time is 0.09 μsec; calibrated

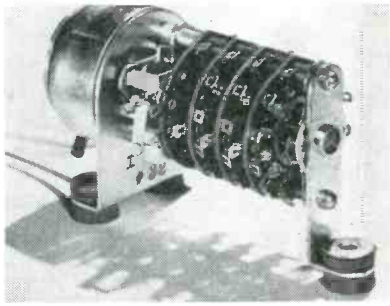




sensitivity, from 0.1 v per div to 50 v per div in 9 steps at d-c to 4 mc. Also featured are a square-wave voltage calibrator and a regulated power supply.

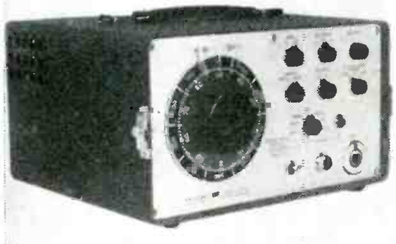
DISTORTION METER
covers 1 to 100 mc

BOONTON ELECTRONICS CORP., Boonton, N. J. Model 85A r-f distortion meter acurately covers 1 to 100 mc. The sensitive full-wave broadband voltmeter circuit is designed to indicate the harmonic voltage up to 300 mc. A recent flyer now available lists applications and specifications. Price of the unit is $595.



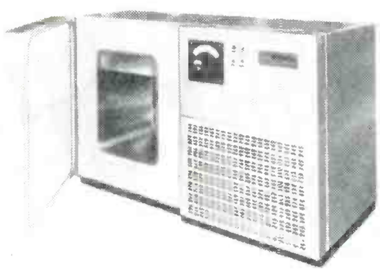
RELAY
features indexing lock

G. H. LELAND, INC., Dayton, Ohio, announces a new, model BD4E, Ledex relay. The compact (4 in. long × 2⅜ in. high) relay features a new indexing lock which prevents misalignment of contacts and enables it to withstand a wider range of rotary solenoid power. It will meet the military vibration requirements under Procedure 1, specifications MIL-E-5272A for frequencies up to 500 cps and 10 g, when properly mounted. The switches mounted on the Ledex will meet the requirements of specification MIL-S-3786 and have silver alloy contacts. The new relay is powered by a Ledex rotary solenoid model BD 4 E.



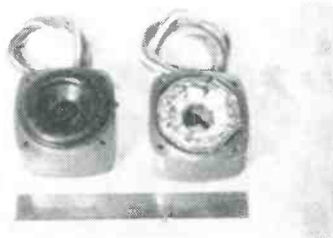
RESISTANCE BRIDGE INDICATOR
is self-balancing

AMERICAN HELICOPTER, division of Fairchild Engine and Airplane Corp., 1800 Rosecrans Ave., Manhattan Beach, Calif. Model 101 resistance bridge indicator is a self-balancing instrument for measuring the output of resistance bridge transducers such as strain gages, accelerometers, pressure pickups, position pickups and resistance thermometers. It will accommodate either full or half bridges with 1, 2, or 4 active legs. The 10-turn, easy-to-read dial indicates strain directly in μin. per in. when the indicator is used with SR-4 Advance wire strain gages. Overall accuracy is 1.0 percent.



TESTING CHAMBER
a small-size, low-cost unit

TENNEY ENGINEERING, INC., 1090 Springfield Road, Union, N. J. Creating a new trend toward small-size, low-cost test chambers which can perform multiple functions in labs and medium-sized shops, the Tenney-Mite operates as a complete low or high-temperature testing unit, a bath or a laboratory oven. With an interior capacity of 1½ cu ft. it is recommended for testing instruments and electronic components. Three low temperature ranges are available: −40 F, −100 F and −120 F. Reported pull-down on the basic −100 F model is approximately 60 minutes. The Tenney-Mite operates on any regular 110-v 60-cycle line, and occupies little floor space. Five separate vertical and horizontal arrangements of the two cabinets are possible, with a top or front opening door.



CASTING RESIN
is low cost, general purpose

EMERSON & CUMING, INC., 869 Washington St., Canton, Mass. Stycast 2651, a low cost, general purpose epoxy casting resin, is supplied as a free flowing liquid which can easily be poured into even small cavities. Cure can be effected at room temperature. The cured material is stable over the temperature range −100 F to +400 F. Low thermal expansion permits embedment of large inserts. Adhesion is excellent to metals, ceramics and plastics. Applications include encapsulation of rotors and stators, embedment of electronic circuits and even dip coating of components.

PEAK METER
has improved performance

CONTROL DEVICES, INC., Van Dyke, Mich. Model PTM-7 peak-meter is a ballistic voltmeter for measuring crest amplitude of single voltage waveforms, handling pulses too fast for conventional voltmeters. It responds to peaks regardless of waveform shape, and holds the reading until the reset button is depressed. Range is from 0.1 to 300 v. Response speed has been more than doubled to 2 μsec, with accuracy improvement down to 2 percent of full scale. Although primarily intended for single pulses, the PTM-7 is more usable on repetitive signals than its predecessors.

SERVO MOTOR
has instant stopping brake

JOHN OSTER MFG. CO., 1 Main St., Racine, Wisc. Type 2V-2397 instant stopping brake-servo motor unit is guaranteed for 100 hours operation at +125 C and for 1,000 hours operation at +75 C. It instantly responds to excitation at −65 C. Theoretical acceleration is 12,000 radians per sec and stopping time 0.02 sec with no external inertia loading. No load speed is 7,000 rpm, stall torque 0.30 in. oz, and total rotor inertia, 1.8 gram cm^2. Input power is 3 w per phase and input current with rotor stalled is 175 ma. Type 2V-2397 is designed for guided missile and other servo applications.

PULSE GENERATOR
covers 12 to 80 mc range

KAY ELECTRIC CO., 14 Maple Ave., Pine Brook, N. J. The Rada-Pulser Sr. is a pulsed carrier generator with wide range and continuously variable carrier frequency. It may be used as a pulsed carrier, variable c-w or video pulse generator. The unit covers 12 to 80 mc range in 5 overlapping bands and provides a wide choice of pulse widths and repetition rates. It may also be

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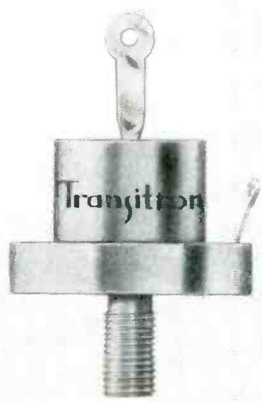
used with an oscilloscope or synchroscope to obtain a graphic display of the steady state and transient response of r-f and i-f amplifiers. A separate output allows the trigger signal to be used for synchronizing the auxiliary equipment. Triggering may be internal or external as desired. Both the pulse width and the repetition rate are adjustable over a wide range. Pulse rise and decay times are 0.03 μsec or less.

VOLTMETER
for extended-range use

WAVEFORMS, INC., 333 Sixth Ave., New York 14, N. Y., announces an improved model of the 520-A extended-range voltmeter. Performance as voltmeter, null indicator, and 60-db decade ampilfier is independent of line voltage interference and external stray fields to a high degree. The unit operates on power line frequencies from 50 to 400 cycles. Full scale sensitivity of 1 mv permits measurements as low as 100 μv, and affords useful indications at still lower levels. Ranges are provided up to 300 v, as well as db scales from -72 to $+52$ dbm. Frequency response as a voltmeter is from 10 cycles to 2 mc, and as a null indicator from 5 cycles to 4 mc.

WIRE ENAMEL
for high temperature work

SCHENECTADY VARNISH CO., 200 Congress St., Schenectady 1, N. Y., has developed Isonel, a new high temperature wire enamel which exceeds the requirements for class B insulation. While far less expensive than silicone varnishes, Isonel exhibits considerably better heat shock characteristics. Compared with Formvar wire, Isonel gives better heat aging, moisture abrasion, and cut-through resistance and shows no tendency to craze. The new enamel paves the way to increased product efficiency and lower costs for transformers, reactors, relays, solenoids, motors, generators and a host of other high temperature devices.



SILICON RECTIFIER for 125 C operation

TRANSITRON ELECTRONIC CORP., Melrose 76, Mass., announces availability of high power silicon rectifiers capable of continuous operation at full rated power at an ambient temperature of 125 C. They overcome the basic disadvantages of selenium, germanium and gas filled tubes, and provide reliable operation under wide variations in ambient temperature. In most applications, efficiencies of 90 to 99 percent are easily achieved. The new hermetically sealed silicon rectifiers offer much longer life under severe operating conditions. Types range in power handling ability is from 10 amperes at 50 v peak inverse to 5 amperes at 200 v peak inverse, all rated at 125 C. Designed for conduction cooling, these rectifiers provide major savings in both size and weight.

RECTIFIER TUBE for tv receivers

RADIO CORP. OF AMERICA, Harrison, N. J. Type 3B2 vacuum rectifier tube is designed for the rectification of the high-voltage pulses pro-

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duced in the scanning systems of black-and-white and color tv receivers. It is a double-ended, glass-octal type of half-wave rectifier utilizing an indirectly heated cathode. Rated to withstand a maximum peak inverse plate voltage of 35,000 v (absolute), the 3B2 can supply a maximum peak plate current of 80 ma, and a maximum average plate current of 1.1 ma.

CONNECTOR
for digital computer uses

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y. A special design connector has been developed primarily for digital computer applications. It features 24 contacts, 90-deg mounting. Stainless steel brackets are an integral part of the construction and also act as supports for the printed circuit assembly. The 90-deg printed circuit plug is dip soldered to the printed circuit board. Polarization is positive with a reverse guide pin and guide socket arrangement. The terminal end of the contacts receive an AMP 53 taper pin. A straight plug with floating mounting washers is also shown.

ELECTRONIC SWITCH
offers compact design

CHATHAM ELECTRONICS, Livingston, N. J. Type 650 electronic switch is a portable instrument which makes possible simultaneous observation of two recurrent patterns on the screen of a single cro. Relative positions of the patterns on the oscilloscope may be varied so that they are superimposed on each

other or separated by a desired amount. Direct comparison of amplitudes, waveforms, frequencies, and phase relationships may be observed. A square-wave voltage of variable frequency and amplitude is available at the output terminals for use as a test signal in studying the transmission characteristics of v-t amplifiers and other circuits.

RASTER TIMER
useful for many studies

AMERICAN ELECTRONIC LABORATORIES, INC., 641 Arch St., Philadelphia 6, Pa. The oscilloscope display timer makes possible detailed study of phenomena separated in time. It may be used for sonar, geophysical research, system control reactions, electrophysiological research and many other studies. The device provides the ordinary oscilloscope with a time base in the form of a 10-line raster containing accurate timing calibration markers. This, in effect, produces the equivalent of a sweep magnification of 10× with no loss of phenomenon detail. Two models are available. Type 101 has a raster range of 10 ms to 0.1 sec and a sweep range of 1 ms to 10 ms; the 101A has a raster range of 1 to 50 sec and a sweep range of

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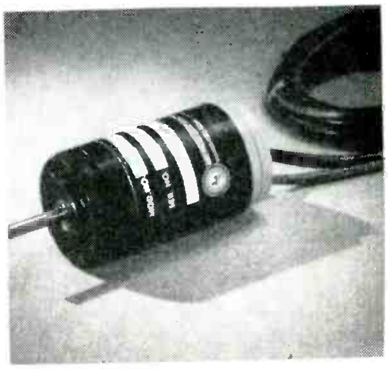
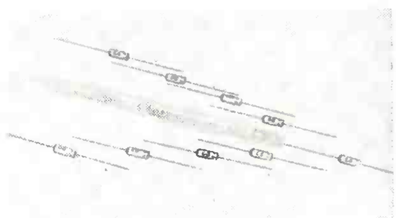
0.1 to 5.0 sec. Timing calibration markers in both units are controlled to 0.1 percent or better.



PRECISION RESOLVER with reduced weight

AMERICAN ELECTRONIC MFG., INC., 9503 W. Jefferson Blvd., Culver City, Calif. The size 11 winding compensated resolver has a frame diameter measuring only 1.062 in., thus reducing weight and making installations more compact. It can be supplied with Mark 4 Mod 0 electrical characteristics, possesses temperature stabilization and is equipped with a closed loop path. Stator winding excitation is 400 cps, 60 v; input impedance, 200 ± 10 percent + $j885$ ± 10 percent; and test voltage, 10 rms. Low corner frequency is 20 cps; peaking frequency, 150 kc. Maximum total null voltage is 1 mv per v; maximum functional error, ± 0.1 percent.

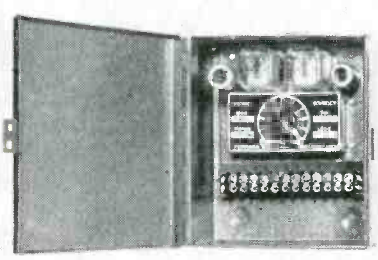


LITTLE CAPACITORS are tantalum electrolytics

CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J., has developed a miniature sintered anode tantalum capacitor with low leakage characteristics, low power factor, long shelf life and moisture-impervious hermetic sealing. The anode of the type TX capacitor consists of a porous, sintered tantalum body with a short length of tantalum wire which terminates in a nickel wire serving as the anode lead. The sealed, fine silver tubular case serves as the cathode to which the cathode lead is attached. The new capacitors with dimensions of $\frac{7}{32}$ in. in diameter and $\frac{3}{64}$ in. in length, have a temperature range of −55 C to +85 C. At −55 C capacitance is at least 70 percent of normal and power factor is not over 40 percent. For complete information request engineering bulletin No. 530.

MAGNETRONS
for 3-cm band operation

AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L. I., N. Y. New additions to the company's magnetron line are two packaged, pulsed, low-power oscillators, types 6229 and 6230, for operation in the 3-cm band and tunable between 8,900 and 9,400 mc. These are extremely small-size, as well as lightweight magnetrons (26 oz), making them particularly suitable for airborne applications. Forced-air or liquid cooling is not required.



ELECTRONIC TIMER
for industrial controls

FERRARA INC., 8106 W. Nine Mile Rd., Oak Park, Mich., has announced a simple electronic timer with ±2-percent repeat accuracy. It permits multiple modes of operation including interval, delayed action, repeat cycle and single-cycle timing. The T-1 timer can be supplied with

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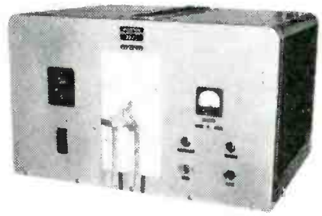
standard time ranges of 0.3 to 25 sec, or 0.5 to 50 sec. The 270-deg calibrated dial assembly can be removed for remote operation. No stand-by power is required. Other features include: 5-ampere, isolated load contacts; built-in regulation; plug-in relays; and open construction.

COIL TESTER
is portable and reliable

SUNSHINE SCIENTIFIC INSTRUMENT, 1810 Grant Ave., Philadelphia 15, Pa. The coil tester illustrated instanteously indicates the presence of short-circuited turns or defective insulation in coils. The unit operates from 115 v, 60 cycles, is portable, easy to use, fast, safe and in-expensive. Under normal conditions the tester can identify down to a single short-circuited turn of No. 42 Awg copper wire (0.0025-in. diameter). A great variety of coil sizes can be tested by simply placing the coil to be tested over one of several cores which are available and noting the deflection of the meter. Catalog No. 10 describes the instrument in detail.

INDUCTION HEATER
with 3-kw output

INDUSTRON CORP., 50 Brook Road, Needham Heights, Mass. Model IH-3 induction heating unit has been announced. Conservatively rated output of 3 kw, simplicity of design and rugged construction assure continuous trouble-free operation. Selective dial setting and recycling by automatic timer facilitate high production rate. Power output is selectively variable. Its output transformer makes possible extremely low voltage in the output



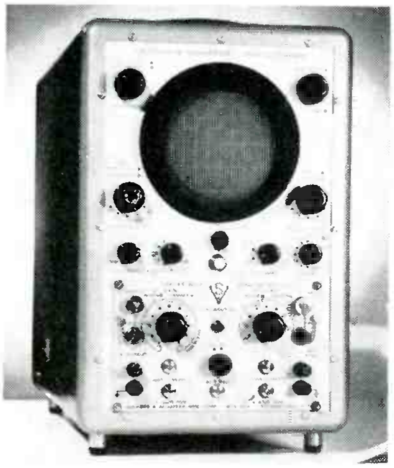
coil. This is a safety factor. The induction heating units feature a single turn coil that accommodates complex shapes. Multiple turn coils also are available, and interchange of coils is readily made with conveniently located heavy-duty studs for attachment.

VOLTAGE REGULATOR
for nonlinear load work

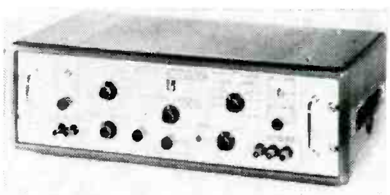
EL MEC LABORATORIES, INC., 730 Boulevard, Kenilworth, N. J. Model E-80 a-c voltage regulator suppresses line harmonic distortion, maintaining a sine wave even under extreme half-wave loading; and it has a response time in the order of 1 millisecond, with no thermal or magnetic circuit lag. These characteristics, along with its extremely low dynamic impedance, makes this unit of special value in work involving nonlinear loads, such as are encountered in semiconductor and magnetic circuit development and test applications. The E-80 is an excellent general purpose regulator for laboratory use as well. Models are available with fixed 115-v output, or variable from 50 to 125 v; for either 60 or 400 cycles; and for various output currents.

D-C OSCILLOSCOPES
are highly sensitive

VOLKERS & SCHAFFER MFG. CORP., Box 996, Schenectady, N. Y. The VS-900B series of sensitive d-c oscilloscopes have small d-c drifts due to chopper-stabilization of their vertical amplifiers. Guaranteed



drifts are less than 1 mv after 2 minutes warmup. The d-c sensitivity is 700 μv per cm. The scopes are available in 3 models. The VS-930B has symmetrical push-pull input on its most sensitive range only; the 940 B has symmetrical push-pull input on all ranges to facilitate elimination of common interference signals such as hum at high as well as low signal levels; and VS-960B has a built-in hushed transistor preamplifier with less than 1 μv rms noise over a 60-kc passband, to increase its a-c sensitivity. It is 1 μv rms per cm with less than 0.5 μv noise.



D-C AMPLIFIER with a gain of 10,000

Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio. Model BL-550 is a direct coupled amplifier employing a chopper stabilized feedback circuit which eliminates the need for matched tubes. This circuit permits extended frequency response. When used with the Brush direct-writing oscillographs, the frequency response is d-c to 100 cps. Measurement range covers a spread of from 100 μv to 500 v and its maximum sensitivity in use with an oscillograph is 100 μv per chart mm. High stability in use is demonstrated by its less than $\frac{1}{4}$ of a chart mm drift per hr. It will handle both low level d-c or a-c volt-

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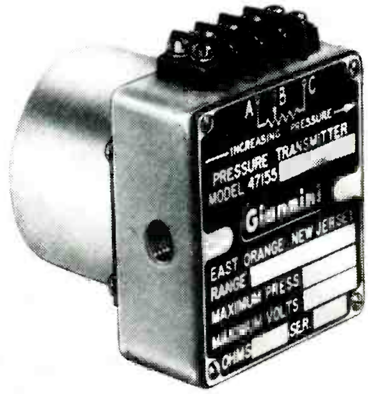
ages with full range of frequencies. The amplifier has 16 steps of attenuation. Single-ended input circuit is provided with the high-gain amplifier. Connections are brought out to provide single-ended or balanced inputs with the medium-gain section of the amplifier. The unit has an input impedance of 1 megohm and its internal calibration is 2 mv and 1 v.

COAXIAL TRIODES
for 25-50 kw equipments

MACHLETT LABORATORIES INC., Springdale, Conn., announces the ML-6426 and ML-6427 coaxial-terminal triodes, employing thoriated-tungsten filaments, for industrial and broadcast equipments of 25 to 50-kw power output. The thoriated tungsten filaments greatly reduce power requirements while offering life increases to 100 percent. They feature high plate and grid current ratings, low terminal inductances and high transconductance characteristics. The 6426 uses a bayonet-pin water jacket and is rated for 80-kw input, 40-kw anode dissipation; the 6427 employs an aluminum radiator to reduce weight to 20 lb. The latter tube is rated for 70-kw input, 20-kw anode dissipation. Full ratings on both tubes to 30 mc; reduced ratings to 90 mc.

PRESSURE TRANSDUCER
for industrial applications

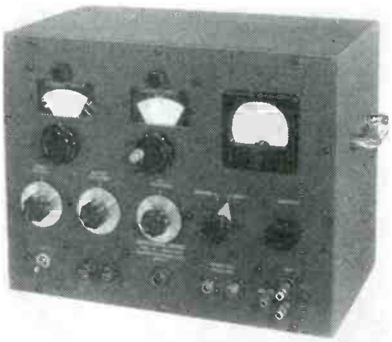
G. M. GIANNINI & CO., INC., East Orange, N. J., is producing a new model 47155 pressure transducer, designed for industrial applications requiring an electrical output pro-



portional to pressure. Utilizing a pressure capsule that operates the wiper of a precision potentiometer in direct proportion to applied pressure, this instrument is available in ranges up to 100 psi, for absolute, gage and differential pressure measurements. The precision potentiometer uses noble precious metals in both winding and wiper for low friction, high resistance to corrosion, and long operating and shelf life. Outputs up to 40 v can be obtained from this instrument and it can be used to operate indicating, recording or control devices with little or no amplification. Standard resistance is 2,000 ohms, with a power rating of 0.5 w. Accuracies to 0.8 percent and sensitivity to 0.4 percent can be obtained. The instrument is approximately 2.75 in. square × 3 in. deep.

PRINTED CIRCUIT CONNECTOR
for coaxial cable

H. H. BUGGIE, INC., 726 Stanton St., Toledo, Ohio. The EC series design in miniature printed circuit connectors consists of a coaxial plug assembly and a receptacle that can be mounted on a printed or etched card by 5 terminal points using the solder dip method. The plug assembly is approximately $\frac{3}{4}$ in. long and $\frac{9}{32}$ in. in diameter. Receptacle has a mounting base $\frac{7}{16}$ in. sq. The 5 terminals, 0.040-in. in diameter, are of phosphor bronze with albaloy plating. Two receptacles can be mounted side-by-side without loss of printed or etched circuit lines. Terminals can be furnished for $\frac{1}{16}$ in., $\frac{1}{8}$ in., and $\frac{1}{4}$ in. card thicknesses.



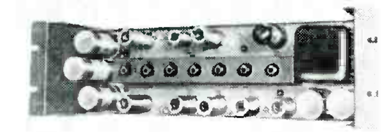
CAPACITANCE BRIDGE
completely self contained

BOONTON ELECTRONICS CORP., Boonton, N. J. Model 74B capacitance bridge was designed to provide the industry with a completely self-contained compact, accurate and sensitive instrument to measure direct or grounded capacitance and conductance. The unit is capable of measuring capacitance of less than 0.001 $\mu\mu$f, continuously to a maximum of 11,000 $\mu\mu$f. The capacitance dial is calibrated from 0 to 1,000 $\mu\mu$f over 20 turns of the vernier dial providing readability from 0.1 percent to 0.01 percent, dependent on setting. Conductance range is 0.01 to 1,000 μmhos. Conductance and capacitance are completely independent of each other; thus, the dial readings when the bridge is balanced on a test is the final answer without further computation.

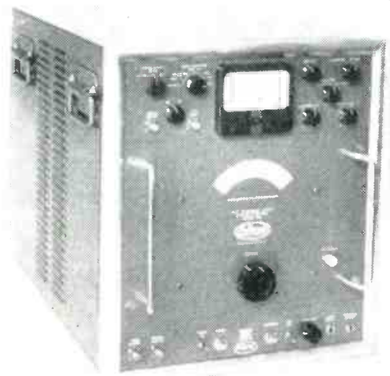
STABILIZING AMPLIFIER
for tv broadcast use

TARC ELECTRONICS INC., 48 Urban Ave., Westbury, N. Y. Model SA 7410 stabilizing amplifier is designed for tv broadcast use and other applications involving the generation and transmission of tv signals. It will correct faulty syn-

 For additional information on all items on this page, use post card on last page.



chronizing signals, remove power line hum, amplify sync signal to the desired level, mix video and sync, establish d-c reference level, maintain constant sync output despite surges, remove l-f distortion, eliminate switching surges or video sweep surges from film leaders, and set sync to pix ratio. For color work, the phase and amplitude distortion of the 3.58-mc color signal is held to an absolute minimum so as to clamp and pass an NTSC color signal.



MICROWAVE RECEIVER
covers 950 to 11,260 mc

POLARAD ELECTRONICS CORP., 43-20 34th St., Long Island City 1, N. Y. Model R field intensity receiver covers the microwave range 950 to 11,260 mc with 4 interchangeable plug-in r-f tuning units. The microwave receiver is designed for communications work, lab measurements, field intensity measurements, production testing and automatic monitoring. It features single-dial frequency control with a direct-reading dial, along with double-tuned r-f preselection and afc. Model R will receive a-m, f-m and pulse. It reads directly in db and provides separate audio and video outputs. Provision is made for external metering and recording, as well as connectors for external i-f attenuators. An external-type cavity klystron is provided with noncontacting chokes. Klystron voltages are regulated and automatically tracked with the oscillator. The unit is completely self-contained.

VSWR COMPUTER
used in production testing

CUBIC CORP., 2841 Cannon St., San Diego 6, Calif. Model 621B vswr computer provides expanded utility and operator convenience in automatic development and production tests of microwave components and systems. Four linear scales, each covering a 10 to 1 range, are provided for voltage reflection coefficient percentages from 0.5 to 100. In addition, the 6.5 in. display meter carries two vswr ranges: from 1.01 to 1.1 and from 1.1 to 3. The 621B is insensitive to r-f power changes over a 20 to 1 change and is equipped with matching transformers for operation with both bolometer and crystal detectors. Used with suitable reflectometers, the 621B is ideally suited for swept or single frequency exploration of transmission characteristics by nontechnical personnel. A linear d-c output is available for simultaneous oscillograph recording or oscilloscope display of voltage reflection coefficient.

Literature

Identification Markers. North Shore Nameplate Inc., 214-27 Northern Blvd., Bayside, N. Y. Samples and descriptive literature pertaining to the Speedy-Sleeve polyvinyl sleeve markers are available. The product line described solves all coding problems. Another item of current interest is a line of F.O.A. markers. They have filled a growing need among suppliers who are cooperating with the Government in this program. Brochure and sample are also available. A stock list of standard Speedy-Marx wire code markers, and the new pipe markers catalog may be had for the asking.

Solderless Wiring. American Pamcor Inc., 181 Hillcrest Ave., Havertown, Pa., has available a 26-page catalog of solderless terminals, connectors and splices, and the tools to apply them. The catalog lists only those most commonly used and is not a complete list of API products.

Current Transformer Bulletin. Associated Research, Inc., 3758 Belmont Ave., Chicago 18, Ill. A complete series of Donut type current transformers for metering applications is described and illustrated in a new 4-page bulletin 365-1. The transformers are available in both the ring type for mounting over wire and cable leads and the rectangular window type for mounting over bus bars. Complete specifications on dimensions and accuracy are given. Methods of extending the range of indicating ammeters through use of Donut transformers are discussed.

Fiberglas-Base Varnished Fabrics. Owens-Corning Fiberglas Corp., 16 E. 56th St., New York 22, N. Y. A 4-page folder gives data on standard Fiberglas-base varnished fabrics. It includes dielectric strengths of fabrics of various construction impregnated with yellow varnish, black varnish, Teflon, silicone rubber and silicone varnish.

Industrial Counters and Controls. Atomic Instrument Co., 84 Massachusetts Ave., Cambridge 39, Mass. Data sheets on a line of unitized modular industrial counters and controls are now available. Two basic groups of instruments are featured: totalizers or simple counters, and preset counting units. The

For additional information on all items on this page, use post card on last page.

company offers more than 140 combinations of equipment for counting and control application, built up from over 15 basic functional strips. Examples of several counters are shown, and full information on specifications and prices is given.

Linear Variable Differential Transformers. Gudeman Co., 340 W. Huron St., Chicago 10, Ill. Bulletin LVDT-100A on linear variable differential transformers is now available. Complete data include dimensional drawings, test circuit diagram, actual size photo, a graph showing displacement of core from null point vs output voltage, applications, temperature range, sensitivity, voltage and frequency range, d-c resistance, impedance and weight.

Oscillogram Processor. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif. Bulletin 1537C gives a 4-page illustrated description of the type 23-109 oscillogram processor, a portable darkroom for on-the-spot developing. Operating features, specifications and information on some of the company's other products are included. A price list is also available.

Power Tube Data. Eitel-McCullough, Inc., San Bruno, Calif., has published revised editions of the Eimac 4-400A radial-beam power tetrode and 4-400A/4000 air system socket data sheets, and Application Bulletin No. 3, "Pulse," dealing with pulse applications of the company's tubes. This material has been mailed to Eimac catalog holders and is available to others on request.

Special Design Connectors. DeJUR-AMSCO Corp., 45-01 Northern Blvd., Long Island City 1, N. Y., has available literature illustrating and describing its special design connectors. It shows how considerable savings and high quality have been effected by using a molded connector with die cast brackets instead of a hand-fabricated assembly. It also announces the fact that the company's engineering department is available to assist in the working out of special connector problems.

Unitized Rectifiers. Magnatran Inc., Kearney, N. J. A new 8-page folder covers the company's unitized rectifiers. The self-contained rectifiers described provide the answer to the need for a highly dependable high-voltage d-c source.

High Velocity Spray Technique. Cobehn, Inc., Passaic Ave., Caldwell, N. J., has published an 8-page illustrated bulletin describing a new high velocity spray technique for the critical cleaning of precision parts. The process described is effective for the critical cleaning of low-torque instrument bearings, semiconductors, and contact points in relays, vibrators, choppers and sensitive switches.

Automation Engineering Bulletin. CDC Control Services, Inc., 400 S. Warminster Rd., Hatboro, Pa. Automation engineering bulletin V-4002 describes techniques used in solving a tough temperature-pressure control problem. The bulletin includes reproductions of actual test data used to determine the final value and other component specifications.

Vibration and Shock Controls. T. R. Finn & Co. Inc., 200 Central Ave., Hawthorne, N. J. A complete line of mounting bases, vibration and shock controls is described in catalog AB-35. The catalog includes detailed descriptions of standard and special mounting bases, and a wide selection of vibration and shock controls—all of which meet JAN and MIL specifications. Of particular interest is the company's all-metal vibration mount. Designed for airborne operation under all operational hazards, its resonant frequency is below 10 cps and its magnification factor less than 1½ at resonance with no double resonant peaks.

Printed Circuit Connectors. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. Sheet No. 42 covers the series PCW-22. The literature gives description, photos and outline drawing of the new Continental connector which accommodates up to 132 solderless wire wrap connections with No. 24 gage wire. (The reverse page describes Continental series Z-16 heavy duty rectangular power connectors.)

pH Meter. Photovolt Corp., 95 Madison Ave., New York 16, N. Y. Bulletin 105 covers the new line-operated pH meter, model 110. The unit discussed incorporates a large-size indicating meter of 7-in. scale length which covers the entire pH range from 0 to 14 without switching and without reversal of the pointer travel. As shown by the illustrations in the bulletin, the instrument can also be furnished in a portable shape with baseboard and carrying cover. Available accessories for the model 110 described include a swing-arm adapter for immersing the electrodes by tilting motion and a shielding hood for use of unshielded electrodes.

Insulation Booklet. Westinghouse Electric Corp., P.O. Box 2099, Pittsburgh 30, Pa. Booklet B-6506 (12 pages) explains the many advantages of Thermalastic insulation. The ten properties that extend the life of generators, synchronous condensers, frequency changers, large motors and other heavy rotating equipment in hard service are discussed. The booklet also contains a short, illustrative story on how Thermalastic insulation was developed.

D-C Amplifier. Hagan Corp., 323 Fourth Ave., Pittsburgh 22, Pa. Bulletin MSP111.1 illustrates and describes the model P d-c amplifier, an electronic low-voltage linear amplifier designed to increase the speed and accuracy of practically all low level d-c voltage measurements. Chief features, recommended uses, performance specifications and ordering information are given.

Custom Made Components. Fisher & Crome, 109 N. Camac St., Philadelphia 7, Pa., has available a 4-page folder illustrating and describing a line of custom made components for electronics and all industrial applications. Included

For additional information on all items on this page, use post card on last page.

are fabricated parts, chassis and panels, dials, brass stencils and drafting guides.

Automatic Code Converter. CGS Laboratories, 391 Ludlow St., Stamford, Conn., has available a bulletin fully describing the TRAK automatic code converter. The all-electronic computer described translates International Morse code signals from the air or other sources and converts them automatically to printed page copy on a standard teletypewriter printer.

Automatic Pyrometers. Assembly Products Inc., Chesterland, Ohio. The four-page bulletin G-8 lists standard ranges and specifications of Simplytrol automatic pyrometers for control of temperature in furnaces and ovens. Ordering information is included; also data on some accessories for Simplytrols.

Video and Pulse Transformers. Carad Corp., 2850 Bay Road, Redwood City, Calif., has released a new technical bulletin on video and pulse transformers. It consists of application notes on the company's complete line of pulse transformers from subminiature blocking oscillator types to 50-kv magnetron units.

Plastic Tubulars. Astron Corp., 255 Grant Ave., East Newark, N. J., has released a 4-page bulletin, No. AB-21, on the Comet, a molded plastic tubular metallized paper capacitor. Attractively printed in two colors with illustrations and tables, it contains full details, descriptions, performance characteristics and test specifications.

Turns-Counting Dial. Helipot Corp., 916 Meridian Ave., South Pasadena, Calif. The Duodial series RB turns-counting dial is the subject of data sheet 54-76. The series described consists of two coaxial dials. The inner dial is calibrated to count hundredths of a turn; the outer dial counts completed turns up to 15.

Electronic Weatherstrip. Metal Textile Corp., Roselle, N. J., announces a 16-page design brochure, entitled "Suppressing Radio Interference with Metex Electronic Weatherstrip and R-F Gaskets." It discusses practical and effective methods for obtaining an r-f tight shield. Its design section gives full design procedures, methods of installation, and lists standard stock items.

Selenium Rectifiers. Donald C. Seibert, U. S. Representative, Box 281, Wilmington, Del., has available a 16-page booklet on new types of AEG selenium rectifiers. A picture and characteristic curves are shown. The rectifier units described are for radio receivers and are similar in appearance to electrolytic capacitors.

Rubber Insulated Mountings. Bushings, Inc., 4358 Coolidge Highway, Royal Oak, Mich. Bulletin 5255 describes Instrumounts—rubber insulated mountings for instruments, laboratory and other light weight precision equipment requiring isolation from vibration and noise. A number of suggested uses are given together with prices, dimensions and load bearing capacities.

Instrument Catalog. Allen B. DuMont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J., now offers an 8-page quick-reference catalog that outlines in detail the company's line of high precision instruments. A recent flyer gives a brief review of the instruments, together with some of their more important characteristics.

Coax Circuitry. Microdot Division, The Felts Corp., 1826 Fremont Ave., South Pasadena, Calif. A 4-page folder illustrates and describes the smallest, lightest and only complete series of microminiature coaxial connectors, cables and assemblies. The Microdot illustrated and described offers over 15 million design possibilities in microminiature coax circuitry.

Printed Circuitry. Cornell-Dubilier Electric Corp., South Plainfield, N. J. A new 8-page illustrated booklet, "Printed Circuitry", describes in detail the application,

 For additional information on all items on this page, use post card on last page.

uses and advantages of printed circuits in various electrical products and equipment, as well as technical information to aid in design or planning of printed circuitry. The 2-color booklet explains simply the different types of base materials, laminate characteristics and circuit designs. Other chapters explain how to prepare master drawings, soldering techniques and pricing variables.

Pressure Pickup. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif. Bulletin CEC-1556 contains illustrations, general description, electrical features and specifications for the type 4-315 pressure pickup. The device described is useful for almost any application, which requires measurement of low differential pressures. Created for flight-load surveys, the units discussed are also useful for respiratory studies and process-control applications.

Impedance Measurements. Hewlett-Packard Co., 3328A Page Mill Rd., Palo Alto, Calif. A recent brochure on impedance measurements lists, among other instruments, the new improved 415B standing wave indicator. An expanded scale and the recorder output are two of the advanced features in the unit described.

Digital Pressure Gages. Byron Jackson Co., 2010 Lincoln Ave., Pasadena 3, Calif. Bulletin BJE-606 covers a line of miniature digital pressure gages developed by the company. The Vibrotron gages discussed, only ¾ in. in diameter × 3 in. and weighing 1 oz, allow precise measurements of static and dynamic pressures. Specifications for Vibrotron models of an absolute pressure gage and a gage pressure gage are presented. A listing of other electronic testing and control instruments available from the company is also included.

Milliohmeters and Microhmeters. Shallcross Mfg. Co., Collingdale, Pa. Ten highly accurate milliohmeters and microhmeters for measuring low resistances between 0.0001 ohm and 100 ohms are described in bulletin L-39. The test sets discussed are recommended for applications where a Kelvin bridge is too slow or impractical, and where an ordinary nonlinear ohmeter is too inaccurate and limited in range. Complete electrical and mechanical specifications on all instruments and accessories are shown.

Automatic Tuning Lock. CGS Laboratories, 391 Ludlow St., Stamford, Conn. A recent bulletin describes the TRAK automatic tuning lock, an auxiliary device designed for frequency-shift communications receivers. The tuning lock discussed automatically maintains a frequency-shift signal in tune despite drift from any cause, receiver temperature changes, or any other contributing factor, and in effect provides greater efficiency in reception from a poorly stabilized receiver than from a highly stabilized receiver operating without the lock.

Electrolytic Capacitor. Astron Corp., 255 Grant Ave., East Newark, N. J. New product bulletin AB-22 covers the type ET subminiature electrolytics. The extra-compact capacitors described are specifically designed for printed circuitry with miniature tubes and/or transistors. Complete details of all features are illustrated with actual size photographs. All essential information including test specifications, performance characteristics, sizes, ratings and list prices are also given.

Relays. Assembly Products Inc., Chesterland, Ohio. Bulletin 108 lists sensitive relays and plug-in assemblies for automatic control circuits. While the relays and plug-in units discussed are designed primarily for use with the company's contact meter-relays, they are also finding other applications in control and automation.

Self-Synchronous Motors. Electric Indicator Co., Inc., Springdale, Conn., has prepared a 6-page folder describing its various commercial types of self-synchronous motors. The folder (EI-5A) briefly covers theory of operation and also lists the design characteristics of over

For additional information on all items on this page, use post card on last page.

30 different models for economically meeting a wide range of instrument applications. Characteristic curves, dimensional drawings and electrical data are included for standard transmitters and receivers, differential units, phase shifters and resolvers, as well as for control and rotary transformer units.

Laminated and Molded Plastics. The Richardson Co., 2662 Lake St., Melrose Park, Ill. A 12-page bulletin describes more than 35 different types and grades of Insurok laminated and molded plastics. It includes two charts—one listing grades of laminated Insurok by outstanding properties, and the other listing sheet Insurok complying with NEMA, federal and military specifications. The bulletin also pictures and discusses a number of typical applications and suggests techniques. A special section includes a discussion of copper-clad Insurok laminates for printed electrical or electronic circuits.

Metal Alloy Designations. Secon Metals Corp., 7 Intervale St., White Plains, N. Y., has available a listing of alternate designations of its precious metal potentiometer winding alloys. The alloys are designated with the numbers corresponding to the specific resistance (ohms per cmf) of each. For further assistance in identification the number is preceded by a letter indicating the predominant component of the alloy as follows: P for platinum metals, G for gold, S for silver.

Shielded Enclosures. Ace Engineering & Machine Co., 3644 N. Lawrence St., Philadelphia 40, Pa. A new catalog provides a depth of engineering and application data in the field of r-f shielded enclosures. Every type of screened and sheet metal standard enclosure is covered individually, with insertion loss or attenuation curves for each room, and complete construction details illustrated by cutaway drawings. Engineering specifications and standard room size availability are presented in a simple, easy-to-use form. Separate sections of the catalog cover application details which are critical in all types of enclosures, such as doors and service entrances; a number of very unusual enclosures which have been engineered and constructed by Ace; and the company's special services.

Thermocouple Circuit Checker. The Peerless Electric Co., Electronics Division, 1401 W. Market St., Warren, Ohio. Catalog R-22 describes the Restorer, a device for correcting inaccurate temperature reading and control caused by thermocouple circuit failure during heat treating and melting operations. The catalog discusses plant applications, operation of manual and automatic types, pyrometer panel and central control models, and the protection tube leak checker, for warning against incorrect temperature reading and control dial to seepage of molten material into thermocouple protection tubes.

Miniature Precision Connector. DeJUR-AMSCO Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. A 4-page brochure in color gives actual size illustrations, outline drawings and specifications on the series 1300 AN-type connectors with one-piece molded inserts. Write for a free copy.

Chassis Catalog. California Chassis Co., 5445 E. Century Blvd., Lynwood, Calif. announces a new 10-page catalog illustrated and punched-for-filing or notebook insertion. More than 400 standard items in varying dimensions and models are listed: standard chassis, including heavy duty, removable top and open end models; desk and enclosed relay racks; sloping front, metal utility and meter cabinets; relay back panels, meter panels and sundry components and accessories.

Electrical Laminations. Thomas & Skinner Steel Products Co., Inc., Indianapolis, Ind. The 40-page bulletin L-355, through product line drawings, graphs and charts, provides full information on special, standard and MIL-T electrical laminations. A test procedure for standard E and I laminations is included. Through the test procedures, design engineers can now correlate va and core loss figures with applications. Test figures provided by the company give both core loss and exciting current at 10,000 gauss on each heat annealed.

Hermetic Seal Bulletin. Cannon Electric Co., P. O. Box 75, Lincoln Heights Station, Los Angeles 31, Calif., has issued a new type of engineering bulletin cutting across the usual connector lines to include in one catalog all current material on Canseal hermetically sealed types. Used largely for aircraft instruments but also adaptable for a wide variety of applications requiring a hermetic seal, also for use in high temperature installations and under moisture environments, the types described all have steel shells and contacts with fused glass insulation. The bulletin contains 16 pages and cover, and includes standard AN types, K-general electronic series, miniature, subminiature and rack-and-panel designs.

Wire and Cable Insulation. Bakelite Co., A Division of Union Carbide & Carbon Corp., 30 E. 42nd St., New York 17, N. Y. Booklet No. 80 contains a 6-page index to Kabelitems 42-79. Its purpose is twofold: (1) to assist readers in locating information pertinent to Bakelite polyethylene, vinyl, or fluorothene resins of compounds for specific end-uses; and (2) to bring this segment of Kabelitems up to date by cross-referencing and pointing out obsolete information.

Miniature Inductance Components. Levinthal Electronic Products, Inc., 2760 Fair Oaks Ave., Redwood City, Calif. Two sizes of small adjustable inductors and a series of i-f transformers of similar design are catalogued in a new leaflet, Form VI-1154. Variable inductors listed in both shielded and unshielded designs are shown for the two inductance ranges—56 μh to 1.8 mh, and 56 μh to 18 mh in standard units having inductance ranges of 2 to 1, voltage ranges of 400 v maximum, and power dissipations of 2.5 and 5 w at 20 C temperature rise. Described as suitable for difficult environmental applications—due to shock, vibration, moisture and chemical resistance—the units are covered in this publication with complete application design data including dimensioned outline drawings and performance curves of typical units, showing plots of Q versus frequency.

Electrolytic Shaping. Anocut Engineering Co., 531 W. Washington Blvd., Chicago 6, Ill., has available a brochure on automatic electronic control of electrolytic grinding and shaping. It explains in detail how standard grinders, equipped with Anocut electronic control and using Anocut electrolytic salts, increases removal efficiency up to 6 times that of conventional grinders and at the same time saves as much as 90 percent in diamond wheel costs. The brochure also illustrates and describes the company's electronic equipment.

Soldering Booklet. Multicore Solders Ltd., Maylands Ave., Hemel Hempstead, Hertfordshire England. A 22-page booklet, which is the third and completely revised edition of "Modern Solders," has just been issued. It contains several articles on the uses of cored solder and the characteristics of alloys of which Ersin and Arax Multicore solders are made. A full description is given of the latest type of Multicore solder which contains 5 cores of noncorrosive flux. Five tables give particulars of melting points, feet per lb, tensile and shear strengths, specific gravities and electrical conductivity of 11 different alloys in which Ersin Multicore solder is regularly manufactured.

Rapid Assembly of Pulse Systems. Burroughs Corp., 1209 Vine St., Philadelphia 7, Pa. A simplified approach to rapid assembly of pulse test and control systems and the equipment needed to do the job are outlined in a new 6-page brochure. The illustrated brochure, called "The Unitized Approach," reviews the entire line of pulse control equipment manufactured by the company. With the unitized approach described, working systems are assembled directly from block diagrams simply by making front-panel, plug-in connections between the desired pulse control units. When a system has done its job, the pulse control equipment can be immediately recabled for an entirely different test, control or computation function.

Multilayer Interference Films. Fish-Schurman Corp., 70 Portman Road, New Rochelle, N. Y. Bulletin M1-318R discusses high efficiency type multilayer interference films. The films described utilize the phenomenon of optical interference at the boundaries of materials of high and low index of refraction. The bulletin gives technical information on three classifications.

Precision Measuring Equipment. New London Instrument Co., Inc., 82 Union St., New London, Conn. A 12-page catalog illustrates a complete line of electronic precision measuring equipment. It contains complete specifications and characteristics of the company's transconductance analyzer and circuit simulator, a-m signal generator, uhf tv sweep frequency generator, square wave generator, frequency standard, f-m signal generator modulation monitor, vhf-uhf noise source, signal generator, broadband amplifier and uhf balun. The catalog also contains illustrations of the company's line of transformers.

Inductors. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa. A two-page data sheet, EB3(1), describes fixed and adjustable inductors. Specifications include the tabulation of physical and electrical characteristics. The data sheet describes standards of self-inductance, a standard of mutual inductance, and the function, coil arrangement and connections of the Brooks Inductometer.

Varistors. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Catalog data bulletin SR-3 covers a line of varistors (asymmetric nonlinear resistors). Included are comprehensive data on applications, characteristics, current ratings, enclosures and terminations. Detailed charts and graphs are shown in 6 pages.

Plants and People

Edited by WILLIAM G. ARNOLD

Technical societies of the electronics industry announce convention plans. Manufacturers expand plants and facilities, make new company acquisitions. Engineers and executives are promoted, move into new positions

Wescon Board Completes 1955 Convention Plans

BOARD OF DIRECTORS for the 1955 WESCON, Western Electronic Show and Convention, has completed plans for the event, to be held in San Fransico, August 24–26.

This year, there will be 570 exhibits representing more than 600 producers, and an extensive technical program. Attendance of more than 20,000 visitors is expected.

The show is co-sponsored by the West Coast Electronic Manufacturers' Association and the San Francisco and Los Angeles Sections of the Institute of Radio Engineers, representing the Seventh Region.

1955 WESCON board of directors, shown clockwise, are: C. Frederick Wolcott (Gilfillan Brothers); W. D. Hershberger (Univ. of California at Los Angeles); Walter E. Noller, secretary-treasurer (Lynch Carrier Systems); Donald B. Harris, Convention vice-chairman (Stanford University); Noel E. Porter, chairman (Hewlett-Packard Co.); Jeanne W. Jarrett, WESCON recording secretary; Norman H. Moore, show vice-chairman (Litton Industries); Mal Mobley, Jr., WESCON business manager; Thomas P. Walker (Triad Transformer Corp.); and Leon B. Ungar (Ungar Electric Tools).

Aerovox To Operate NBS Modular Electronics Plant

THE NAVY BUREAU of Aeronautics and the National Bureau of Standards announced that the NBS pilot line in Arlington, Va. for the mechanized production of electronic equipment will be operated by Aerovox Corp. of New Bedford, Mass.

Aerovox succeeds the Kaiser Electronics Division of Willys Motors in the operation of the line.

The arrangement with Aerovox Corporation is designed to broaden the nation's industrial base is experience and know-how for the use of modular design concepts in military equipment. Key personnel formerly associated with Kaiser, have been employed by Aerovox to take advantage of their experience in modular design concepts and in the operation of the mechanized production facility. Emphasis will be placed on the production of modules for experimental use by interested electronic equipment manufacturers. The pilot plant will continue to be operated at its present location.

Philco Forms New Transistor Division

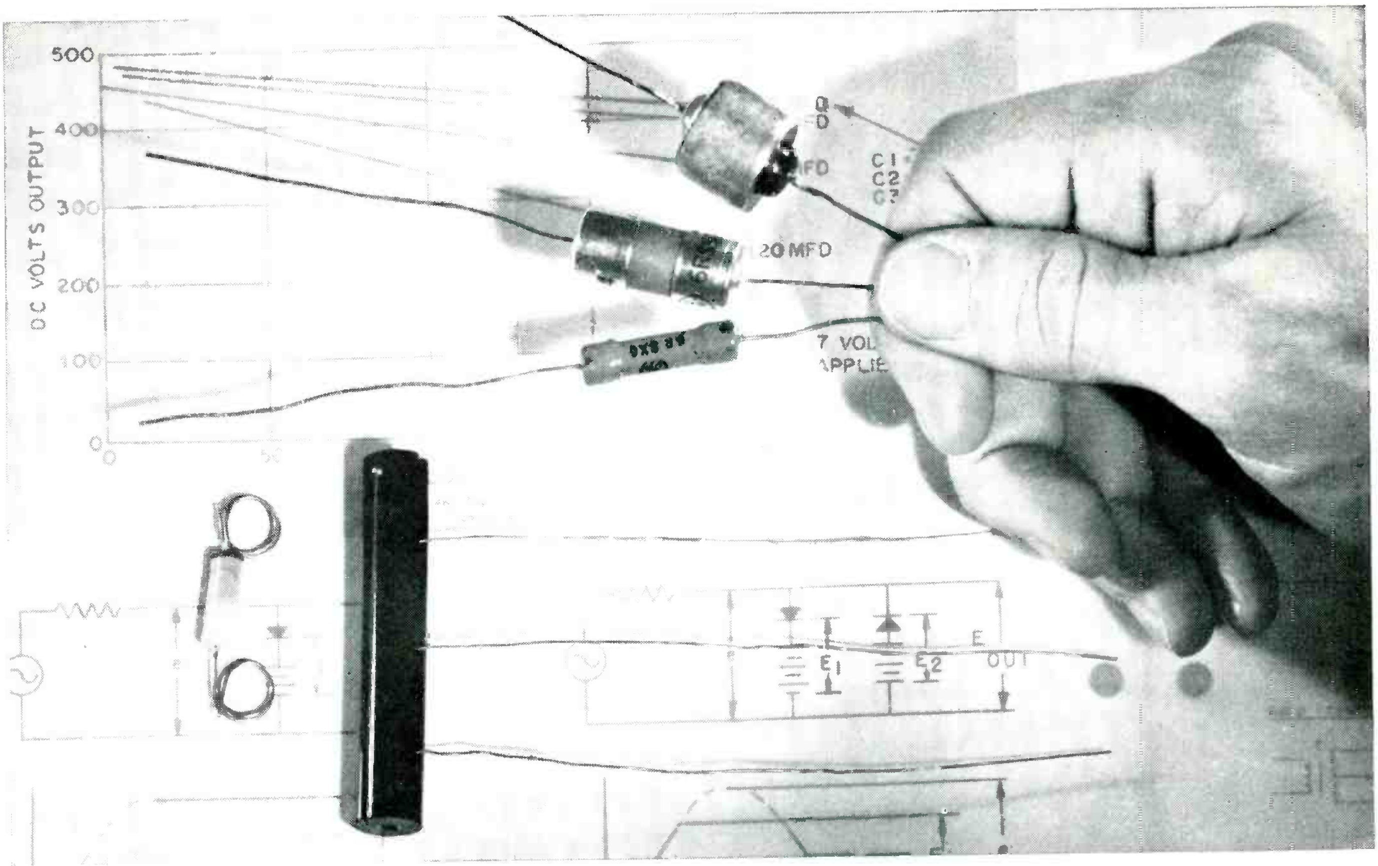
PHILCO CORP. has created a new division to be known as the Lansdale Tube and Transistor Company.

William J. Peltz, formerly vice-president in charge of operations for the television division, has been named vice-president and general manager of the new division.

The division, will manufacture and market a wide range of cathode ray tubes, vacuum tubes, transistors, diodes and other semi-conductor devices.

The division, with its main plant at Lansdale, Pa., has been a Philco subsidiary since 1947.

Peltz has been with Philco for 30 years. In 1942, he was named radio production manager and the following year was placed in charge of the company's production of airborne radar for the Armed Forces. Since then, Peltz has served successively as production manager of the refrigeration division, manager of operations for the government



G-E Miniature Vac-u-Sel* Rectifiers Provide 60,000 Hours Life; —65 C to 130 C Ambient Range

General Electric miniature Vac-u-Sel rectifier stacks provide outstanding advantages in the areas of:

- Long life expectancy—60,000 hours at 35 C
- Broad ambient temperature range—-65 C to 130 C
- Wide adaptability—variety of stack ratings to 9250 volts peak inverse.

Vac-u-Sel is the G-E trade-mark for a new line of metallic rectifiers with outstanding electrical characteristics.

LONG LIFE EXPECTANCY—Applications requiring 60,000 hours of life and more can be handled with assurance of highly dependable performance with these top-quality rectifier stacks. Long life is an inherent characteristic of these rectifiers. Aging (increase in forward drop) is exceptionally low.

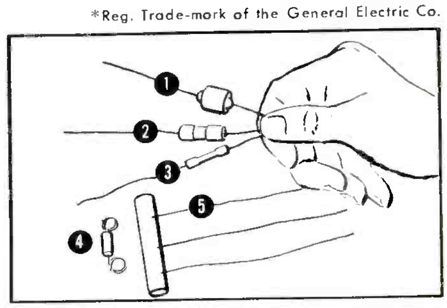
BROAD AMBIENT TEMPERATURE RANGE—All G-E miniature Vac-u-Sel rectifier cells are specially processed to maintain a high stability of characteristics over an ambient temperature range from -65 to 130 C. Full voltage ratings may be used in all high-temperature applications, and current need not be derated in cases where shorter life is acceptable.

WIDE ADAPTABILITY—Miniature Vac-u-Sel rectifiers are available in individual stacks rated up to 9250 volts peak inverse (6500 volts RMS). Higher voltages may be obtained by using two or more stacks in series. Basic cell ratings are 2.5 ma, 8 ma, and 25 ma (half wave).

Vac-u-Sel rectifiers are available in a variety of housings. The ceramic-tube and metal-tube housings are hermetically sealed. Military specifications on protective coatings are met by applying a special finish to the Textolite* tube stacks at additional cost, and by potting (sealing). Special housings can be offered for large-quantity applications.

PROMPT SERVICE—Immediate attention to any proposition can be obtained by contacting your nearest G-E Apparatus Sales Office, or by writing Section 461-37, General Electric Co., Schenectady 5, N. Y.

*Reg. Trade-mark of the General Electric Co.



VARIETY OF HOUSINGS available for Vac-u-Sel rectifiers. 1) Metal-clad casing, 2) Textolite tube, 3) Ceramic tube, 4) Nylon tube, 5) Slotted Textolite tube.

Progress Is Our Most Important Product

GENERAL ELECTRIC

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and industrial division, and as vice-president-operations, television division.

Reese B. Lloyd, director of industrial and personnel relations for Philco Corp., was appointed vice-president in charge of operations for the television division, succeeding Peltz.

Also, William H. Mattison, production manager of the television division, was named to the newly-created position of vice-president in charge of production for television.

Lloyd joined Philco in 1950. In 1951, he was assigned to the government and industrial division to organize and put into production a new plant at Bedford, Indiana, for the manufacture of hermetic compressors and to organize manufacturing programs on several government projects. The following year he was named assistant to the vice-president in charge of planning and in 1954 he was appointed director of industrial and personnel relations. Prior to joining Philco, Lloyd was general manager in charge of all plant operations for the Rheem Manufacturing Co.

Mattison joined Philco in 1926 when the company was known as the Philadelphia Storage Battery Co. In 1934 he became superintendent of production for radios and in 1948 was made production manager of the television division, his position prior to promotion.

New York Coliseum Leased For 1956 IRE Show

THE INSTITUTE of Radio Engineers has signed a lease with New York's Triborough Bridge and Tunnel Authority for all four exhibit floors of the New York Coliseum at Columbus Circle in New York City for the Radio Engineering Show, to be held March 19–22, 1956.

It is the only show thus far to lease the entire exhibit area and is to be the first to use the full capacity of the new building. The coliseum is still scheduled for completion on March 1, 1956 despite a structural collapse in May, 1955.

Over 800 electronics firms are expected to participate in the 1956 Radio Engineering Show and the Coliseum will accommodate the entire exhibit.

Seated left to right: James F. Walsh of the Triborough Bridge and Tunnel Authority, John D. Ryder, president of IRE. Standing left to right: William C. Copp, radio engineering show manager, Royal W. Ryan, of the New York Convention and Visitors Bureau, George W. Bailey, executive secretary of IRE, Haraden Pratt, secretary of IRE and Elwood K. Gannett, managing editor of IRE publications

Scientists To Meet In International Symposium

LEADING mathematicians, physicists and scientists will meet in July at the Navy Electronics Laboratory, San Diego, Cal., in an international symposium sponsored by the Laboratory, the Office of Naval Research and the Ryan Aeronautical Co.

Purpose of the symposium is an exchange of ideas on radar, radio and sound wave propagation through stratified media, the known methods of approaching the problem and the outstanding unanswered questions.

Participants will present no formal papers, but will instead hold round table discussions on the so-called "normal mode theory". Chairman will be S. A. Schelkunoff of the Bell Telephone Laboratories, Murray Hill, N. J.

J. B. Smyth, head of the research, theory and analysis staff of the N.E.L.'s propagation division, will serve as secretary of the symposium.

Besides Schelkunoff, and Smyth, the round table group will comprise: D. C. Potts of NEL, Carl Eckart of Scripps Institution; W. S. Ament, Martin Katzin and L. G. McCracken of the Naval Research Laboratory; C. J. Bouwkamp and H. Bremmer of Phillips Research Laboratories; T. J. Carroll of Lincoln Laboratory of MIT; Dr. B. Friedman of New York University; W. C. Hoffman of Land-Air; H. W. Marsh, Jr. of Navy Underwater Sound Laboratory; E. C. S. Megaw of the British Admiralty; J. A. Ortusi of Research Compagnie Generale de T.S.F., Paris, France; C. L. Pekeris of The Weizmann Institute, Rehovoth, Israel; K. M. Siegel of the University of Michigan; Balthasar van der Pol of the International Telecommunication Union, Geneva, Switzerland and M. Jean Voge of Laboratorie National de Radioelectricite, Paris.

GE Expands Plants, Promotes Engineers

GE OFFICIALLY opened its new multi-million dollar, 190,000 sq ft manufacturing plant in Waynesboro, Va., the first of two company plants to be completed in the state. George E. Burens, G-E vice president and general manager of the company's switchgear and control division said that the plant was built specifically to meet the growing demand for electronic controls used in automated processes. It will

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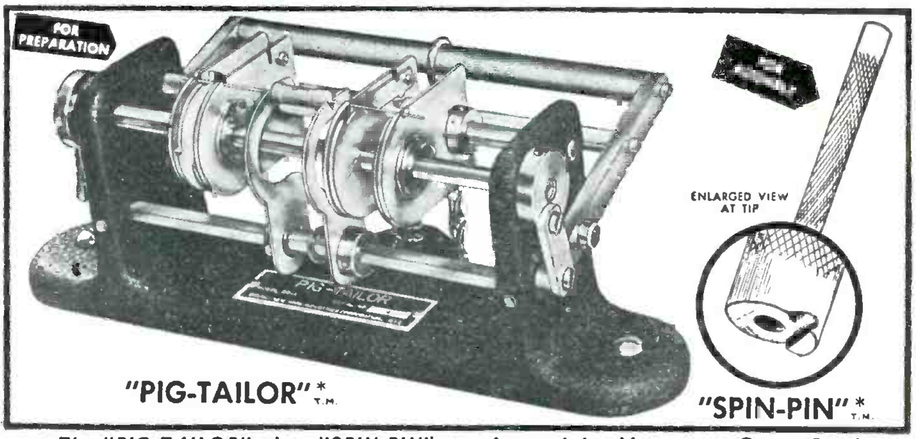

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eventually employ between 500 and 600 people with an annual payroll of approximately $2½ million. By 1957, the department expects to be spending an additional $1 million annually in Virginia for materials, utilities and supplies.

A second GE plant, to be headquarters for the company's industry control department, is now under construction in Roanoke County, near Salem, Virginia. It is scheduled for completion early in 1956.

Dr. L. T. Rader, general manager of the specialty control department, said that plans for future plant expansion are already being prepared although the installation is not yet operating at full capacity. He said that the demand for electronic controls of this type, essential to modern and highly mechanized production lines is expected to double within the next five years, and triple by 1965.

GE also announced plans to double the size of its new microwave research laboratory on Stanford University land at Palo Alto, California.

In addition to constructing 10,000 sq ft more floor space, G-E is doubling its leasehold from three to six acres and will double the number of employees from 70 to 140 by the end of the year when the expansion is completed.

Laboratory manager H. R. Oldfield, Jr., said another expansion of about one-third is planned for the future.

GE also announced a new promotion. Lyman R. Fink has been appointed manager of the research application services department at the GE research laboratory.

He will assume the position at the research laboratory formerly held by Edwin E. Parker, who recently was named general manager of the instrument department.

NBC And Westinghouse To Exchange Stations

AN AGREEMENT has been signed for an exchange of the Philadelphia television and radio stations owned by the Westinghouse Broadcasting Co. and the Cleveland television and radio stations owned by NBC. It is subject to approval by the FCC. The Westinghouse stations in Philadelphia are WPTZ and KYW. The NBC stations in Cleveland are WNBK, WTAM and WTAM-FM. The agreement calls for the payment to Westinghouse of $3,000,000 in addition to the exchange.

Bomac Elects Heins And Tremblay

BOMAC LABORATORIES of Beverly, Mass. has elected Harold Heins as vice-president of engineering and Louis S. Tremblay as vice-president of production. Heins has been connected with Bomac in various engineering responsibilities since its inception. In addition to his duties as engineering vice-president, he is also a member of the board of directors. Tremblay, in his new position, is responsible for all production and plant functions, including primary production, factory engineering and plant maintenance.

Bendix Names Four To New Posts

JOHN M. MILLER JR. has been named to the newly created position of director of engineering of the television and broadcast receiver division of Bendix Aviation Corp.

Stanley R. Scheiner has been named assistant director of engineering.

Miller, former chief engineer, joined the Bendix staff eight years ago. During World War II he was a radio and radar engineer at the Naval Research Laboratory and the Navy Bureau of Ships.

Scheiner also joined the Bendix staff eight years ago. He has been on the television engineering staff

John M. Miller

for the past six years.

Two appointments were also made to the staff of the research laboratories division of Bendix Aviation Corp.

Ralph A. Lamm has been appointed to head special missile development activities of the division. He will be responsible for coordinating the guidance and control developments in special missile fields for the division.

Arthur C. Prine has been named assistant to the general manager of the division. His duties will include customer relations and market research.

Prior to joining the Bendix staff Lamm served as technical director of the Naval Ordnance Laboratories, Corona, Calif. During World War II he was a staff member of the radiation laboratory at M.I.T. After the war he headed the missile division at the National Bureau of Standards.

Watson-Watt Heads Logistics Research

SIR ROBERT ALEXANDER Watson-Watt has been named president and board chairman of Logistics Research, designers and manufacturers of electronic computers in Redondo Beach, Calif.

Famed for the development of radar, he was knighted by King George VI and awarded the Medal of Merit by the President of the United States.

In developing the potentialities of Logistics Research, he will draw upon the scientific, engineering and management services he also heads. These are Sir Robert Watson-Watt and Partners, in London and its two North American subsidiaries, Adalia, in Canada and Adalia in New York.

The immediate program is to guide the development, manufacture and sale of ALWAC III, a low-priced, high-speed, general purpose digital computer.

Raytheon To Buy Plant, Opens Warehouse

RAYTHEON MANUFACTURING CO., has arranged to purchase the 210,000 sq ft plant in Tewksbury and South

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Lowell, Mass. It was formerly the South Lowell Ordnance Plant, later occupied by Davis Aircraft Co.

The plant has been converted for electronics manufacturing. It has been operating as a Raytheon branch plant since 1952, under lease. Approximately 700 employees are engaged in government classified work there. More than $2,000,000 worth of the most modern precision machinery and tooling have been provided by the Navy's Bureau of Aeronautics and the Army Ordnance. The plants annual payroll is somewhat more than $1 million a year.

Raytheon also opened a new tube warehouse and sales office in Franklin Park, Ill.

The new structure has approximately 30,000 sq ft of floor space. Of this space, one-sixth is devoted to offices, while the remainder is used for stockpiling receiving and cathode ray tubes, transistors and semiconductor diodes, and a line of industrial tubes. The warehouse also contains an engineering laboratory for handling commercial engineering problems.

Technology Instrument Opens New Plant

TECHNOLOGY Instrument Corp. of California has opened a new plant in North Hollywood. Engineering services have now been supplemented with full production facilities for the manufacture, assembly, testing and inspection of precision potentiometers.

New Firm Organized In Washington, D. C.

A NEW COMPANY has been set up in Washington, D. C. to manufacture and market the LogEtronics contact printer, a photographic printing device which produces prints automatically, by means of electronic controls. The new firm, LogEtronics, has purchased all LogEtronic patent rights from Reed Research of Washington, D. C.

President of LogEtronics is Richard N. Johnson, until recently assistant director of the Foreign Operations Administration. During and after World War II, he was a division director in the War Production Board, an officer of the export-import bank, and a member of the White House staff. He has been president and publisher of the Boston Evening Transcript, assistant to the president of Bemis Industries and president and treasurer of Hillsboro Woolen Mill Co.

Dwin R. Craig, inventor of the LogEtronics principle and devices, is vice-president and technical director of the new company. From 1948 to 1954, he was field and project engineer for Reed Research.

The LogEtronics system, on which patents are pending, compensates electronically for varying differences in density in the same negative, to produce uniform photographic prints.

United-Carr Fastener Elects Groves

SAMUEL A. GROVES has been elected to the newly-created office of executive vice-president of United-Carr Fastener Corp. He has been serving heretofore as vice-president and general manager of the eastern divisions of the company. Previously he was vice-president in charge of sales.

Hoffman Laboratories Names Engineers

LEONARD A. MAYBERRY has been appointed to the newly created position of engineering manager of Hoffman Laboratories. Gene Lamphear, former radar group engineer for Hoffman, has been advanced to the position of chief electrical engineer of the labs.

Mayberry will be responsible for over-all administration of the company's rapidly expanding engineering department.

He has been chief engineer for Motorola's military engineering department in Chicago. Prior to joining Motorola in 1952, he was assistant to the president of Magnavox and was chief engineer for Hallicrafters handling engineering supervision for the company's aircraft communications equipment.

Lamphear joined Hoffman Laboratories in 1954 as group engineer in charge of the design and development of heavy radar equipment. A radar engineer with the Signal Corps during World War II, Lamphear brings to his new post of chief electrical engineer more than 12 years' experience in the development of precision bombing and airborne search radar for Bell Telephone Laboratories, Western Electric and Stavid Engineering.

Hoffman Labs also appointed John R. Bly as director of quality control. Bly was formerly quality control manager of General Controls Company, Glendale, where he had served since 1940.

RCA Opens New Administration Center

A NEW five-building center in Cherry Hill, N. J. that houses administration and engineering facilities for RCA consumer products and the RCA Service Co. has been completed.

The installation, upon which construction was begun in February, 1954, is located on a 58-acre tract between Haddonfield and Merchantville, N. J.

Approximately 1,400 persons are employed there. The two and three story buildings have a total of 325,000 sq ft of space.

The buildings house the executive, administrative and engineering staffs of the television division, the radio and "Victrola" division, and the RCA Service Company, which formerly were located in Camden and Gloucester, N. J., respectively. RCA's engineering products division, as well as various corporate staff activities, still are

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maintained in downtown Camden, N. J.

RCA also announced the appointment of C. W. Taylor to the newly created position of manager, color kinescope marketing in its tube division. For the past ten years, Taylor has acted as manager, tube parts and machinery sales. In his new assignment he will be responsible for market planning and promotion of color tv picture tubes.

He joined RCA in 1930 as a receiving tube engineer. In successive steps he served as radio tube design engineer and staff assistant to the general manager of the Harrison, N. J. plant assigned to coordinating the metal receiving tube program.

Airborne Instruments Promotes Two

AIRBORNE Instruments Laboratory of Mineola, N. Y. has promoted Lawrence J. Torn to chief electronics control engineer of its engineering and production division and J. Gregg Stephenson to assistant supervising engineer of the applied electronics section of the division.

Torn's new assignment calls for coordination of the company's production design activities in the field of industrial control systems involving automatic machine and process controls.

His experience has been in the fields of servomechanisms, feedback amplifiers, analog computers and closed-loop radar data processing systems, including responsibility for engineering development as project engineer of a large-scale radar data processing system.

Lawrence J. Torn

Prior to his employment with Airborne in 1945, Stephenson was a research associate at the radio research laboratory of Harvard University, where he worked on radar countermeasures. He also served with the American British Laboratory in England and was a technical observer in the Mediterranean area.

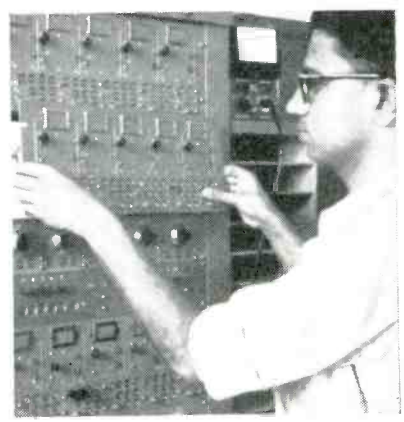
Stromberg-Carlson Leases New Plant

AN INDUSTRIAL building providing 40,000 sq ft of floor space has been leased in Rochester, N. Y. by Stromberg-Carlson for the additional manufacture of carrier equipment. Production will start July 18.

The operations scheduled for the new plant will include winding of toroidal coils, building of filters, assembly of components for a complete line of carrier units for both wire line and microwave multiplex service. A carrier research and development engineering department also will be accommodated in the building.

The volume of business is such that full-scale production of carrier equipment also will continue at the Stromberg-Carlson plant in Dallas, Texas, for the next four months, without the usual shutdown for vacations.

Indian Institute Engineers Build Computer



V. N. CHIPLUNKAR is shown installing an operational amplifier panel of a new computer recently built in the electrical communication engineering department of the Indian Institute of Science, Bangalore, India. Most of the components, including plug in d-c amplifiers, were brought from the U.S.A. by Technical Cooperation Mission Visiting Professor V. C. Rideout of the University of Wisconsin.

The chassis and panel design and construction were carried out in India by Prof. Rideout, V. N. Chiplunkar and N. N. Biswas. The linear section of the computer comprising 20 operational amplifiers and 10 potentiometers, power supplies and control panel is now complete, and a number of problems have been tried.

Development of limiters and other nonlinear units for use with this computer is now well under way, and a new type of timing-marker generator has been designed and tested.

Recently L. K. Wadhwa, of the Defense Sciences Organization, New Delhi, solved a propeller vibration problem on this machine for the Hindustan Aircraft Company of Bangalore, the first use of this machine for Indian Industry.

The Technical Cooperation Mission supplied the parts for the computer. Total cost of parts, including a-c regulator, oscilloscope, voltmeters, as well as the computer elements was less than $4,000.

FTR Forms Community TV Group

A COMMUNITY tv cable service section, which will provide technical information and associated services to community tv operators, has been created by Federal Telephone and Radio Co. of IT&T.

Richard A. Hyer has been appointed to head the operation. He was formerly sales manager for wire and cable products.

Burroughs Makes Expansion Moves

CONSTRUCTION has started on a new building near Paoli, Pa., to accommodate the research and development program of Burroughs Corp. in electronics, particularly devices for the armed services.

The building will have 28,500 sq ft of floor space and will be erected on a newly-acquired 104 acre tract. Paoli is the location of the company's new Research Center, a 105,000 sq-ft laboratory which was occupied just a year ago.

Burroughs is leasing 10,000 sq ft of floor space in another building in Paoli.

The company also announced that if stockholders approve, it will acquire The Todd Company of Rochester, N. Y.

Todd produces such protective devices as checkwriters and check signers, safety paper, checks and other forms associated with disbursement of funds.

In another move, Burroughs appointed Milton E. Mengel as vice-president. He will be in charge of corporation-wide product planning.

Since June 1953 Mengel has been director of product planning. In his new position he will have the responsibility for co-ordinating the planning of future development of the corporation's line of business machines and electronic devices for business and scientific applications. He joined the firm in 1927.

Scott Appoints Chief Research Engineer

DANIEL R. VON RECKLINGHAUSEN has been appointed chief research engineer of Hermon Hosmer Scott of Cambridge, Mass., manufacturers of acoustic measuring instruments and sound reproduction equipment.

He has had experience with Rohde and Schwarz of Munich, Germany, in the design and development of uhf test gear and allied instrumentation. He joined Scott in 1951. In recent years, as senior project engineer, he has been in charge of audio developments, and his new duties include technical responsibility for acoustic and audio instrumentation research and development.

Emerson Creates New Engineering Division

THE ENGINEERING division at Emerson Radio has been expanded into two separate divisions, the commercial engineering division and the government projects engineering divison. R. T. Capodanno, vice-president in charge of engineering, continues as the head of the commercial engineering division and Werner A. Auerbacher has been named director of the newly-constituted government projects engineering division.

For the past three years, Dr. Auerbacher has been an Emerson government engineering head in charge of several government projects. Prior to joining the firm, he held important engineering posts with electronics organizations in this country and in Europe.

Daystrom and Weston Complete Merger

THE STOCKHOLDERS of Daystrom and Weston Electrical Instrument Corp. approved the merger of Weston into Daystrom. Earl R. Mellen and Edward F. Weston, president and chairman of Weston, respectively, have joined the Daystrom board of directors.

Terms of the merger, by which one share of Weston stock is converted into one share of Daystrom, were approved by 524,017 shares or 79.6 per cent of the Daystrom stock outstanding and by 362,581 shares or 84.7 per cent of Weston outstanding stock. Weston becomes a wholly owned operating subsidiary of Daystrom and will continue to use the Weston corporate name and trademarks.

Unaudited figures released by Daystrom on May 2, for its fiscal year ended March 31, 1955, showed estimated sales of $73,800,000 compared to $62,473,000 for the year before. Net income for the past fiscal year was estimated at $1.690,000, or $2.56 per share on the 658,761 shares outstanding, against $1,459,000, or $2.33 a share on 624,911 shares outstanding in the previous period.

Weston reported sales of $28,672,800 for the year ended December 31, 1954, compared with sales of $32,409,800 in 1953. Net income for the year amounted to $1,056,714, or $2.47 a share, compared with earnings of $1,025,930 or $2.40 a share in the previous year. For the first 13 weeks of 1955 Weston reported sales of $6,272,429 and net income of $213,403.

T. R. Jones, president of Daystrom, stated that "the merger of Weston into Daystrom means that we have realized one of our important goals in the transition of Daystrom to a company with primary interest in electrical, electronic and related products. It is estimated that these products will account for 70 per cent of our shipments in the current fiscal year."

Tyler-Evans Opens New Factory

TYLER-EVANS, manufacturer of transformers and coils, opened a new plant at Antioch, Ill.

Paul Evans, who incorporated the firm last March, has been in the electronics field since 1937. He was

Paul Evans

project engineer of Sylvania's test equipment division and chief of tv component design at Heppner Manufacturing Co. He also was with the Westinghouse component laboratory, home radio division.

Data Processing Elects Officers

DATA PROCESSING Associates of Ottawa, Canada elected George Glinski as director and president and Douglas Peacock as managing director and vice-president. Glinski has been associated with electronic research and development for 20 years and since 1948 has specialized in electronic computation and automation. For the last seven years he has been a director of Computing Devices of Canada having been a co-founder of that company in which he held the offices of president and vice-president.

Peacock has been associated with systems and procedures applications for 10 years and for the last three years has specialized in the sale of electronic data processing and data reduction equipment. He formerly was sales and contract manager for Computing Devices of Canada.

Motor Maker Enters Electronics

HALL-SCOTT MOTORS CO., Berkeley, California engine manufacturer, has entered the electronics field through the acquisition of Bardwell & McAlister of Burbank, Calif. The addition of this new division is another step in the policy of product diversification.

The new Bardwell & McAlister division occupies a completely equipped plant in Burbank, California, with 88,000 sq ft of space.

Closed Circuit TV Firm Formed

A NEW CONCERN, Norwood Electronics Co., has recently been established in Philadelphia, Pa. It has been organized to design and produce closed circuit television equipment, television microwave transmission equipment, special oscilloscopes and cathode-ray tube indicating devices. The new firm has acquired 3,000 sq ft of factory space for offices and laboratories.

William Ussler, former project manager of television microwave and industrial television equipment for the Philco Corp., is president and general manager of the new concern. He was formerly chief engineer of the Electronics Tube Co., instrument division.

Norden Ketay Appoints Levine

BERNARD LEVINE has been appointed director of design and application engineering of Norden-Ketay Corp.

He was previously engineering director of the Ketay Laboratories division.

He will be responsible for the design and application of products of both the precision components division and the instrument and systems division.

General Transistor Appoints Works Manager

BERNARD B. COHEN has been appointed works manager of General Transistor Corp. of Jamaica, N. Y., manufacturer of transistors, germanium diodes and related semiconductor products. Cohen, who recently specialized in mechanization of transistor production processes, brings fifteen years of electronics experience with him. He has served in engineering capacities with Radio Receptor Co., Tele-tone Radio Corp., Electromatic, and Emerson

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Radio and Phonograph Co. He will be responsible for all manufacturing operations including production engineering, quality control and automation.

William Brand Dedicates New Plant

A NEW PLANT to manufacture Turbo plastic insulated wire and cable and electrical insulating tubing was dedicated at North Windham, Conn. by William Brand, president of William Brand & Co. of Willimantic, Conn. Speaking at the ceremonies, in addition to local city and town officials, was the Honorable Abraham Ribicoff, Governor of the State of Connecticut.

The new 60,000 sq ft building that replaces an old 35,000 sq ft factory, was built at a cost of over $500,000.

The firm's first plant started operation in 1939 in Willimantic with 37 employees and an annual payroll of $35,000. Currently 250 people are employed with an annual payroll of $950,000.

Increased emphasis is being placed by the firm on research and development. Laboratory space has been increased from 1,500 sq ft in the former plant to almost 3,000 sq ft in the new structure. The new plant is expected to be in full operation in August.

Tinnerman Elects New Officers

ROBERT C. OVERSTREET was elected president of Tinnerman Products succeeding George J. Schad, who has retired.

John E. Potter, formerly comptroller, has been elected secretary and treasurer of the firm and also elected to its board of directors.

Overstreet, who had served as executive vice-president since 1953, joined Tinnerman in 1941. He was named assistant to the vice-president and general manager in 1945 and was made secretary in 1948. He was elected a vice-president and to the board of directors, and reelected secretary in April, 1952.

Potter joined Tinnerman as office manager in 1947 after 13 years' service with Globe Machine and Stamping Company, where he was assistant secretary and assistant treasurer.

Ridenour Joins Lockheed Aircraft

LOUIS N. RIDENOUR has joined the Lockheed Aircraft missile systems division as director of program development.

Dr. Ridenour, during five years as staff member and assistant director of M.I.T's Radiation Laboratory, headed development work leading to the SCR 584 radar system.

He edited the "Radiation Laboratory Series" of reference books.

In addition to his work at M.I.T., he has served as consultant to the Office of Secretary of War; professor of physics and dean of the Graduate College of the University of Illinois; chief scientist for the U. S. Air Force; and most recently as a vice-president of International Telemeter Corp.

Litton Acquires Ahrendt Instrument

AHRENDT INSTRUMENT Company of College Park, Maryland has been purchased by Litton Industries.

Ahrendt designs and manufactures automatic control equipment.

It is the ninth electronics firm to become integrated into Litton Industries, Inc. in the past eighteen months.

Ahrendt employs 175 people in a

30,000 sq ft plant.

William Ahrendt, president, will remain with the company and become a principal executive with Litton Industries.

Litton now employs approximately 1,200 people in its seven plants, five of which are located along the West Coast from San Francisco to San Diego, California, and two located on the East Coast.

Sylvania To Expand New Laboratory

SYLVANIA ELECTRIC is increasing the size of its new electronics laboratory nearing completion in Waltham, Mass. It will be leased by the firm. The new facility is being enlarged from 80,000 sq ft to 120,000 sq ft. The addition is to be completed by early Fall.

The new lab will house the missile systems laboratory, now located temporarily in Whitestone, N. Y., and the engineering laboratories now in Boston.

The new facilities are a part of the electronic systems division with headquarters of the division, as well as engineering and production facilities, in Buffalo, N. Y.

Packard-Bell Elects Gleis

JEAN P. GLEIS was elected as vice-president in charge of manufacturing for Packard-Bell.

He joined the organization in 1945 as a model maker in the tool shop, progressing from that position to the post of assistant to the general manager.

He was appointed plant manager in 1949 and has continued in that capacity until his elevation to the vice-presidency by the board of directors.

Bailey Meter Promotes Executives

PAUL S. DICKEY, former vice-president and a director of Bailey Meter Co. has been elected president succeeding Robert S. Coffin, who was elected chairman of the executive committee and named management consultant. Coffin, with the company since its establishment in 1916, had been president since 1944.

Harvard H. Gorrie, chief engineer, has been elected a vice-president in charge of all engineering activities, and Raymond D. Junkins, head of the patent department, has been elected a vice-president and director. H. M. Hammond continues as a director and vice-president in charge of all sales activities.

U. S. Steel Appoints Automatic Control Head

HAROLD R. NELSON has been appointed chief research engineer in the research and technology division of United States Steel Corp.

In this newly-created position, Nelson will supervise and coordinate research work in the application of automatic controls, instrumentation and mechanization to steel processes.

He joined GE in 1941. He also spent several years with the United Engineering and Foundry Co. before joining the Columbia-Geneva Steel Division of U. S. Steel Corp. in 1951. He was general supervisor of electrical engineering at Geneva works at the time of his present appointment.

Hycon Forms New Firm, Elects Directors

A NEW COMPANY, Hycon Eastern, has been formed in Cambridge, Mass. with Hycon Manufacturing Co. of Pasadena, Calif. the major stockholder. The firm plans to develop new products and techniques in nuclear instrumentation, microwave communication and computing.

Prominent in the formation of the firm were two M.I.T. scientists, Dr. Jerrold Zacharias, director of the Laboratory for Nuclear Science at M. I. T., and Dr. Jerome Wiesner, director of M. I. T.'s Research Laboratory of Electronics. Both will serve as directors of Hycon Eastern, and will aid in the technical supervision of the company.

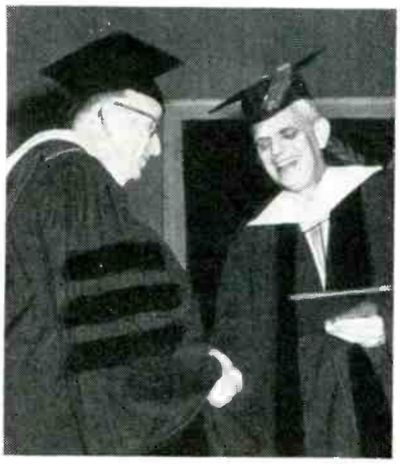
President of the new concern, M. M. Hubbard, is the third director of the company to be drawn from the staff of M. I. T. Prior to accepting his present position with Hycon Eastern he was assistant director of M. I. T.'s Lincoln Laboratory.

The election of Russell H. Varian and Edward E. Tuttle as directors of Hycon Mfg. Co. in Pasadena, California, was also announced.

Russell Varian is president of Varian Associates of Palo Alto, Calif. and vice-president in charge of research of Hycon Aerial Surveys.

Edward E. Tuttle is a partner in the Los Angeles law firm of Tuttle, Tuttle and Taylor. The firm is legal counsel for Hycon.

NYU Awards Honorary Degrees



CHANCELLOR Henry T. Heald of New York University (right) conferred the honorary degree of Doctor of Engineering upon Mervin J. Kelly, president of Bell Telephone Laboratories. The honor was bestowed at the final convocation marking the 100th anniversary of the NYU College of Engineering. Thirteen outstanding engineering, scientific, industrial and civic leaders received degrees. The NYU Engineering Centennial was observed in the 1954–55 academic year on the theme "Teaching and Research Build the Future".

Dever Elected SAMA President

HENRY F. DEVER, president of Brown Instruments division of Minneapolis-Honeywell Regulator Co., has been elected president of the Scientific Apparatus Makers Association.

Dever, formerly member of the board of directors and president pro tem of SAMA, joined Honeywell in 1931. Prior to appointment to his present company post in Philadelphia in 1946, he was vice-president in charge of engineering in Minneapolis.

Navy Needs More Engineers

THE U. S. NAVAL Ordnance Plant at Indianapolis, Indiana, has openings in the fields of research, development, design and production of mechanical and electronic equipment.

The plant is offering such positions to qualified engineering and scientific personnel, with or without experience, who have degrees in physics, mathematics and engineering—electrical, electronic or mechanical. Salary ranges are from $3410 to $6940 per year. Further information can be obtained from the Industrial Relations Officer at the plant.

Servomechanisms Names Components Manager

JOHN J. DEMPSEY has been appointed division manager of the components division of servomechanisms. In his new capacity, he will report directly to Harold R. Larsen, vice-president and general manager of the firm.

Dempsey joined the company in 1947 and from 1951 until his recent appointment was chief development engineer for the Eastern division.

Link Radio Acquires New Plant

LINK RADIO has acquired a new plant in New Hyde Park, N. Y. The new Link headquarters is now in full operation producing 2-way radio equipment.

ElectroData Appoints Chief Development Engineer

GLEN F. NIELSEN, former technical staff assistant to the vice-president, has been named chief development engineer for ElectroData Corp.

He will be responsible for the research and new product program centering on the company's Datatron electronic data processing machines and auxiliary equipment.

He was formerly associate engineer and group leader in systems planning for large-scale computing equipment at IBM.

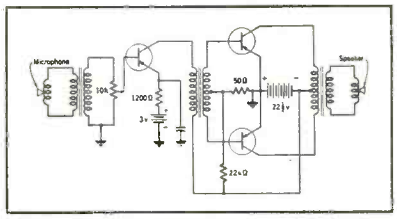
New Books

Transistor Audio Amplifiers

By Richard F. Shea. *John Wiley & Sons, Inc., New York,* 1955, 219 p, $6.50.

This book is a logical sequel to the author's first volume "Principles of Transistor Circuits". Unlike that volume, however, it is not the result of the efforts of several coauthors, but the work of Mr. Shea alone.

The purpose of this book is to "Provide the user with the necessary tools whereby he can design an audio (transistor) amplifier to meet certain prerequisites such as frequency response, signal-to-noise ratio, input power and output power in such a manner as to insure maximum reproducibility, longest life, maximum freedom from deleterious effects as temperature and humidity and last, but not least, lowest cost."



Public-address amplifier using *pnp* transistors described in "Transistor Audio Amplifiers"

Basic Principles

The first and second chapters cover the fundamental principles and characteristics of transistors. Equivalent circuits are developed with h parameters in contrast with z and y parameters which are more commonly used in earlier texts. A table on page 71 enables the reader to convert from any one of the parameter systems to any of the others. This is a great convenience since it is possible to encounter any of the three systems while using various manufacturers specifications sheets.

To help the designer choose the proper transistor for a particular need, chapter 2 includes 48 pages of transistor specifications. In almost every case, collector characteristics for both grounded-base and grounded-emitter configurations are given. The data covered includes that of General Electric, Germanium Products, Radio Receptor, Raytheon, Texas Instruments and Transistor Products transistors.

Chapter 4 deals with the various methods of coupling transistor stages. The tables on pages 118 and 119 list the gains available with various combinations of configurations.

Amplifier Circuits

Chapter 5 is devoted to preamplifiers. Some of the topics covered are: transistor-noise characteristics; noise as a function of operating point and source impedance; grounded-emitter configuration with degeneration; high and low-frequency response compensation; volume and tone controls.

Chapters 6 and 7 cover class A and class B power amplifiers. Considered are: input characteristics; linearity; power output and peak clipping for various transistor configurations. Bias stabilization, feedback, drive stages and high-temperature operation are also covered.

Chapter 8 covers many examples of practical amplifier design. This material should be of great value in the application of the theory of the previous chapters. Circuit designs worked out include three hearing aids, a phono preamplifier with equalization for use with a magnetic cartridge, an electronic megaphone and a high-power (13 watts at 5-percent harmonic distortion) amplifier.

A bibliography at the end of the volume lists pertinent articles and books written in the period from 1948 to 1954.

This book should be of value to audio enthusiasts as well as practicing engineers.—H. A. M.

Elements of Servomechanism Theory

BY GEORGE J. THALER. *McGraw-Hill Book Co., New York, N. Y.*, 1955, 282 *p*, $7.50.

"ELEMENTS of Servomechanism Theory" is an introduction to the theory involved in the design of feedback control systems. The book is written for undergraduates and assumes only a familiarity with conventional a-c circuit theory.

As a result of the many servo books which have appeared during the past few years, additional books in this field must be justified on the basis of either the presentation of new material or a selection of material particularly appropriate for a broad class of readers. The author here seems to have done a very commendable job in selecting material appropriate for a senior course in the subject.

Other available books in this field frequently attempt to drop to the senior level by emphasizing components. In this book, the author places essentially no emphasis on components, but concentrates on a cautiously advancing development of the frequency-domain design techniques. The component characteristics are primarily brought in through examples and problems. This general approach should be of considerable assistance in motivation of the student.

Transfer Functions

The author avoids the use of the Laplace transform and works in terms of transfer functions expressed in $j\omega$. The resulting elimination of the usual, rapid description of the Laplace transform is thus possible, and the book is able to concentrate on the ideas basic to the field. Although a number of universities are now introducing the concepts of complex frequency and the Laplace transform in the junior year, other schools should welcome Thaler's approach.

The most significant contribution of the author seems to be the discussion of compensation techniques. The first six chapters cover the usual introductory material — transient analysis, transfer functions, and analysis of single-loop systems. In Chapters 7 and 8, Thaler, discussing specifications and effects of gain adjustment, lays the groundwork for Chapters 9 and 10.

Chapter 9 describes series (tandem) compensation, with both lag and lead networks discussed. Chapter 10 describes feedback compensation, with primary emphasis on tachometric compensation. In both chapters, the theory is developed in terms of specific and comprehensive examples, which are described in welcome detail. Instead of the usual vague statements on selection of time constants, the examples require the author to be specific. Each step in the development is justified. The discussion of the two chapters does not (and of course should not) comprise a complete study. For example, the advantages of considering integral compensation as a means of boosting the velocity constant without changing the relative stability are not stressed, but the material seems very well suited for the senior level.

The final two chapters constitute a very brief survey of advanced topics (presumably to whet the students' appetite for advanced study). The entire book reflects a desire on the part of the author to make the presentation clear, interesting and easily understood.—JOHN G. TRUXAL, *Associate Professor, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.*

License Manual for Radio Operators: a guide to FCC examinations

BY J. RICHARD JOHNSON. *Rinehart & Company, Inc., New York,* 1955, 430 p, $5.00.

THIS BOOK sets forth the answers to questions appearing on the FCC commercial operator's license examinations. The book includes all questions issued by the Commission in its "Study Guide". The questions are presented in the sequence in which they appear on FCC examinations. This includes elements 1 and 2—basic law and operating practice, elements 3 and 4 on radiotelephone, elements 5 and 6 on radiotelegraph, element 7 on aircraft radiotelegraph and element 8 on ship radar techniques.

Element 4, advanced radiotelephone contains 36 questions on frequency modulation and 28 questions on television in addition to a-m broadcast techniques. Element 6, advanced radiotelegraph includes material on fsk and loran. The section on aircraft radiotelegraph, element 7, deals at some length with modern electronic navigation systems in use.

The book is designed both as a home study aid and for classroom

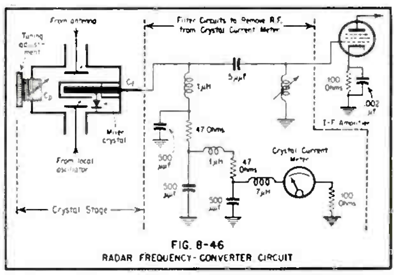


FIG. 8-46
RADAR FREQUENCY-CONVERTER CIRCUIT

Schematic of a ship radar frequency-conversion circuit illustrated in "License Manual for Radio Operators"

work. An appendix lists the various questions as they would be answered in a standard course in electricity and radio on the technical-school level. Headings include: d-c theory, a-c theory etc. For the reader interested in regulatory matters, another appendix keys particular questions and answers back to the basic treaty, law or regulation upon which they are based.

Twenty four text and reference books on radio and electricity are listed for additional reading and keyed to the parts of FCC examinations to which they are most applicable. A list of Q signals and their meanings is given.—J. M. C.

Circuits and Networks

BY GLENN KOEHLER. *Macmillan Company, New York*, 1955, 349 *p*, $6.50.

AS CLEARLY stated in its preface, this text presents a coordinated treatment of basic fundamentals applicable to both communications and power circuits. It is written primarily for electrical engineering students who have formally completed a course in alternating-current theory. It is particularly well suited as a senior-level text on passive, steady-state networks involving both lumped and distributed parameters. In this purpose, the reviewer feels that the text has succeeded admirably.

Basic Topics

The arrangement of topics is as follows: general analysis procedures are developed in chapter 1 based upon phasor algebra leading to the complex impedance concept. Both mesh and nodal methods are described and applied. Network equivalences are derived using transformation procedures. On this broad foundation, chapter 2 is introduced to simplify the analysis problem by the superposition theorem, Thevenin's theorem, Norton's theorem, maximum power transfer theorems, and the compensation theorem. Resonance phenomena are described in chapter 3 in terms of bandwidth, selectivity, and Q-factors. This is followed by coupled circuits (chapter 4). A variety of configurations are carefully discussed to illustrate the principle of tuning and resulting selectivities.

Chapters 5 through 7 treat four-terminal networks. Techniques are developed for the analysis and design of impedance-matching networks, filters, attenuators, and equalizers. Well chosen examples illustrate procedures for realizing desired characteristics pertaining to magnitude and phase as frequency is varied.

Transmission Lines

Transmission-line concepts appear in chapters 8 through 10. The first chapter of this group serves to acquaint the reader with distributed parameters as a convenient way of analyzing transmission lines. Resistance, leakage conductance, inductance and capacitance are individually discussed to ascertain factors which influence their behavior. The second chapter presents the equivalent circuit of a transmission line in terms of these distributed parameters and methods for analyzing its performance.

The solutions reveal the wave nature of voltage and current along the line and their dependence on load. Ensuing discussions relate to propagation constant phase velocity, wavelength, impedance, reflection, power and characteristics of special lines such as telephone lines, distortionless lines and high-voltage lines. The third chapter deals with high-frequency transmission lines and approximations which can be made at such frequencies in order to simplify analysis. Standing-waves are interpreted and related to the reflection coefficient and impedance measurements. Additional topics include impedance matching devices and charts for graphical solutions.

Chapter 11, the final chapter of

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the book, pertains to transformers and reactors. A unique attempt is made to classify transformers in accordance with various operating criteria. Parameters of the equivalent circuit representation of the transformer are discussed and analysis procedures evolved for different frequency ranges. This chapter is concluded with an analysis of air-core, ferromagnetic-core and saturable-core reactors.

The text maintains a good balance between subject matter and technical detail. Each chapter is augmented with an excellent choice of problems. On the whole, it is lucidly written and very coherent. The publisher deserves to be commended on the fine styling. This book is most heartily recommended, not only to students but also to practicing engineers.—ANTHONY B. GIORDANO, *Polytechnic Institute of Brooklyn, Brooklyn, N. Y.*

Communication Theory

EDITED BY WILLIS JACKSON. *Academic Press, Inc., New York,* 1953, 532 *p,* $11.00.

THE particular symposium, of which this volume is the record, was held at the Institute of Electrical Engineers, London, during September, 1952. The purpose of the symposium, as noted by Prof. Jackson, was to consider the practical value of statistical communication theory to the field of electrical communication in which it originated.

Topics

The papers have been grouped under the following topics; transmission systems and coding (9 papers), transmission in the presence of noise—signal discrimination (8 papers), characteristics of transmission channels (4 papers), application to television (3 papers), hearing (1 paper), transmission and analysis of speech (8 papers) and associated studies (4 papers).

The amazing growth and vitality of the subject are evidenced by the active participation of eminent scientists from most of the Continent, England and the United States. The editor and publishers have performed a valuable service since this book represents the most complete available exposition of the major lines of development and application of communication theory. Although some of the papers have been previously published in the technical journals, the addition of new material, the grouping with other papers on aspects of the same topic and the availability make these of increased value. Considerable care seems to have been taken in the preparation of the material for publication, and the careful reporting of the discussions is commendable.

Main Points

It is not possible in this brief review to examine each of the papers. We shall describe some of the salient features (perhaps of particular concern only to the reviewer) and leave the detailed examination to interested readers. The book opens with a survey of the definitions, concepts and results of the basic theory by Prof. D. Gabor. This is intended as a reference for the nonspecialists and a refresher for the professionals. It is particularly well-written with an excellent selection of material. The grouping of papers on transmission in the presence of noise deal for the most part with improvement of signal-to-noise in the simpler systems, such as military radar and navigational systems. Extensive use is made of the correlation functions and elimination of watered factors, in particular where excessive use is made of bandwidth or time. It appears on the basis of this reportage and the personal experience of the reviewer that significant improvements in the performance of such systems can be achieved, but at a considerable cost in complexity and in versatility of application. Apparently situations are not infrequent where this price is willingly paid. In the case of television transmission and reception, where the rate of transmission of information is very much greater than for the periodic pulsed systems of radar or navigation, improvements are still in the talking stage and likely to be much more costly and hence less desirable. The technical difficulties of bandwidth compression, which is the usual objective in this application, are discussed in a very interesting paper by Cherry and Gouriet.

The penetration and worth of the theory in the various fields of communication as presented at this symposium is somewhat startling, especially when one recalls the very vague hints as to the development of a theory in communications which were first brought to the engineering reader in the editorials of ELECTRONICS not too many years ago. These references were to the thesis of Dr. William Tuller, then at MIT, which presented the fundamental aspects in the clearest and most complete form prior to the definitive work of Shannon.—M. LEIFER, *Engineering Manager, Electronic Defense Lab., Mountain View, Calif.*

Thumbnail Reviews

ASTM Publications. Standards on Metallic Electrical Conductors. Copper and copper alloys, copper-covered steel, aluminum, iron and steel, 272 p, 1954, single copies $3.25; $2.50 to ASTM members. Standards on Materials for Radio Tubes and Electrical Devices, Electrical Heating and Resistance Alloys, 244 p, 1954, single copies $2.75; $2.00 to ASTM members. Symposium on Radioactivity. Radioisotopes, personnel, radiation, management problems, 54 p, 1954, $1.75; $1.35 to ASTM members. Standards on Copper and Copper Alloys. Wire, plate, sheet, pipe, tube, etc, 600 p, 1954, single copies $5.00; $3.75 to ASTM members. All obtainable from American Society for Testing Materials, Philadelphia, Pa.

Electrical Elements of Power Transmission Lines. By Herbert Bristol Dwight. Macmillan Company, New York, 1954, 188 p, $4.25. Long and short lines, circle diagrams, load studies, stability, traveling waves, economics, lightning protection, etc. Numerous practical problems each requiring about an hour to solve. A useful text for students and engineers.

Basic Television. By Bernard Grob. Second Edition, 1954, McGraw-Hill, N. Y., 660 p, $6.00. A basic text covering all aspects of present-day monochrome and color tv.

1000 Electronic Questions and Answers. By R. J. Fredericks. Radio Sound Publications Co., Box 38, Utopia Station, Flushing 66, N. Y., 70 p, 1954, $1.00. For self-testing one's knowledge and ability in electronics. Chapters on radio and tv receivers and transmitters, antennas and test equipment.

Backtalk

Review Revised

DEAR SIRS:

YOUR FEBRUARY issue contained a review by me of N. L. Enrick's "Quality Control", second revised edition, published by the Industrial Press, New York.

The tone of the original review was influenced to a large extent by a misunderstanding. It seem ironical that this sort of thing should happen to me for the first time in thirteen years of quality control work while reviewing a book for the beginner.

As a result, I criticized the statistical validity of some of the methods used in the book. It is now clear that the author was not guilty of any statistical inaccuracy.

I am sure the author is aware of the hazards inherent in simplifying a mathematical subject, because he has taken occasion to caution the reader where required. I hope that these cautionary phrases will be given the attention they deserve.

I trust this letter will correct any doubts about the value of Professor Enrick's book.

ROBERT MCGHEE
Sylvania Electric Products Inc.
Kew Gardens, New York

Patent Bill Pending

DEAR SIRS:

ELECTRONICS AND OTHER McGraw-Hill publications, I know, are cognizant of patents, as well as of the fact that patents during the long past, as well as the present history of our country, have laid the foundations of a great many industries, especially electronics.

However, inventors and patents have been kicked around pretty badly during the past 25 years or so, especially during prior administrations. Hand-picked United States District Courts have laid a heavy hand on the validity of many good patents; the "Flash of Genius" opinion of Justice Douglas some years ago has permeated the entire patent and judicial system, so much so that the long-accepted concept of an invention as a new and useful combination of old elements has been almost completely invalidated;

the assurances by the great preponderance of invalidations against validations, in patent infringement suits, has resulted in a great deal of patent pirating, and patent owners seldom take the risks involved in preventing this; the niggardly appropriations for operating the Patent Office have put that worthy institution in insecure jeopardy; the Treasury Department's rulings on income from patents have been so tough that many inventors are leaving to others the risks involved in this precarious business; big industry appears to feel that it can very well get along without independent inventors, who, in fact, have given us most of the great milestones in inventive progress. .... wartime restrictions on the use of manpower and materials made impossible the development, promotion and production of many patents and patented articles, so that the all-too-brief 17-year patent life in many fields has been curtailed.

Due to World War II and the Korean War, this amounts to from four to six years. In my own case, patents on electronic musical instruments, far ahead of backward industries, did not get to the working stage until they were six or eight years old; many had never reached that stage before they expired into the public domain. Those which did reach commercialization in the late thirties were promptly choked off by the mentioned wartime decrees, so that their income-productive lives were shortened, or they expired during the interim.

A patent is a contract between the government and the inventor. The latter agrees to give a full and clear exposition of his invention in return for a guarantee of the sole right to use that invention for a period of 17 years, after which it becomes public property. While, of necessity, the Government must curtail the use of manpower and strategic materials in the non-essential fields, it nevertheless has not kept its agreement, and remedial legislation should be enacted to make proper restitution for the expropriation of the lost years of patent life.

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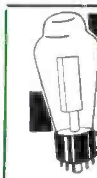

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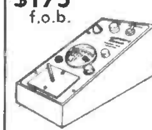

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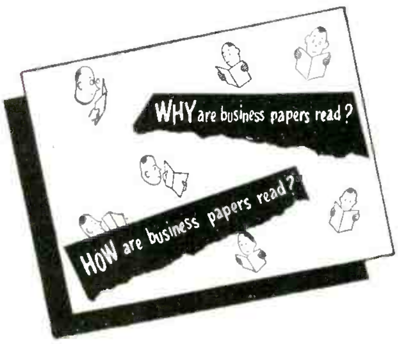

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many, who has been thus unjustly treated, as well as vice-president of the Patent Equity Association, a non-profit organization devoted to reforms in the patent system, I have for a number of years been devoting much of my time towards the promotion of such reforms.

Patent Extension Bill H.R. 3534, in the Senate, during the last hectic hours of the last session of Congress barely missed passage, because it could not be brought to a vote.

A duplicate bill, H.R. 2128, is now before the House Judiciary Committee for action, and all possible aid is required for its passage in the House and Senate.

B. F. MIESSNER
President
Miessner Inventions, Inc.
Morristown, N. J.

Microstrip Lines

DEAR SIRS:

IT HAS BEEN brought to my attention by one of the readers of ELECTRONICS that the published version of our technical paper, "Bandpass Filters Using Strip-Line Techniques", contained an erroneous statement. On page 154 of the May issue, the statement, "A normal type transition, similar to those used with most strip transmission lines . . ." should have read, "A normal type of transition, similar to those used with most Microstrip lines . . ." as in the original manuscript submitted for publication.

As a word of explanation, the term "Microstrip" generally designates a special type of strip transmission line having an unbalanced line structure or, in other words, a single ground plane; this type of line has been employed extensively by the Federal Telecommunication Laboratories. On the other hand, the term "strip-line" generally indicates a balanced or "sandwich" structure in which two ground planes are employed; several companies (e.g., Melpar, AIL and Sanders Associates) have been actively engaged in the development of strip-line components.

I am particularly apologetic for this error since it apparently escaped my attention in my review of the galley proofs.

E. H. BRADLEY
Project Engineer
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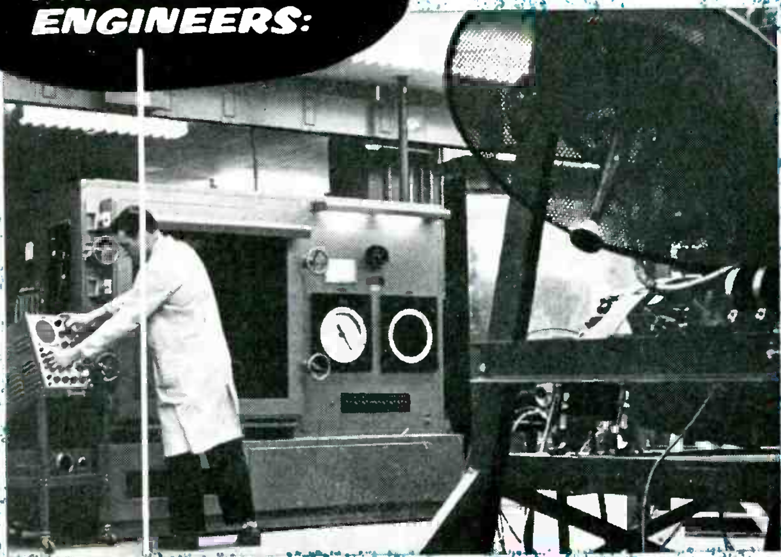

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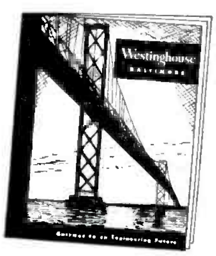

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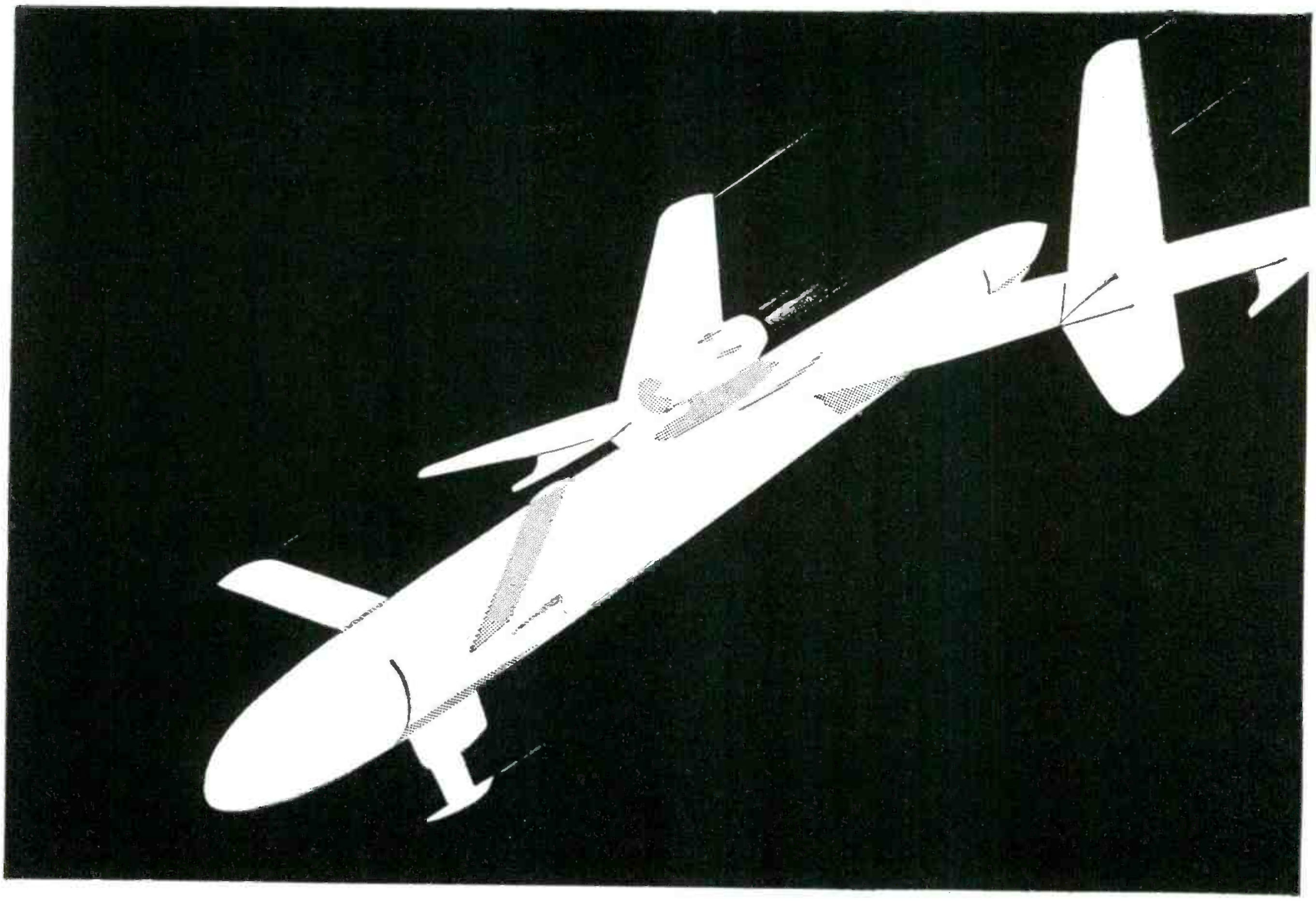

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FIELDS OF ENGINEERING ACTIVITY	TYPE OF DEGREE AND YEARS OF EXPERIENCE PREFERRED											
	Electrical Engineers			Mechanical Engineers			Physical Science			Chemistry Ceramics Glass Technology Metallurgy		
	1-2	2-3	4+	1-2	2-3	4+	1-2	2-3	4+	1-2	2-3	4+
SYSTEMS (*Integration of theory, equipments, and environment to create and optimize major electronic concepts.*)												
AIRBORNE FIRE CONTROL			W						W			
DIGITAL DATA HANDLING DEVICES			C			C			C			
MISSILE AND RADAR			M			M			M			
INERTIAL NAVIGATION			M			M			M			
COMMUNICATIONS			C O						C O			
DESIGN • DEVELOPMENT												
COLOR TV TUBES—Electron Optics—Instrumental Analysis—Solid States (Phosphors, High Temperature Phenomena, Photo Sensitive Materials and Glass to Metal Sealing)	L	L	L	L	L	L	L	L	L	L	L	L
RECEIVING TUBES—Circuitry—Life Test and Rating—Tube Testing—Thermionic Emission	H	H	H		H	H		H	H		H	H
SEMI-CONDUCTORS—Transistors—Semi-Conductor Devices	H	H	H				H	H	H			
MICROWAVE TUBES—Tube Development and Manufacture (Traveling Wave—Backward Wave)		H	H		H	H		H	H		H	H
GAS, POWER AND PHOTO TUBES—Photo Sensitive Devices—Glass to Metal Sealing	L	L	L	L	L	L	L	L	L	L	L	L
AVIATION ELECTRONICS—Radar—Computers—Servo Mechanisms—Shock and Vibration—Circuitry—Remote Control—Heat Transfer—Sub-Miniaturization—Automatic Flight—Design for Automation—Transistorization	X	F X	M C F X	X	F X	M C F X	X	F X	M C F X			
RADAR—Circuitry—Antenna Design—Servo Systems—Gear Trains—Intricate Mechanisms—Fire Control	X	F X	M C F X	X	F X	M C F X	X	F X	M C F X			
COMPUTERS—Systems—Advanced Development—Circuitry—Assembly Design—Mechanisms—Programming	C	C F	M C F	C	C F	M C F	C	C F	M C F			
COMMUNICATIONS—Microwave—Aviation—Specialized Military Systems		F	M C F		F	M C F		F	M C F			
RADIO SYSTEMS—HF-VHF—Microwave—Propagation Analysis—Telephone, Telegraph Terminal Equipment		O	O F		O	O F		O	O F			
MISSILE GUIDANCE—Systems Planning and Design—Radar—Fire Control—Shock Problems—Servo Mechanisms		F	M F		F	M F		F	M F			
COMPONENTS—Transformers—Coils—TV Deflection Yokes (Color or Monochrome)—Resistors		C	C		C	C		C	C			
MACHINE DESIGN Mech. and Elec.—Automatic or Semi-Automatic Machines		H	H		H	H		H	H			

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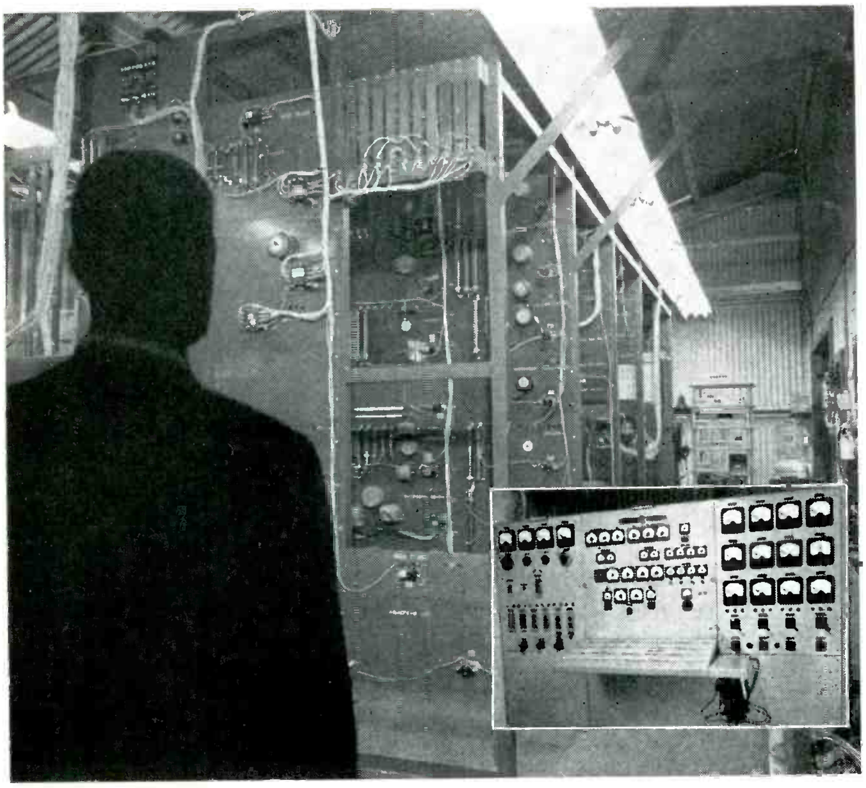

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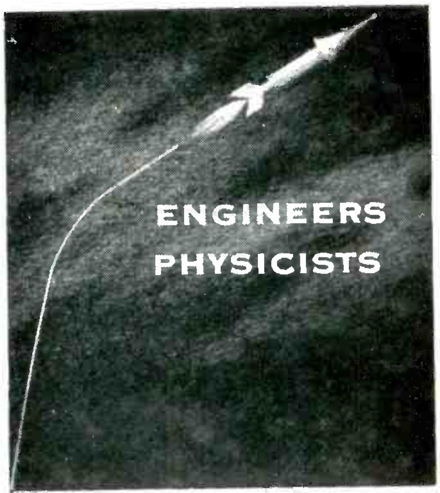

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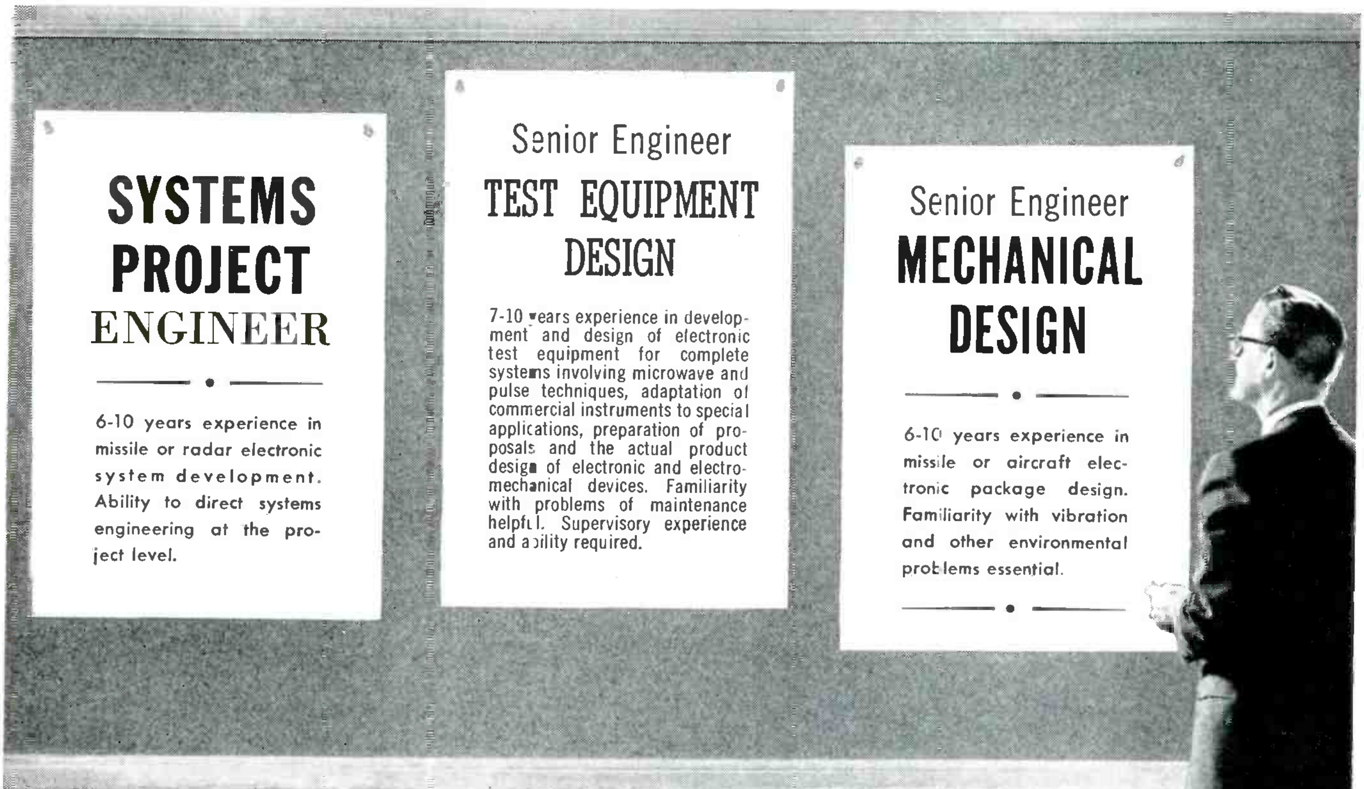

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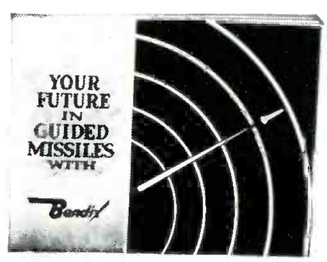

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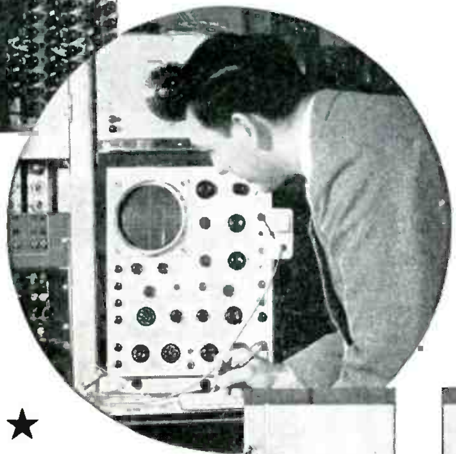

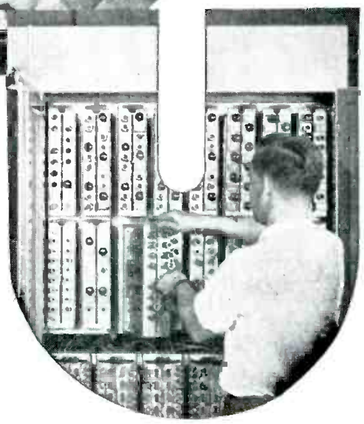

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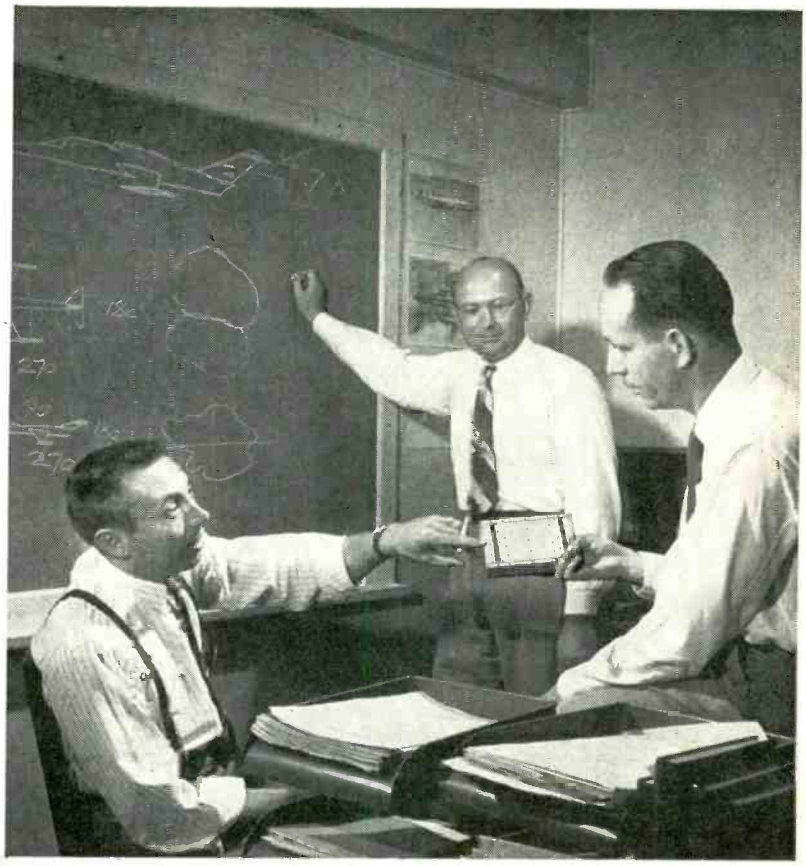

Research Specialist Edward Lovick (right) discusses application of experimental slot antenna in the vertical stabilizer of a high-speed aircraft with Electronics Research Engineer Fred R. Zboril and Electronics Research Engineer Irving Alne.

Lockheed antenna program offers wide range of assignments

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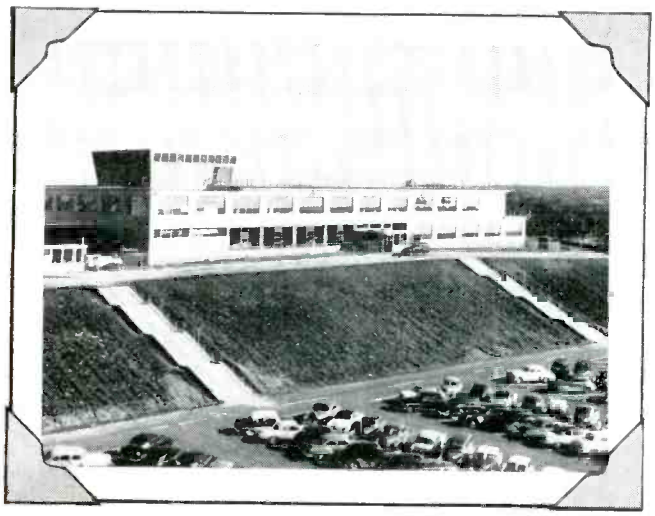

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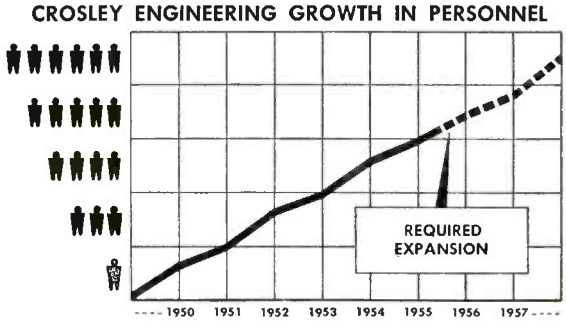

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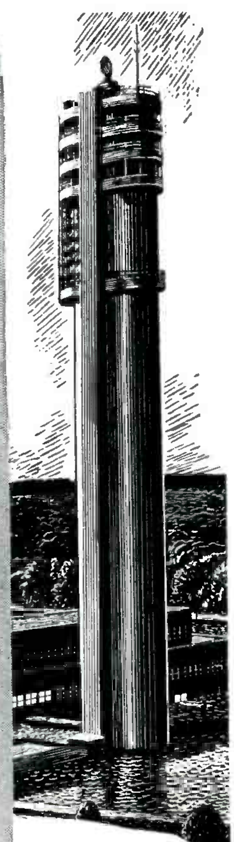

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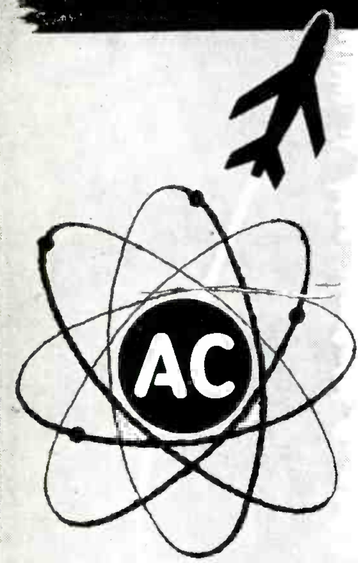

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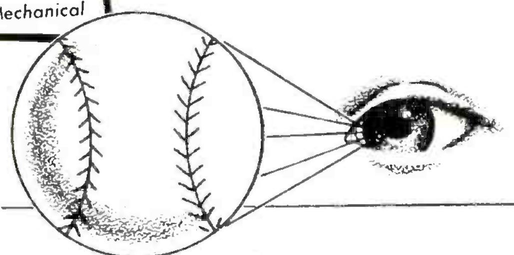

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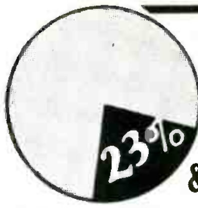

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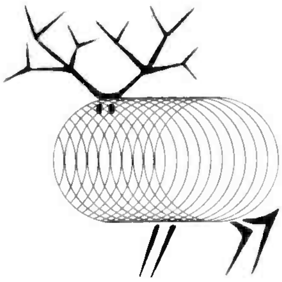

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Mr. T. E. DePinto
ARMOUR RESEARCH FOUNDATION
of Illinois Institute of Technology
10 West 35th St.
Chicago 16, Illinois

SEMICONDUCTOR DEVELOPMENT

DEVICE ENGINEERS PRODUCTION ENGINEERS
APPLICATION ENGINEERS SALES ENGINEERS

Responsible positions are now available with one of the leading and fastest growing semiconductor manufacturers. These are outstanding opportunities for Physicists and Engineers in research, development, or production of advanced germanium and silicon diodes and transistors.

Experience in semiconductors or other components such as tubes or capacitors is desirable.

Send resume or call

Transitron electronic corporation
407 MAIN STREET, MELROSE, MASS.
MElrose 4-9600

Supervisory Engineers

for major manufacturer of
ELECTRONIC TUBES
Location: Eastern Seaboard.

RECEIVING TUBE DESIGN SECTION SUPERVISOR

APPLICATION ENGR SECTION SUPERVISOR

Minimum 5 years experience in the same or related work.

- **Salary open**
- **Outstanding opportunities for professional progress.**

Traveling and moving expenses paid. All replies confidential. Send resume to Box E. 616, 221 W. 41 St., New York.

WIRE LINE CARRIER SYSTEMS ENGINEER

wanted for high-level position with managerial responsibilities in established electronics manufacturing company.

Should have 5 years' experience in wire line carrier telephone work, with at least 2 years spent in applications, either with manufacturer or large carrier operator. Experience in carrier operation in Armed Forces is applicable. Bachelor's degree or professional engineer status required. Travel, about 10% of time, may be necessary.

The right man for this job will find no quibbling about salary.

Stromberg-Carlson Company has been pioneering in telephone industry for 60 years, and is known for high quality of products. One of fastest growing companies in the industry, offering excellent opportunities for advancement. Liberal bonus, other benefits.

Located in Rochester, New York, in heart of beautiful Finger Lakes Country. Community noted for fine schools, cultural, recreational facilities.

Also have openings for several carrier and microwave sales engineers. Must be free to travel in limited territory. Successful sales experience required. There may be an opening in your area.

If you qualify for either of above positions send resume of experience to General Manager, Telephone Division, Stromberg-Carlson Company, Rochester 3, N. Y.

Manufacturers' Representatives

WANTED

All territories—for quality line of slip ring assemblies, brush block assemblies, encapsulation, plastic embedment, and custom molded parts for the electronic industry—

P-6798 Electronics
330 W. 42 St., New York 36, N. Y.

REPRESENTATIVES WANTED

Manufacturer of electronic test equipment for military and commercial applications needs technically qualified representatives. Write giving qualifications, lines handled, territory covered.

RW-2178, Electronics
1111 Wilshire Blvd., Los Angeles 17, Calif.

NEW ADVERTISEMENTS

received by June 30th will appear in the August issue, subject to space limitations.

Address copy to the Classified Advertising Division

ELECTRONICS
330 W. 42nd Street, New York 36, N. Y.

CAREER OPPORTUNITIES

ELECTRONIC and MECHANICAL ENGINEERS PHYSICISTS and PHYSICAL CHEMISTS

Desiring the challenge of interesting, diversified, important projects—
Wishing to work with congenial associates and modern equipment and facilities—
Seeking permanence of affiliation with a leading company and steady advancement—
Will find these in a career here at GENERAL MOTORS.

Positions now open in RESEARCH, ADVANCE DEVELOPMENT and PRODUCT DESIGN

- COMMERCIAL AUTOMOBILE RADIO
- MILITARY RADIO, RADAR and ELECTRONIC EQUIPMENT
- ELECTRONIC COMPONENTS
- INTRICATE MECHANISMS such as tuners, telemetering, mechanical linkage, controls, etc.
- ACOUSTICS—loud speakers, etc.
- TRANSISTORS and other SEMICONDUCTORS—with leadership by a physicist with an outstanding record in this field.
- TRANSISTOR APPLICATIONS

Salary increases based on merit and initiative. Relocation expenses paid for those hired. Vacations with pay, complete insurance and retirement programs.

Inquiries invited from recent and prospective graduates as well as experienced men with baccalaureate or advanced degrees in physics, electrical or mechanical engineering, chemistry, metallurgy.

All inquiries held in confidence and answered—Write or Apply to

Personnel Department **DELCO RADIO DIVISION**

GENERAL MOTORS CORPORATION

1446 South Home Ave. Kokomo, Indiana

SYSTEMS ENGINEERS

APPLIED PHYSICISTS

PERMANENT ASSIGNMENTS

•

IN THE FIELD OF

MILITARY WEAPONS SYSTEMS

Missiles Reliability Studies
Fire Control Radar
Sonar
Underwater Ordnance

REAL CAREER OPPORTUNITIES

You'll enjoy the advantages of a small company atmosphere in the Silver Spring Laboratory . . . along with the stability of being part of the rapidly growing Vitro Corporation of America with 5 diversified operations throughout the United States.

- Suburban Location in residential community adjacent to Washington, D. C.
- Plentiful housing—modern apartments, houses to rent or buy
- Advanced courses available at 4 major universities
- Cultural advantages of the nation's capitol

Similar opportunities also available at West Orange, N. J. and Eglin Field, Florida Laboratories

Write to Personnel Manager

VITRO LABORATORIES

962 WAYNE AVE. SILVER SPRING, MD. Vitro

SEARCHLIGHT SECTION
Classified Advertising

OPPORTUNITIES

Plants • Properties • Business

EQUIPMENT—SURPLUS & USED

CONDENSERS

GUARANTEED—CONDENSER—SPECIALS

OVER 20,000 SOLD

10 mfd.—600 V . . . . . $.89

Three term. bot. mfg. channel type. Dims. 3¾"x2½"x2". Two 5 mfd. sections rated 400V at 72 deg "C", 1800 V test. Meets commercial specs. for 600 V operation up to 40 deg "C". Ideal for filter or power factor application. Repeat sales prove its rugged high quality condenser to be of outstanding value. Carton of 24, weight 42 lbs. Large quantity avail... .79

1 mfd - 15 KV $28.95

2 mfd.—7500 V . . $19.95

4 mfd.—600 V . . . . . . $.85

Inverted cylindrical cap. single term. Mount through ¾" hole in chassis. Hardware included. Factory cartons

GUARANTEED

16 mfd.—600 V $1.89

Dual 8 mfd oil filled cond. hermetically sealed and packed. Tobe type PT-SC-11 measuring 3¾"x2⅝"x2⅝". Stud mntg. centers 2". Plugs into standard four prong socket.

20 mfd.—650 V . . . $1.69

.115 mfd.—2 KV Mica 20 a. @ Imc $3.98

7 mfd.—600 V . . . . $.98

80 mfd.—4000 V $45.50

3x4 mfd.—600, 1000 & 2000 V—4¾x3¾x3¼ @ $1.39

8 mfd. 1000 V $2.35

The above are just a few specials from our large inventory of capacitors from 600 V to 50 KV in all ratings and style, oils and micas, channel, tubular, bathtub, power rheostats and potentiometers. Your inquiries solicited.

Write: ART HANKINS, *Owner*

MONMOUTH RADIO LABORATORIES

Box 159 Capitol 2-2776 Oakhurst, N. J.

SEARCHLIGHT ADVERTISING
Appears On Pages 354-366

For rates and information write:

ELECTRONICS
Classified Adv. Division
330 West 42nd St., New York 36, New York

CLASSIFIED SEARCHLIGHT SECTION ADVERTISING

BUSINESS OPPORTUNITIES — EQUIPMENT - USED or RESALE

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PROPOSALS, $2.10 a line an insertion.

BOX NUMBERS count as one line additional in undisplayed ads.

DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

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The advertising rate is $18.50 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

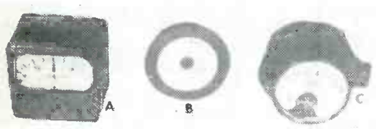
AN ADVERTISING INCH is measured 7/8 inch vertically on one column, 3 columns—30 inches—to a page.

EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

Send NEW ADVERTISEMENTS to N. Y. Office, 330 W. 42nd St., N. Y. 36, N. Y. for August issue closing June 30th

The publisher cannot accept advertising in the Searchlight Section, which lists the names of the manufacturers of resistors, capacitors, rheostats, and potentiometers or other names designed to describe such products.

Western Electric Meters—New!



A. 80-0-80 amperes. Diam. 5½ in. Individually boxed. With shunt.................$15.00

B. 100-0-100 Voltameter. Diam. 3¼ in. Basic movement 1 miliamp. Model D-165573 Individually boxed. SPECIAL.................$8.75

C. 150-0-150 amperes. Diam. 4¼ in. Individually boxed. With shunt.................$12.75

10-0-10 amperes. Diam. 4¼ in. Individually boxed. With shunt. Only.................$10.75

20-0-20 amperes. Diam. 4¼ in. Individually boxed. With shunt. Only.................$11.50

40-0-40 amperes. Diam 4¼ in. Individually boxed. With shunt. Only.................$11.50

46 ACJ UHF RECEIVER

13 tube double conversion receivers. Frequency range 450-600 MC. This unit employs 446A lighthouse tubes in the RF section, mixer and oscillator circuits. First IF frequency of 55 MC has two stage of amplification, second IF frequency of 16 MC has 4 stages of amplification. Two video stages follow the second detector. With schematic and tubes 8-6AC7, 3-446, 1-6AG7, 1-6H6 New Condition.................$9.95

SPRING COIL CORD

3 conductor microphone cable with lugs in both ends Norman length is 18 inches. During use it will expand to over 5 ft. Heavy rubber casing to insure long life. Excellent condition.
6 for.................$5.00

Q-5'ER NAVY TYPE BEAM FILTER

Can be used same as FL-8. FL-30. This unit has selector knob which will select or reject a 1020 cycle note. Two phone jacks for plugging your headsets in series with the receiver. Wt. 3 lbs. New, with schematic. Ea.................$1.95
2 for $3.75

FM WOBULATOR CAPACITOR

Excellent for sweep generator.

Frequency modulation unit permanent magnetic field and a moving coil mechanism driving a metal diaphragm supported at its rim. This diaphragm acts as a moving plate of the frequency modulator capacitor. With schematic. See Dec. Radio TV News for data. Brand new.
WT. 3 lbs.................$2.75
TWO FOR.................$4.95

AN/ARD-2

Complete tunable receiver with a frequency range of 1,000-3,000 MC. This unit has a directional antenna system, spare parts, and test set for adjusting the receiver. With manual. Brand new..P.U.R.

TS-10C/APN

Latest model for testing FM radio altimeters. Complete with cables and indicator. New condition.................P.U.R.

NEW CATALOG NO. 114
1955 ISSUE
LISTS LATEST INVENTORY OF AIRCRAFT. INDUSTRIAL AND MILITARY ELECTRONICS EQUIPMENT. SEND FOR YOUR COPY.

ARROW SALES INC.
Western Division
Mailing Address: P.O. BOX 3878-E, N. HOLLYWOOD, CAL.
Office-Warehouse: 7460 VARNA AVE., N. HOLLYWOOD, CAL.
Phones: STanley 7-6005 • POplar 5-1810
Sales-Showroom: 2005 EMPIRE AVENUE, BURBANK, CAL.
Phone: Victoria 9-2834
Cable Address: ARROWSALES, NORTH HOLLYWOOD
Telegraph Address: WUX, NORTH HOLLYWOOD
Central Division
Mailing Address & Sales-Showroom:
2441 S. MICHIGAN AVE., CHICAGO 16, ILLINOIS
Phone: CAlumet 5-4750

Component Bargains!

LARGE QUANTITY

3BPI—RCA, Sylvania, Individ. Box.........$1.00
6J6—6AQ5. Unbranded but Guaranteed........25¢

Quantity Prices on Request

CARBON RESISTORS ½ W.......$10 per M. 1 W....... 20 per M. 2 W 30 per M. Min. Order 100 of Each

8 mfd 450V Condensers.................15

CONTROLS—½ & 1meg w/switch.................28¢

CERAMIC CONDENSERS — Tubular, All Sizes $25 per M. Min. order 100

70° CONSINE YOKE WIRED.................1.00
90° YOKE UNWIRED.................85¢

AIR TRIMMERS—3 to 15 mmfd w/shaft......15¢

12" DYNAMIC SPEAKERS — New — with/without output trans. 2000, 680, 625 Min. order 4 each $1.25

And Many Other Items

We Also Purchase Your Surplus Inventory

BELVISION, INC
254 Greenwich St., N. Y. 7, N. Y. BA 7-6063

FOR SALE

Get Measured Value in any make, model, size, range, quantity at INSTRUMENT SERVICE. New or Surplus Meters, Standard or Special Meters for electronic, aircraft, military and ham requirements.

INSTRUMENT SERVICE
455 B. 67th., Arverne, N. Y. NEPTUNE 4-8594

ART-13 APR-4 BC-610-E

BC-348, BC-312, BC-342, RAK, RAX.
BC-221, TS-174, #241 Scope, LM
ARC-1, APA-10, DY-17, DY-11

Alltronics, Box 19, Boston 1, Mass
Telephone: Richmond 2-0048, 2-0916

High Frequency Machine, Dielectric

3 KW 27 MC to 40 MC, 110 V 1 phase, Mfgd. by Scientific Electric. Used less than 1 hour. Priced to sell.

JOHN RAMSAY & SON
513 N. Madison St. Allentown, Pa.

TELEPHONE RELAYS

See our May Ad for a more complete listing

Chase ELECTRONIC SUPPLY CO.
105-07 225 St., Queens Village, N. Y. HOllis 4-5033

LABORATORY PARDNER

Will sell half interest in old established electronic design and product development business to younger man with physics or electrical degree. Highly successful for 43 years, and have highly potent new components and advanced semiconductor devices ready to sell or market. Laboratory located So Calif and is very completely equipt both electronically and mechanically. Here is your chance to get into the big money fast. Requires $35,000.00

Box 6778, Electronics
111 Wilshire Blvd, Los Angeles 17, Calif.

GOOD INDUSTRIAL PLANT

available for lease in Winston Salem, N. C., the home of the Electronics Division of Western Electric Company. The building which is in excellent condition has been occupied by Bell Laboratories. Forty thousand square feet floor space, large parking lot.

W. C. WRIGHT, Owner
Robert E. Lee Hotel Winston Salem, N. C.

VIBRATION TEST MACHINE All American Model 110H complete with 1½ hp 220v 60 cy AC 3 ph. motor and Frequency Indicator. Excellent condition.
Also: 400 cy GENERATOR—3.3KVA Onan, with 7½ hp 115v 1 ph. motor, V Belt, steel base. Top Condition.

Hillyer Instrument Company, Inc.
54 Lafayette St., New York 13, N. Y.

WANTED

WANTED

ART-13 transmitters, parts, and components, DY-12 and DY17 dynamotors, CU-25 etc. Also ARC-1 and ARN-7 material.

Advise price, condition first letter.

FLORIDA AIRCRAFT RADIO & MARINE, INC.
International Airport Branch
P. O. Box 205 Miami 48, Florida

WANTED

Type R19/TRC-1 Receivers

W-3652, Electronics
330 W. 42 St., New York 36, N. Y.

WILL BUY ALL

Art-13 T47A Transmitters $225.00
Art-13 T-47 Transmitters $150.00
BC-788C Altimeters $150.00
RS/ARN7 Radio Compass $160.00
ARC-3 Complete $185.00
BC-348 Rec'r modified $25.00
BC-348 Rec'r unmodified $50.
ARC-1 Radio complete $200.00
BC-312 Receiver $40.00
BC-342 Receiver $50.00

Ship via Express C.O.D., Subject to inspection to:

H. FINNEGAN
49 Washington Ave. Little Ferry, N. J.

SPECIAL PURPOSE TUBES

OA2	.75
OA3	1.00
OA5	4.00
OB2	.75
OB3	.75
OC3	.75
OD3	.75
EL-C1B	2.50
EL-1C	1.50
1B22	1.50
1B23	3.50
1B24	4.75
1B26	1.25
1B27	10.00
1B32	1.00
1B35	4.75
1B38	30.00
1B40	3.50
1B42	4.50
1B51	7.25
1B59	10.00
1C21	2.00
1P21	30.00
1P23	2.00
1P25	75.00
1P30	2.00
1P32	1.00
1P34	1.75
1P36	2.50
1Z2	2.00
VG-2	10.00
2AP1	5.00
2AP1A	5.00
2AS15	6.00
2B21	1.00
2B26	1.50
2C21	.50
2C22	.35
2C24	.75
2C25	.35
2C26A	.50
2C33	.75
2C34	.35
2C39A	8.50
2C40	7.50
2C42	15.00
2C43	12.00
2C44	.50
2D21	.75
2D21W	1.50
2E22	2.00
2E24	2.50
2E26	3.25
2J21A	3.50
2J26	5.00
2J27	5.00
2J29	15.00
2J30	25.00
2J31	15.00
2J32	15.00
2J33	15.00
2J34	15.00
2J36	25.00
2J37	5.00
2J38	10.00
2J39	10.00
2J40	15.00
2J50	35.00
2J51	150.00
2J53	25.00
2J55	50.00
2J56	75.00
2J61	15.00
2J62	5.00
2J62A	50.00
2JB51	1.00
2K25	15.00
2K28	30.00
2K30	100.00
2K33A	75.00
2K39	135.00
2K41	100.00
2K54	10.00
2K55	7.50
2P21 (Image orthicon)	100.00
2V3G	2.25
2X2	.35
2X2A	1.00
3A4	.50
3A5	.50
3AP1	5.00
3B21	5.00
3B22	1.50
3B23	3.50
3B24	2.00
3B24W	5.00
3B25	4.00
3B26	3.00
3B28	6.00
3B29	7.00
3BP1	2.00
EL-3C	5.50
EL-3CJ	7.50
3C22	60.00
3C23	3.75
3C24	1.50
3C31	2.50
3C37	30.00
3C45	7.00
3D21A	6.00
3D22	9.75
3DP1	3.75
3DP1A	7.50
3E29	10.00
3EP1	2.00
3FP7	2.00
3FP7A	5.00
3GP1	2.50
3HP7	3.00
3J21	75.00
3J31	35.00
3JP1	9.50
3K27	150.00
3KP1	7.25
3RP1	7.25
4-400A	40.00
KC-4	75.00
4AP10	3.75
4B22	6.50
4B23	15.00
4B24	5.50
4B25	8.00
4B26	3.50
4B27	4.00
4B28	3.00
4B30	.75
4B31	35.00
4B32	10.00
4C22	7.50
4C25	3.00
4C27	3.50
4C30	1.50
4C35	15.00
4E27	9.00
4J52	50.00
4X100A	25.00
EL-5BHD	15.00
EL-5B2.5	6.50
5AP1	2.00
5B21	2.00
5BP1	2.00
5BP1A	10.00
5BP2A	10.00
5BP4	2.00
5C21	6.50
5C22	30.00
5C30	1.50
5CP1	3.00
5CP1A	10.00
5CP7	7.50
5D21	7.00
5D23	7.50
5FP7	1.50
5FP14	5.00
5GP1	5.00
5J26	100.00
5J29	7.50
5J30	7.50
5J32	25.00
5JP1	15.00
5JP2	7.50
5JP4	7.50
5JP5A	7.50
5JP11	25.00
5LP1	8.00
5LP1A	25.00
5NP1	5.00
5R4GY	1.00
5R4WGY	1.50
5X3	3.00
EL-C6A	6.00
EL-C6J	6.50
EL-C6L	3.75
EL-6C	8.00
6AC7W	1.00
6AJ5	1.25
6AJ6	2.00
6AK5W	1.50
6AL5W	.85
6AN5	3.00
6AR6	2.00
6AS6	1.50
6AS6W	2.00
6BM6	25.00
6C21	20.00
6G4	2.00
6J4	3.50
6L6WGB	4.00
6Q5G	2.00
6SC7GTY	2.00
6SK7Y	.50
6SN7WGT	2.00
6SU7GTY	2.25
7BP7	5.00
7CP1	15.00
7EP4	10.00
9GP7	5.00
9LP7	3.50
9MP7	7.50
10Y	.35
CE-11V	2.50
12A6	.50
12DP7A	35.00
12GP7	15.00
12J5WGT	2.00
12K8Y	.75
12L8GT	1.00
LM-15	200.00
NE-16	.35
FG-17	3.50
RK-19	1.00
RK-20A	9.75
TZ-20	2.00
CE-21C	3.00
RK-21	1.00
RK-22	3.50
CE-23C	1.50
PJ-23	2.00
RK-23	2.75
HK-24	3.00
HK-24G	1.00
CE-25A/B	2.00
RK-25	3.00
25T	3.00
25TG	1.00
FG-27A	12.00
CE-28D	2.50
RK-28	2.50
28D7	.75
28D7W	1.50
CE-29	1.25
CE-30C	1.25
Twin 30	7.50
HY-30Z	2.75
CE-31V	2.50
FG-32	6.00
FG-33	11.50
RK-33	.50
RK-34	.35
35TG	3.00
RK-38	6.50
RK-39	2.50
T-40	2.50
TZ-40	3.50
CE-42C	1.50
RK-44	1.00
QK-47	50.00
RK-47	1.75
CE-48	1.75
RK-49	3.00
HY-51B	1.00
FP-54	44.00
HK-54	3.00
T-55	5.00
RK-57	2.75
RK-58	1.25
QK-59	35.00
QK-60	35.00
RK-60	1.50
HY-61	1.25
QK-61	35.00
RK-61	2.00
QK-62	35.00
RK-62	1.75
RK-63	20.00
HY-65	3.00
RK-65	7.50
FG-67	10.00
RK-69	2.00
RK-72	.75
RK-73	.75
HY-75	3.00
RK-75	1.00
VR-75	1.00
75TL	5.00
VR-78	.50
FG-81A	5.00
VR-90	.75
CV-92	3.50
FG-95	17.50
C-100D	2.00
HF-100	7.50
ML-100	75.00
100R	5.00
100TH	6.50
WE-101F	2.50
WE-102D	2.50
FG-105	15.00
VR-105	.75
VU-111S	1.00
HY-114B	.75
WE-121A	3.50
WE-122A	1.50
F-123A	5.00
WE-123A	5.00
WE-124A	3.50
VT-127A	1.50
F-128A	20.00
HF-130	1.50
VR-150	.75
FG-154	17.50
HK-154	5.00
VT-158	10.00
FG-166	25.00
FG-172	20.00
QK-181	20.00
FG-190	7.50
HF-200	12.50
CE-201	4.00
C-202	7.50
203A	5.00
203Z	5.00
204A	35.00
WE-205B	.75
207	75.00
211	.75
WE-211C	10.00
WE-211D	8.00
211W	5.00
WE-212E	25.00
217A	2.00
217C	5.00
WL-218	25.00
CE-220	.75
WE-220B	100.00
220C	150.00
CE-221	8.00
CE-222	1.50
CE-224	5.50
CE-225	3.00
CE-226	3.00
WE-231D	2.00
RX-233A	.75
CE-235A	5.00
235R	50.00
WE-242A	5.00
WE-242C	8.00
WE-249B	3.25
WE-249C	3.25
250R	5.00
250TH	20.00
250TL	15.00
WE-251A	50.00
WE-252A	10.00
WE-253A	5.00
WE-254A	6.00
HK-257B	9.00
WE-257A	2.25
FG-258A	135.00
WE-258B	5.00
WE-259A	12.50
WE-261A	10.00
WE-262B	7.00
WE-264C	3.00
WE-267B	10.00
WE-271A	10.00
WE-272A	5.00
WE-274A	4.75
WE-274B	3.00
274B	.75
WE-275A	5.00
276A	3.00
WE-282A	7.50
WE-283A	4.00
WE-285A	5.00
WE-286A	6.00
WE-287A	5.00
WE-295A	5.00
WE-296A	25.00
HF-300	17.50
WE-300B	7.50
CE-302	1.00
EL-302.5	5.00
CE-303	2.50
WE-304B	7.50
304TH	10.00
304TL	10.00
WE-305A	3.50
307A	1.00
CE-309	3.50
WE-310A	4.00
WE-310B	5.00
WE-311A	5.00
WE-312A	3.00
WE-313C	3.00
316A	.50
WE-323A	10.00
323B	5.00
327A	2.50
WE-328A	3.50
WE-329A	7.50
WE-331A	7.50
WE-332A	25.00
WE-336A	5.00
WE-337A	6.00
WE-338A	5.00
WE-339A	15.00
WE-347A	3.50
WE-348A	5.00
WE-349A	7.50
WE-350A	3.00
WE-350B	3.00
WE-351A	6.00
WE-352A	10.00
F-353A	2.00
WE-353A	3.50
WE-354A	15.00
WE-355A	15.00
WE-359A	3.00
WE-368A	3.00
371A	.75
371B	1.00
F-375A	15.00
WE-388A	1.50
WE-393A	5.00
394A	2.50
WE-394A	3.50
410R	100.00
WE-417A	15.00
WL-417A	5.00
GL-434A	3.00
446A	.50
446B	2.00
450TH	50.00
450TL	45.00
451	5.00
WL-460	10.00
464A	2.25
WL-468	15.00
SS-501	7.25
RH-507	35.00
CK-510AX	.75
WL-525	10.00
527	15.00
WL-530	15.00
WL-531	5.00
WL-532A	1.00
WL-535	10.00
WL-538	.50
GL-553	2.00
559	.75
GL-564	1.50
575A	15.00
WL-579B	10.00
KU-610	7.50
HY-615	.50
WL-629	1.25
WL-630	1.00
631-P1	7.50
WL-632A	17.50
WL-655/658	135.00
WL-670A	8.00
WL-681/686	35.00
WE-701A	3.00
702A	.50
702B	1.00
703A	1.50
WE-704A	1.00
705A	1.00
707A	3.50
707B	4.50
WE-708A	1.00
WE-709A	1.00
710A	.50
713A	.50
714AY	17.50
715A	2.50
715B	5.00
WE-715C	15.00
717A	.50
WE-719A	10.00
721A	1.00
721B	7.50
722A	1.00
723A/B	10.00
WE-724A	1.00
WE-724B	1.00
WE-725A	3.50
WE-726A	7.50
WE-726B	30.00
WE-726C	25.00
WE-730A	7.50
731A	1.50
WE-732A	2.00
WL-735	2.00
WL-741	1.25
750TL	45.00
WL-759	12.50
WL-786	25.00
800	1.50
801A	.50
802	3.00
803	2.50
804	9.75
805	3.00
806	9.75
807	1.25
807W	4.75
808	1.50
809	2.75
810	10.00
811	3.00
811A	4.00
812	2.25
813	12.00
814	2.00
815	1.35
816	1.50
822	10.00
826	1.00
828	7.50
829	7.50
829B	10.00
830B	1.00
832	4.00
832A	5.50
833A	35.00
834	7.50
835	10.00
836	2.50
837	1.00
838	1.25
842	2.50
843	.50
845	5.00
845W	8.50
846	75.00
849	25.00
850	25.00
851	12.50
852	7.50
860	3.00
861	15.00
864	.35
865	.50
866A	1.15
868	2.00
869B	25.00
GL-872A	2.00
872A	1.00
874	.75
876	.75
878	1.00
879	.35
884	1.25
885	1.25
902P1	3.50
905	2.00
913	15.00
917	2.50
918	2.00
919	2.50
920	3.00
921	1.00
922	1.25
923	1.50
924	1.35
925	2.00
926	2.50
927	1.00
928	2.50
929	1.25
930	1.25
931A	2.75
954	.35
955	.50
956	.75
957	.35
958A	.75
959	1.75
975A	15.00
991	.35
CK-1005	.35
CK-1006	2.00
CK-1007	.75
CK-1009	5.00
CK-1026	3.00
R-1100	5.00
R-1130B	10.00
HY-1269	5.00
1500T	100.00
1602	2.25
1603	3.50
1608	3.75
1609	9.25
1610	2.25
1611	1.50
1612	1.25
1613	1.00
1614	1.50
1616	.50
1619	.35
1620	5.00
1621	1.50
1622	1.50
1623	3.00
1624	1.00
1625	.35
1626	.25
1629	.25
1630	.75
1631	1.50
1632	.50
1633	.75
1634	1.35
1635	1.50
1636	1.25
1641	1.50
1642	.50
1644	1.00
1649	1.00
1654	3.50
1655	2.00
1656	6.50
1661	6.00
1846	50.00
1851	1.75
1887	100.00
1904	10.00
1960	.50
1984	10.00
2000T	150.00
2050	1.25
2051	.75
2172	12.50
2183	5.00
2252	25.00
ZB-3200	75.00
R-4100	7.50
R-4330	10.00
5528	3.75
5550	35.00
5551	40.00
5553	135.00
5556	6.75
5557	3.50
5560	17.50
5610	1.25
5625	75.00
5632	7.50
5645	6.50
5651	1.50
5656	7.50
5670	2.00
5691	5.00
5696	1.00
5703	1.25
5720	11.50
5725	2.00
5728	10.00
5740	44.00
5801	2.50
5820	350.00
5826	375.00
5827	2.50
5829	1.50
5842	15.00
5932	4.75
5933	4.75
5948	250.00
5963	1.00
5981/5650	50.00
6010	1.25
6011	4.75
6013	10.00
6031	4.75
6033	7.25
R-6160	2.00
R-6175B	1.00
R-6200	.75
R-6210	15.00
UX-6653	.75
8001	9.00
8002R	25.00
8005	4.25
8008	6.00
8011	.10
8012	1.00
8012A	2.50
8013	2.75
8013A	3.75
8014A	50.00
8016	2.50
8020	1.25
8021	.75
8022	.75
8023	1.50
8025	2.00
8025A	2.50
8026	3.50
PD-8365	75.00
9001	1.00
9002	.75
9003	1.15
9004	.35
9005	1.50
9006	.35

The prices quoted above are FOB shipping point

western engineers

ELK GROVE, CALIFORNIA

GEORGE WHITING, OWNER

All tubes are new individually cartoned, fully guaranteed

WANTED

VIBRATORS	ARC-3	FT 107	APN-2 Material
Loops LP 21	ART-13	IE-17	SCR 720 Material
Microphones, all types	CH 88A	Kites	SCR 522 Material
Keys J-38	CH 89A	PE 210 & PE 95	H 4/ARHeadsets
Keys J-45	CH 119A	SCR 211	Gibson Girl Material
T-17 Mikes	CH 120A	JK-55	Telephone Material
APN-3	CPN-6	Boom Mikes	Control Boxes BC434
ARC-1	CPN-8	307A Tubes	Generators GN 45
	CPN 17	RM52, RM53, RM29	R5/ARN-7

CORDS & CABLES

Cable CC 358	CC59
Cords CC 338	Cable CC 338
CD335	CD1108
CD267	

FIELD EQUIPMENT

BC788	BC434
BC939	BC348 or parts
BC614	BC221 or parts

FOR SALE!

Teletypewriter 4TB22/210 .... $175.00
Recorder BC 791 .... 75.00
Power Supply REC-30 .... 95.00
Antenna Dipole AN 154 .... $25.00
Antenna AN 104 .... 1.00
TS 100/AP .... 10 @ $30.00
MT 96/APS-3 .... 150 @ .75¢

TUBES

2J 21 .200 @	$1.50	829B	5.50
2J 22 .300 @	1.50	715C	5.50
2J 26	1.75	3B24	.50
707A	1.75	6J6	.25
3E29	5.50	3FP7	.75

TELEPHONE RELAYS:
W. E. 215A RY 20 .... $5.00 new boxed

TELETYPE CAPACITORS:
3DB-500-7 .... .50
3DA750-1 .... .50

GENERATORS:
GN 38B $4.00

TELEPHONES:
EE 8 Field Phones $20.00
Coil Repeating W. E. #120 .... 1.25
TS 9 Handsets 3.25
TS 15 Handsets 5.50
Upright Telephones Complete 1.50
DESK PHONES, Leich #90 with Handset and Dial & Cord $4.50
W.E. 302 BW 3 .... 7.50
Microphones ANBMC-1 .... .75
MN 31C 125.00
MN 36C 125.00
MN 44A 15.00
I D11/APS-4 .... 2.00
PE 120 **INVERTERS** .... 200 ea. $5.00
6-12 or 24 volts
MG 149F **INVERTER** 19.50

PE 94 **DYNAMOTOR** 2.00
PE 118 **INVERTER** 5.00
PE 103 **POWER UNIT** 15.00
PE 73 **DYNAMOTOR** 5.00
PE 112 **POWER UNIT** 5.00
PE 115 **INVERTER** 5.00
PE 186 **DYNAMOTOR** 10.00
DM 42 **MOTOR** 4.00
PE 206 **INVERTER** 12.00
PE 218 **INVERTER** 7.50
LIP MIKES .... .85
THROAT MIKES .... .15
MR 44A **MOUNT** for TA 2J 24 .... 3.50
MT 96/APS-3 NEW 1.00

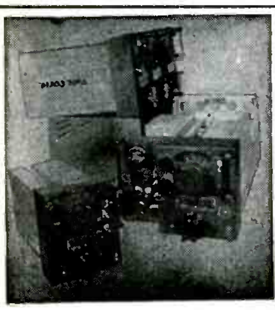
CRYSTALS

IN 21—Brand new—Sylvania—each in lead Sheath 50,000 .... @ .06 ea.
FT 241, FT243, FT 500 } 110,000 Misc. Freq. all at .03 ea.
Sets of 80 boxed 3.25
Sets of 120 boxed 5.50
Receiver Radar R 85/TPL-1 .... 15.00
Trans-Receiver GP-7 .... 7.50
Receiver BC 966 .... 7.50
WE Receiver Unit HA-1 .... .75
WE Transmitter Unit F-1 .... .75
CA 355 **Capacitor** F or EE 8 .... .40
EE 70 **Head & Chest Set** 1.25
Gibson Girl Transmitter S.O.S. 500 K.C.
Manual operated. Complete—New 15.00
Reflector Corner Radar 2.50
Butyl Acetate 1 oz. bottle .... .10
CD 1250 Cord with PL 291 .... .10
VB 8 Vibrators .... .25
BC 611 Cover Top. Assy .... .50

TALLEN CO., INC.

159 CARLTON AVE. BROOKLYN 5, N. Y.
TRiangle 5-8241

AN/APR-4 LABORATORY RECEIVERS



Complete with all five Tuning Units, covering the range 38 to 4,000 Mc; wideband discone and other antennas, wavetraps, mobile accessories, 100 page technical manual, etc. Versatile, accurate, compact—the aristocrat of lab receivers in this range. Write for data sheet and quotations.

We have a large variety of other hard-to-get equipment, including microwave, aircraft, communications, radar; and laboratory electronics of all kinds. Quality standards maintained.

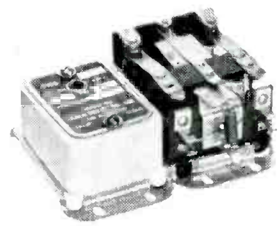
NEW TS-13/AP X-BAND SIGNAL GENERATORS with manual $575.00; T-47A/ART-13 Transmitters, $450.00; H-P, Boonton, G-R, Measurements, many others in stock.

ENGINEERING ASSOCIATES
434 PATTERSON ROAD DAYTON 9, OHIO

world's largest stock

RELAYS

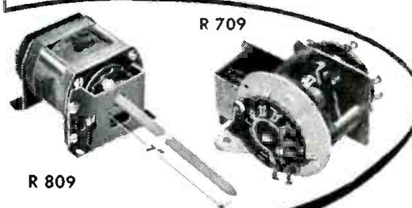
immediate delivery!



ADJUSTABLE THERMAL TYPE TIME DELAY RELAY

Operates on 115 V.A.C. Continuously adjustable delay from 5 to 20 seconds. ¼ Inch D.P.D.T. 12½ amp. contacts. Primarily designed for use with radio transmitters but has wide variety of other applications.
Catalog No. R 686 Price $6.10 each

R 709



R 809

STEPPING UNIT

Operates on 22 to 30 V.D.C. 12 Position driving mechanism operates through 360° in progressive steps. Indexes one position for each momentary current impulse. Attached wafer switch may be used for self interruption. 7 inch flatted shaft will drive pulley, gear or one or more wafer switches.
Catalog No. R 809 Price $2.45 each

SOLENOID OPERATED RATCHET STEPPER

Operates on 6 V.D.C. Operates three 12 position wafer switches. Most standard wafers are interchangeable with those supplied. Rotates 30° with each impulse.
Catalog No. R 709 Price $3.90 each

HUNDREDS OF RELAY TYPES IN STOCK

- Standard Telephone Relays
- Short Telephone Relays
- Midget Relays
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- Rotary Relays
- Western Electric Type "E" Relays
- Keying Relays
- Hermetically Sealed Relays
- Voltage Regulators and Cutouts
- Differential and Polarized Relays
- Special Relays
- BK-Series
- Antenna and Ceramic Relays
- Motor and Control Relays
- Relay Assemblies
- Latching and Interlocking Relays
- Mechanical Action Relays
- Ratchet and Stepping Relays

All relays are new, individually inspected and unconditionally guaranteed. They are first line products of leading manufacturers. Special attention given to orders of one or more relays. 24 Hour delivery.
Write for new catalog.
Phone, write or wire your requirements.

Relay Sales
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SAVE ON TUBES BRAND NEW TUBES GUARANTEED TUBES

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1B24 4.50
1B24A 15.00
1B27 12.50
1B29 3.00
1B35 4.50
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1B51 6.00
1B63A 25.00
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1D21/SN4 3.50
1N21B 1.90
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1N23BM 5.00
1N25 4.00
1N26 4.95
1N34A .79
1N35 1.50
IN42 8.00
1N44 .99
N47 4.50
1N63/K63 1.75

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2J61 19.50
2J62A 50.00
2K22 15.00
2K25 12.50

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4J50 99.50
4J51 149.50
4J52 50.00
4J57 149.00

HY65 2.00
RK65/5D23 10.00
FG67/5728 10.00
RKR72 .50
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287A 3.00

ML531 4.00
559 .50
KU610 5.00
WL616 99.50
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845 6.00
849 24.50
851 12.50
852 7.50
860 3.50

5654 1.40
5656 9.00
5657 125.00
5663 1.50
5667 150.00
5670 2.00
5672 1.25
CK5678 1.00
5686 2.00
5687 3.50
5691 5.50
5692 5.25
5693 4.75
5696 1.10
5702 2.00
5703 1.25
5718 3.00
5719 2.50
CK5721 189.50
5725 2.00
5726 1.00
5744 1.00
5750 3.10
5751 2.20
5780 199.50
CK5787 4.95
5814 1.60
5842 13.50
5844 4.50
5851 4.00

JSH Sales Co. Stocks one of the largest tube inventories in the U.S. Try us for dependability.

We buy complete tube inventories. Quantities large or small, we buy them all.

1108 VENICE BLVD. LOS ANGELES, 15

2K26 45.00
2K33 150.00
2K33A 65.00
2K34 139.50
2K39 115.00
2K45 55.00
2K48 90.00
2K54 17.50
2K56 45.00
2X2A 1.00
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3B22 1.50
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4X500A 60.00
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5CP1 1.75
5C22 29.50
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5D21 7.50
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5JP2 7.50
5JP4 7.50
5JP5 7.50
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ML100 70.00
100TH 6.50
FG104 29.50
FG105 12.50
F123A 3.50
F128A 20.00
FG154 17.50
VT158 12.00
WL200 75.00
207 25.00
211D 8.00
211E 8.00

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304TL 8.95
307A/RK75 1.00
312A 2.95
316A .50
323B 5.00
338A 6.00
350A 3.00
350B 3.00
354A 15.00
354C 5.00
365B write
368AS 3.00

KU628 12.50
648PI write
WL651 39.50
WL652 25.00
WL681/586 15.00
701A 1.95
703A 1.50
704A 1.95
706AY-GY 15.00
707B 5.00
708A 1.95
714A 12.50
714AY 25.00
715A 1.50

861 15.00
865 .50
866A 1.25
869B 15.00
872A 1.50
874 .60
878 .60
880 200.00
884 1.25
GL889 60.00
GL889A 74.50
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Vacuum Capacitors

6 mmfd. 30 KV 10.00
50 mmfd. 32 KV 12.50
50 mmfd. 40 KV 14.50
75 mmfd. 20 KV 12.50
150 mmfd. 20 KV 14.00

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3E29	8.50	271A	12.00
3FP7A	3.95	836	2.00
6K4	2.50	845	5.00
HK24	2.00	5675	7.50
F123A	3.50	5910	.75

SPECIAL!

5" DUAL GUN TUBE

Long persistency face. Value at $200.00. This tube has been rejected for military use.

Tested Before Shipped & Fully Guaranteed. Only **$17.95**

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1P28 9.00
1P29 2.00
1P36 2.50
1P39 1.20
1W5 1.25
1Z2 2.00
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2C39 9.00
2C39A 9.00
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2C44 .50
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2C51 3.25
2C52 3.50
2C53 11.00
2D21 1.00
2D21W 1.75
2J31 15.00
2J32 15.00
2J33 15.00
2J34 15.00
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2J42 69.50
2J48 49.50
2J49 35.00
2J50 12.50
2JB51 .80
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3FP7 1.95
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3K27 160.00
3K30 125.00
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4C27/CV92 14.00
4C28 25.00
4C35 15.00
4E27 10.00
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4J26 75.00
4J27 25.00
4J28 25.00
4J29 25.00
4J30 49.50
4J31 79.50
4J34 25.00
4J36 79.50

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5NP1 5.00
5R4WGY 2.40
C6J 6.50
C6L/5528 4.00
6AC7W 1.25
6AJ5JAN 1.25
6AL5W .85
6AR6 1.70
6C21 17.50
6F4 2.75
6J4 3.75
6K4 2.50
6L6WGB 4.50
6SN7W 2.00
7C22 40.00
7C23 69.50
SCR12 150.00
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FG17 3.00
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28D7 .90
RK28 2.50
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D42 40.00
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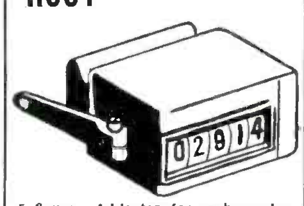
211/VT4C .50
212E 17.50
WL218 25.00
220C 182.00
FG-235A 35.00
QK221 125.00
249C 3.00
QK249 150.00
249B 3.00

393A 4.50
394A 3.00
403B/5591 2.30
WL417A 4.00
421A 15.00
422A 11.00
RT434 25.00
434A 4.00
446A .70

VEEDER ROOT COUNTER



5 figure. Adds ten for each revolution of shaft in one direction; subtracts ten for each revolution in opposite direction. Size 3/4"x3/4"x1" dovetail mounting; lever arm removable. Each **$1.25**

250TL 12.50
251A 50.00
252A 10.00
QK253 149.50
254A 6.50
FG258A 130.00
271A 10.00

446B 2.25
450TH 40.00
450TL 35.00
WL456 59.50
464A 2.50
CK512AX 1.10
527 15.00

715B 6.00
715C 15.00
717A .75
719A 10.00
720AY-EY 25.00
721A 1.00
721B 8.75
722A .75
723A/B 8.50
724B .75
725A 4.50
726A 7.00
726B 25.00
726C 25.00
730A 10.00
802 2.75
803 1.50
804 9.50
805 4.75
806 9.50
807 1.25
811A 3.50
812 2.50
813 12.00
814 2.00
815 1.50
828 9.00
829 6.00
829B 8.50
830B .95
832A 6.00
833A 34.50
837 1.00
838 1.00

922 1.25
927 1.00
931A 2.75
955 .40
956 .40
957 .40
958A .40
959 1.00
CK1006 2.75
1500T 95.00
1616 .75
1620 2.95
1623 2.50
1624 1.00
1625 .23
1630 .50
1636 1.25
2050 1.00
2051 .70
ZB3200 85.00
5550 24.50
5551 25.00
5552 50.00
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5561 29.50
5586 150.00
5591/403B 2.30
5608A 3.50
5611 99.50
5634 7.50
5636 4.00
5651 1.40

5896 6.50
5899 5.00
5901 6.50
5902 8.00
5905 8.95
5907 7.90
5908 7.95
5910 .75
5932 4.50
5933/807W 4.50
5963 1.00
5977 4.50
6005 2.00
6021 4.00
6072 3.95
6080 3.50
6080WA 4.25
6111 6.50
6159 4.95
6177 79.50
6247 8.50
8002R 8.00
8005 4.95
8012 1.00
8013 4.95
8014A 55.00
8025A 2.50
9001 .90
9002 .70
9003 1.00
9004 1.25
9005 1.10
9903 20.00

THIS IS ONLY A PARTIAL INVENTORY. CHECK WITH US FOR YOUR REQUIREMENTS

Thousands of other types in stock. Send us your requirements. RECEIVING TUBES! We Carry a complete line in stock. Standard brands only.

JSH SALES CO.
ELECTRONICS
Dept. ER
1108 Venice Blvd.
Los Angeles 15
California

All Prices F.O.B. Los Angeles, subject to change without notice. Minimum order $5.00. *Check with us for items not listed.*

COMPASS ELECTRONICS SUPPLY

A Division of Compass Communications Corporation

WE MAINTAIN OUR OWN FULLY EQUIPPED TESTING LABORATORY TO TEST AND GUARANTEE ANYTHING WE SELL

Wholesale, Industrial and Institutional Sales Only

TEST SETS

TS-3A/AP
TS-10A and B
TS-12/AP
TS-13/AP
TS-14
TS-16/AP
TS-35A/AP
TS-36/AP
TS-61/AP
TS-62/AP
TS-74/UPM
TS-89/AP
TS-98
TS-101/AP
TS-104
TS-110
TS-125/AP
TS-131
TS-173/UR
TS-184
TS-278
TS-323
TS-UPM-1
OAA
OAP
OBU
LAE
LM
LU
IE-19
1-46
1-56
1-208
1-222
SCR-211
AND OTHERS

TRANS-MITTERS

TAJ
TAQ
TBL
TBK
TBM
TBN
TCE
TCP
TDE
TDQ
TDO
AND OTHERS

RECEIVERS

ARB
ARC-1
ARC-3
ARC-4
ARC-5
AR-88
ART-13
CR-91
SLR
RAK
RAL
RAO
RBB
RBO
RBG
RBL
RBA
RBM
RCH
BC-224
BC-312
BC-314
BC-344
BC-348
AND OTHERS

FIELD EQUIPMENT

SCR-274
284
300
399
503
536
808
828
BC-191
375
603
604
610E
683
684
923
924
1000
1306

TEST SETS

TS-13/AP-X BAND RADAR TEST SET—Measures power, freq. signal-to-noise ratio, I.F. Bandpass, etc. Input—115/1/60—800 .... **WRITE**

TS-35A/AP-X-BAND—Measures transmitted power & frequency of Radar Transmitters, also used for receiver adjustments .... **NEW**..$375.00

TS-100/AP—TEST SCOPE, type A, R, J & X indications, gated & ungated sweep, Int. or Ext. trigger .... **WRITE**

SPECIAL PURPOSE TUBES

Write for Latest Listing at Great Savings, of New Tubes, Standard Brands Only—Guaranteed!

MICROWAVE ACCESSORIES

15 LB. ALNICO-V MAGNET—approx 4800 gauss $16.00

WAVEGUIDE, FLEX, with flanges, 3 cm., 12"l .... $12.50 ea.
3 CM., 24"l.—$11.00 ea. **10 CM., 60"l.—$22.50 ea.**

BENDS, E. & H. plane; 3 & 10 CM .... **WRITE**

DUPLEXER, Mixer & Preamp Ass'y., 3 CM .... **WRITE**
also cavitys, klystron mounts, rotating joints, circular waveguide stubs, etc. .... **WRITE**

WESTERN ELECTRIC VARISTORS, THERMISTORS, Res. Networks, Relay Ass'y, Precision Potentiometer, #60 A Key Selectors, etc. .... **WRITE**

RADAR BEACONS

YJ and YG...for shipboard use
AN/CPN-6 .... 3 cm.
AN/CPN-8 .... 10 cm.
AN/APS-2, APS-3, APS-4, APS-6, APS-15

Also SA, SF, SG, SD, SJ, SK, SN, SQ—both equipment and spare parts

SA-2 RADAR Used for air traffic control, tracking and search, both land-based and ship-borne. 5 microsec. pulse. PPI indication, operates at 200 mcs. peak power of 150 K.W. Input 110/120 volts a.c. 4 complete installations in stock.—Write for price.

Write for More Details on Any Particular Item in Which You are Interested
These are partial listings only of our stock. Please write for other types.

393 Greenwich St. **New York 13, N. Y.**
BEEKMAN 3-6510 *Cable:* **COMPRADIO, N. Y.**

MOTOR GENERATORS AND CONVERTERS

50, 60, 400 and 800 cycle and DC Power Supplies

28dc to 110/1/800@1kva (Overall length: 12 inches)	**$49.50**
110dc to 110/1/800@350va	**150.00**
110ac to 110/1/800@350va	**235.00**
110dc to 110/1/400@2kva	**395.00**
110/1/60 to 110/1/400@2kva	**435.00**
220/1/60 to 110/1/400@2kva	**435.00**
440/3/60 to 110/1/400@2kva	**435.00**
32dc to 110/1/60@350va	**100.00**
110dc to 110/1/60@350va	**100.00**
110dc to 28dc@250va	**95.00**
110/1/60 to 28dc@250va	**115.00**
220/1,3/60 to 28dc@250va	**115.00**
110dc to 110/1/60@1.25kva	**135.00**
220dc to 110/1/60@1.25kva	**145.00**

Partial listings write for others

SYNCHROS & SELSYNS

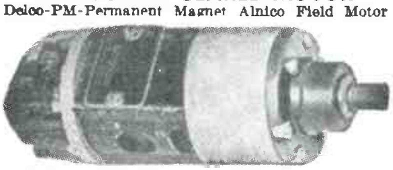
5F	**$40.00**	7G	**$70.00**
5G	**45.00**	2J1F1	**10.00**
5CT	**45.00**	2J1G1	**10.00**
5SDG	**27.50**	2J1H1	**10.00**
6G	**55.00**		

PIONEER 12602-1-A Torque Unit with CK-5 Motor and AY-43 Autosyn $34.50

115 V AC BLOWER
w/motor, 1/150 h.p. 3000 RPM **$10.00**

REVERSIBLE GEARED-MOTOR

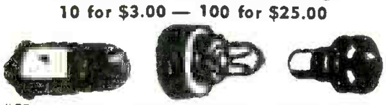
Delco-PM-Permanent Magnet Alnico Field Motor



#5071895 ¼ SHAFT or 11/16 GEAR **$17.50**
#5069000 .... **$18.50**
Clamps to hold motor: $1.50 ea.

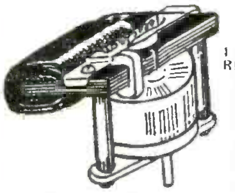
GRAIN OF CORN LAMPS

10 for $3.00 — 100 for $25.00



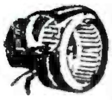
#328, 6 Volts #326, 2½ Volts #321, 28 Volts

TELECHRON Motors



1 RPM on 50 cycles or 4¾ RPM on 60 cycles .. 2.85
2 RPM $2.90
3 RPM 3.90
4 RPM 2.90
3.6 RPM 3.15
1 RPM 3.95
3 R.P. Hr 2.85
1 R.P. 2 Hr 2.80
1 R.P. 12 Hr 3.25
60 RPM 4.85

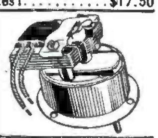
Laboratory Special 1 of Each Above $25.00



BLOWERS 115 Volts A. C. 60 c.

REDMOND 5" 18 watts..... $8.95
DELCO 60 cfm. 40 watts....$14.50
#5062369 used in 584 RADAR
EASTERN AIR DEVICES 70 watts. 3400 RPM. labeled 80 cfm, but blows like blazes! $17.50

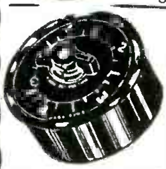
HAND WOUND 10 Sec. to 24 Min. TIMER SWITCH..$1.25



6 Watt Most POWERFUL TELECHRON 1 RPM 110 volts 60 cy $6.50
10 for $50.00

3" Round Elapsed Time Meter **$13.75**
Square Case **$14.50**

MARKTIME 5 HOUR SWITCH



A 10 amp. timing device. Pointer moves back to zero after time elapses. Ideal for shutting off radios and TV sets when you go to bed. Limited supply at this special PRICE..... **$4.90**
Also available in 15 min., or 30 min. or 1 hr. at $6.50

HAYDON TIMING MOTORS

110v. 60 cycle 30 RPM... **$2.60**
110v 60 cycle 1 RPM..... **2.85**
230V 1 RPM........ **1.00**
60C 2 RPM........ **1.00**

please include postage **BLAN** EST. 1932 **64K Dey Street New York 7, N. Y.**

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Wholesale to Institutions Industrials & Dealers Only

RELAYS ● METERS
MOTORS ● BLOWERS
SYNCHROS ● MAGNETS
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SWITCHES ● RESISTORS
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TORQUE UNITS ● CONTROL BOXES
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POTENTIOMETERS ● MICROWAVE PARTS

●

ALL TYPES OF TUBES

●

WRITE TO

AMBER INDUSTRIAL CORP.
METALS AND SALVAGE DIVISION
732 E. Monument Ave. Dayton, Ohio

CONSISTENT, DEPENDABLE SOURCE

FOR QUALITY TUBES

- Secialists in Western-Electric, Subminiature, Jan, and Ruggedized Types.
- Many new types such as GM Counter, Scintilation, 5000/6000 Series, as well as obsolete types stocked.
- Critical types Lab certified for your extra protection.
- All fully guaranteed, unused, and boxed merchandise.

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OA4G	$1.00
OB3/VR90	.85
OC3/VR105	.85
OD3/VR150	.85
1B26	1.50
1B32	2.00
1B35	6.50
1B63A	22.50
1B85	9.95
1B86	7.75
1P30	2.00
1Q22	88.50
2C39A Surplus	13.75
2C40	12.75

5C22	29.95
6A7	.85
5D21	7.75
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7BP7	4.50
7EP4	12.50
7GP4	12.50
8D21	455.00
12DP7	10.00
15E	1.00
FG27A	11.95
FG41	12.50
FG67	12.00
CRP72	.60
FG98A	20.00
100R Surplus	5.00
100TH	6.75
100TL Surplus	8.50
FG105	15.00

WE355A	19.75
359A	2.00
394A	3.50
401A/5590	3.10
403B/5591	3.15
404A/5847	12.00
416A	39.95
416B	79.95
417A	3.00
417A/5842	12.50
422A	9.95
429A	8.75
464A	2.55
CK503AX	1.00
GL562	50.00
WL651/5552	50.00
GL673	13.00
703A	1.25
705A	.85

1620	4.75
1851	1.75
1960	.60
5514	4.50
5516	6.50
5634	7.00
5641	6.00
5642	.95
5651	1.40
5656	7.95
5670	2.15
5676	1.00
5678	1.15
5686	2.00

RKR 50¢ EA.
50 at 40¢ ea
100 at 30¢ ea

3B24 1[50] EA.
50 at $1.25 ea
100 at $1.00 ea

DIRECTRON SELENIUM RECTIFIERS

Max Amps.	18VAC 14VDC	36VAC 28VDC	54VAC 42VDC	72VAC 56VDC	130VAC 100VDC
1	$1.35	$2.35	$3.75	$4.50	$7.45
2	2.00	2.75	5.35	5.90	9.15
3	2.95	4.15	5.85	7.85	12.75
4	3.50	6.45	11.35	14.35	21.75
6	4.00	7.75	12.85	17.30	29.75
10	5.90	11.45	19.50	24.80	41.35
12	7.25	14.35	22.10	29.75	44.25
20	13.05	25.05	37.25	48.75	78.50
24	14.25	28.75	44.50	57.65	81.00
30	17.95	34.35	56.50	71.00	109.00
36	22.45	42.35	65.00	86.95	134.00
50	29.50	54.35	105.45	115.75	174.00
100	59.50	119.00	.....	.....	.....

We build other Selenium Rectifiers. Transformers and Chokes to your specifications.
Buy from the Direct Source for Quick Delivery.

2C43	12.75
2C46	6.60
2C51	3.75
2E30	1.75
2E31	1.90
2E35	1.95
2J33	10.00
2J36	35.00
2J32	15.00
2J37	10.00
2J42	52.50
2J49	35.00
2J54	35.00
2K25	22.50
2K45	65.00
2K59	25.00
2K60	25.00
2K61	25.00
2K69	25.00
3B24	1.50
3B24/W	5.00
3B27	3.50
3B28	6.00
3B29	6.00
3C22	62.50
3C23	7.50
3C31/C1B	2.25
3C45	7.95
3D21A	4.50
3J30	45.00
3J31	45.00
3BP1	2.95
3BP11	7.00
3DP1	3.30

CONTINENTAL ELECTRIC TUBES

BRAND NEW—BOXED

EXCESS INVENTORY CLEARANCE SALE!

TYPE	PRICE	TYPE	PRICE
CE-1-A/B	2.80	CE-30-A/B	2.70
CE-1-A/B*	2.80	CE-30-C*	1.26
CE-1-C	2.06	CE-30V-A/B	4.95
CE-1-C*	2.06	CE-30V-C	1.47
CE-1-D	1.50	CE-30V-C*	1.47
CE-1V-A/B	4.54	JAN-IP40	1.33
CE-3-A/B*	5.22	CE-34-Q*	6.05
CE-3C*	3.39	CE-34-R*	2.66
CE-3-C	3.39	CE-36-A/B*	7.20
CE-18-C*	7.32	CE-36-C	1.95
CE-A22-A/B	4.35	CE-36-C*	1.95
CE-B22-A/B	4.35	CE-64-R	2.12
CE-B22-C	2.18	CE-91R	2.00
CE-B22-D	1.43	CE-C1A	8.25
IP-41	2.18	CE-C1B	8.25
CE-25-A/B*	7.20	CE-229	2.20
CE-25-C*	1.94	CE-309	4.78
CE-25-C	1.94	CE-309*	4.78
CE-B25-C	1.94	CE-311	7.86
CE-B25-D	1.43	CE-393	9.62
CE-25V-A/B	7.20		

* TUBES ARE NOT BASED

5687	3.00
5691	5.50
5692	5.25
5693	4.75
5696	1.15
5702	2.00
5703	.95
5704	1.90
5718	4.25
5726/6AL5W	1.10
5732	3.00
5744	1.00
5751	2.50
5762	100.00
5763	1.10
5780	250.00
5787WA	5.75
5795	250.00
5812	2.75
5814	1.60
5820	Write
5829	2.00
5840	5.00
5844	4.00
5879	1.40
5881	2.65
5886	2.50
5899	5.50
5963	1.20
6021	5.00
6073	1.65
6080	3.25
6080WA	4.25
6095	1.25

NEW RECTIFIER TRANSFORMERS

Pri: 115V. 60 cycles input
SEC: 9, 12, 18, 24, and 36 volts. Continuous

1 Amp	$5.75
2 Amps	6.75
5 Amps	8.65
12 Amps	16.65
24 Amps	35.65
50 Amps	59.00
100 Amps	108.00

NEW RECTIFIER CHOKES

Continuous Ratings

1 Amp	.1 Hy	1.5 ohm	$4.95
2 Amps	.04 Hy	.9 ohm	5.95
4 Amps	.07 Hy	.6 ohm	7.95
12 Amps	.01 Hy	.1 ohm	14.95
24 Amps	.004 Hy	.025 ohm	29.95
50 Amps	.005 Hy	.01 ohm	54.00

FILTER CAPACITORS

Capacity	W. Voltage	Each
500 MFD	200 V.	$1.95
500 MFD	50 V.	.85
1000 MFD	15 V.	.35
2000 MFD	50 V.	2.25

8020 (Surplus) 1[25] EA.
50 at $1.15 ea
100 at 90¢ ea

3FP7	2.50
4B24	5.00
4B28	3.00
4C35	13.50
4E27	9.50
4J21	77.50
4J36	75.00
4J37	75.00
4J63	7.00
4PR60A Surplus	75.00
4X150A Surplus	30.00
4X500F Surplus	65.00
5BP4	3.95

VT127A	2.50
VXR130	.75
FG172	45.00
QK181	25.00
203A	2.50
207	45.00
211	.50
249A	3.50
249B	3.50
251A (WE)	3.00
253	5.50
266B	45.00
274B	1.00
275A	3.50
276G	8.50
300B	6.00
304TH Surplus	8.75
304TL Surplus	10.75
311A	5.50
311C	2.50
337A	6.50
350A (WE)	3.00

707A	4.00
707B	5.00
708A	2.00
709A	1.75
715B	3.00
715C	8.00
717A	.50
721A	.75
722B	1.00
723A/B	9.50
725A	4.50
726B	25.00
726C	35.00
750TL	Write
800	2.00
803	1.75
829B	8.75
838	1.50
891	125.00
958A	.50
1603	3.10
1619	.30

100R (Surplus) 1[25] EA.
50 at $1.15 ea
100 at 90¢ ea

6096	Write
6097	1.50
6098	1.90
6099	1.50
6100	4.75
6101	1.50
6106	2.90
6113	1.25
6146	3.90
6187	4.00
6189/12AU7WA	3.75
8020 Surplus	1.25

NOW AVAILABLE!

WHITE COATED TUBE CARTONS

SIZE	EACH	SIZE	EACH
Miniature 1"x1"x3" 6AU6, 6AL5, etc.	$ .01	LARGE/GT 1 ½"x1 ½"x4 ½" 1B3, 6BQ6GT, etc.	.015
GT 1¼x1¼"x3⅜" 6SN7GT, 6W4GT, etc.	.0125	LARGE G 2"x2"x6" 5U4G 6BG6G, etc.	.02

Also in Super-Gloss Red and Black

Both types with new safety partitions—they meet U. S. Government specifications! Attractive discounts for quantity users. Minimum order 100 of a size. Be sure to specify white or color when ordering.

KILOWATT POWER SUPPLY

Matched, compact, hermetically-sealed components for KW power supply. Ideal for new Collins KWS-1K, etc.

- Power xfmr. Pri: 115 v. 60 cy. with taps for ¼, ½, and full power. Sec: 3400 v. @ 400 ma. 39 lbs.—8"x5⅝"x7⅜".
- Choke to match above—12 henries @ 400 ma. 34 lbs. 8"x5⅝"x7⅜".
- Filament xfmr for 4—866A's in bridge circuit. Pri: 115 v. 60 cy. Sec: 2.5 v. @ 5.0 A, 2.5 v. @ A., and 2.5 v. @ 10 A. Complete set only $45.00.

CL2 WESTING-HOUSE **19[90]**
CEASIUM VAPOR, INFRA RED, LIGHT SOURCE

Write For Listings of XMTG Receiving & Special-Purpose Tubes—Over 2,000 Types IN STOCK at Low, Low Prices—

CV147 INFRA-RED **3[95]**
SNOOPERSCOPE TUBE
SNAP-ON FILTER FOR ABOVE **1[05]**
Free Hook-Up Data Supplied with Combination

Terms: F O B—N Y C—25% Deposit with order—or send full remittance to save C O D charges—D & B Rated Firms (F2½ or Better) Net 10 days. CABLE: BARRYELECT, N. Y. TELEGRAPH,: BARRY ELECTRONICS, FAX, N. Y.

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Authorized Distributors of Eimac, CBS, Continental Electric (Cetron), Lewis & Kaufman and Penta Tubes and others.

512 Broadway, New York 12, N. Y. Dept. 7-E

Phone: Walker 5-7000

WANTED
BC-788, T-47A/ART-13, BC-348R, R-5/ARN-7, RT-18/ARC-1

AN/ASQ-1 and 1A MAGNETOMETERS
This is an airborne magnetometer used to measure the magnetic flux of the earth and to locate submarines and other metallic objects by their distortion of the magnetic field. Sensitivity 2-3 gamma or better. POR.

AN/GSQ1-A SPEECH SCRAMBLERS
Speech scrambler for use on any comm. channel to insure privacy. We can supply complete installations of this equipment 28v DC input. Also 110v 60 cyc.

SCR-291A DIRECTION FINDER
Automatic ground direction finder covering 1.5mc-30mc. Provides instant bearings on a C.R. indicator of any signal in its range. This equipment is transportable and can be set up quickly. 110v 60 cyc. POR.

P.P.I. REMOTE RADAR REPEATERS
We can supply the following types of remote Radar P.P.I. Repeaters. The main radar provides the Syncronizing, Syncro. and Video. Pulses to operate the Repeaters. These repeaters may be used with any marine ground or airbourne.

VC 7″ P.P.I. Upright deck mount Repeater. 4 Ranges are provided from 4-200 miles. Input 110 Volt 60 Cyc.

VD 7″ P.P.I. Deck mount Repeater. This unit is very similar to the VC but is completely Waterproof and may be used on deck. The ranges are the same as the VC. Input 110 Volt 60 Cyc.

VE 7″ P.P.I. Table mount Repeater. This is a very compact set. 4 ranges are provided from 4-200 miles. Input 110 Volt 60 Cyc.

VF 9″ P.P.I. Deck mount Repeater. This is a very late model Repeater enabling 20 radars to be fed into it. 4 Ranges from 4-200 miles are provided. Input 110 Volt 60 Cyc.

VG 12″ P.P.I. Plotting Table Projection Repeater. This is a very elaborate Remote Indicator. For use in a plotting center. Up to 20 Radars may be fed into it. This set utilizes a Skiatron tube to provide data that can be retained on the screen and can be erased at will. Input 110 volt 60 Cyc.

Accessories are available such as repeater adaptors enabling the set to be used at a greater distance than normal. Input switches to select the radar to be viewed etc.

RADALAB
87-17 124th STREET
Richmond Hill 18, New York
Phone Virginia 9-8181-2-3

SCR-682-A RADAR
10CM high power long range harbor surveillance and early warning RADAR. This equipment is a 3000 mc mobile search radar that can be transported in a truck. The equipment incorporates a 7″ PPI for operation up to 240,000 yards. Azimuth accuracy is ± 1%. Range accuracy is 100 yards at 10,000 yard range and 5000 yards at 240,000 yard range. Trans. output is approx. 225 KW. pulse width is one microsecond. Antenna beam width is 6″. Input is 110v 60 cyc. Can be supplied with or without operating shelter or antenna tower. POR.

We can supply many types of radars, test sets, communications equipments, manufactured after 1947. Write us if you cannot find it.

AN/APR-4 38-4000 MC RECEIVER
This is a precision receiver covering 38-4000 mc. The set utilizes 5 tuning units with direct reading dials in megacycles. The receiver has a wide and narrow band-width 30mc. I.F. strip which may be selected at will. An output meter is provided to measure signal strength. Outputs are provided for a pulse analyzer and pan adaptor. Each tuning unit has an automatic sweeping mechanism which enables any portion of the tuning range to be scanned automatically. Input 110v 60 cyc. POR.

500-1300 MC SIGNAL GENERATOR
This is a high precision signal generator covering 500-1300 mc. A precision attenuator is built in providing accurate determination of output from 0-100,000 microvolts. Either CW or pulsed carrier output with the following characteristics are provided. Pulse rate 60-2,500 CPS. Pulse length 2-30 microseconds. Output line 50 Ohm impedance. Accuracy better than one percent. Input 110 v 60 cyc. With calibration charts. Price $249.50

90-600 MC SIGNAL GENERATOR
This set covers 90-600 mc. with an accuracy of one percent or better. C.W. or pulse output with the following characteristics are provided. Output from 0-100,000 microvolts 2-30 microseconds long. Pulse rate 60-2500 cyc. Pulse delay 3-300 microseconds. Output 50 ohm line. Input 110v 60 cyc. Price................$249.50

Prices FOB NYC. Rated firms open account. Prices subject to change without notice.
CABLE: Radalab, NY
TELETYPE: NY-4-4361

CF-3A CARRIER REPEATER
This is a transportable 4 wire carrier telephone repeater. This set amplifies all signals when used in an intermediate position on a carrier system to extend the range. DC signaling and telegraph communications can be performed to the terminal equipments or to other repeaters. Monitoring and transmission circuits are built in. Power input 110 or 220v or 12v DC. This set can be used with all CF terminals and commercial equipments. Brand New in original cases. POR.

AN/APA-17 DIRECTION FINDER
This is an automatic direction finder covering 300-1,000 mc to be used with the APR-1 and APR-4 radar search receivers. The bearing is presented on a cathode ray screen in a cardoid pattern. The set can be used in aircraft or on the ground. Input 110v 400 cyc and 28v DC. POR.

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AN/CPN-8 S-BAND HIGH POWER Airport Beacon. This is a very compact set. This set will Interrogate S-BAND Radars up to 200 Miles. Variable Coding and monitoring facilities are provided. Input 110 Volt 60 Cyc.

AN/CPN-17 S-BAND High power version of the CPN-6 with all the latest improvements. Input 110 Volt 60 Cyc.

AN/UPN-4 X-BAND Very lightweight Portable Beacon. This set will interrogate X-BAND Radars up to 60 miles. Variable Coding is provided. Input 12 Volts D.C. Weight Approx. 40 Lbs.

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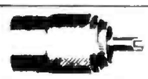
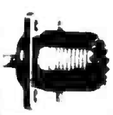
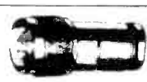

PL 259 .... 30c ea.


SO 239 .... 30c ea.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UG 43/U & UG 44/U .... $4.95 per set

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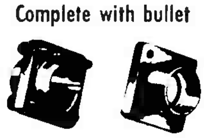
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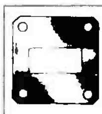
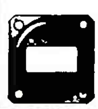

UG 39/U ...... 95c ea.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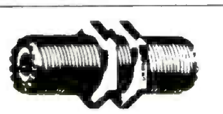
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10 CFM BLOWER (Pictured—right) 27.5 VDC; 1/100 HP.; 7000 RPM; Oster Motor C2BP-1A; L-R Mfg. Co. Bakelite Blower #2, overall size: 3-½" x 4-½". Price $5.95
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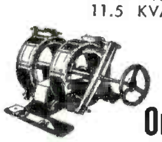

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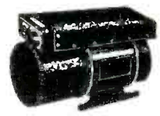

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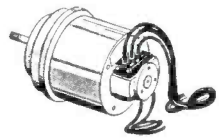

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5F MOTOR: 115-90 volt; 60 cycle $45.00

5SDG DIFFERENTIAL GENERATOR: 90-94 volts; 400 cycle . . . $30.00

BENDIX TRANSMITTER TYPE C-78248; 115 volt; 60 cycle $22.50

DIFFERENTIAL TYPE C-78249; 115 volt; 60 cycle $5.00

BENDIX REPEATER TYPE C-78410; 115 volt; 60 cycle $37.50

REPEATER, Type C-78663, AC Synchronous 115 volt, 60 cycle $9.95

DIEHL REPEATER TYPE FJE 22-2; 115 volt; 400 cycle; secondary 90 volt. $27.50

5G GENERATOR; 115/90 volt; 60 cycle $45.00

7G SYNCHRO GENERATOR: 115/90 volt; 60 cycle $75.00

6G SYNCHRO GENERATOR: 115/90 volt; 60 cycle $60.00

6DG SYNCHRO DIFFERENTIAL GENERATOR; 90/90 volt; 60 cycle. $50.00

2J5F1 SELSYN CONTROL TRANSFORMER: 105/55 volts; 60 cycle $22.50

2JD5HA1 SELSYN GENERATOR; 115/105 volts; 60 cycle $50.00

2J1F1 GENERATOR: 115/57.5 volts; 400 cycle $12.50

2J1H1 DIFFERENTIAL GENERATOR; 57.5/57.5 volt; 400 cycle. $12.50

2J1G1 CONTROL TRANSFORMER: 57.5/57.5 volts; 400 cycle $7.50

2J5H1 SELSYN GENERATOR: Mfr. G. E.; 115/105 volts, 60 cycle . . . $27.50

SIMPLE DIFFERENTIAL

Size: 2-5/32" long x 1¼" dia.; bearing one end ½" O.D.; Shaft Size: 1" long, threads 8-32-¾" long, with bearing shaft ⅛" dia. x ¼" long. Gear on shaft end 1-7/16" dia., gear on bearing end 1¼" dia. Drive gear 25/32" dia.

Stock No. 101 **$3.95 ea**

SPIDER DIFFERENTIAL

Size: 6½" long x 1¾" wide with 3/16" shaft.

Stock No. 107

$2.50 ea.

DUAL SIMPLE DIFFERENTIAL

1:1 reverse ratio on both. Size: 3¼" long x 1-7/16" dia. Shaft size: ⅛" and 5/32".

Stock No. 110

$7.50 ea.

SIMPLE DIFFERENTIAL

1:1 reverse ratio. Size: 6¾" long x 2¾" dia. Shaft size: 11/32".

Stock No. 111

$7.50 ea.

SIMPLE DIFFERENTIAL

Size: 5½" long x 2¼" dia. Shaft size: ⅜" on one end and 11/32" on other end. Hub is 1-3/32" dia. on each end.

$7.50 ea. *Stock No. 112*

PRECISION PLANETARY DIFFERENTIAL

1:1 reverse ratio, ring gear 3" dia., 120 teeth. Overall length 5¼". shaft dia. 11/32", ⅛" key on one end.

Stock No. 114

$7.50 ea.

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Ohm	Watt	Each	Ohm	Watt	Each	Ohm	Watt	Each
.1	150(L)	5.54	25	25	1.49	500	75(G)	3.15
.25	50	1.98	25	25(H)	1.86	500	100(K)	3.55
.5	100(K)	3.79	25	50	1.86	500	150(L)	5.05
.5	150(L)	5.34	25	75(G)	3.15	500	150	4.25
1	25	1.75	25	100	3.25	500	300(N)	8.42
1	50	1.98	25	100(K)	3.55	585	150(L)	5.05
1	50(J)	2.34	50	25	1.49	750	25	1.49
1.1	50	1.98	50	25(H)	1.86	750	25(H)	1.86
2	25	1.75	50	50	1.86	750	150	4.25
2	25(H)	1.86	60	25	1.49	780	100(K)	3.55
2	50(J)	2.10	75	25	1.49	800	25	1.49
2	100(K)	3.79	75	25(H)	1.86	1000	25	1.66
2.5	150	4.45	75	50	1.86	1000	25(H)	2.10
3	100(K)	3.79	75	75(G)	3.15	1000	50(J)	2.22
5	25	1.56	75	300	6.30	1200	225(P)	6.99
5	50(J)	2.10	80	500(R)	12.18	1200	3001	6.95
5	100(K	3.79	100	25	1.49	1250	50(J)	2.22
6	25(H)	1.86	100	25(H)	1.86	1250	150(L)	5.34
6	50(J)	2.10	100	50	1.86	1500	25	1.66
6	75(G)	3.15	100	100(K)	3.55	1500	25(H)	2.10
7	25	1.49	100	150(L)	5.05	1500	50(J)	2.22
7.5	75(G)	3.15	125	25	1.49	1600	50(J)	2.22
7.5	225(P)	6.99	125	25(H)	1.86	1800	50(J)	2.22
8	25	1.49	150	50(J)	2.10	1800	150(L)	5.62
8	25(H)	1.86	175	25	1.49	2000	25(H)	2.10
8	50(J)	2.10	175	25(H)	1.86	2000	50	2.10
8	50	1.86	175	500(R)	12.18	2250	150(L)	5.62
10	25	1.49	185	25	1.49	2500	25	1.66
10	25(H)	1.86	200	25	1.49	2500	50(J)	2.22
10	50	1.86	200	25(H)	1.86	2500	100(K)	3.71
10	100	3.25	200	100(K)	3.55	2500	150	5.62
12	25(H)	1.86	200	150(L)	5.05	2500	500(R)	12.18
12	50	1.86	250	25	1.49	3000	25	1.66
12.	500(R)	12.18	250	25(H)	1.86	3000	100(K)	3.79
13	100(K)	3.55	300	50	1.86	3500	25	1.66
15	25	1.49	300	50(J)	2.10	5000	25	1.66
15	25(H)	1.86	300	75(G)	3.15	5000	25(H)	2.22
15	50	1.86	350	25	1.49	5000	50(J)	2.45
15	50(J)	2.10	350	25(H)	1.86	5000	100(K)	4.04
15	75(G)	3.15	350	150(L)	5.05	7500	50(J)	2.45
15	100	3.25	375	150(L)	5.05	7500	100(K)	4.30
15	150(L)	5.05	400	25	1.49	10000	25	1.98
16	50	1.86	400	75(G)	3.15	10000	50(J)	2.50
20	25(H)	1.86	500	25	1.49	10000	50	1.98
20	50(J)	2.10	500	25(H)	1.86	15000	25	1.98
			500	50	1.86			

Notice: Specify type shaft—1/8" screw driver or for knob, or we ship our own choice. Mfg. quantities available at special prices. All initialed types are OHMITE.

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Ohms	Ohms	Ohms	Ohms	Ohms	Ohms
50	2000	50K	60-60	10K-100K	250K-250K
100	2500	100K	600-600	25K-400K	300K-300K
150	3000	150K	2K-2K	40K-40K	500K-500K
200	4000	200K	2K-25K	100K-100K	1meg-500K
250	5000	250K	7K-1meg	100K-200K	1meg-1meg
300	10K	500K	10K-10K	150K-150K	2meg-2meg
400	15K	1meg			
500	20K	2meg			
1000	25K	3meg			
1500	30K	5meg			

ohms	ohms
60-1K-5K	700K-700K-700K
20K-200K-15K	800K-800K-800K
45K-27K-2500	1meg-1meg-1meg

SPECIFY SCREWDRIVER SLOT OR KNOB TYPE SHAFT

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G-1 (CM 75)

.0001	6 KV	12.18	.001	6 KV	14.00
.00015	5 KV	12.18	.0039	6 KV	14.95
.00015	10 KV	14.95	.02	3 KV	15.44
.0002	6 KV	12.18	.032	2 KV	15.44
.00024	6 KV	12.76	.04	1 KV	17.55
.00025	6 KV	12.76	.051	1.5 KV	18.31
.0004	6 KV	13.31	.08	1.5 KV	19.73
.0005	6 KV	14.00	.09	1.5 KV	20.25
.00062	6 KV	14.00			

G-2 (CM 80)

.0001	10 KV	19.67	.0005	10 KV	19.67
.00015	10 KV	19.67	.001	10 KV	19.67
.0002	10 KV	19.67	.002	10 KV	19.67
.00027	10 KV	19.67	.004	6 KV	19.67
.0003	10 KV	19.67	.005	5 KV	19.67
.00033	10 KV	19.67	.01	5 KV	20.75
.000375	10 KV	19.67	.031	2 KV	21.00
.0004	5 KV	19.67	.045	2 KV	21.00

G-3 (CM 85)

.00005	20 KV	33.27	.0011	20 KV	43.50
.0001	20 KV	36.30	.0012	20 KV	44.62
.0001	25 KV	37.80	.00124	15 KV	44.75
.00015	20 KV	37.80	.002	12 KV	42.35
.0002	20 KV	38.75	.0025	12 KV	45.00
.00025	20 KV	39.33	.006	10 KV	45.38
.0003	20 KV	39.33	.015	3 KV	42.35
.0004	20 KV	41.15	.015	7 KV	45.50
.00047	20 KV	41.15	.02	3 KV	45.38
.0005	20 KV	41.15	.05	3 KV	45.81
.00095	5 KV	42.35	.15	2.5 KV	45.81
.001	15 KV	42.35	.25	1.6 KV	45.81
.001	20 KV	43.50			

G-4 (CM 90)

.00025	30 KV	66.35	.0066	15 KV	75.68
.0003	25 KV	66.35	.0075	15 KV	78.00
.00032	25 KV	66.35	.0091	12 KV	79.50
.00032	30 KV	67.25	.01163	5 KV	34.95
.00065	35 KV	67.50	.02	10 KV	84.50
.001	25 KV	68.73	.022	6 KV	34.95
.001	30 KV	75.50	.02325	3 KV	34.95
.0015	25 KV	68.73	.02448	3 KV	34.95
.0016	25 KV	68.73	.03076	2.5 KV	34.95
.002	20 KV	71.50	.03356	3.5 KV	34.95
.0025	25 KV	71.50	.04228	2.5 KV	34.95
.003	20 KV	72.50	.04300	2 KV	34.95
.0039	20 KV	72.50	.05	5 KV	82.50
.004	20 KV	72.50	.056	5 KV	83.17
.004044	15 KV	73.62	.05668	2 KV	34.95
.006	15 KV	75.68	.06808	1.5 KV	34.95

G-5 (CM 95)

.000155	30 KV	139.20	.000533	30 KV	151.50
.0004	30 KV	139.20	.001	30 KV	163.20

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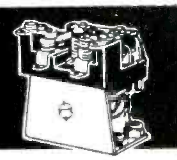

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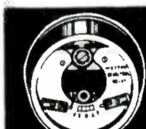

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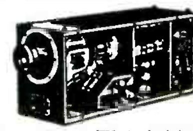

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2G-22	1.19
2J-21	2.49
2J-22	2.99
2J-26	4.99
2J-27	6.99
2J-31	14.99
2J-32	15.99
2J-33	16.99
2J-34	16.99
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4J23	34.50
4J24	34.50
4J25	34.50
4J26	59.50
4J27	59.50
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719A	11.75
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721A	1.21
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816	1.39
827R	79.50
828	9.75
829B	9.50
830B	1.99
832A	8.49
833A	37.49
836	3.20
837	.99
838	.99
841	.26
843	.26
845	7.49
849	49.69
851	15.49
860	3.99
861	9.99
864	.29
865	1.89
866A	.99
869B	15.99
872A	1.26
874	.86
876	.96
878	1.29
884	.99
885	1.49
9-3	.19
902A	4.99
918	2.10
927	1.95
931A	2.99
954	.16

Type	Price
955	.29
956	.26
957	.26
958	.59
959	1.99
991	.44
1500T	84.50
CK1005	.49
CK1006	3.19
1608	.99
1613	1.70
1614	1.99
1616	.99
1622	1.55
1624	1.64
1625	.19
1626	.11
1629	.16
1630	.69
1632	.49
1633	.59
1639	.89
1641	2.49
1642	.29
1644	.69
1806P1	3.99
1851	1.39
1960	.99
2050	1.19
2050W	3.49
2051	.81
1A3	.69
1B3	.89
1G6GT	.69
1LC5	.94
1LD5	.94
1L4	.84
1T4	.69
1A5	.79
1H5	.69
1N5	.89
1R5	.69
1S4	.84
1S5	.69
1U4	.69
1U5	.65
1X2A	.89
1V2	.69
2A3	.99
2A4	.99
3B7	.39
3D6	.39
3V4	.73
3Q4	.83
3S4	.69
5U4	.59
5Y3	.50
5T4	.91
5V4	.89
5Z4	1.19
5W4	.89
6AC7	.89
6AC7W	1.12
6AB7	.99
6AF4	1.29
6AG5	.84
6AG7	1.19
6AH6	.89
6AL5	.59
6AJ5	1.69
6AK5	.74
6AK6	.79

Type	Price
6AN4	1.35
6AQ6	.59
6AR6	1.69
6AS5	.76
6AS7G	2.99
6AX4	.79
6B4G	.99
6BA7	.89
6B5	.99
6B8	.69
6BG6G	1.99
6BH6	.79
6BE6	.69
6BJ6	.69
6BK7A	1.21
6BL7	1.10
6BM6	35.99
6BN6	1.24
6BQ6	1.19
6BQ7A	1.19
6BX7	1.24
6CD6	1.72
6CB6	.69
6C4	.40
6C5	.49
6C6	.49
6C8G	.99
6D4	2.75
6E5	.79
6F5	.49
6F6	.99
6F6G	.69
6J4	3.29
6J6	.72
6J7	.94
6J8	.96
6K4	2.69
6K5	.79
6K6	.69
6K7	.79
6K8	1.19
6L6M	1.49
6L6G	.99
6L7	.99
6N7	1.10
6R7GT	.69
6S4	.59
6SC7	.74
6SF5	.74
6SG7	.69
6SH7	.79
6SK7	.64
6SL7	.79
6SR7	.59
6SS7	.79
6W4	.69
6W6	.84
6V6GT	.66
6X4	.49
6X5	.49
6T4	1.44
6T8	.99
7A5	.95
7A6	.85
7A7	.79
7A8	.79
7B5	.69
7C4	.39
7C5	.79
7F7	.89
7G7	.89
7H7	.69
7N7	.89
7Q7	.99
7Y4	.69

Type	Price
7Z4	.69
12A6	.59
12AT6	.49
12AU7	.79
12AT7	.99
12AV7	.94
12AX4	.83
12AX7	.79
12AY7	1.31
12BA6	.64
12BA7	.64
12C8	.69
12SC7	.89
12SQ7	.59
12SR7	.59
12SF7	.82
12SG7	.85
12H6	.65
12SH7	.69
12SJ7	.69
12K8	.69
12SK7	.69
12SN7	.79
12SL7	.89
12Z3	.49
14A7	.79
14B6	.69
12B8	.79
14N7	.99
14R7	.99
14W7	.99
19T8	.99
25L6	.64
25Z6	.61
26D6	1.75
28D7	1.21
35L6	.69
35Z3	.69
35Z5	.51
35Y4	.69
50A5	.69
50B5	.69
50C5	.69
50L6	.69
77	.49
78	.59
80	.49
83V	.99
5651	1.39
5654	1.10
5670	3.99
5686	1.79
5687	3.49
5725	1.99
5751	2.15
5763	1.59
5796	7.99
5814	1.27
5879	1.29
5915	1.09
5963	.99
5964	1.30
8193	.09
8002R	9.50
8005	4.90
8012	1.94
8013A	4.69
8020	2.50
8025	2.49
8602	.69
9001	.79
9002	.69
9003	1.29
9004	.19

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5—KW, single phase, A.C. generators, 1200 RPM, 110/220 volts, single bearing, with cranking exciters, $300.00 each, subject to prior sale.

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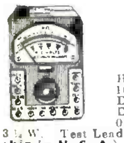
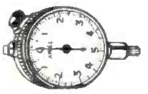


Pocket AC-DC Multitester "TAB" 27C

$9.45 Lots of 3

Hi-accuracy precision VOM. 1000 Ohms per V. Reads AC & DC Volts 0, 5, 25, 250, 1000V. DCMA; 0, 1, 10, 100MA. Ohms 0, 10, 100K. Size 1¼ D, 4⅝L, 3¼ W. Test Leads. **Sold Singly $9.95; (plus 40c ship in U. S. A.)**

Dealers Distributor Write for Discounts



"AMES" PRECISION DIAL MICROMETER GUAGE. Jeweled shockless #111 Range .025" Dial 0-5-0 dial calibration 1/10000 divs. Regular $36.50. **SPECIAL $18. @ 2/$32**

Micro & Mu Switches Switchettes

Mu/leaf sw. 3½" DPNO & NC/15A @ .98, 12/$10
MICRO sw. Pin plunger SPDT/10A @ .39, 12/$3
MICRO Sw. Plunger SPDT/10A @ .39, 10/$3
MICRO Sw. Plunger SPNO/10A @ .35, 12/$3
PUSH Toggle AH&H DPST/12A @ .35, 12/$3
MICRO Sw. Roller SPNC/10A @ .59, 12/$5
C.H. 3DPT/A/hp @ .98, 6/$5
MICRO Sw. Plunger SPNO&NC @ .39, 10/$3
Mu & Micro Sw. SPDT & reset @ .59, 12/$5
MICRO Plunger Button SPDT @ .69, 12/$6
MICRO Sw. Cased Hvy Duty & arc Sup Magneta Plunger SPNC/30A @ .79 6/$4, 12/$7
SWITCHETTE DPNO & NC @ .30, 12/$3
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KIT 8 asstd types $3

Qtys 100 additional 20% Discount

ORSA WOOD SAW

Finest SWEDISH SANVICK STEEL. Non-breakable, double action cutting edge. CLOSING Out Reg $12 to $18 ea.
SPECIAL @ $4, 3 for $10, 6 for $18

A B C D E F G

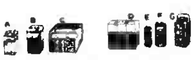
SOLDERING LUGS. EYELETS

#	MFG.	LGTH	HOLE	100	1000
A	Z#28	5/8	8	.50	$3
A	Z#28	1"	10	.75	$4
B	Z#221	3/4	8	.50	$3
B	Z#221	5/8	6	.50	$3
C	Z#80	1/2	10	.75	$3
C	Z#29A	13/16	1/4	.75	$4
D	Z#190	9/16	8	.50	$2
E	Z#328	1/2	4	.50	$2
E	Z#355	15/16	3/8	$1	$5
F	Z#81	7/8	10	.75	$4
F	Z#76	5/8	4	.50	$2
G	Z#45	7/16	6	.50	$3
C	Z#29A	5/8	4	.50	$2
C	Z#80	7/8	10	.75	$4
C	Z#37	1-3/8	8	.50	$3

EYELETS

MFG	LGHT	DIA		
S	3/16	.125	.39	$2
S	3/8	.093	.39	$2
S	5/8	.156	.39	$2
S	7/32	.281	.39	$2

Z — Zierick S — Stimpson
Discount 5000 Qtys 20%, Qtys 10M disc 40%
Write for complete list LARGE STOCK LUGS



BATTERIES Dry & Storage

A) SPECIALTY 180V Dry Bat. $1 @, 6 for $5
B) BURGESS 1½V cells 1C or 2D @ .11, 48 for $4.75
B) BB54/2V Storage Baty. $2.25 @, 6 for $11
C) GOULD 4V/16AH Storage Bat $2 @, 6 for $8
E) EVREDI 6V#1461 Hotshot $1 @, 12 for $8
F) 6V/NT6/BB214U $2 @, 6 for $10
D) 6V/12AH Storage Bat $5 @, 6 for $24
F) 2V/12AH GE Storage Bat $4 @, 6 for $20

VACUUM CAPACITORS

25mmf/7.5Kv @ $4.98, 3 for $10
50mmf/7.5Kv @ $6.98, 4 for $20
100mmf/7.5Kv @ $7, 4 for $20
12mmf/20Kv @ $9, 3 for $21
50mmf/20Kv @ $10, 3 for $24
100mmf/20Kv @ $21, 3 for $48
12mmf/32Kv @ $16, 3 for $36
Buy $100 & Deduct 20% Discount

CIRCUIT BREAKER FUSES

Push to Reset

Amps 3-5-7-10-15-20 **Ea 27c; 4 for $1; 25 for $5; 100 for $18**
Circuit Breaker Fuse w/2 Mounting Clips **39c; 3 for $1; 20 for $6; 100 for $25; 1000 for $200**
Fuse is 3AG size. Please state Amps (Current) desired. **Kit of Six $1.50**

HI-MEG HI-VOLT RESISTORS

.75 MEG "MVP" 10W/10KV 69c 12 for $6.00
2 MEG 5W/10KV 89c 12 for $9.00
2.5 MEG "MVT" 5W/7.5KV 79c 12 for $8.00
7 MEG "MVP" 10W/10KV $1.00 12 for $10.00
12 MEG 10W/10KV $1.50 12 for $16.00
20 MEG "MVO" 35W/50KV $2.00 12 for $20.00
50 MEG "MVE" 25W/40KV $2.50 12 for $25.00
10 MEG "MVP" 10W/10KV $2.00 12 for $20.00
Lots Fifty 20% Disc; Lots 100 Disc. 40%

NEW SONIC SOUND GENERATOR

115 VAC Input
Cleans! Agitates! Washers & Mixes
"TAB" SPECIAL $19.99
Write For Complete Details

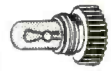
$ $ *Price Slashed* $ $ "J" POTENTIOMETERS

Short Shaft ⅛", 150, 200, 500, 3K, 5K, 10K, 15K, 25K, 30K, 50K, Ohms **50c EA; 12 Ass'td 40c EA; Lots 100 Special 30c EA; W/Shaft ¼; & up**, 5, 50, 150, 200, 1K, 1500, 2K, 2500, 3K, 10K, 25K, 30K, 70K, 100K, 750K, 10 Meg Ohms, **65c EA; 12 or More Ass'td 55c EA; "TAB" Special Lots of 100 @ 39c** 500. **Dual ⅛; Shaft & up**, 150/50, 1500/50 1500/500 2x25K, 25K/450, 25K/5K, 35K/5K 50K/5K 2x500K, 2x1Meg, 2x10Meg, **Triple** 5K/1K/1Meg 3x750K Ohm @ **85cEA. 12 or More Ass'td 75c EA; 100 Lots @ 50c EA. Use 100 Lot Price on Ass't'l Qtys 100 or More**
Many others in Stock. Write for Listing

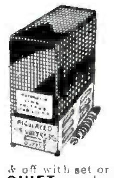
NEW PRECISION POTENTIOMETERS

Helipot 1000 Ohm/0.5%/10 Turn
Helipot 2000 Ohm/0.5%/10 Turn
Helipot 5000 Ohm/0.5%/10 Turn
Micropot 5000 Ohm/0.1%/10 Turn
Micropot 20000 Ohm/0.1%/10
SPECIAL $6.49 ea; 6 for $24
$100 or more 20% Discount

LAMPS "Grain of Wheat"



323 Volts 3 CLEAR 5 for $1
323 Volts 3 RED 5 for $1
321R Volts 28 & Shutter RED 4 for $1
321G Volts 28 & Shutter GREEN 4 for $1
Discount 100 Qtys 15%; Qtys 1000 @ 30%



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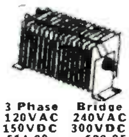
$ $ *Popularly Priced* $ $

ONLY $16.98

Line Voltage Stabilizer Automatically Regulates Line Voltage for LAB or INDUSTRIAL USE—or TV, Radio Insures full size, strength, & sync of TV picture regardless of line voltage. Automatically operated . . . regulator turns on & off with set or Equipment. **TROUBLE FREE, QUIET**, needs no adjustment. Universal Use—from 100 to 300 Watts. Input 100 125V/Output 115V + or − 3% 50/60 cycles—**Sold on "TAB" Money Back GUARANTEE.**
ORDER SIX ADDITIONAL 10% DISCOUNT

NEW "TABTRON" SELENIUM RECTIFIERS

ENGINEERED *for* INDUSTRY



"TAB" manufactures power rectifiers to your specifications. From one amp up to and above 1000 amps, convection or fan cooled, single or 3 phase. "NEMA" & JAN. Specs. Write for catalog.

FULL WAVE BRIDGE • DATED & ONE YEAR GTD

Max Amp	18VAC* 14VDC	36VAC* 28VDC	54VAC* 42VDC	72VAC* 56VDC	130VAC* 100VDC	266VAC* 217VDC	Ctr Tap AC/DC 30/12	3 Phase 120VAC 150VDC	Bridge 240VAC 300VDC
1	$1.40	$2.35	$3.75	$4.50	$8.25	$22.25	$2.10	$14.90	$28.95
2	2.10	2.95	5.35	5.90	10.00	28.85	2.35	15.90	30.90
3	3.00	4.15	5.85	7.85	12.75	36.85	2.65	17.40	33.50
4	3.70	7.35	11.35	14.35	24.75	38.85	2.95	18.90	36.95
6	4.45	8.75	12.85	17.30	32.00	54.85	3.25	20.90	39.95
10	6.50	12.50	19.50	24.80	41.35	84.85	4.75	36.90	71.95
12	8.00	15.75	22.10	29.75	44.25	99.85	5.95	41.90	81.95
20	13.05	25.05	37.25	48.75	78.50	160.85	7.95	50.90	97.95
24	16.00	31.95	44.50	57.65	85.00	190.85	9.95	89.90	159.95
30	19.75	33.50	56.50	71.00	109.00	235.85	Q	117.90	225.95
36	24.75	47.50	65.00	86.95	134.00	295.85	14.95	134.90	269.95
50	29.50	54.35	97.35	106.35	174.00	405.35	23.95	179.90	359.95

High Current Power Supplies

ONE YEAR GTD

Variable 0-28VDC. Completely Built, Ready to Go. Full Wave Selenium Rectifier, Transformer, Variac, Volt & Amp Meters, Switch, Terminals & Fuse. Hvy Duty Steel Cabinet Std 115V/60 cy Input or 220V† (3 phase) to order.

Stock Number	Continuous Rating	With Meters
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T28V5ACC	5 Amp (1% Ripple)	75.00
T28V5A2CC	5 Amp 0.01% Ripple	129.00
T28V12A	0-28 VDC at 12 Amp	108.00
T28V12ACC	12 Amp (1% Ripple)	145.00
T28V12A2CC	12 Amp 0.01% Ripple	199.00
T28V24A†	0-28 VDC at 24 Amp	135.00
T28V24A2CC†	24 Amp 0.01% Ripple	279.00
T28V/24ACC†	24 Amp (1% Ripple)	195.00
T28V50A†	0-28 VDC at 50 Amp	260.00
T28V50ACC†	50 Amp (1% Ripple)	370.00
T28V100A†	0-28 VDC at 100 Amp	469.00
T28V100ACC†	100 Amp (1% Ripple)	650.00

Variable 75 to 135 VDC Completely Built, Ready to go. Includes F. W. Selenium Bridge Rectifier, 4" Rectangular Volt & Ammeter, Over-Load cutout Dsgnd for cont. service.
Specify for 115 or 230 VAC/1 phase, 60 cy Input

T120V5AC	75 to 135 WVDC at 5 Amp	$170.00
T120V5ACC	5 Amp (1% Ripple)	218.00
T120V10AC	75 to 135 VDC at 10 Amp	216.00
T120V10ACC	10 Amp (1% Ripple)	266.00

New! Basic Supplies, 115 Vac In

B12V10ACC	10 Amp (1% Ripple)	65.00
B12V24A	12 WVDC at 24 Amp	81.00
B12V50A	12 WVDC at 50 Amp	125.00

Less Meters.

110-115 V DC Power Supplies

for Fans, Shavers, Motors, Bells, Drills, Solenoids, Business Machines, Battery Cgrs, Machine Tools & Signal Systems.
up to 50W $4.95; **up to 100W** $7.95
up to 250W $12.95; **up to 350W** $14.95
up to 800W $28.95; **up to 1100W** $32.95

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Variable DC Power Supply Full Wave Rectification 6000MFD Condenser Filter Ready to Operate Input 115V 50cy Output 6.3V or 12.6 Amp
Model 2DCF (2 amp) $12.98
Model 5DCF (5 amp) $29.95
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CR6001/1 Amp/0.1 HY/1.4 *Ohm*/3 Lbs. $3.95
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CR6003/5 Amp/.07 HY/.6 *Ohm*/10 Lbs. $7.95
CR6004/12 Amp/.01 HY/.1 *Ohm*/12 Lbs. $14.95
CR6005/24 Amp/.004 HY/.025*Ohm*/20 Lbs. $29.95

New Rectifier X-frms

PRIMARY 115V 60cy

5 Amp† $8.65; 2 for $15.75
12 Amp† $16.65; 2 for $29.95
24 Amp† $35.65; 2 for $69.95
*50 Amp $59.00; 2 for $112
*100 Amp $108; 2 for $210
18 Volt 2 Amp $1.98; 2 for $3.50
SEC (Dual†) 18-15-9-0:0-9-15-18 Volts
† **Wndgs In Series at Ratings shown; Parallel 2xAmps; Voltage one half max.**
* **Dual Primary 115 & 220V 60cy; Tapped 36VCT**

1st Quality TUBES

"TAB" TESTED! *INSPECTED & CERTIFIED* GUARANTEED!!!!

OA2	.74
OA3	.98
VS-1	12.49
1AG4	1.35
1AX2	1.25
1B3	.79
1B22	1.68
1B24	4.98
1B41	48.00
1B63A	42.50
1D21	3.49
1P21	33.00
1Q23	150.00
1X2A	.88
2C22	.32
2C39A	16.90
2D21	.75
2E22	1.89
2E24	2.48
2E26	3.78
2J30	50.50
2J42	99.50
2J51	150.09
2K25	23.88
2K28	29.50
2K30	130.00
2K33	219.48
2K41	125.00
2K42	149.55
2K43	130.00
2K48	110.00
2K50	315.00
2P23	298.00
3B24W	8.48
3C22	72.50
3C24	3.98
3D21A	7.99
4-65A	19.49
4-125A	19.09
4B23	16.98
4B27	4.98
4C35	16.95
4J26	79.55
4J30	99.55
4J47	485.00
4J52	649.95
4X150A	45.00
5D21	9.48
5U4G	.54
6AN5	3.60

6BM6	67.99
6J6	.48
6SN7	.59
7C29	69.95
8D21	298.00
12AU7	.58
12AX7	.78
FG17	3.01
19BG6	1.98
24G	1.96
HK24	4.90
35Z5	.47
REL36	.49
TZ40	4.49
HK54	3.75
HY69	5.49
75TH	5.07
CV147	10.00
CV148	10.00
QK155	699.99
QK202	99.99
250R	10.95
250TH	35.00
HK254	14.49
304TH	12.90
304TL	12.95
313C	2.98
316A	.48
5340	2.98
HK354	24.98
394A	1.96
FP400	15.98
WE417A	13.49
434A	3.94
446B	2.98
450TH	75.49
502AX	2.05
512AX	1.35
531DX	1.89
536AX	1.55
538DX	.98
539DX	2.50
544DX	2.50
571AX	4.45
608CX	.97
HY615	.46
703A	1.48
704A	.98
705A	.98
710A	1.68

723AB	9.98
724A	2.94
725A	4.49
750TH	99.99
750TL	32.55
807	1.19
807W	4.98
815	3.98
829B	8.49
832A	5.49
CK1090	2.98
R1100	5.00
R1130	8.24
E1148	1.34
1201	.78
1203A	1.68
HY1231	5.28
HY1269	5.45
1290	.91
1612	1.98
1613	1.27
1616	.79
1619	.34
1620	5.01
1621	1.90
1622	1.60
1625	.44
1629	.22
1632	.68
1633	.98
1634	1.39
1636	1.29
1642	.62
1644	.99
1850A	564.95
1851	2.55
2050	.98
2050W	2.48
2051	.68
R4210	18.99
R4330	14.99
5514	4.69
5516	5.51
5517	2.22
5586	150.25
5588	119.99
5634	7.50
5636	5.00
5638	9.99
5640	11.57

5641	6.59
5642	.99
5654	1.72
5656	9.98
5663	1.06
5670	2.24
5672	1.55
5686	2.99
5687	3.59
5692	6.48
5693	5.49
CK5694	3.70
CK5697	3.70
CK5702	2.50
5713	173.50
5718	5.99
5719	5.99
5721	189.55
5722	6.39
GL5727	1.77
5732	3.94
5736	159.95
5744	2.39
5749	1.72
5750	3.10
5751	3.09
5764	55.99
5765	55.99
5769	298.00
CK5783	5.55
CK5787	4.95
5794	8.99
5812	2.99
5814	1.28
5819	49.99
5820	148.00
5823	1.29
5825	11.99
5828	6.70
5840	5.05
5841	7.98
5842	13.49
5844	4.48
5852	7.57
5857	59.50
5863	49.94
CK5875	2.05
5876	12.49
5879	1.59
5881	2.70
5893	7.55

5901	6.55
5902	6.99
5905	9.00
5907	8.00
5908	8.00
5910	.74
5927	89.45
5932	5.00
5950	6.45
5959	37.25
5965	1.75
6005	2.80
6027	179.95
6072	3.99
6080	5.95
6099	1.55
6101	1.55
6110	6.55
CK6111	8.95
6119	6.45
6121	9.00
GL6136	1.89
6146	4.87
6164	64.95
6199	49.99
6201	3.99
6270	199.95
6271	159.95
6273	199.95
8002R	17.55
8005	4.97
8012	1.09
8013	4.91
8014A	50.15
8020	1.30
8025A	2.99
9001	.88
9002	.96
9003	.98
9004	.28
9006	.24

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3BP1A	6.55
3CP1S1	5.98
3DP1	4.81
3DP1A	6.80
3EP1	4.71
3FP7	1.91
3FP7A	6.91
3GP1	1.91

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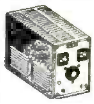

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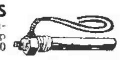

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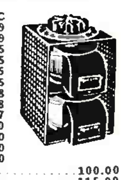

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0-135V/3A* 11.99
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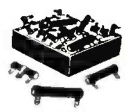

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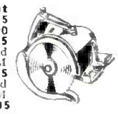

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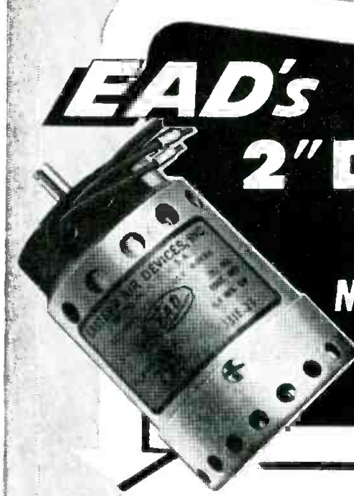

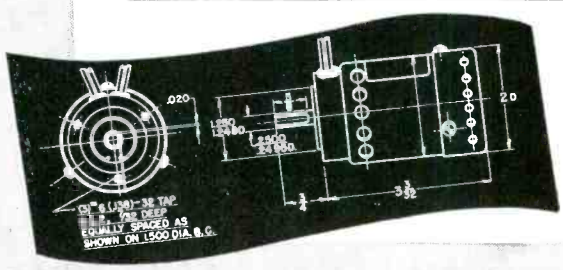
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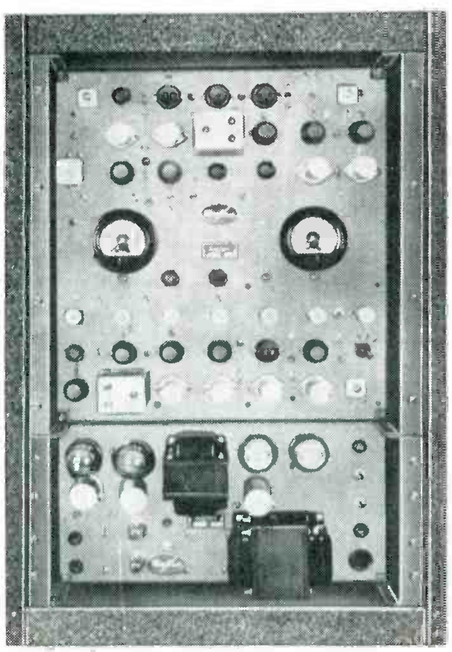

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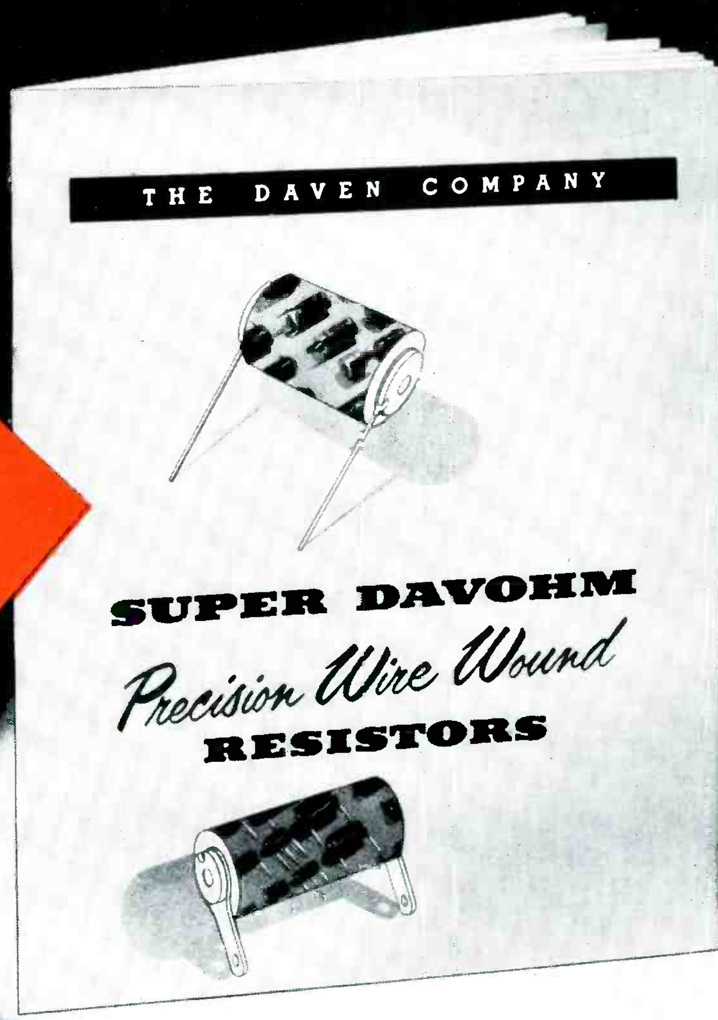

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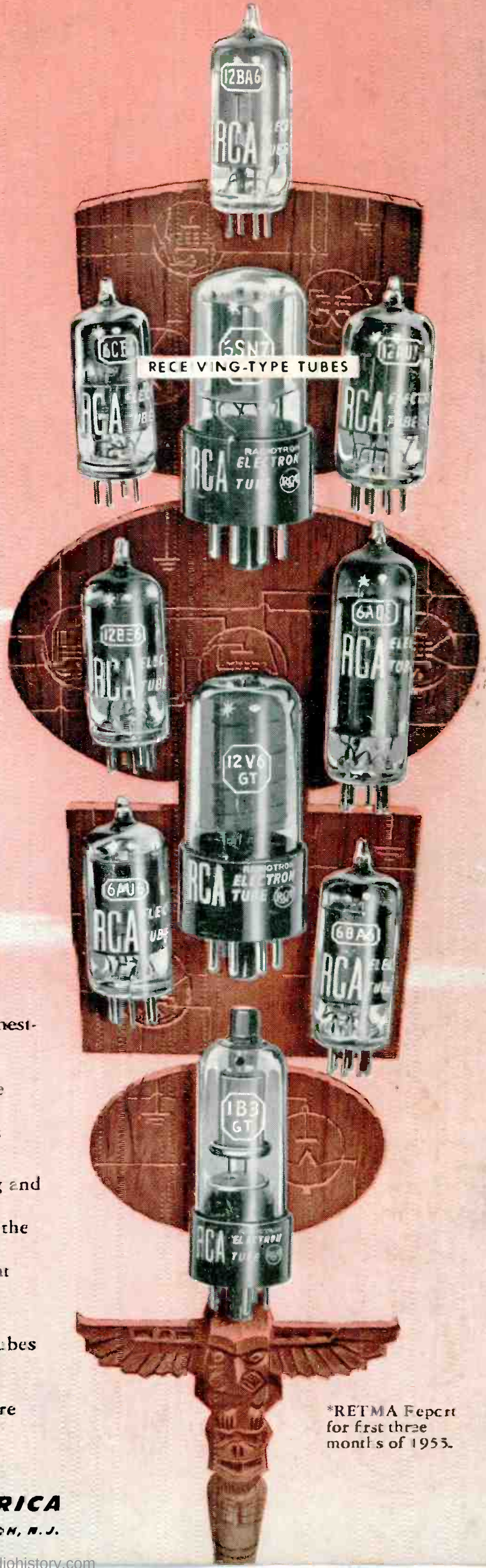

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