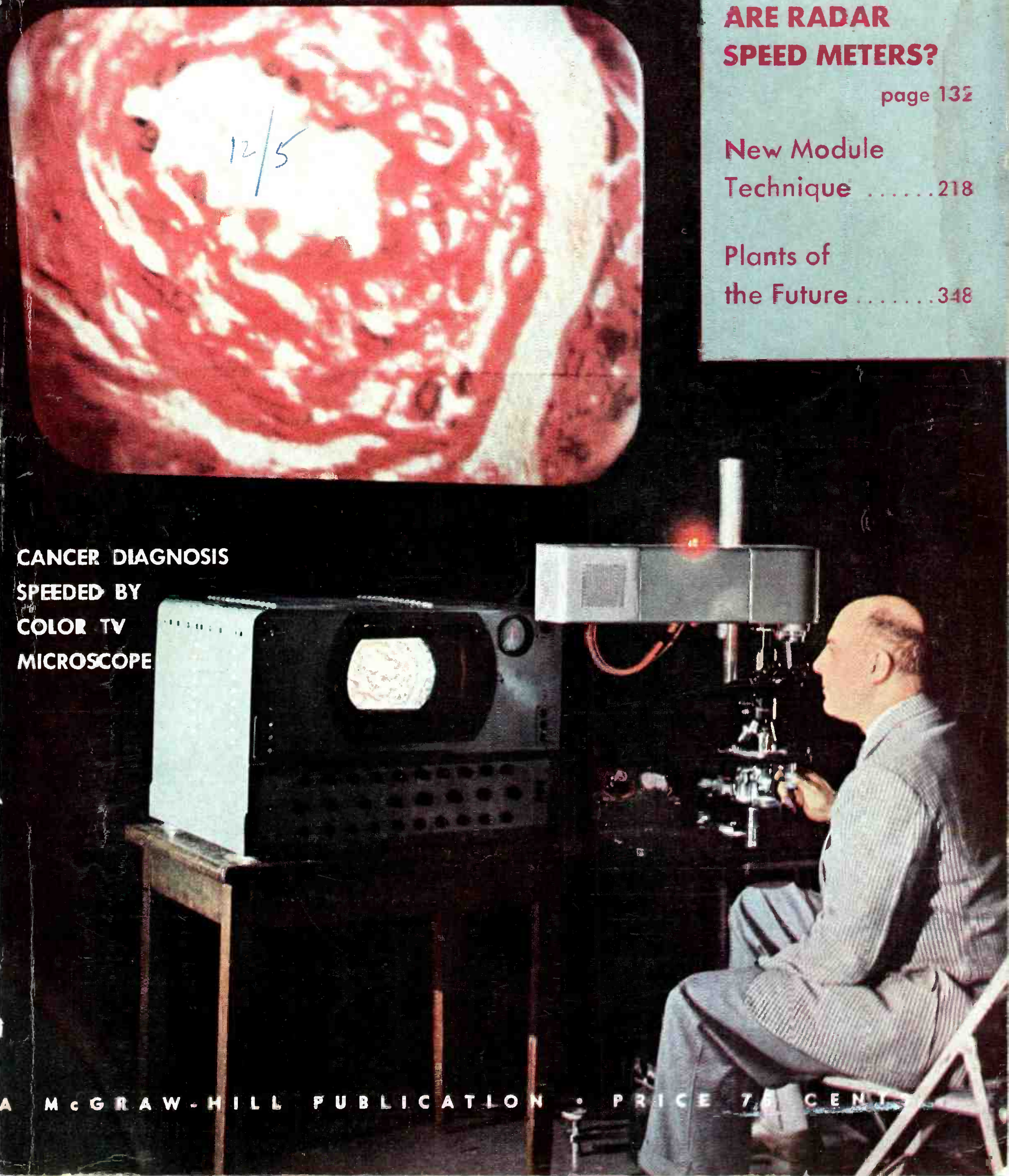
electronics

DECEMBER · 1955



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MINIATURIZED TRANSFORMER COMPONENTS FROM STOCK

Items below and 650 others in our catalog A.

HERMETIC SUB-MINIATURE AUDIO UNITS

These are the smallest hermetic audios made.

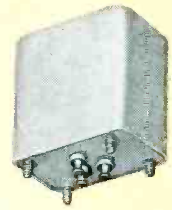
Dimensions . . . 1/2 x 11/16 x 29/32 . . . Weight .8 oz.

TYPICAL ITEMS

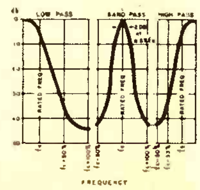
Type No.	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	DC in Pri MA	Response ±2 db (Cyc.)	Max. level dbm
H-30	Input to grid	TF1A10YY	50*	62,500	0	150-10,000	+13
H-31	Single plate to single grid, 3:1	TF1A15YY	10,000	90,000	0	300-10,000	+13
H-32	Single plate to line	TF1A13YY	10,000*	200	3	300-10,000	+13
H-33	Single plate to low impedance	TF1A13YY	30,000	50	1	300-10,000	+15
H-34	Single plate to low impedance	TF1A13YY	100,000	60	.5	300-10,000	+ 6
H-35	Reactor	TF1A20YY	100,Henries-0 DC, 50 Henries-1 Ma. DC, 4,400 ohms.				
H-36	Transistor Interstage	TF1A15YY	25,000	1,000	.5	300-10,000	+10

*Can be used with higher source impedances, with corresponding reduction in frequency range and current

COMPACT HERMETIC AUDIO FILTERS



UTC standardized filters are for low pass, high pass, and band pass application in both interstage and line impedance designs. Thirty four stock values, others to order. Case 1-3/16 x 1-11/16 x 1-5/8 – 2-1/2 high . . . Weight 6-9 oz.

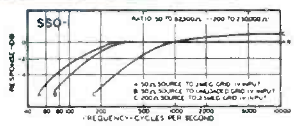


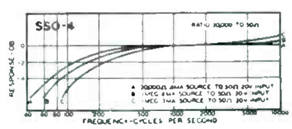
HERMETIC MINIATURE HI-Q TOROIDS

MQE units provide high Q, excellent stability and minimum hum pickup in a case only. 1/2 x 1-1/16 x 17/32 . . . weight 1.5 oz.

TYPICAL ITEMS

Type No.	Inductance	DC Max.
MQE-1	7 mhy.	135
MQE-3	20 mhy.	80
MQE-5	50 mhy.	50
MQE-7	100 mhy.	35
MQE-10	.4 hy.	17
MQE-12	.9 hy.	12
MQE-15	2.8 hy.	7.2





SUB-SUBOUNCER AUDIO UNITS

UTC Subouncer and sub-subouncer units provide exceptional efficiency and frequency range in miniature size. Constructional details assure maximum reliability. SSO units are 7/16 x 3/4 x 43/64 . . . Weight 1/50 lb.

Type	Application	Level	Pri. Imp.	MA D.C. in Pri.	Sec. Imp.	Pri. Res.	Sec. Res
*SSO-1	Input	+ 4 V.U.	200 50	0	250,000 62,500	13.5	3700
SSO-2	Interstage /3:1	+ 4 V.U.	10,000	0-.25	90,000	750	3250
*SSO-3	Plate to Line	+20 V.U.	10,000 25,000	3 1.5	200 500	2600	35
SSO-4	Output	+20 V.U.	30,000	1.0	50	2875	4.6
SSO-5	Reactor 50 HY at 1 mil. D.C. 4400 ohms D.C. Res.						
SSO-6	Output	+20 V.U.	100,000	.5	60	4700	3.3
*SSO-7	Transistor Interstage	+10 V.U.	20,000 30,000	.5 .5	800 1,200	850	125

* Impedance ratio is fixed, 1250:1 for SSO-1,1:50 for SSO-3.
Any impedance between the values shown may be employed.

OUNCER (WIDE RANGE) AUDIO UNITS

Standard for the industry for 15 yrs., these units provide 30-20,000 cycle response in a case 7/8 dia. x 1-3/16 high. Weight 1 oz.

TYPICAL ITEMS

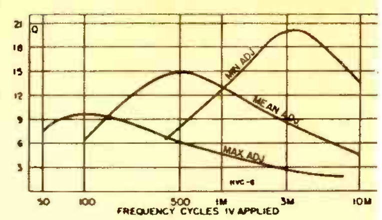
Type No.	Application	Pri. Imp	Sec. Imp
0-1	Mike, pickup or line to 1 grid	50, 200/250, 500/600	50,000
0-4	Single plate to 1 grid	15,000	60,000
0-7	Single plate to 2 grids, D.C. in Pri.	15,000	95,000
0-9	Single plate to line, D.C. in Pri.	15,000	50, 200/250, 500/600
0-10	Push pull plates to line	30,000 ohms plate to plate	50, 200/250, 500/600
0-12	Mixing and matching	50, 200/250	50, 200/250, 500/600
0-13	Reactor, 300 Hys.—no D.C.; 50 Hys.—3 MA. D.C., 6000 ohms		

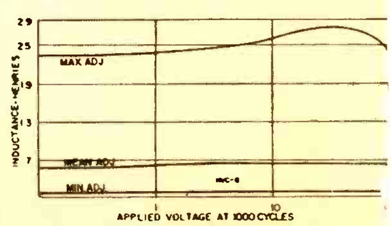
HERMETIC VARIABLE INDUCTORS

These inductors provide high Q from 50 - 10,000 cycles with exceptional stability. Wide inductance range (10 - 1) in an extremely compact case 25/32 x 1-1/8 x 1-3/16 . . . Weight 2 oz.

TYPICAL ITEMS

TYPE No.	Min. Hys.	Mean Hys.	Max. Hys.	DC Ma
HVC-1	.002	.006	.02	100
HVC-3	.011	.040	.11	40
HVC-5	.07	.25	.7	20
HVC-6	.2	.6	2	15
HVC-10	7.0	25	70	3.5
HVC-12	50	150	500	1.5





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CABLES: "ARLAB"

electronics

A McGRAW-HILL PUBLICATION

DECEMBER • 1955

CONTINUED ON NEXT PAGE

contents

continued

SHOP

▶ **CAREER . . .** One of the things that helps ELECTRONICS maintain its unique position in the field is the magazine's receptivity to ideas suggested by readers. A surprising number of presumably busy men volunteer topic and treatment suggestions and, in so doing, exhibit considerable publishing flair.

There is an opportunity for one such man to turn pro; we're looking for an editorial staffer. As you would expect, the job requires an engineer with industry experience. Reporting, writing or editing knowhow would represent plus value.

Take a look at the names on our page 1 masthead back over the years and it will be obvious that many of us like our work, our paper and our company very much indeed. There is nothing like an editing career for the right man, nothing tougher for the wrong.

If you think you are the right man write the editor.

▶ **ATOMIC READERS . . .** At the Hanford atomic plant, more than 75,000 copies of 800 different magazines are circulated annually among General Electric personnel.

An estimated 1,500 of the 9,200 people on the payroll receive one or more weekly or monthly publications.

Of the 10 magazines most in demand by Hanford people on regular circulation lists, 4 are published by McGraw-Hill; *Nucleonics, Busi-*

electronics

DECEMBER, 1955 Vol. 28, No. 12

Member ABC and ABP

TALK

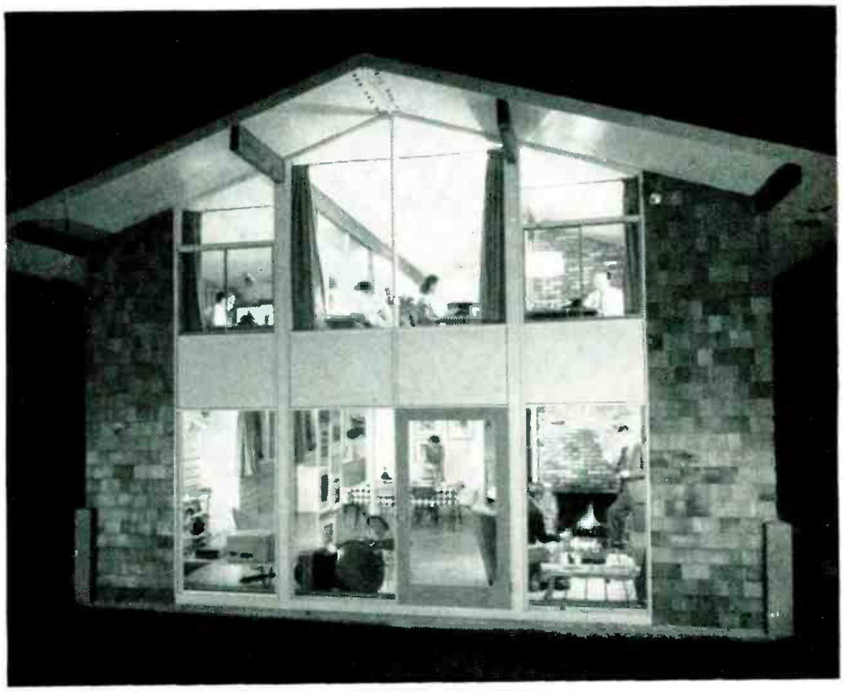
ness Week, *Today's Secretary* and ELECTRONICS. The latter is the only one in its field in the top 10.

▶ **DX AID** . . . The problem we had of obtaining a certain 1951 issue (Shoptalk, May '55) brought in a number of suggestions from readers. One of these is from L. van Zeyl of Pretoria, South Africa. He did some research into photocopying equipment and found that there is at least one machine that reproduces book or magazine pages, even though curved, without harming the binding.

▶ **MOVING TORQUE** . . . We met recently a friend of a friend of ours, Harold Varley, an electronics engineer with one of the large firms in the business. He told us of a problem he had several years ago when he was transferred to a West Coast branch.

At that time he had ten years, 120 copies, of ELECTRONICS which provided him with reference material. The bulk and weight of these brought up two problems, convincing his wife that the issues were really going with them, and the problem of packing them for a cross-country trip.

The trucker refused to take the first packing because of excess weight per package. This meant a complete repacking of all the boxes and barrels and redistributing the 120 copies with a few issues in each box and barrel. Each was then filled with lighter items from the household.



EDITORS and engineers often dream of a vocational environment like this one but few achieve it. The staff shares this shop pin-up with readers; it's the headquarters of Technical Marketing Associates, Inc., Concord, Massachusetts

Everything reached the West Coast in good order, fortunately. We didn't mention it to Harold, but suppose he now wanted to move east; his number of copies is now nearly doubled.

▶ **DESK PROBLEM** . . . Engaged in a research project, a visiting engineer commented that our Industry Report each month provides him with much useful data.

His boss, however, is quite a stickler for maintaining clear desk tops. Our friend goes along with this completely for most of the material he handles. But his present assignment requires keeping a dozen or more open copies of ELECTRONICS on his desk top for ready reference at all times. What to do?

▶ **ANNUAL INDEX** . . . Industry Report articles are indexed cumulatively for the first time on p 30 of this issue. This step has been prompted by the number of telephone calls we get like this:

Voice on phone: "I read something on rising design costs in your magazine. What issue was it in?"

Editor (after a mad scramble through back issues: "That article was in Industry Report, for April."

Voice: "In Industry Report! No wonder I couldn't locate it in the general index."

Published monthly with an additional issue in June by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder, **Executive, Editorial and Advertising Offices: McGraw-Hill Building, 330 W. 42 St., New York 36, N. Y.** Longacre 4-3000. Publication Office, 99-129 North Broadway, Albany 1, N. Y. Donald C. McGraw, President; Paul Montgomery, Executive Vice-President; Joseph A. Gerardi, Vice-President and Treasurer; John J. Cooke, Secretary; Nelson Bond, Executive Vice-President, Publications Division; Ralph B. Smith, Vice-President and Editorial Director; Joseph H. Allen, Vice-President and Director of Advertising; J. E. Blackburn, Jr., Vice-President and Circulation Director.

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Single copies 75¢ for United States and possessions, and Canada; $1.50 for Latin America; $2.00 for all other foreign countries. Buyers' Guide $3.00. Subscription rates—United States and possessions, $6.00 a year; $9.00 for two years. Canada, $10.00 a year; $16.00 for two years. Other western hemisphere countries and the Philippines, $15.00 a year; $25 for two years. All other countries $20.00 a year; $30.00 for two years. Three-year rates, accepted on renewals only, are double the one-year rate. Entered as second-class matter August 29, 1936, at the Post Office at Albany, N. Y., under act of Mar. 3, 1879. Printed in U.S.A.

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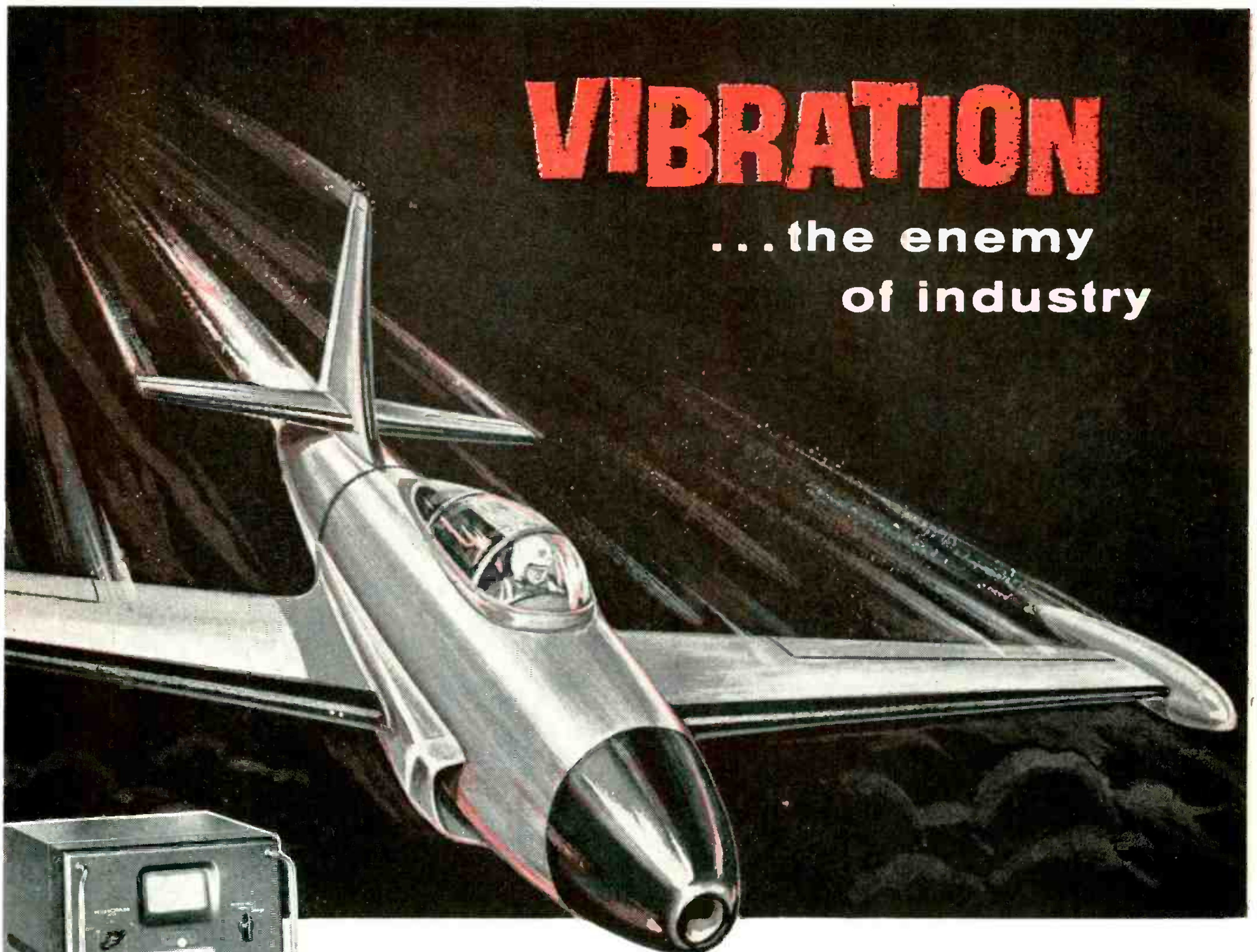

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The MUIRHEAD Wave Analyzer operates as a negative feedback, tuned band-pass filter insuring constant selectivity at all frequencies, and simplifying frequency selection. Output voltage is available at tuned frequency for viewing or recording.

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FEATURES

- No internal oscillator—eliminates drift
- R/C-tuned circuits—reduces hum and noise pickup
- Choice of 4 bandwidth characteristics: In-tune High, In-tune Medium, Narrow Band and ⅓ Octave.
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- Frequency range—19 c/s to 21 kc (extendable down to 2 c/s)
- Frequency Stability— ± 1 db over several days
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- Output Voltage—10 v
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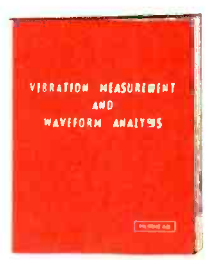
- Power Supply (external)—100/120 v, 60 or 400 cycles, 130 w
- Dimensions—12¾" x 13½" x 17½"
- Weight—55 pounds



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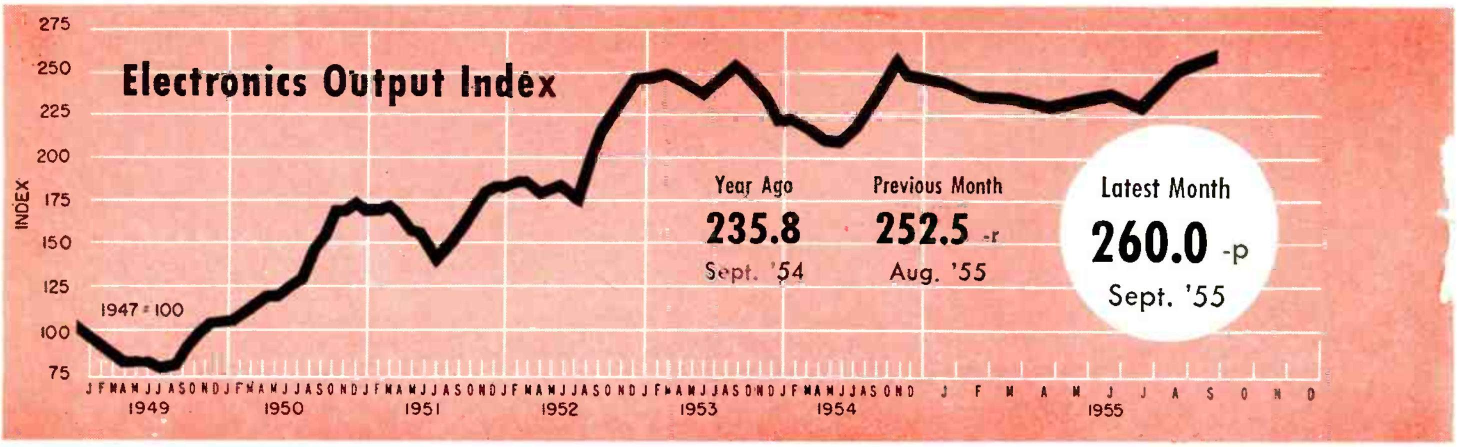


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month Sept. '55	Previous Month Aug. '55	Year Ago Sept.'54
Television sets, total ...	939,515	647,903	947,796
With UHF	140,022	105,673	136,613
Color sets	nr	nr	nr
Radio sets, total	1,302,350	947,634	932,323
With F-M	27,313	13,172	17,644
Home sets	417,802	300,513	352,499
Clock radios	234,106	137,604	207,226
Portable sets	139,164	106,197	76,271
Auto sets	511,278	403,320	296,327

RECEIVER SALES

(Source: RETMA)	Sept. '55	Aug. '55	Sept.'54
Television sets, units ...	978,838	586,577	986,136
Radio sets (except auto)	753,068	456,625	763,589

RECEIVING TUBE SALES

(Source: RETMA)	Sept. '55	Aug. '55	Sept.'54
Receiv. tubes, total units	47,588,000	45,238,000	40,966,063
Receiv. tubes, value....	$34,596,000	$33,099,000	$28,953,592
Picture tubes, total units	1,202,430	1,048,534	1,149,791
Picture tubes, value....	$22,867,851	$19,812,567	$23,892,469

SEMICONDUCTOR SALES

	Aug. '55	July '55	Aug. '54
Germanium diodes, units } Silicon diodes, units	1,700,000	911,000	1,150,000

INDUSTRIAL TUBE SALES

	Quarterly Figures		
	Latest Quarter	Previous Quarter	Year Ago
(Source: NEMA)	2nd '55	1st '55	2nd '54
Vacuum (non-receiving)	$8,933,453	$8,784,478	$9,851,020
Gas or vapor	$3,365,008	$3,747,490	$3,987,036
Phototubes	nr	nr	nr
Magnetrons and velocity modulation tubes ...	$13,193,395	$14,229,442	$16,429,553
Gaps and T/R boxes...	$1,677,574	$1,434,683	$1,914,313

TV SETS INSTALLED*

(Source: NBC Research Dept.)	Latest Month July '55	Previous Month June '55	Year Ago July '54
Total sets..............	36,477,000	36,100,000	30,717,000

BROADCAST STATIONS

(Source: FCC)	Oct. '55	Sept. '55	Oct. '54
TV stations on air......	473	473	431
TV stations CPs—not on air	110	108	147
TV stations—new requests	35	28	167
A-M stations on air....	2,788	2,771	2,627
A-M stations CPs—not on air	110	113	126
A-M stations—new requests	235	219	137
F-M stations on air....	539	538	558
F-M stations CPs—not on air	14	17	10
F-M stations—new requests	9	7	2

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Sept. '55	Aug. '55	Sept.'54
Aeronautical	44,183	45,203	40,695
Marine	52,908	52,440	47,360
Police, fire, etc.	19,153	18,877	16,109
Industrial	26,357	25,189	22,132
Land transportation	8,078	7,804	6,982
Amateur	139,628	138,852	121,762
Citizens radio	13,530	13,189	8,143
Disaster	319	319	305
Experimental	661	652	600
Common carrier	2,001	1,988	1,699

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Sept. '55	Aug. '55	Sept.'54
Prod. workers, comm. equip.	389,700-p	371,300-r	365,200
Av. wkly. earnings, comm...	$74.34 -p	$72.32 -r	$69.95
Av. wkly. earnings, radio...	$70.30 -p	$69.43 -r	$68.57
Av. wkly. hours, comm.....	41.3 -p	40.4 -r	40.2
Av. wkly. hours, radio.....	40.4 -p	39.9 -r	40.1

STOCK PRICE AVERAGES

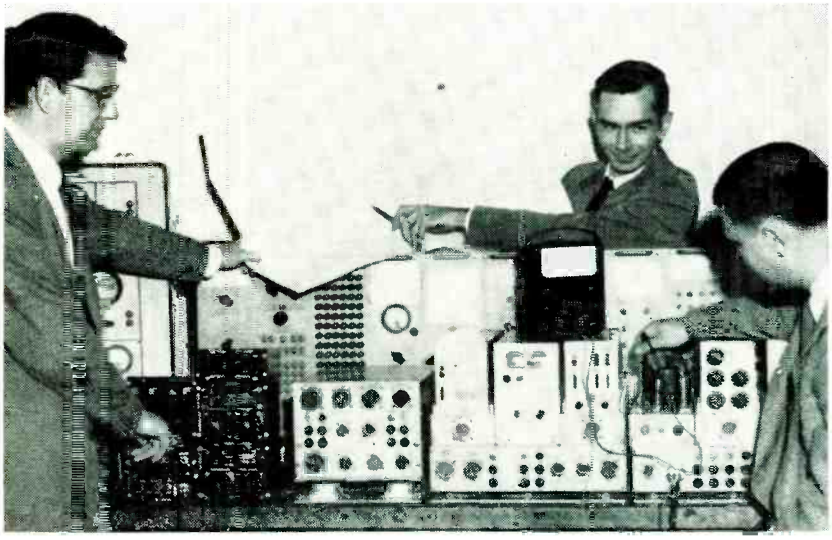
(Source: Standard and Poor's)	Oct. '55	Sept. '55	Oct. '54
Radio-tv & electronics	428.9	467.7	360.4
Radio broadcasters	486.9	537.7	400.7

p—provisional; r—revised
nr—not reported
*being revised in light of Census data

FIGURES OF THE YEAR

	TOTALS FOR FIRST NINE MONTHS 1955	1954	Percent Change	1954 Total
Television set production	5,760,506	4,733,315	+21.8	7,346,715
Radio set production	10,027,362	7,042,442	+42.4	10,400,530
Television set sales	5,149,997	4,645,063	+10.9	7,317,034
Radio set sales (except auto)	3,942,676	4,032,704	— 2.2	6,430,743
Receiving tube sales	347,668,000	266,050,907	+30.7	385,089,458
Cathode-ray tube sales	7,680,781	6,476,566	+18.6	9,913,504

U. S. Air Force Aerial Inspection Goes Robot



ELECTRONICS automatically controls photo settings and operation as . . .

Air Force uses computers to automatically adjust airborne cameras for best pictures

NEW automatic, electronic remote control system to operate aerial cameras in high-speed photo reconnaissance, developed by the Air Research and Development Command, is now used by the Air Force. The equipment, known as the Universal Camera Control System, (UCCS) can operate in flight without human attention. It eliminates the need for many camera controls and can be adapted to operate as many as 11 cameras.

▶ **How**—The heart of UCCS is a series of analog computers into which focal length, camera angles, film sensitivity, shutter, type of lens, ground speed and altitude information is set manually. After that, all operation is automatic and the system constantly adjusts the cameras for best pictures.

For night work, the system records when flash bombs have been released then calculates when each is to explode and works camera shutters accordingly. The equipment is built on a building block plan so that faulty electronic assemblies can be changed easily.

▶ **Who**—The Aerial Reconnaissance Lab at Wright ADC laid out the performance requirements and general electronic design of the system. The firms that developed and constructed the system are the Bill Jack Scientific Instrument Co., which did much of the development work, A. B. DuMont Labs, Chicago Aerial Industries and Fairchild Camera and Instrument Corporation.

▶ **Ike's Plan**—Practicality of aerial photographic inspection of military installations in both Russia and the U. S., as proposed by President Eisenhower, has been questioned by the U.S.S.R. But the value of the method has been upheld by both the U. S. government and private aerial survey firms.

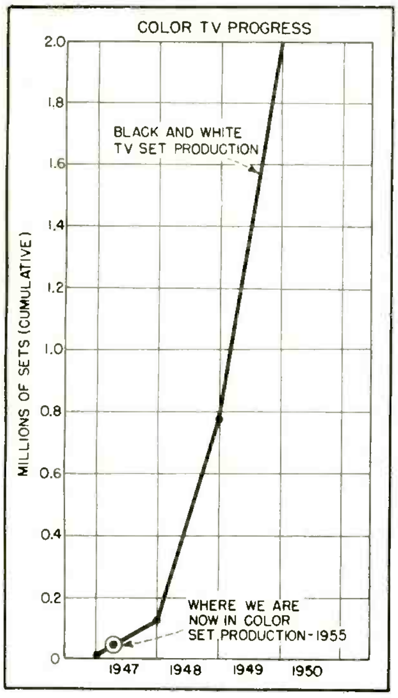
Photographic Survey Corp. of Canada has pointed out that even during World War II, aerial photos taken at 30,000 feet showed objects as small as 18 inches. Today, with the aid of electronics, a jet fighter ten miles above West Germany can photograph Czechoslovakia, Poland as far east as Warsaw, all of Hungary, as well as a large part of the western areas of Romania and the Ukraine.

Color TV Warms Up For Takeoff

Industry moves ahead in color planning and sales, but has a long way to climb

IN November, NBC, RCA and Westinghouse stepped-up their tv activities. The network announced a $12-million program to expand its color facilities in New York, Chicago and Hollywood, doubling its present live-color schedule of 40 hours monthly by the fall of 1956. It also announced that its station in Chicago, WNBQ, will be made an all-color tv station by April 15, 1956.

▶ **Tube**—Westinghouse announced



a $1-million program to buy equipment for the production of its new all-glass color tv picture tube which it feels will be ready for the market next spring.

▶ **Sets**—RCA reports a current sales rate of 1,000 color sets a week. A recent survey by the firm showed its distributors' color-set sales in individual markets. Its Cincinnati distributor reported that 68 color sets were sold during the World Series. Its Washington, D. C. outlet reported sales of 28 sets to consumers and 7 to public places during the first three weeks of October.

The RCA Philadelphia distributor, during the three-week period before, during and after the Series, sold 333 sets to authorized dealers who moved 109 to consumers and public places. In the Los Angeles area, 181 color sets were sold in a 10-day period before and during the Series.

▶ **Time**—Despite sizable gains being made in color-set production and sales, the industry has a long way to go to equal present black-and-white business. This is shown in the chart of present total color set output on black-and-white tv's time scale. On that basis, color tv now is about where monochrome was in mid-1947.

More Small Computers Appear

Prototype machine employs magnetic amplifiers. General purpose unit is desk size

MAGNETIC amplifiers have made their appearance in the electronic digital computer field. A business-type machine announced by Sperry Rand uses magnetic-amplifier units known as micro-feractors instead of electron tubes or transistors.

A prototype unit was built last June and models will be available early in 1957. It will sell for about $12,500.

Other computer designers, engaged largely in government work, are working on machines combining transistors and magnetic amplifiers. The transistors will provide the high-speed switching while the magnetic amplifiers will build up the necessary amplification for driving the ferrite-core memories.

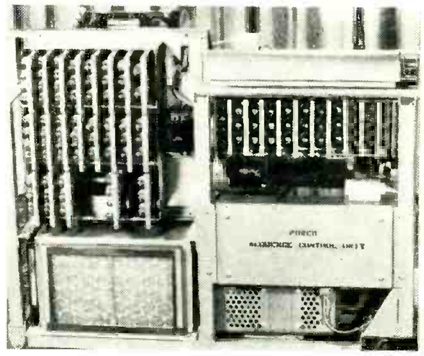
General Purpose—A desk-sized computer designed for engineering and scientific computation has been unveiled by Librascope of Glendale, Calif.

The machine has 16 basic orders. A library of subroutines is available. The magnetic-drum memory stores 4,096 30-bit words. The machine operates serially using single-address internal binary operation with fixed point.

Access time varies from 2 to 17 milliseconds. Clock frequency is 120 kc. Addition requires 0.26 milliseconds excluding access time; multiplication and division require 17 milliseconds. The machine consumes 1.5 kw; sells for $29,800.

▶ **New Company**—Boston's Laboratory For Electronics, makers of character recognition devices and other electronic equipment, is working on a general-purpose digital computer.

Through arrangement with British Tabulating Machine, LFE intends to have available a comprehensive line of data-processing equipment, it is reported.



Librascope general-purpose computer

▶ **Tandem**—In some government applications, any failure of data processing equipment could be disastrous. A new wrinkle is connecting two IBM model 704 computers in tandem with connecting equipment to enable one machine to act as a spare in the event of failure.

The model 704 is a large-scale digital computer especially designed for engineering and scientific computation.

Electronics Gains In Atomic Energy

Many companies move into the field as peacetime use of nucleonics gains ground

TWENTY percent of the exhibitors at the U. S. Nuclear Congress Exposition in Cleveland are in electronics. At the recent atomic exposition in Geneva in August and in New York in October nearly 40 percent of the exhibitors were electronics producers.

▶ **Equipment**—For many electronics firms now in the atomic field, instrumentation is the big business. It includes prospecting equipment, radiation monitoring instruments, instrument components, low-level anticoincidence counters, radiation spectrometers, pulse-height analyzers, and medical instruments.

But electronics manufacturers

(Continued on page 10)

Shown more than twice the actual size

Sylvania NPN Power Transistor 2N95 Exhibits

3½ times more gain

Operated at 1.0 amp emitter-current, the Sylvania 2N95 Transistor typically provides a current gain of 17 . . . 3½ times that of comparable types A and B. Even at 1.5 amp emitter current the 2N95 typically exhibits a high gain of 13 . . . in fact, as the curve shows, the Sylvania 2N95 provides the highest gain over the widest range of operating current conditions.

In addition, Sylvania's 2N95 combines all the important features you want in a power transistor, whatever your application. If, for example, yours is a switching application, the 2N95 offers high gain at high currents.

Designed for low thermal resistance, the Sylvania 2N95 Transistor provides dissipation up to 2½ watts without an external heat sink and up to 4 or more watts with a suitable heat sink. This insures stable operation in high ambient temperatures.

You compare

Check the Sylvania 2N95 against similar Transistor types yourself—for current gain as well as all of these important power Transistor features.

Does the Sylvania 2N95 offer—	answer
1. lower cost	yes √
2. low input impedance	yes √
3. low thermal resistance	yes √
4. high current switching	yes √
5. high current gain	yes √
6. mounting for air cool or heat sink	yes √
7. hermetic seal	yes √

A smaller version for heat sink mounting, the Sylvania 2N102 is also available with the above features.

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LIGHTING · RADIO · ELECTRONICS · TELEVISION · ATOMIC ENERGY are not only in instrumentation for the atomic field. Sylvania, for example, is producing reactor fuel elements. Others produce special electronic components for reactors. As much as $85,000 worth may be used in the typical small unit.

▶ **Potential**—It is estimated that a total annual volume of over $200 million in electronic equipment will result within the next ten years from the expansion of the peaceful use of atomic energy. In addition, there will continue to be considerable government and military business for the industry.

This volume will not be gained without increased expenditures for control and instrumentation research. According to the Atomic Industrial Forum, such spending will rise from the $106,000 of 1953 to $4.2 million by 1958.

It was pointed out that the industry does not know which type of reactor will prove superior in the near future. Consequently the development of control and sensing components will have to be approached on a piece by piece basis. For instrumentation components, however, design and development can proceed nearly unhampered because the general outline of the system is known.

Industry Plans Spending for '56

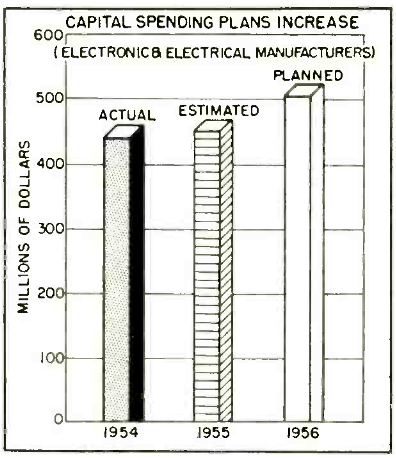
Companies schedule increased plant and equipment outlays, see increased sales

SPENDING for new plants and equipment next year by electronic and electrical machinery firms will be 13 percent higher than this year, according to a preliminary survey of business' plans for capital spending in 1956 by the McGraw-Hill Department of Economics.

Over $507 million will be spent by companies in the field in 1956 compared to $449 million this year and $439 million in 1954. Most of the firms surveyed believe that they will equal or exceed their 1956 spending in 1957. Some 62 percent of companies surveyed are planning about the same investment and 10 percent expect to increase plant and equipment investment in 1957.

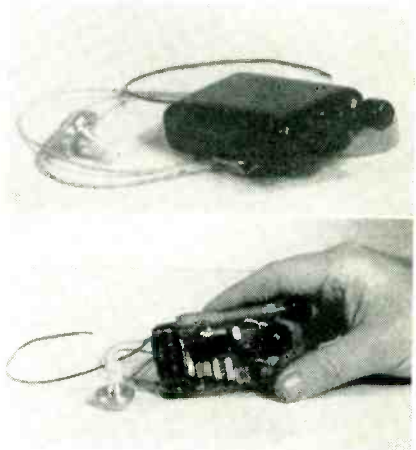
▶ **Sales Higher**—The survey also shows that electronic and electrical machinery firms expect sales in 1956 to be 7 percent higher than in 1955, explaining to some extent the reason for increased expansion. The sales increase equals that expected by industry as a whole. For individual industries the expected increases range from 2 to 12 percent.

▶ **Status**—Although spending in the electronics and electrical machinery industry will be up in 1956, plans are not yet equal to the peak expenditures made in 1953. Also, compared to all manufacturing the increase for the electronics industry is relatively small. Manufacturers as a whole plan to increase capital spending 30 percent in 1956. The largest increases are in primary metals, the chemical industry and the automobile industry.



▶ **Future**—Indications that plant expansion in the electronics and electrical machinery field will continue in 1957 show that the industry may not lose its expansion momentum. Although such plans are tentative now, in the past companies have usually added to their advance plans, as the target date drew near.

Wrist Radio Uses Three Transistors



Wrist radio, complete with earphone and a few inches of antenna

FULL advantage is taken of the inherent small size of the transistor in a wrist radio receiver just announced.

The receiver contains three transistors. One is employed as a regenerative detector and the other two comprise the audio stages. One control allows slug tuning from 550 to 1,600 kc and the other is a regeneration control.

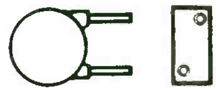
▶ **Operation**—Sensitivity of the receiver, designed by Linear Equipment Labs, Copiague, N. Y., is high. In the environs of New York City no antenna is needed for most stations. Six inches of wire is sufficient to pick up the weaker locals. At 30 miles from the city, one to three feet of antenna provides reception.

Mercury cells provide 6 volts to power the receiver. Total power input is 3 milliwatts.

Operation of the detector at the point of oscillation is different from that of vacuum tubes. No beat note is heard with the transistor detector of this receiver. Instead, circuit constants have been chosen so that oscillation takes place at a low pulse rate, similar to that of motorboating in an audio amplifier. The effect on the listener who misadjusts the regeneration control while tuning is much less disconcerting.

(Continued on page 12)

ceramic capacitors designed for mechanized assembly

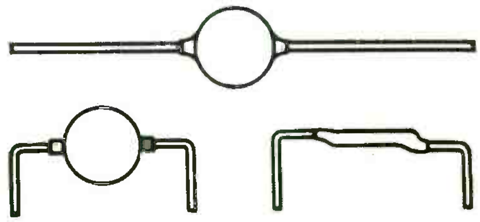


Pin Terminal Disc Ceramic Capacitors
The short, stiff terminals, 3/16" long, are accurately held to predetermined lead spacings. Closely controlled coating "pants" on the leads prevent resin from extending beyond the tangent line of the disc, yet no bare disc is exposed between leads. Available in bulk or in Tube-Paks.

NOW

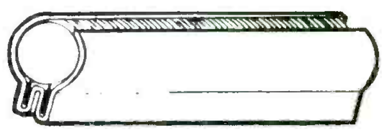
Just as Sprague pioneered in the automatic *manufacture* of capacitors, it now takes the lead in supplying these capacitors for automatic *insertion*. New ceramic capacitor configuration—with double-tinned leads and terminals spaced precisely to a tolerance of ±.005"—assures foolproof automatic insertion in printed wiring boards. New packaging means top efficiency in handling, testing, and feeding the capacitors. And whichever styles you choose, you benefit from the advanced manufacturing techniques . . . exhaustive quality control procedures . . . and priceless on-the-spot engineering counsel which have built Sprague's reputation.

Brief descriptions of the designs and packages are shown at right. Complete information is available on letterhead request to the Technical Literature section, Sprague Electric Company, 35 Marshall St., North Adams, Massachusetts.



Diametral Lead Disc Ceramic Capacitors
After tape loading in magazines by the manufacturer, these capacitors need only have their leads precut before automatic insertion.

Taper-Tab Terminal Disc Ceramic Capacitors
Flat terminals are designed to jam easily into chassis slots, holding capacitors firmly during subsequent assembly steps prior to dip soldering. Available in bulk or in Tube-Paks.



Tube-Pak★ Packaging
Up to 200 disc capacitors, pin terminal or taper-tab terminal, can be packed in each two foot long Tube-Pak. These slotted cylindrical magazines are a perfect fit for automatic insertion equipment now in use by several leading television manufacturers. Both types are plugged at each end before shipment.

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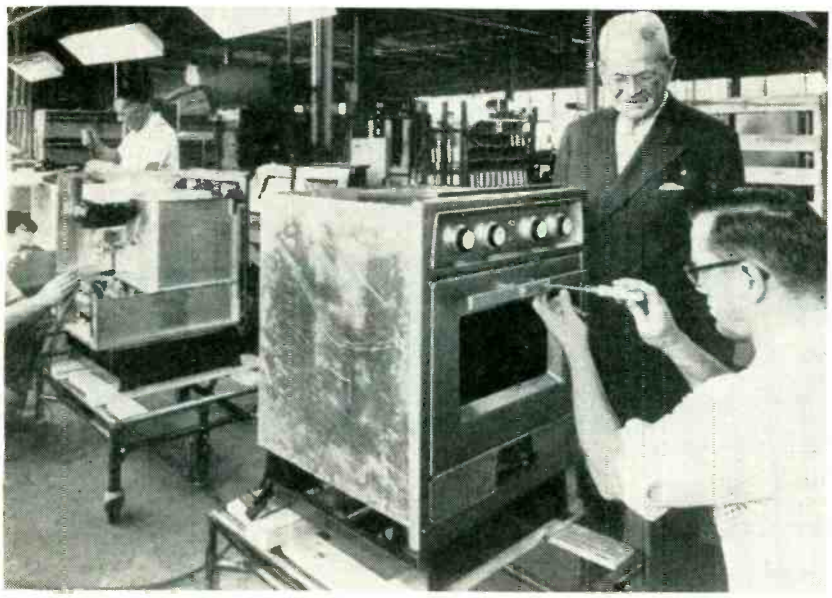


FIRST electronic range comes off the Tappan Stove production line as . . .

Home Cooking Goes Microwave

Units priced at $1,200 go on the consumer market. Plant expansion to boost output

MAGNETRONS started moving into home kitchens last month when the Tappan Stove Co. put a microwave range designed for home use on the market. The electronic unit was developed in conjunction with Raytheon which has had a commercial electronic range available for some time.

▶ **Features**—The range is offered by the firm as a built-in or stack-on type. It weighs 150 pounds and is about the same size as conventional built-in ovens. It incorporates an electric unit for browning, since microwave cooking cooks uniformly throughout and doesn't produce a hardened surface.

Temperature controls have been eliminated on the new range. The four controls are high and low speed selectors and individual timers for the microwave and browning units. The microwave timer is calibrated in seconds for the first three minutes of its settings because of the fast cooking speed. A potato can be baked in 5 minutes, a five-pound rolled rib roast in 30 minutes and a two-layer cake in six minutes.

The range operates on 220-volts with the same type of cable as an electric range. It requires no special installation or plumbing. The magnetron operates at 2,400 mc, a frequency assigned by FCC for microwave cooking. Power is supplied by a four-tube rectifier unit.

▶ **Market**—Although Tappan does not plan immediate nationwide distribution of the electronic range, it will be offered in Detroit and several other major markets this year. The introduction is being limited to enable factory service personnel and home economists adequately to train distributor personnel.

Although the price of the range is higher than conventional units, the cost of operation is lower, according to Tappan.

Tappan is allocating some of the space provided by a $300,000 plant expansion for increased electronic range production. GE plans to put its version of the electronic range on the market in 1956. Other major range makers including Westinghouse and Frigidaire are also expected to move into the field.

Small Business Gets More Air Force Work

Total of $20 million more in prime contracts went to firms with under 500 workers

AIR FORCE spending for electronic equipment totaled $350 million in fiscal '55. The Air Force spends more for electronics than any other armed service.

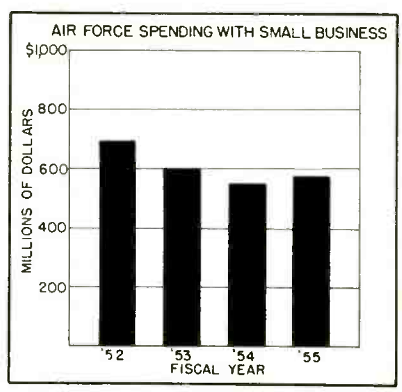
Small business firms, those having less than 500 employees, are getting more of this business. In fiscal 1955, small business was awarded $20 million more in prime contracts than in 1954. See chart.

Total awards were less than in 1953 and 1952 but an apparent downward trend has been reversed. The figures represent all Air Force awards to small business. A significant portion goes for electronics.

▶ **Orders**—During fiscal 1954, a total of 5,614 awards of over $10,000 were placed with small business for a total value of $425.2 million. In addition, $131.4 million was placed in orders under $10,000 to bring the grand total to $556.7 million. In fiscal 1955, 801,555 contracts and purchase orders were awarded worth a total of $576.8 million.

▶ **Reasons**—Air Force expenditures rose from $5.6 billion in 1954 to $6.1 billion for fiscal 1955. More of the equipment needed by Air Force in '55 could be produced by small business.

In 1954, it was estimated that



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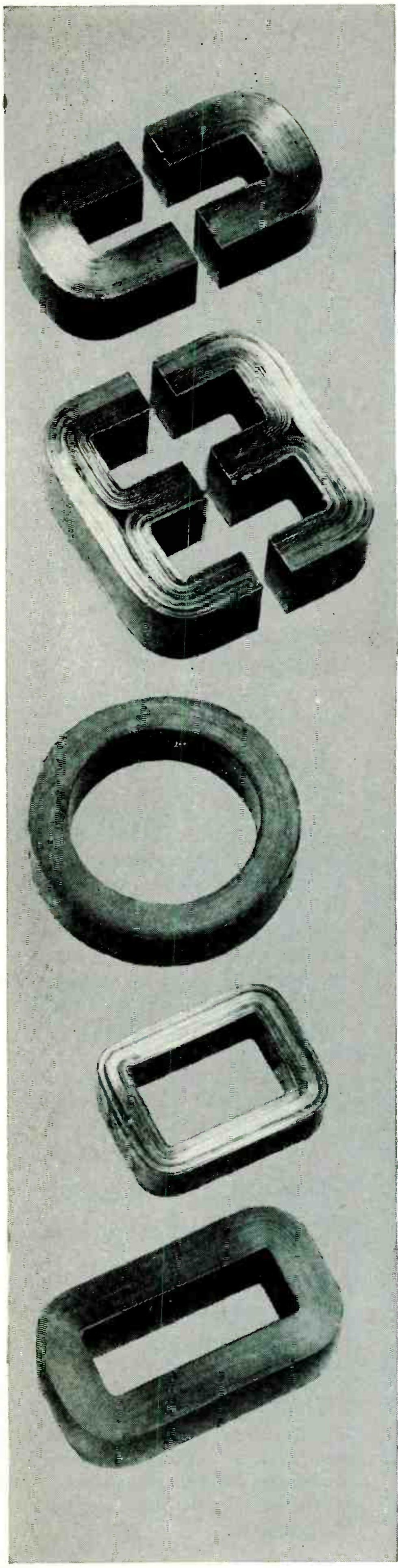

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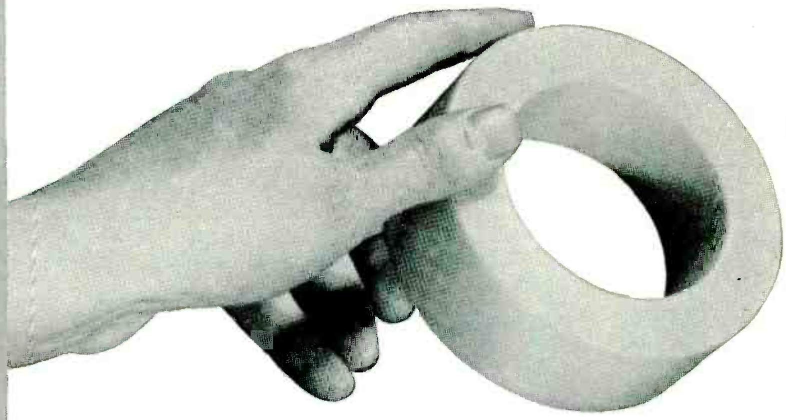

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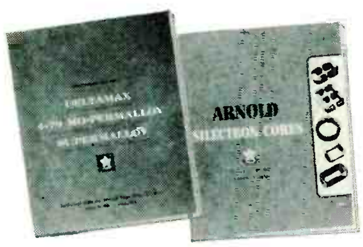

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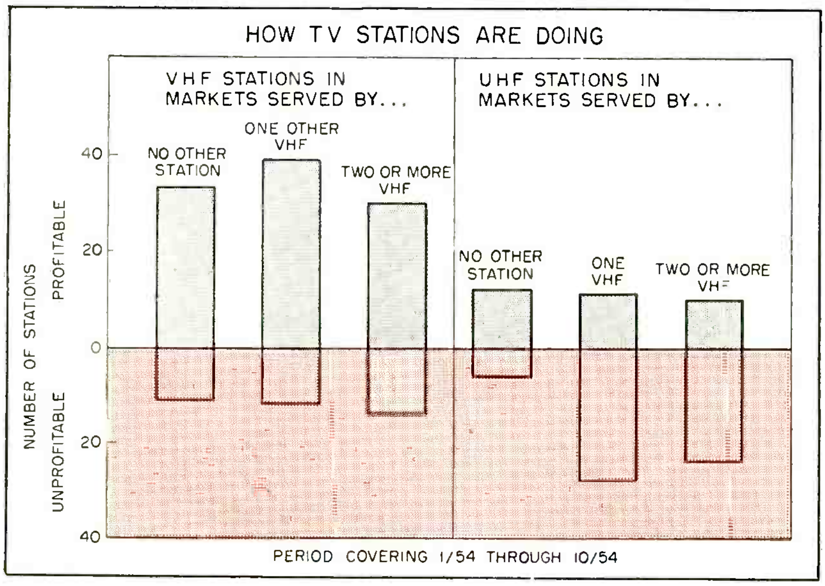
contracts worth $733 million could be handled by small business. For 1955 the figure was $755 million. When actual awards were made, 76 percent of the amounts in both years went to small business.

This was due to prices that were out of line, physical facilities that were inadequate, inability to meet delivery dates or no bids being received from small business.

▶ **More**—Along with the increased volume of Air Force prime contracts, small electronic businesses are receiving greater help in securing subcontracts. Large prime contractors have been active in supporting small businesses.

GE, for example, has a manufacturing services division to funnel orders to defense subcontractors and suppliers that have available production capacity. The government has asked large prime contractors to report periodically on the number of subcontracts awarded to small business.



FCC Looks At TV Competition

Survey of uhf and vhf stations shows effect of competition, population and programs

THIRD survey of post-freeze tv stations by FCC compared the profits of uhf and vhf stations. As shown in the chart, the number of unprofitable vhf stations increased with the number of vhf competitors. For uhf stations with vhf competition, the same thing happened only more so.

▶ **Losses**—In areas served by two or more vhf stations, 70 percent of surveyed uhf stations and 32 percent of the vhf stations covered had continuing monthly losses during the ten-month period of the survey. In areas served by one vhf, 71 percent of the uhf's and 29 percent of the vhf's were unprofitable every month. In single-station markets, 33 percent of the uhf's and 25 percent of the vhf's were in the red.

▶ **Other Factors**—In addition to competition, the size of the market and programs offered were important to the profit-loss picture. Over half of the vhf stations with continuing monthly losses were in communities with less than 75,000 population. As for the effect of network programs, the study showed that only 18 percent of the vhf stations that carried network programs in excess of 7.5 hours a week and 38 percent of uhf lost.

Electronic Gear Withstands Atom Blast

Communication equipment stands up under impact of 30-35 kiloton blast

DETAILED information released on the effects of atomic-blast exposure on commercial communication equipment indicates that it is generally much more resistant to nuclear effects than some typical residential structures.

A brick building located at a test point 4,700 feet from ground zero collapsed but a tv receiver, located in the same building, was still in operation without any servicing required.

▶ **Damage**—Mobile-radio antennas members were bent but still usable as a result of direct blast damage at the building location. Minor damage to coaxial cable coverings was caused by thermal radiation.

The plastic cases and knobs on tv sets and radios were cracked and chipped when struck by falling objects. However, performance was in no case seriously impaired.

Under blast conditions, whip antennas on mobile rigs showed a tendency to bend or break off where attached to the vehicle. Television receiving antennas were damaged beyond repair.

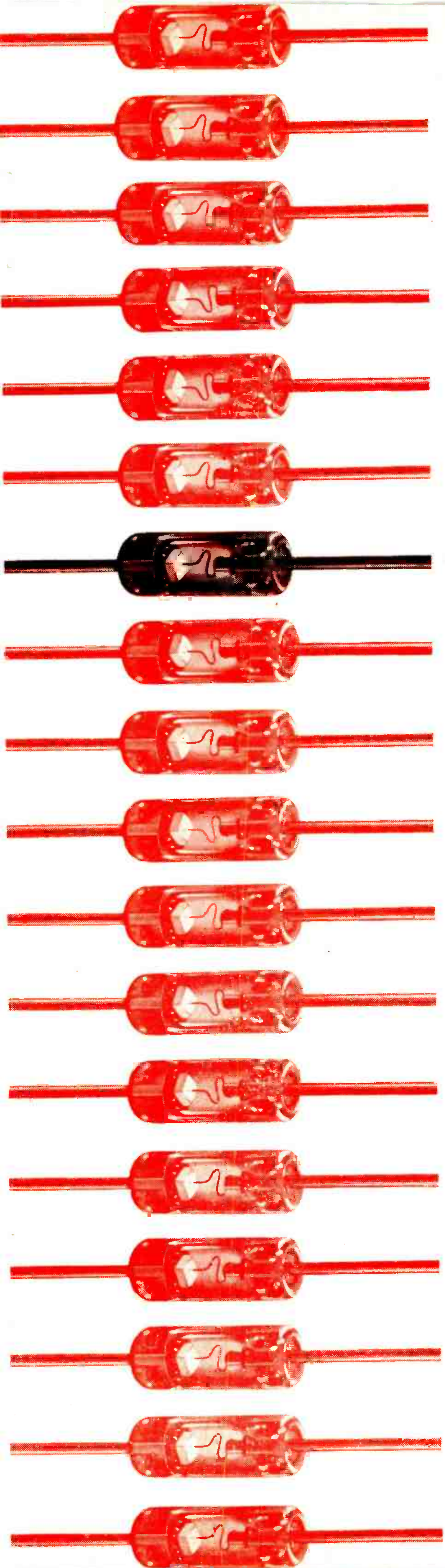
Outage of one a-m broadcast transmitter was due to the failure of the 60-cycle power supply.

Operations Research Gains In Industry

Some firms establish new departments; others retain consultants

APPLICATION of operations research is gaining ground in the electronics industry according to a survey reported at the operations research conference held in New York City by the Society for Advancement of Management.

(Continued on page 16)



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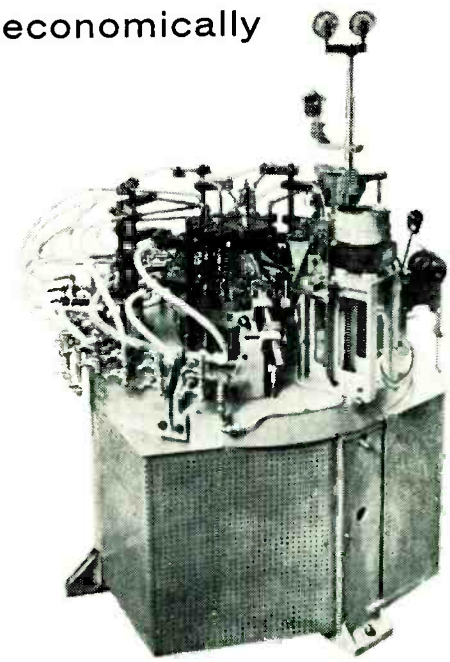

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▶**Survey**—Of 33 electrical and electronic firms queried, 22 replied. Twelve of the 22 companies now use operations research and have a total of 59 people assigned to the work. Six of the companies use consultants for operations research studies.

▶**Use**—Operations research was developed during World War II by the military. According to SAM, it helps executives predict the results of an operation under different sets of variable conditions. This provides a sound basis for decision-making and forecasting.

Operations research has been applied to marketing, determining radar reliability, blending raw materials, scheduling of personnel, industrial communications, budgeting, financial incentives, transportation, traffic, allocation of sales effort and production and inventory control. Operations research has boosted use of electronic computers in business and industry.

Personal Paging Business Advances

Potential market seen for thousands of tiny vhf receivers and 200 transmitters

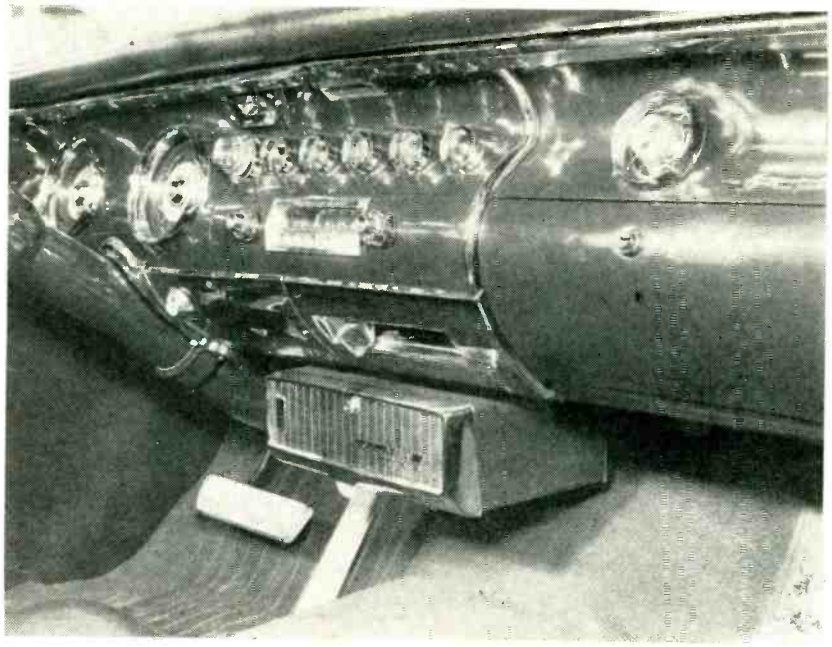
PHYSICIANS, delivery services and repair crews are finding radio paging essential in their work.

The paging transmitter continuously broadcasts numbers assigned to the individuals paged until the person calls into the office by telephone.

Signals are received on a pocket-size vhf receiver. Transmitters operate on 35.58 or 43.58 mc and cost about $2,000. The paging service usually operates on a subscription service with each subscriber paying $12 to $15 a month.

▶**Operators**—A paging service is in general an outgrowth of telephone answering services. There are currently 50 to 100 services with an estimated total of 4,000 receivers.

Potential market at present is about 200 transmitters.



RECORDS can now be heard while traveling as . . .

High-Fidelity Hits the Road

Automobile record players introduce new style and disk standards and open new market

FOR $80, any owner of a 1956 Chrysler Corp. automobile may have his car equipped with a newly developed record player that mounts under the car's dashboard. The player's pickup arm will track the record under all road-operating conditions . . . short of a collision.

Each player is supplied with six records. Additional records can be purchased for $2.50 to $4.95.

▶**Technical Details**—The record player was developed by CBS-Columbia Laboratories. It operates at $16\frac{2}{3}$ rpm from 18 v 60 cps, which is converted from 12 v d-c cps by a vibrator power supply.

The pickup cartridge is of ceramic and is mounted in a counterbalanced arm that concentrates the mass at the pivot point. The cartridge is fed into the car's radio.

Records are 7 inches in diameter and are cut with 550 to 700 groves per inch depending on whether music or speech is recorded. (LP records have an average groove pitch of 235 lines per inch.) Playing time of the records varies from 20 to 40 minutes per side depending on the groove pitch.

The fine grooves of the 7-in. record require a stylus with a 0.3-mil tip radius, ten times smaller than that used with conventional 78-rpm records.

▶**Other developments**—A German portable, distributed by Chemtron Industries, Inc., N. Y. features a-m/f-m reception and a built-in 45-rpm record player. The unit operates from 110/220 v a-c or from self-enclosed batteries. The rec-

A-M/F-M radio has built-in 45-rpm record player

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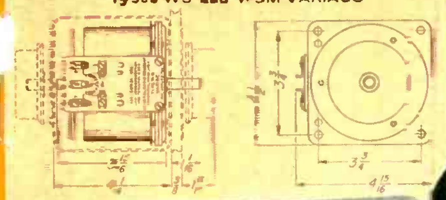

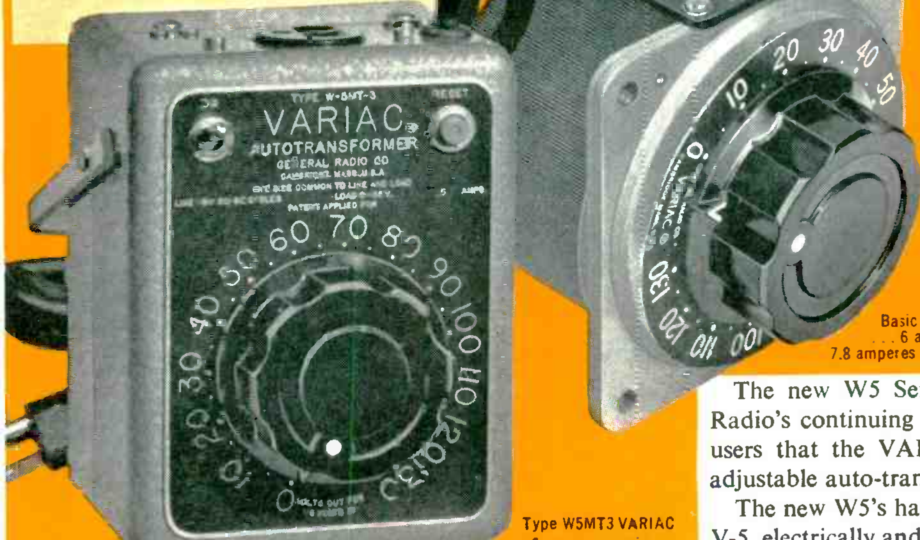

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with Overload Protection

Basic Type W5 VARIAC . . . 6 amperes rated and 7.8 amperes maximum current (0.90 kva)

Type W5MT3 VARIAC . . 6 amperes maximum . . . 5 amperes rated current . . . light weight, provided with carrying handle, overload protection, line switch, convenience outlet, 3-wire grounding cord and plug (W5MT is identical except 2-wire line cord is used)

The new W5 Series VARIACS are another step in General Radio's continuing research and development program to assure users that the VARIAC will always be the best continuously-adjustable auto-transformer available anywhere in the world.

The new W5's have many improvements over the popular Type V-5, electrically and mechanically and in operating convenience.

Type W5M VARIAC, panel mounted . . . four screws in corners of square base

Fixed-type manually reset thermal overload breaker provides protection from prolonged overloads

Type W5M VARIAC . . . 6.5 amps maximum . . . 5.0 amps rated current . . . completely enclosed . . . for wall, bench, panel or behind-panel mounting . . . aluminum gray Hammertone finished cases with four conduit knockouts

Some Features Are:

Basic W5 model has 20% Increased Power Rating

Drawn Wrought-Aluminum Square Base, Designed for Excellent Heat Transfer . . . much more rugged . . . will withstand MIL-T-945A Shock and Vibration Tests

Improved Brush Radiator . . . setting of radiator and brush independent of position of shaft . . . disc-type radiator completely covers and protects Duratrak brush track

Enclosed single and ganged models in industrial-type rectangular cases . . . can be panel, behind panel, wall or table mounted . . . conduit knockouts conveniently located . . . all mounting hardware included

Same mounting holes as all V-5's plus additional mounting holes in each corner of square base for convenience and extra rigidity. In most cases can be substituted directly for V-5's.

INPUT Volts	OUTPUT KVA	Volts	Amperes Rated	Max.	Type	Price	Description
115	0.90	0-115 0-135	6.0 6.0	7.8 6.0	W5	$17.00	Uncased
115	0.75	0-115 0-135	5.0 5.0	6.5 5.0	W5M	21.50	see footnote A
115	0.69	0-115 0-135	5.0 5.0	6.0 5.0	W5MT	26.50	see footnote B
115	0.69	0-115 0-135	5.0 5.0	6.0 5.0	W5MT3	28.50	see footnote C
230*	0.60	0-230 0-270	2.0 2.0	2.6 2.0	W5H	19.00	Uncased
230*	0.60	0-230 0-270	2.0 2.0	2.6 2.0	W5HM	23.50	see footnote A
230*	0.55	0-230 0-270	2.0 2.0	2.4 2.0	W5HMT	28.50	see footnote B

*The 230-volt models can be used on 115-volt lines. When so used, the 0-270 volt output range is limited to a rated and a maximum current of 1 ampere.

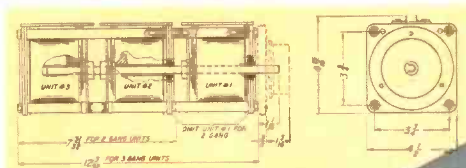
A Completely enclosed with conduit knockouts

B Bench model with 2-wire line cord, line switch, outlet, overload breaker and carrying handle

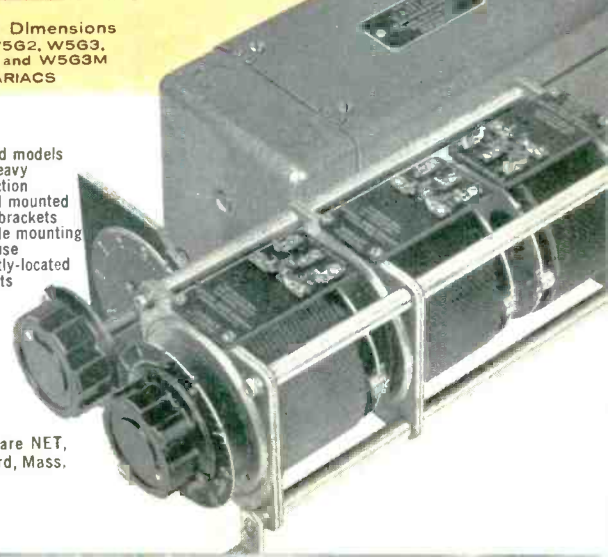
C same as (B) except 3-wire grounding line cord and 3-terminal plug

Type W-5 VARIAC Assemblies

Type	Description	Price
W5G2 W5G2M	*2-Gang W5* *2-Gang W5 completely enclosed with conduit knockouts*	$41.00 49.00
W5G3 W5G3M	*3-Gang W5* *3-Gang W5 completely enclosed with conduit knockouts*	61.00 69.00
W5HG2 W5HG2M	*2-Gang W5H* *2-Gang W5H completely enclosed with conduit knockouts*	45.00 53.00
W5HG3 W5HG3M	*3-Gang W5H* *3-Gang W5H completely enclosed with conduit knockouts*	67.00 75.00



Essential Dimensions
Types W5G2, W5G3, W5G2M and W5G3M VARIACS



Three-gang cased models showing extra-heavy internal construction . . . can be panel mounted . . . 4 mounting brackets provided for table mounting or vertical wall use . . . 8 conveniently-located conduit knockouts

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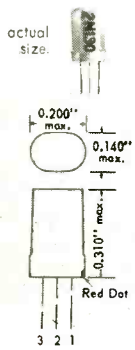
Raytheon's new Semiconductor Division Plant at Newton, Mass.

With this $3,000,000 plant Raytheon now utilizes approximately 180,000 square feet of space for semiconductor research, engineering and manufacturing activities.

Not only in better supply, but of the highest quality, uniformity and reliability. *All are PNP Germanium Transistors hermetically sealed.*



SUBMINIATURE LOW FREQUENCY TRANSISTORS

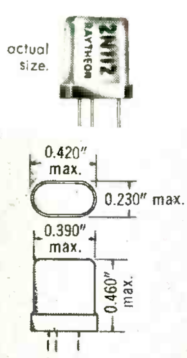
Type	Collector Volts	Collector Meg. ohms	Collector Cutoff μA	Emitter Current mA	Base Resistance ohms	Base Current Ampl. Factor	Max. Noise Factor db	Alpha Freq. Cutoff mc.
2N130	−6	2.0	6	−1.0	350	22	25	0.6
2N131	−6	2.0	6	−1.0	700	45	22	0.8
2N132	−6	2.0	6	−1.0	1500	90	20	1.2
2N133	−1.5	1.0	6	−0.5	700	45	10	0.8
new **2N138**	−6	2.0	6	−1.0	1800	140	25	1.2

RAYTHEON TRANSISTOR FIRSTS

FIRST company to make point contact transistors commercially available — in late 1948.

FIRST to mass produce germanium junction transistors — in late 1952.

FIRST to mass produce fusion-alloy RF transistors — in late 1954.



HIGH FREQUENCY TRANSISTORS

Type	Collector Volts	Collector Cutoff μA	Emitter Current mA	Extrin. Base Resis. ohms	Base Current Ampl. Factor	Alpha Freq. Cutoff mc.	Coll. Capac. μμf	Gain at 455kc db	Gain at 2 mc db	Rise time* μsecs	Decay time* μsecs
new **2N111/CK759**	−6	1	−1.0	50	25	3	12	33	18	—	—
2N112/CK760	−6	1	−1.0	55	40	5	12	35	20	0.05	0.06
2N113/CK761	−6	1	−1.0	60	65	10	12	36	22	0.04	0.05
2N114/CK762	−6	1	−1.0	75	100	20	12	36	25	0.02	0.03

*measured in circuit which will be supplied on request

Note: above characteristics are average except where noted

RAYTHEON TRANSISTORS

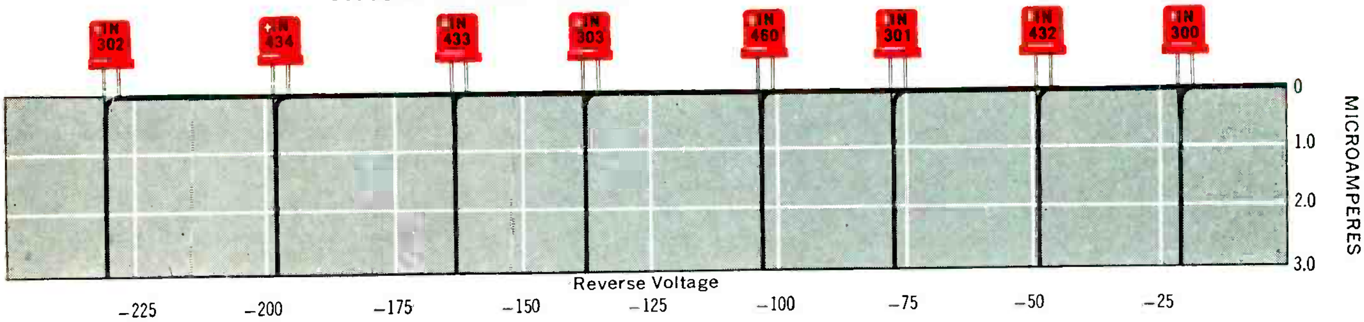
more in use than all other makes combined

RAYTHEON *Presents . . .*

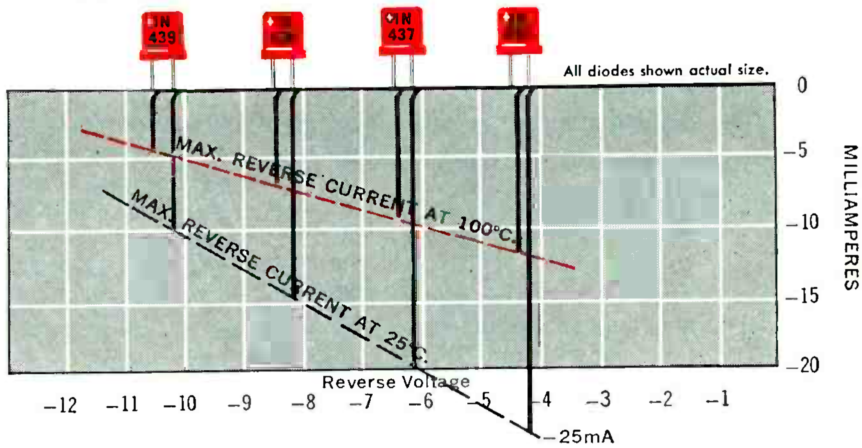
A COMPLETE LINE OF

Bonded Silicon Diodes

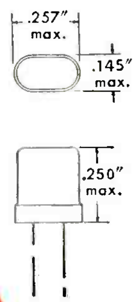
TYPICAL REVERSE VOLTAGE CHARACTERISTICS AT 25°C.



TYPICAL REFERENCE DIODE CHARACTERISTICS



Raytheon Bonded Silicon Diodes provide low reverse current and good stability at high temperature. Every diode receives four temperature cycles of one hour at −55°C and one hour at +150° C, followed by thirty-six hours at 95% relative humidity and 70°C. Exact characteristics are maintained after temperature cycling and stability remains excellent over long periods.



Type	Peak Inv. Volts	Min. Forward mA at +1.0V	Max. Reverse μA at Volts	
1N300	15	8	0.001	−10
1N432	40	10	0.005	−10
1N301	70	5	0.05	−50
1N460	90	5	0.1	−75
1N303	125	3	0.1	−100
1N433	145	3	0.1	−125
1N434	180	2	0.1	−150
1N302	225	1	0.2	−200

Above ratings at 25°C

RAYTHEON

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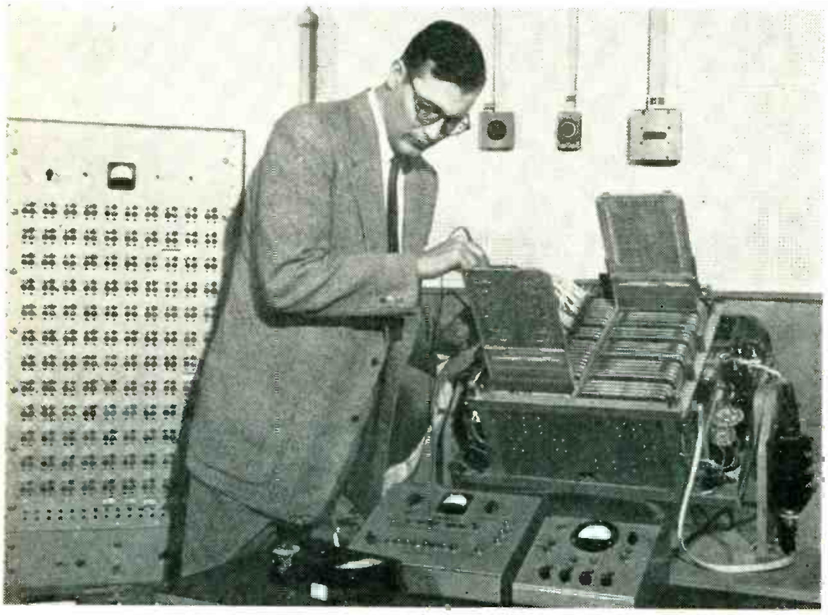
RAYTHEON MAKES ALL THESE:

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

Want more information? Use post card on last page.

ord player operates from the batteries too. European-type tubes are used.

Battery or a-c line operation is also a feature of a new RCA Victor portable radio and 45-rpm record-player combination now on the market.



SMALLER lighter equipment, like this airborne digital computer, is developed as . . .

Transistors Gain In The Military

Airborne digital computer and underwater torpedo control operate without tubes

ELECTRON tubes have been replaced by transistors in an Air Force airborne digital computer and in a Navy ultrasonic torpedo control system.

▶ **Airborne**—The computer, developed and flight tested by North American Aviation for the Air Force, uses some 1,000 transistors and etched circuits. It takes up only three cubic feet of space and weighs 125 pounds.

An electron-tube computer with half the capacity would be four times heavier and would take the space of an average closet. The computer uses less than 100 watts compared to about 3,000 watts for an electron-tube counterpart with only half the capacity.

The etched and transistorized circuits in the unit are designed in the form of 51 standardized panels for reliability and quick servicing. The panels can be pulled out like file cards for testing and replacement. The computer can continuously integrate 93 quantities simultaneously and generate continuous solutions of differential and trigonometric problems.

▶ **Underwater** — Developed by Westinghouse research laboratories for the Navy's Bureau of Ordnance, the new ultrasonic torpedo control is fully transistorized. The transistors can operate directly on the low voltage of the torpedo battery. This eliminates the need for a separate source of power and makes the system more simple and compact. The total power required for the control using transistors is only about one-tenth that of an equivalent electron-tube control. With transistors the warmup time of 30 seconds or more needed for electron tubes is eliminated. The transistorized torpedo is ready for instant operation.

Why Television Sets Are Failing Today

Tubes and capacitors lead as troublemakers; average is down to 1½ service calls

WITH the average number of service calls per tv set settling down to around 1½ per year, as compared to 6 or more in the early postwar days, the causes of trouble change also.

Percentage figures compiled five years ago (Why Television Receivers Fail in Service, ELECTRONICS, p 66, July 1950) are summarized in the accompanying tabulation for comparison with the 1955 year-end picture for representative service organizations.

Reason for Service Call	1955	1950
Replace regular tube	60	28
Replace picture tube	2	6
Repair antenna system	2	14
False call	1	13
Replace paper capacitor	9	4
Replace electrolytic	3	1
Replace selenium rectifier	2	—
Replace resistor	6	6
Repair or replace tuner	3	8
Replace other component	6	6
Repair regular connection	3	4
Repair etched wiring	1	—
Realignment and adjustment	2	12
Total	100%	100%

▶ **Trends**—Although tube performance in tv sets is much better today, the tube percentage figure is up for two reasons: the tube failure rate is still highest for the first few months, hence tube troubles run high in factory service organizations where many repair jobs are within the 90-day warranty period; and independent servicemen tend to replace weak tubes hoping the resulting higher gain will offset the circuit defect and avoid pulling the entire chassis. Where organizations train servicemen to repair only the primary cause of trouble, the tube percentage drops to approximately 35 percent.

With the almost complete demise of the service contract, false calls have just about vanished. However, with around 60 percent of its calls still made under service contracts, RCA Service Co. reports 4 percent false calls.

Although millions of antennas are now well over five years old,

(Continued on page 22)

JACK & HEINTZ MODEL 50127-000 CONTROL PANEL

PHOTOS COURTESY OF CONVAIR AND JACK & HEINTZ.

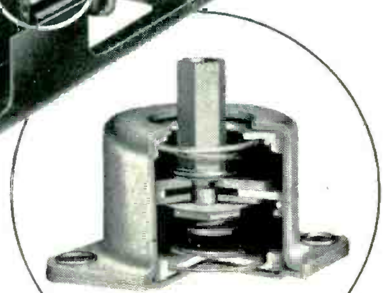
ALL-ANGL Barry Mounts give sure protection

Jack & Heintz proved this in testing mounts to protect their Hi-Phase voltage regulators and control panels for Convair's supersonic F-102A interceptor.

No other miniature isolator tested could meet Procedure I of MIL-E-5272A. ALL-ANGL Barry mounts exceeded life-test requirements.

And the ALL-ANGL works in any position— to give sure protection for vital controls through every twist, turn, and dive in the aircraft's most violent maneuvers.

Write for Data Sheet J-11. And for your airborne requirements to meet standard MIL specifications, ask about All-Metl, Air-damped, and special Barry mounts.



Miniature All-Angl Barry Mount

Here's the mount that meets the new needs of today's jet aircraft and missiles — where equipment must have greater protection against shock and high-frequency vibrations — and where MIL-standard mounts prove inadequate.

BARRY CONTROLS incorporated 707 Pleasant St. Watertown 72, Mass.

New engineering opportunities are open in Barry's expansion program, at all levels in all departments. Send resumé.

increased sensitivity of new sets may be one factor covering up gradual deterioration in antenna and transmission-line insulation.

One independent serviceman summarized his experience this year in one sentence: "Half the troubles are tubes and the other half are in the horizontal sync system."

Tube Machine Makers Stack Up Big Year

New plant expansions for increased tube output has upped machinery sales

GROWING production of all types of tubes has increased the business of the industry's tube machinery makers. One firm estimates that sales in the field this year will top $20 million.

▶ **Why**—A look at the plant expansions of the industry's tube makers so far this year indicates the reason for increased business. In the first 10 months of the year a dozen tube firms have announced new plant construction.

In the past month, two tube makers announced extensive expansions. Sylvania will construct a 110,000 sq ft receiving tube plant and Westinghouse has placed orders for $500,000 worth of new equipment, primarily exhaust machines, for color picture tubes.

▶ **Types**—Most of the production equipment sold so far this year has been for picture tubes and special-purpose tubes. The machinery market for standard receiving tubes has dropped in importance and consists mainly of replacement business.

▶ **Firms**—There are some 15 manufacturers of tube machinery. Among the largest producers are several tube manufacturers themselves. They build machinery for their tube licensees and for themselves. But most of the companies are independent machinery firms, some specializing solely in equipment for the electronics industry.

Research Heads For Billion Mark

Investment in research and development will rise as the industry's volume climbs

SPENDING for electronics research and development will reach a billion dollars a year in the next decade if present spending and sales rates continue.

Currently, the industry spends approximately 6 percent of its total sales on research and development. This figure is indicated by an analysis of the expenditures of 13 firms in the field and by a government survey of research in electronics and electrical machinery firms.

▶ **Companies**—Present importance of research in the industry has been indicated by recent statements of firms in the field. It was also pointed up at the American Management Association's special conference on managing product research and development.

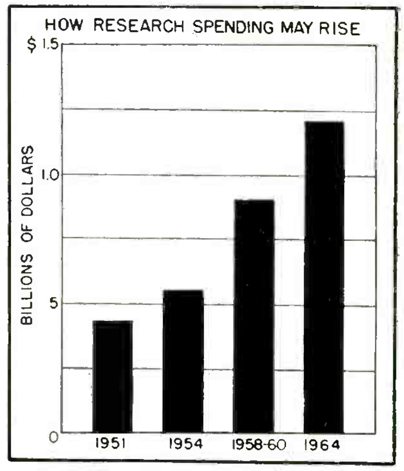
RCA recently estimated that 80 percent of its business in 1955 will be in products and services introduced on the market during the last ten years.

IBM has indicated that it now spends about 4 percent of its gross on research and development. In its accounting and data processing division there are about 2,100 people working on development.

GE indicates that its Electronics Division's laboratory has a budget of $3.6 million. The laboratory has the following subdivisions: engineering analysis, semiconductors and solid state, thermionics, dielectrics and magnetics, advanced circuits, communication and computers, video circuits and display, microwave and radar, application engineering.

Remington Rand had a total of 75 people working on Univac five years ago. It now has approximately 500 in the division's engineering research and development group alone.

▶ **Budget**—Consolidated Engineering increased research and devel-



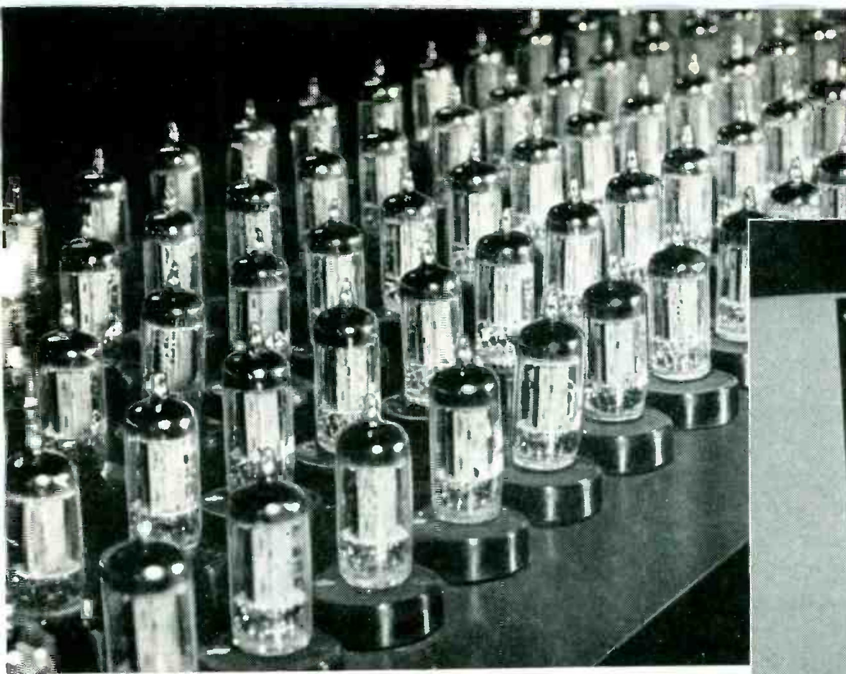
opment expense from $165,502 in 1946 to $1.7 million in 1954, according to AMA. In the same period, sales increased from $925,-787 to $15.7 million. The firm allocated research and development expense as follows: 21.5 percent for improvement of released products; 24.7 for product design; 35.9 for product development; 13.2 for applied research and 4.7 for studies and service. Its research and development expenditures are normally set at 10 to 12 percent of predicted sales for the next year.

Varian Associates has announced that it plans to up its research expenditures and plans to spend $500,000 on new product research this year.

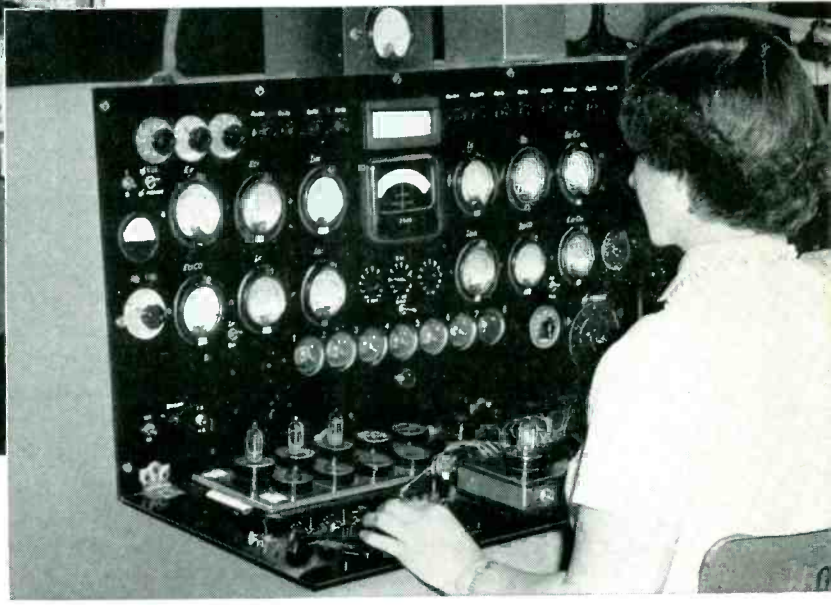
▶ **Shortages**—Growth of research in electronics is also indicated by the shortage of research personnel. A survey by the Department of Labor showed that in the electronics and electrical equipment industry, three-fifths of the surveyed companies reported shortages of scientists and engineers.

All the firms with shortages said that this was impeding their research and development programs. Several manufacturers of electronic equipment stressed that their shortage of research engineers and scientists was extremely acute. One of the companies had been able to fill only half the budgeted research positions.

(Continued on page 24)



LEFT: G-E computer tubes undergo a cut-off life test. The tubes are operated for long intervals with their grids biased to cut-off. Periodically the tubes are given a cathode interface check, to make sure no "sleeping sickness", or failure to respond to changed grid voltage, has developed during inactivity.



RIGHT: extensive instrumentation is used to test tube electrical qualities that closely affect operation in computer circuits. Zero-bias plate current; cut-off performance; any difference in cut-off between twin-triode sections—these are three of many characteristics checked.

G-E Computer Tubes are specially tested for qualities that safeguard computer reliability!

General Electric pioneered special tubes for computers . . . also developed tests such as those above, which assure that G-E tubes in your computer circuit can be relied on to meet designers' aims in all respects.

The tests are specific in purpose. Each covers one or more tube characteristics important in computer use, and which closely influence the accuracy and reliability of the equipment.

There is no substitute for G-E computer-tube quality, which starts with special tube design—extends through precision manufacture—concludes with exhaustive tube tests that relate directly to computer service.

Also . . . there is no counterpart to G.E.'s range of special computer tubes *now in production.* You have a choice of proved G-E types available for your present circuit needs, with new tubes constantly being added.

Ask for "G-E Computer Tubes And Their Applications" (ETD-1140). 54 pages—just off the press. A book every designer and builder will find useful! *Tube Department, General Electric Company, Schenectady 5, New York.*

* * *

● G-E computer-tube development is a continuing process, with new types being added regularly for faster, more advanced equipment, or to meet special customer requirements where volume warrants. Five types—proved, popular—already are in full production:

GL-5844 **GL-6211**
GL-5965
GL-5915A **GL-6463**

Progress Is Our Most Important Product

GENERAL ELECTRIC

162-1C

Subminiature Relay Makers Grow

More relay makers widen lines to include the small units for military use

In the past two years, the number of relay manufacturers in the subminiature field has more than doubled. Today there are about 35 relay manufacturers who produce subminiature relays while in 1953 about 15 firms were in the field.

Main reason for the trend to miniaturization in relays, as with many other components, is that weight and size considerations are becoming increasingly more important in military equipment, particularly airborne gear, the principal market for the units.

▶ **Market Survey**—One of the latest entrants into the subminiature and miniature relay field is Elgin National Watch Co. which has acquired two relay firms. In making its move into the field, it surveyed the market.

Elgin estimates 85 percent of the miniature and subminiature-relay business is accounted for by the military and aviation markets; 10 percent by the industrial market and 5 percent by the commercial equipment market.

Because of the trend toward greater use of business machinery and toward automatic production in industry, use of small relays in industrial and commercial lines is expected to increase considerably in the next 5 to 10 years. It estimates the military and aviation market will account for 50 percent of small relay output; the industrial field, 35 percent and the commercial field, 15 percent.

▶ **Size Defined**—In differentiating between miniature and subminiature relays, Elgin defines the miniatures as those that have a volume of approximately 1 to 3 cubic inches and subminiatures as those with a volume of less than 1 cubic inch.

Electronics Grows In Business

Intercoms and dictating machines take the spotlight at Business Show

Growing use of electronic equipment in the nation's business offices was mirrored at the National Business Show in New York City. Over 25 companies displayed electronic gear ranging from dictating machines to facsimile equipment. Electronic computers were not shown this year.

▶ **Dictation**—Trend toward greater use of multiple dictating systems was evident. Up to 20 phones can be connected to a single recording unit. One manufacturer estimates that it is adding more than 1,000 new users a month. The price of the equipment is roughly ⅓ the price of individual dictating instruments.

Indications are that the systems can cut dictation costs by nearly 50 percent. A net saving of almost $15,000 was made by one user with 20 stations and 4 recorders. Annual savings of over $24,900 are expected when the system is expanded.

▶ **Intercoms**—Estimates based on Department of Commerce figures place the annual value of intercommunication equipment shipments in the range of $20 to $30 million, more than double 1947 shipments of $9.9 million. A substantial part of this volume is accounted for by the office equipment field.

▶ **Future**—Intercom and dictating machine firms see expanding sales ahead for the equipment. They feel that the vast market of over 4.1 million business establishments in the U. S., not counting individual offices, has hardly been scratched.

As for future equipment design changes, indications are that more dictation and intercom equipment may be combined in a single unit. A few companies already have such dual phone-dictation and intercommunications systems available.

Television Girds For New Markets

Vidicon tube prices are lowered. Low-priced tv station is demonstrated

Sales help for expanding television applications was indicated recently when RCA announced lower prices on two vidicon tubes and Dage demonstrated a complete tv broadcasting station costing less than $50,000.

▶ **Tubes Drop**—Suggested resale prices were reduced from $315 to $230 on vidicon type 6198 which is used for industrial television applications. Type 6326, used in black-and-white and in color tv broadcast film cameras, was reduced from $565 to $515. According to RCA, the reductions were made possible by substantial savings in manufacturing costs.

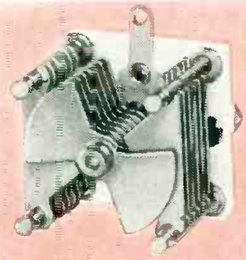
▶ **Low Power**—The Dage station is designed for communities of less than 50,000 population. It is adapted from one developed by the firm for military installations overseas where stations now in operation include those in the Azores; Deflavik, Iceland; Thule, Greenland; and Bermuda.

The equipment meets the requirements of the recent FCC change in tv rules reducing the minimum required power of tv stations in small communities to 100 watts and eliminating any requirements as to antenna height.

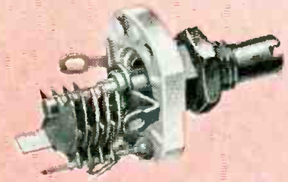
▶ **School Circuit**—Dage also demonstrated a plan to transmit audio-visual programs to schools via closed-circuit tv based on the use of a central point to originate all audio-visual activities. A three-

(Continued on page 26)

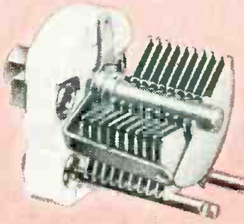
For VARIABLE CAPACITORS...



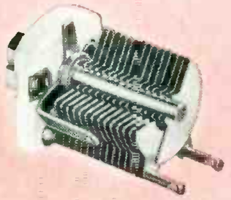
"BFC" butterfly-type capacitor with isolated rotor, very low minimum capacity and low inductance. For VHF applications as series capacitor with no rotor connection.



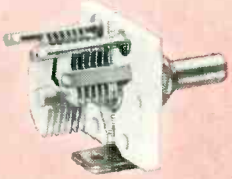
"MAC" Low minimum capacity and very low inductance. Ideal for VHF-UHF applications. Designed for use in miniaturization. Also available as butterfly type "MACBF".



"APC" A compact, high quality air dielectric trimmer. Extremely high resistance to temperature changes, moisture and vibration.

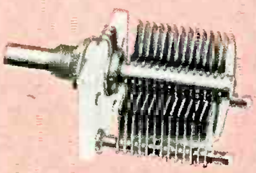


"MAPC" A scaled down version of the "APC". Designed to fill the needs of miniaturization. Suitable for VHF use.

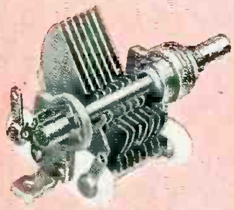


"HF" A high frequency design featuring extra long sleeve bearing and positive contact nickel-plated phosphor bronze wiper. Also available as a dual unit.

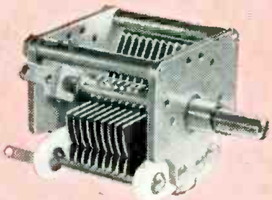
naturally,



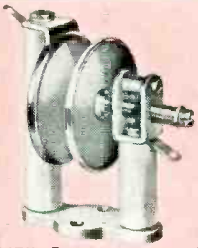
"HFA" Similar to "HF" model, but with larger air gaps for higher breakdown ratings. Used for high-frequency, low-power transmitting. Also available as dual unit.



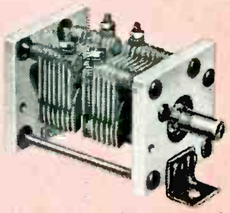
"MC" Designed for maximum versatility in mountings, connections and capacity characteristics. Rotor stop permits 180° clockwise rotation with increasing capacity. Also available as dual unit.



"RMC" Similar to "MC-S" but featuring extra rigid design. Heavy frame of aluminum tie rods and end plates.



"NZ" Compact transmitting neutralizing capacitor designed for easy and accurate adjustment. Long leakage paths to ground from both rotor and stator.



"VU" Permits use of "lumped constant" circuits up to 500 MC. Two sections in series eliminate rotor wiper. Pyrex glass ball bearings eliminate noise from usual metal-to-metal bearings.

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For commercial, military and industrial applications, you just can't beat Hammarlund Variable Capacitors for uniformly high quality design, materials and workmanship. The capacitors illustrated here are just a small representative portion of the complete Hammarlund line. In addition to stock designs, Hammarlund offers you unparalleled variable capacitor know-how in development, design and production. Whatever your needs, when it comes to special or standard variable capacitors, naturally, come to Hammarlund.

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vidicon color tv film camera which uses a folded optical system was also demonstrated by the firm along with a tv-microscope system and a servo pan and tilt mechanism for remote control of industrial tv.

Civil Defense Fosters Electronics Sales

Federal, state and local governments spend increasing amounts on equipment

In fiscal 1955, approximately $2.4 million was available from the federal government for civil-defense communications equipment. When matched by state and local groups, this brings the total available near the $5 million mark.

To qualify for federal aid electronic equipment to be purchased by local units must meet engineering specifications of the Federal Civil Defense Administration.

▶ **Markets**—A number of electronics manufacturers have garnered a sizable share of the business. Probably the largest amount has been spent with two-way mobile radio manufacturers. But other equipment is taking a share.

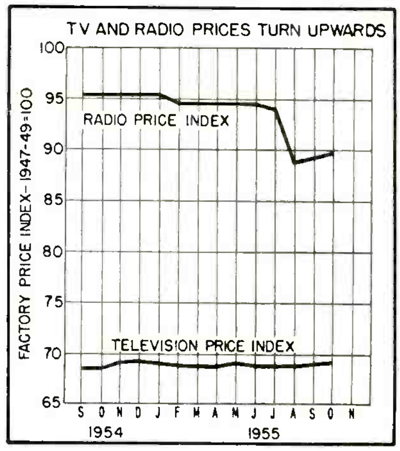
For example, the Cincinnati division of Bendix Aviation, received an order for 30,000 self-indicating ionization-chamber dosimeters. The units, which sell for approximately $10 apiece, will be stockpiled throughout the country for emergency purposes.

Bell Telephone has available its bell-and-lights air-raid warning system. It consists of a special telephone dial, located at a central control point, connected by private one-way telephone circuits to any number of bell-and-lights signal boxes, at warning points. One turn of the control dial flashes warning signals and sounds to all warning points. Bell also supplies two-way radio equipment which it leases and maintains.

Alden Electronics & Impulse Recording Equipment Co. has facsimile equipment available for civil defense use.

Set Prices Go On The Upgrade

Set makers revise prices upwards in face of rising labor and materials costs



Nearly every major tv-set manufactured has increased receiver prices in the past few months causing an average rise of $10 in the retail price of many models. According to set makers, the rise is due to increasing costs of material and labor.

▶ **Chart**—Trend of radio and tv factory prices over the past year is indicated by the government's wholesale price indexes for the products which cover factory prices. Latest figures are beginning to show recent tv price increases. They may also indicate that more higher price sets are being sold.

The radio index shows recovery from the sharp drop that took place in August.

▶ **TV Price Drops**—Every year since 1947 the average retail price of tv receivers has fallen. Last year it took one of its biggest drops, a $50 decline from $280 to $230. The decline is expected to continue this year despite recent price increases, but it may not be as severe.

Manufacturers have emphasized lower priced sets for the second set market. Large-screen sets priced below $100 are reported to be selling well. Indications are that a greater proportion of total set sales this year will be in table models than last year. In June the ratio stood at 60 percent table models and 40 percent consoles.

▶ **Radio Down Too**—Radio receiver prices have also followed a downward path over the years. In 1954, average retail prices declined by about $3 from 1953. The drop in the U. S. wholesale price index for the product in August indicates that the decline will be much more severe this year, despite the upward trend of the last few months.

Glass Makes Headway In Resistors

Just about a year has passed since low-power glass resistors first became available for use in radio and television receivers. In that time a dozen tv manufacturers have adopted the component for use in current sets and another has the units on order.

▶ **Why**—Glass resistors have been used in specialized military electronic equipment, but cost was prohibitive for civilian consumer goods. It was not until low-cost low-power types with 3, 4 and 5-watt ratings were introduced that volume use began. Now prices of the units, depending on size, range from 30 cents to $1. In quantities the price is lower. In some cases these lower prices have forced price adjustments in the conventional resistor field.

▶ **Construction** — The low-power resistors are made of a film of metallic oxides bonded to a Pyrex glass rod under heat. By means of electronically controlled machines, the film is automatically cut to the proper value and as-

(Continued on page 28)

KAY Wide Band Sweeps for Aligning Radar IF Amplifiers

KAY *Rada-Sweep*

A combined sweeping oscillator and crystal marker generator, the Rada-Sweep is designed especially for rapid alignment of radar IF amplifiers. Used with an oscilloscope, it will display response curves of IF amplifiers and mark up to nine frequencies to allow precise adjustment of response.

SPECIFICATIONS

Center Frequencies: 30 and 60 megacycles. Others may be added to special order.

Sweep Width: Wide—20 mcs or Narrow—3 mcs selected by a panel switch.

Sweep: All electronic, linear sawtooth. Sweep signal is brought out to terminals for connection to oscilloscope horizontal amplifier. Sweep repitition rate is adjustable around and may be synchronized to the cps line.

Markers: Up to 9 crystal positioned pulse type marks fed directly to scope vertical amplifier. Four supplied standard at 25, 35, 55 and 65 mcs. Others located as specified by purchaser. The standard marks may be replaced with others as specified. Individual on-off control of each mark.

Amplitude Modulation While Sweeping: Less than .05 db/mc.

RF Output Voltage: 250 millivolts across 70 ohms.

RF Output Control: Switched Attenuator: 20 db, 20 db, 10 db. Continuous Attenuator: covers approximately 5:1 ratio.

Marker Output Voltage: Positive pulse, approx. 10 V peak.

Marker Output Control: Continuously variable, 0 to maximum.

Power Supply: 105 to 125 volts, 50 to 60 cps. Power input approximately 100 watts. Circuit electronically regulated.

Price: $395.00 f.o.b. plant with standard marks. Any standard mark may be replaced with a special frequency—$10.00 each. Additional marks at $20.00 each.

KAY *Radaligner*

The Radaligner is a two-band sweeping oscillator designed to be used with a standard oscilloscope to determine frequency response of circuits from 10 to 170 mc. For frequency identification, the Radaligner includes eight narrow, cuustomer-specified, crystal-controlled markers and a single variable marker covering both sweeping oscillator ranges. Center frequencies of sweep ranges also set to customer's requirements.

SPECIFICATIONS

Sweep: Regular sawtooth, adjustable around or synchronized with 60 cps power line.

Frequency Range: Center frequencies may be selected at any two points in the 10 to 170 mc band.

Sweep Width: Center Frequency below 30 mcs: ±5 mcs Wide Band, ±0.5 mc Narrow Band; Center Frequency above 30 mcs: ±10 mcs Wide Band, ±1.5 mcs Narrow Band.

Amplitude Modulation While Sweeping: Less than 0.05 db/mc.

RF Output Voltage: 250 millivolts into 70 ohms.

RF Output Control: Switched attenuators: 20 db, 10 db and 3 db. Continuous attenuator: approximately 6 db.

Markers: Fixed: Eight, narrow pulse-type, crystal-controlled markers, positioned at customer's option. Available singly or in any combination through individual switches.
Variable: Frequency continuously variable throughout selected sweep ranges. Frequency calibration accurate to within 0.5%.

Marker Output Voltage: Positive pulse, approximately 10 volts peak.

Marker Output Control: Continuously variable, zero to maximum.

Power Requirements: 105 to 125 volts, 50-60 cps, approx. 110 watts.

Price: $795.00 (rack-mounted), f.o.b. plant. Cabinet $35.00 extra.

For complete information write:

KAY ELECTRIC COMPANY

DEPT. E-12 14 MAPLE AVENUE PINE BROOK, N. J.

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sembled with caps and leads.

Corning Glass, makers of the low-power units, has formed a components department to handle increased business from the electronics industry.

Financial Roundup

Many companies rack up record net profits for 1955's first nine months

THIRD quarter profits for many companies in the electronics field helped to boost nine month's earnings to new highs. Following are the net profit reports of 23 companies for the fiscal periods indicated:

Company	Net Profit 1955	1954
Avco 9m	$63,801	$3,336,721
Borg-Warner 9m	26,076,149	14,052,304
Burroughs 9m	8,255.002	6,922.436
Clevite 9m	3,219,431	1,980,501
T. A. Edison 9m	900,162	500.873
Elgin Watch 6m	268,446	269.648
Garrett 3m	1,093,000	840.000
General Controls 9m	1,156,664	717,237
General Electric 9m	141,359,000	136,191,000
Hoffman 9m	934,292	1,139,421
Magnavox 3m	564.807	331,729
Minn. Mining 9m	24,685,380	17,308,226
Motorola 9m	4,885,848	4,590,067
Philco 9m	4,854,000	2,275,000
Precision Instrumer's 9m	496.658	122,835
RCA 9m	30,995,000	27,557,000
Standard Coil 9m	304,753*	1,912,279
Stewart-Warner 9m	4,345,959	1,831,719
Sylvania 9m	9,556,210	6,166,226
Texas Instruments 9m	1,099,748	811,842
Tung-Sol 9m	2,286,511	1,478,493
Varian Assoc 12m	433,000	225,000
Webster-Chicago 9m	691,476	236,894

* (loss)

▶ **Securities** — Pyramid Electric filed with SEC covering 35,000 shares, par $1, to be issued against warrants, at $3.25 per share. Net proceeds are to be used for general corporate purposes.

RCA registered with SEC covering $100 million of 25-year convertible subordinated debentures to be offered to its common stockholders. They will be offered in the ratio of $100 principal amount for each 14 shares of common stock held of record. The offering will represent the first public financing by the company. Proceeds will be used for working capital, property additions and improvements and for further expansion of facilities.

FUTURE MEETINGS

DEC. 12-16: Nuclear Engineering and Science Congress, coordinated by Engineers Joint Council, Cleveland, Ohio.

DEC. 14: IRE Operations Research Symposium, University Museum, University of Pennsylvania, Philadelphia, Pa.

DEC. 15-17: URSI Fall Meeting, University of Florida, Gainesville, Fla.

JAN. 9-10, 1956: Second National Symposium on Reliability and Quality Control In Electronics, ASQC and RETMA, Hotel Statler, Washington, D. C.

JAN. 18-20: 12th Annual Technical Conference, Society of Plastics Engineers, Hotel Statler, Cleveland, Ohio.

JAN. 19-21: IRE National Simulation Conference, AIEE, ACM, Baker Hotel, Dallas.

JAN. 25-26: Third Annual Industrial Show, Penn Sherwood Hotel, Philadelphia, Pa.

FEB. 2-3, 1956: IRE National Symposium on Microwave Techniques, University of Pennsylvania, Philadelphia.

FEB. 9-11: IRE Southwestern Regional Conference and Show University of Pa. Philadelphia, Pa.

FEB. 15-17: 1956 Conference On High-Speed Computers, Louisiana State University, Baton Rouge, La.

FEB. 16-17: IRE, AIEE, Univ. of Pa. Conference on Transistor Circuits, University of Pennsylvania, Philadelphia, Pa.

FEB. 28-29: Scintillation Counter Symposium, IRE, AIEE, Shoreham Hotel, Washington, D. C.

MAR. 19-22: IRE National Convention, Waldorf-Astoria Hotel, Kingsbridge Armory, New York, N. Y.

APRIL 5-6: IRE, AIEE, ISA, Magnetic Amplifier Conference, Hotel Syracuse, Syracuse, N. Y.

APRIL 10-12: Twelfth Annual Meeting and Metal Powder Show, Hotel Cleveland, Cleveland, Ohio.

APRIL 11-13: 1956 IRE 7th Region Technical Conference, Hotel Utah, Salt Lake City.

APRIL 13-14: Tenth Annual Spring Television Conference, IRE, Engineering Society Building, Cincinnati, Ohio.

APRIL 23-24: New England Radio Engineering Meeting, IRE, Sheraton Plaza, Boston, Mass.

Industry Shorts

▶ **Total** of eleven f-m subsidiary communications authorizations have been approved by the FCC.

▶ **Market** in batteries for transistorized radios will reach $100 million in three years, according to Olin Mathieson Chemical Corp.

▶ **Small** airborne Pye tv camera has been used to observe deicing tests on Britannia airliner engines.

▶ **Selenium** shortage continues and the government is again urging tv and radio repairmen to salvage discarded selenium rectifiers.

▶ **New** techniques of broadcast transmission which use the scatter principle make possible the immediate establishment of tv relay stations linking America and Europe, according to Allen B. Du Mont.

▶ **Latest** Admiral tv sets have three automated printed circuits equivalent to 80 percent of all the wiring in the set.

▶ **Color** film-scanner shipments total 63 units to 59 stations.

▶ **Two** contracts to apply the principle of acoustic interference (electronic sound absorption) to military problems have been undertaken by RCA.

▶ **General** Electric now employs some 16,000 people in the electronics field in central New York state alone, with an annual payroll of

(Continued on page 30)

By specializing in servo motors only—not systems—G-M gives you these advantages...

- A broader line of servo motors in sizes and types to meet a wide range of applications.
- Servo motors available in *all* the standard sizes.
- Standard sizes specially modified to meet specific circuit requirements—available on a quick-service basis.
- Creative engineering in designing special motors with special characteristics.
- Faster production—better service.

When reliability under extreme conditions is essential—specify G-M Servo Motors! G-M has long specialized in supplying precision servo motors to the Military Avionic Industry, especially designed to meet military specifications for humidity, salt spray, temperature, vibration and altitude. Whatever your needs, let G-M build a servo motor with the *right* characteristics to perform to your specifications.

Write *today for G-M charts, specifications, or consultation.*

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between $76 to $80 million, according to R. J. Cordiner, president.

▶ **Single-sideband** for all mobile, Alaskan and maritime fixed service radiotelephone below 25 mc is under consideration by FCC to help provide more communications channels.

▶ **Production** of tv sets in Germany is expected to reach 350,000 this year and may rise to 1.2 million sets by 1958, according to Telefunken.

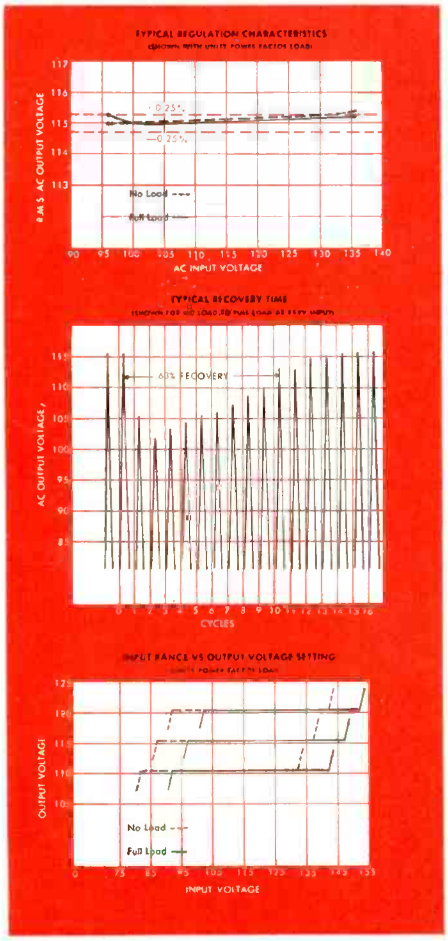
Industry Report Index

PERKIN ANNOUNCES

IMMEDIATE DELIVERY on a NEW TUBELESS!

MAGNETIC AMPLIFIER

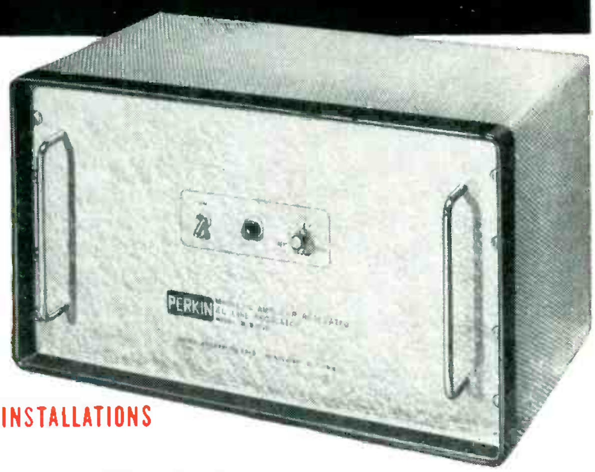
AC LINE VOLTAGE REGULATOR



MODEL MLR - 1000

1 KVA

- ☆ NO TUBES TO REPLACE
- ☆ NO MOVING PARTS
- ☆ NO VIBRATING CONTACTS
- ☆ REGULATES RMS VALUE
- ☆ IDEAL FOR UNATTENDED INSTALLATIONS



Specifications...

- **Input Voltage Range:** 95 to 135 volts
- **Output Voltage:** Nominal 115 volts, can be adjusted from 110 to 120 volts.
- **Output Current:** 8.5 amperes
- **Regulation Accuracy:** ±0.25% for any combination of line or load
- **Frequency Range:** 60 cycles ±10%
- **Wave Form Distortion:** 3% maximum
- **Power Factor Range:** 0.5 lagging to 0.9 leading
- **Response Time:** 0.2 sec.
- **Maximum Load:** 1.0 KVA
- **Ambient Temperature Range:** Up to 45° C.
- **Dimensions:** 19½" wide x 11" high x 11½" deep (cabinet)
  19" wide x 10½" high x 11½" deep (rack panel)
- **Mounting:** Cabinet or 19" Rack Panel
- **Finish:** Gray Hammertone
- **Weight:** 85 lbs.

For PROMPT REPLY, wire the factory collect or phone our nearest sales office.

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What happens when you put a soldering iron to your present insulation? Ten to one it cracks or melts right off the wire. But replace or protect it with BH"1151" Sleeving and your troubles are over.

BH"1151" is an inspired combination of two inorganic materials—Fiberglas and silicone rubber. The Fiberglas is braided and heat-treated under BH patented methods, then the silicone is fused on to become an integral part of the sleeving. It can be twisted and bent, but it will not craze or crack. It is completely unaffected by hot spot temperatures up to 700°F.—can even be potted in molten solder without injury. To be sure, it costs a little more than ordinary sleevings, but the money saved by using a less effective sleeving will be lost on your first reject.

If you are interested in effective insulation for continuous operation through a temperature range of —90°F. to 400°F.—then try BH"1151". If you are interested in a sleeving with permanent flexibility—then try BH"1151". If you are interested in fungus resistance—then try BH"1151". If you are interested in a sleeving that conforms to the stringent requirements of MIL-I-18057—then try BH"1151".

You'll probably prefer spool or coil put-up, but 36" lengths and short pieces are available on special order. You can get BH"1151" the way you want it. Write today for data sheets and free Production Testing Samples—you'll welcome the extra protection your products gain with BH"1151".

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Telephone: Conshohocken 6-0634

BENTLEY, HARRIS *Fiberglas SLEEVINGS**

*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U.S. Pat. Nos. 2393530; 2647296 and 2647288). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

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TO PANEL DESIGN
Marion Medalist meters combine handsome, modern design in a choice of colors to enhance the styling of your equipment, with the greater readability of scales up to 50% longer than ordinary type panel instruments of the same size. They are interchangeable with ASA/JAN 2½ and 3½ inch sizes. Delivery now in all standard ranges.
Comparison of Medalist and Standard Style
marion meters
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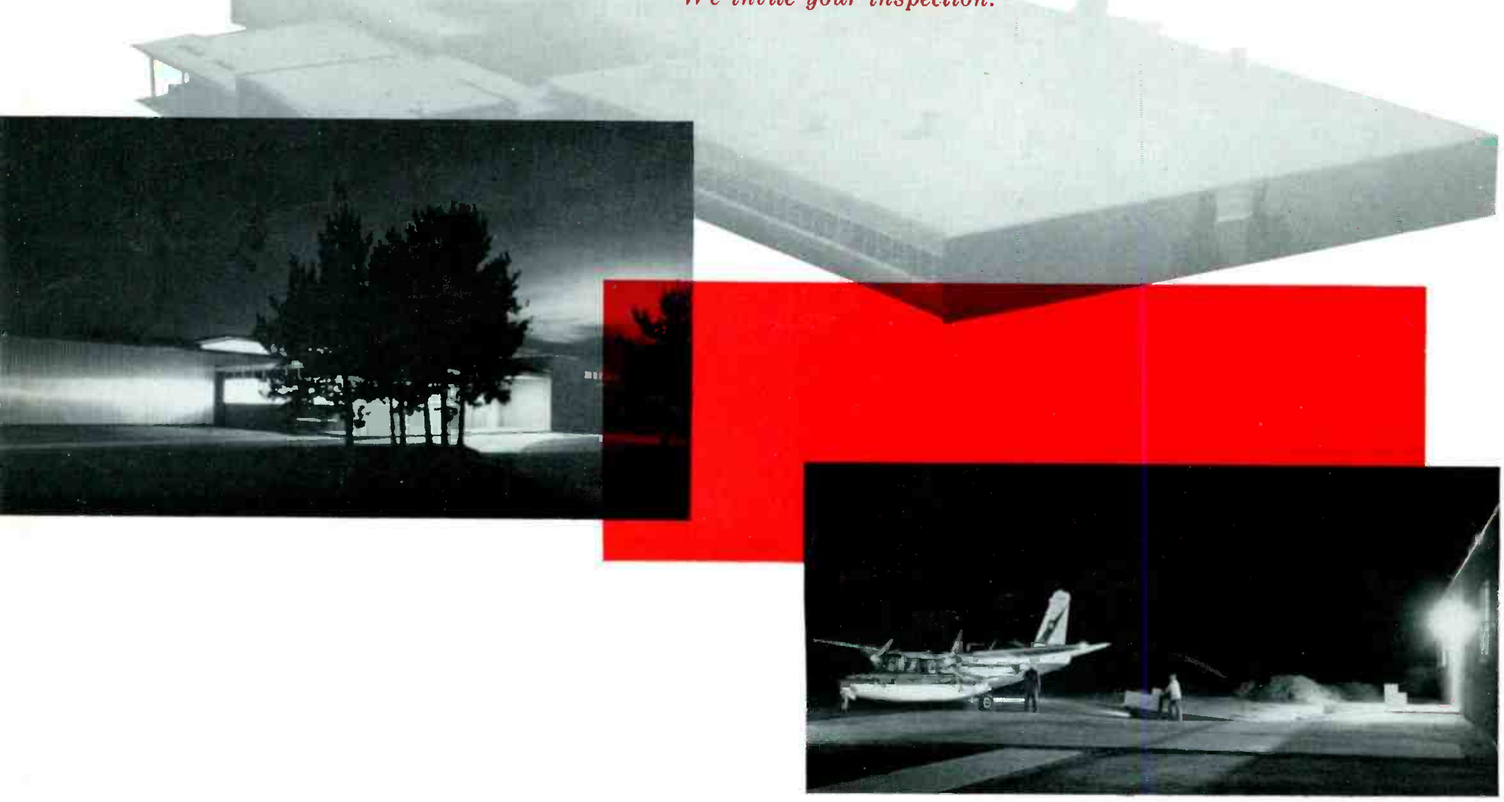

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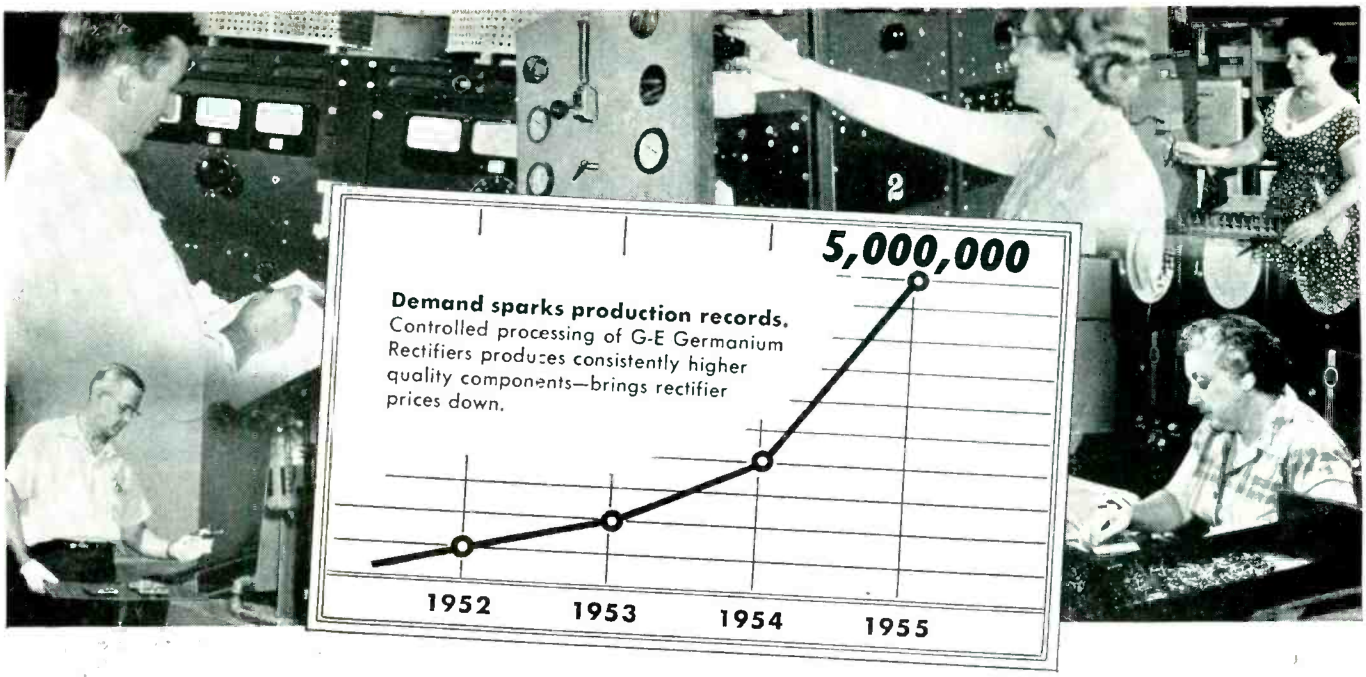


G-E Germanium Rectifier Production Breaks the 5 Million Mark

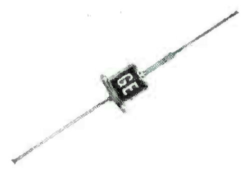
Customer requirements accelerate the production of a full line of highly reliable, long-life germanium rectifiers

THE NEW germanium rectifiers were introduced by General Electric in 1952 and since then more than 5 million units have been produced for industrial and military needs. In effect, this achievement represents more than *ten billion hours* of rectifier life—in hundreds of diversified commercial and military applications.

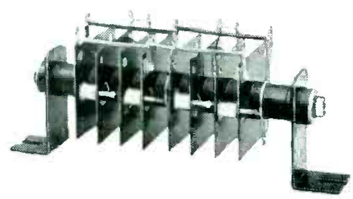
PROVED QUALITY! Of the 5,000,000 rectifiers produced, only a fraction of 1% have required adjustment under the terms of General Electric's full year warranty!

Wide Range of Designs. G-E rectifiers are available in a broad range of designs for many applications—for electronic computers, control equipment, power supply units, magnetic amplifiers; for military and industrial needs requiring custom designs; and for almost any application where DC power is required. G-E Germanium Rectifiers are more compact, and weigh less—as much as 75% less than comparable rectifiers of other types—and meet the rigid requirements for performance established by the U. S. Navy, Air Force, and Signal Corps. What's more, G-E Germanium Rectifiers are *warranted for one full year.*

Immediate Delivery. Mass production assures fast delivery on all G-E Germanium Rectifiers regardless of quantity. For complete information concerning your rectifier needs, contact your G-E Semiconductor Representative. Or, write: *General Electric Company, Semiconductor Products, Section X4125, Electronics Park, Syracuse, New York.*



Diffused Junction Germanium Rectifiers combine very high forward conductance with very high back resistance. The high temperature and magnetic amplifier rectifiers feature very low reverse current ratings at ambient temperatures of 85°C.



Power of the basic rectifier unit is boosted 5 times by adding a copper fin. Stacked one to twelve fins in series or parallel, the rectifier may be operated as half wave, full wave, or bridge circuits, and many other types of single or polyphase circuits. Typical power ratings are as high as 3 amps @ 190 volts; 1.3 amps @ 575 volts; 3.6 amps @ 140 volts, etc.

The Medium Power Rectifier has a 5 amp rating at 200 volts (55°C). At 85°C it is rated 2.5 amps at 100 volts. These rectifiers, stacked in series or parallel, have ratings in thousands of watts depending on the design of the circuit.

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GENERAL ELECTRIC

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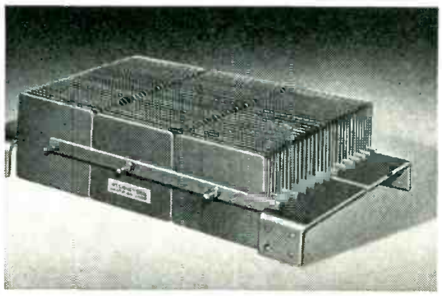
International Rectifier

Selenium and Germanium Rectifiers

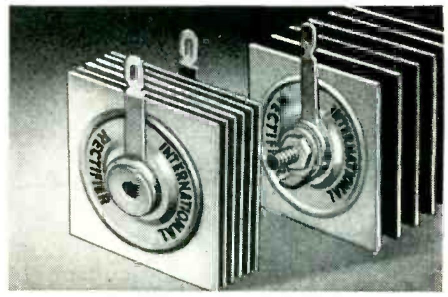
International Selenium Products

Pressed powder or vacuum process used as determined by our Applications Engineering Dept. The most widely used Industrial Power Rectifiers in Industry today!



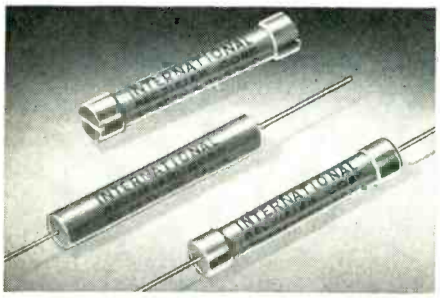
INDUSTRIAL POWER RECTIFIERS

For all DC power needs from microwatts to kilowatts. Features: long life; compact, light weight and low initial cost. Ratings: to 250 KW, 50 ma to 2,300 amperes and up. 6 volts to 30,000 volts and up. Efficiency to 87%. Power factor to 95%. **Bulletin C-349**



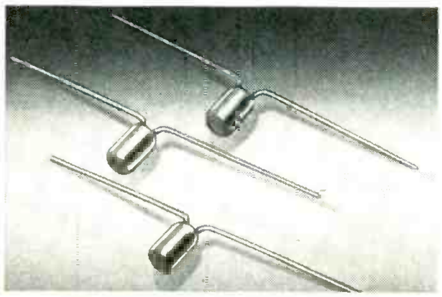
TV AND RADIO RECTIFIERS

The widest range in the industry! Designed for Radio, Television, TV booster, UHF converter and experimental applications. Input ratings from 25 to 195 volts AC and up. DC output current 10 to 1,200 MA. Write for application information. **Bulletin ER-178-A**



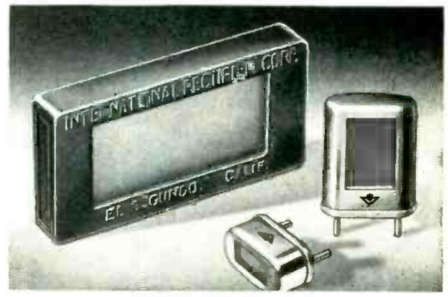
HIGH VOLTAGE CARTRIDGE RECTIFIERS

Designed for long life and reliability in Half-Wave, Voltage Doubler, Bridge, Center-Tap Circuits, and 3-Phase Circuit Types. Phenolic Cartridge and Hermetically Sealed types available. Operating temperature range: −65°C to +100°C. Specify **Bulletin H-2**



SUB-MINIATURE SELENIUM DIODES

Developed for use in limited space at ambient temperatures ranging from −50°C to +100°C. Encapsulated to resist adverse environmental conditions. Output voltages from 20 to 160 volts; output currents of 100 microamperes to 11 MA. **Bulletin SD-1B**

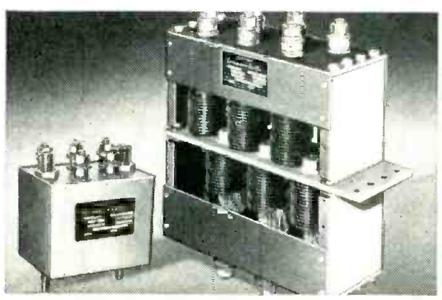


PHOTOELECTRIC CELLS

Self-generating photocells available in standard or custom sizes, mounted or unmounted. Optimum load resistance range: 10 to 10,000 ohms. Output from .2 MA to 60 MA in ave. sunlight. Ambient temperature range: −65°C to +100°C. **Bulletin PC 649**

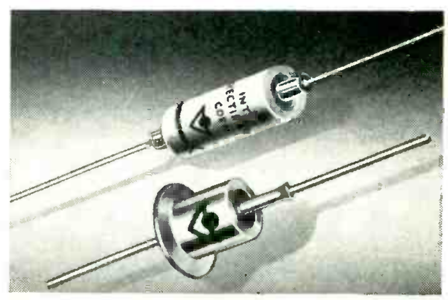
International Germanium Products

High quality units of improved design are the results of years of experience in the production of exceptionally fine germanium crystals plus extensive research, development and field performance testing!



GERMANIUM POWER RECTIFIERS

This new line features: High efficiency—up to 97%, Lowest forward drop, High reverse to forward current ratio, unlimited life expectancy. No reforming required after storage. Ratings: 26 to 66 AC input v. per junction: 150 to 100,000 amps DC output. Operating temperature range: −55°C to +75°C. In three styles. **Bulletin GPR-1**



GERMANIUM DIODES

POINT CONTACT. High quality crystals—long reliable life—superior resistance to humidity, shock, temp.-cycling. **Bulletin GD-2**
JUNCTION POWER. Hermetically sealed—welded construction. Available in Standard JETEC 1N91, 1N92, 1N93 types. For diodes to meet your specific requirements, consult our Semiconductor Division.

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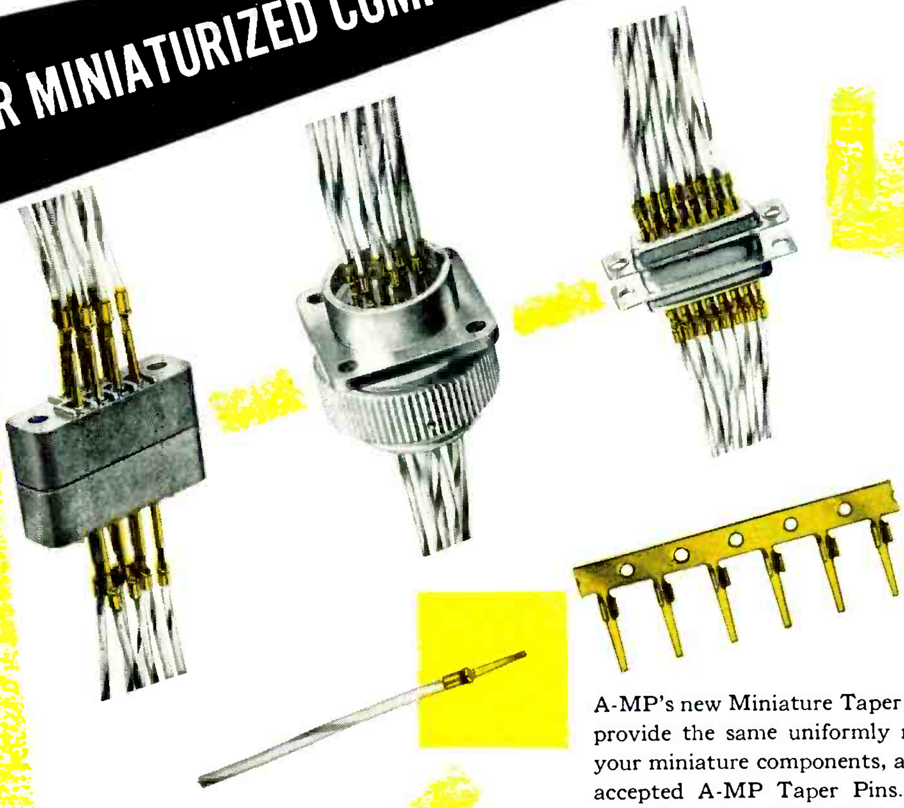

A-MP's new Miniature Taper Pins, shown here actual size, provide the same uniformly reliable wire connections for your miniature components, as the larger, widely used and accepted A-MP Taper Pins. Miniature Taper Pins are applied to wire with A-MP Automatic Machines at speeds up to 4000 per hour. They are then inserted into components quickly and easily with A-MP CERTI-LOK Insertion Tools. Miniature Taper Pins are available for wire sizes #26 to #20.

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Torture

Brumfield Way

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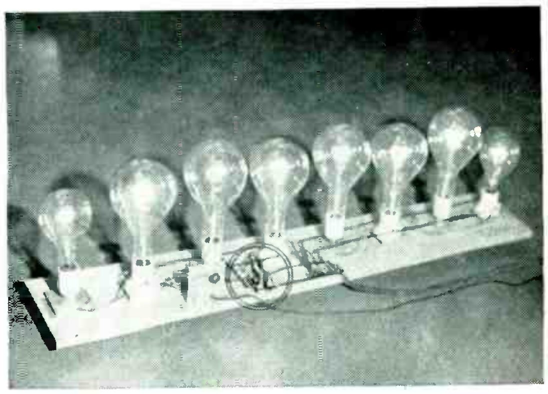
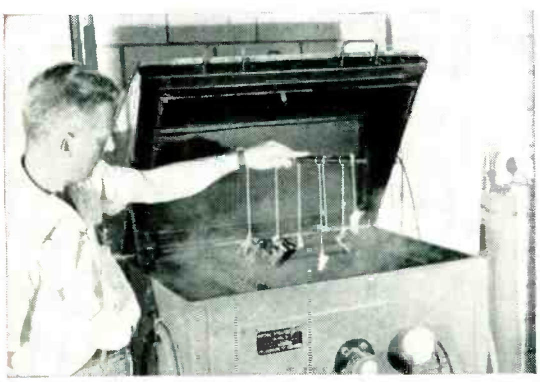
For quick delivery over 350 different standard relays stocked by 500 Franchised Electronic Parts Distributors throughout the United States and Canada.

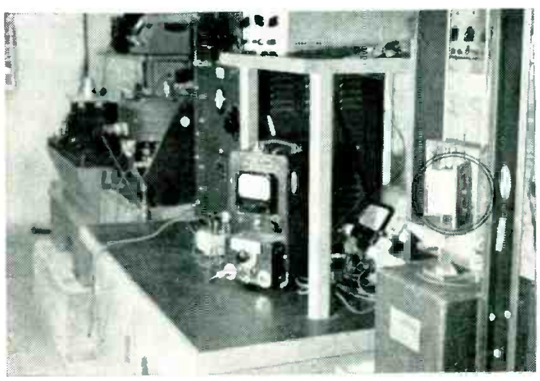


Typical rugged life test using a series of 1000 watt lamps causing the relay to operate under a load 10 times more severe than normal.

PRINCETON, INDIANA



Control of metal finishes are a must for accurate relay operation. Parts are periodically subjected to a minimum 20% salt spray to check their resistance to corrosion.



Tester built to JAN specifications provides shock of over 100 G's. Contact reactions are indicated on oscilliscopes—thyratrons or other special equipment depending on speed.

ALL TYPES—ALL SIZES—FOR ALL APPLICATIONS

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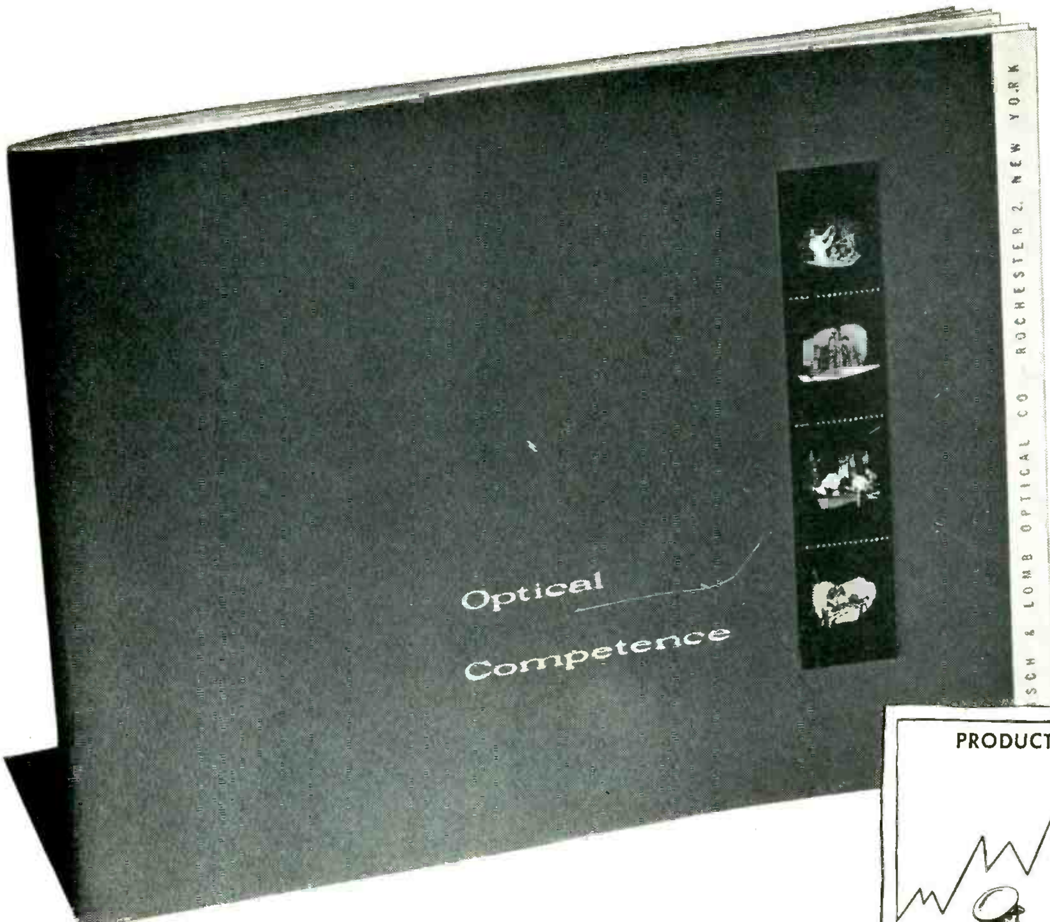
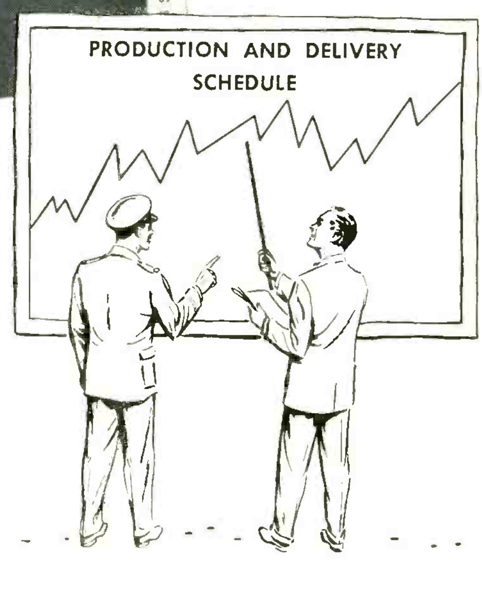
This valuable book is *must* reading if your contract specifies precision image formation . . . exact control of light and color. It's *rewarding* reading . . . you'll learn how revolutionary new achievements in optical engineering can help simplify your product design; how laboratory precision in volume production assures performance to contract specifications, yet keeps costs down. Find out how Bausch & Lomb coordinated contract execution protects your contract commitments, from design to delivery. Get better acquainted now with America's major source of optical products.





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ERIE PAC Facts

- **Cost Savings**
  Fewer insertions
  Simplified insertion equipment
  Fewer items purchased
  Fewer chassis holes
  Smaller chassis
  Reduced inspection
  Simplified chassis wiring

- **Simplified Circuit Design**
  Design engineers can determine optimum parameters by quick, easy component "snap-in" kit, simulating actual final layout.

- **Easy Circuit Changes**
  Component value changes facilitated by simple assembly program variation. Modest circuit modification costs.

- **Flexibility**
  All resistance values between 5 ohms and 50 megohms. All capacitance values between 1 mmf and 5100 mmf. Parallel and series arrangements readily obtained. Excellent Circuit Flexibility thru use of printed wiring type base.

- **Isolated Components**
  Low shunt capacitance due to low K base.

- **Close Tolerances**
  Resistors as close as ± 5%.
  T.C. capacitors as close as ±1% or ±.1 mmf.

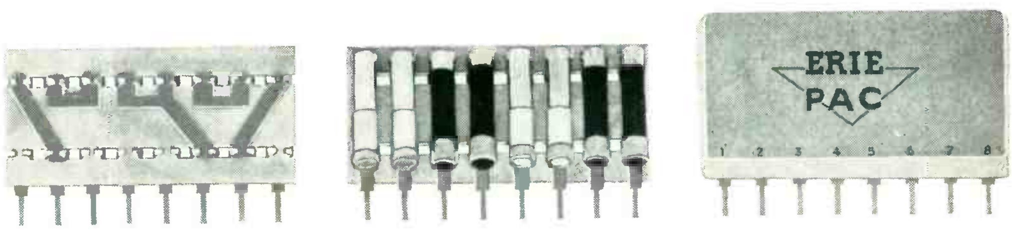
- **Ruggedness**
  Reduced breakage. No pulled-off terminals.

- **Reduced Chassis Area**
  15 components per square inch — achieved by mounting "PAC" in vertical plane.

- **Low, Uniform Strays**

PAC*

ERIE'S New Simplified Automation *PIN ASSEMBLY CIRCUIT Lowers TV Costs



TYPICAL CIRCUIT — ACTUAL SIZE

The Pin Assembly Circuit "PAC" simplifies automation for the electronic industry by the grouping of components such as resistors and capacitors into a unitized modular package for quick, accurate installation. Packaging a group of components greatly reduces assembly labor costs. This is the real key to *lower cost television sets*, radios, computers, controls and other electronic items, both commercial and military.

Based on uniform "building block" components, having a ⅛" diameter and a ⅝" length, the Pin Assembly Circuit combines up to 92 individual components in one package. Thus, in a conventional 21" television receiver, all resistive and capacitive elements can be included in just a few "PAC" modules. This means a considerable reduction in cost of assembly labor and equipment, whether modules are assembled to the chassis by hand or by automatic equipment.

Write for Erie Engineering Bulletin #450.

ERIE electronics

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Time Delay Timers

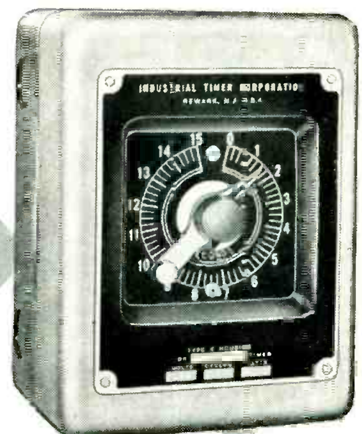
The more automatic control problems we get, the better we like it. For while it's true each automatic control job is a bit different from the rest, the record shows that our 19 years of timer experience has given us the special knowledge it takes to give you the right answers, and in near-record time.

If one of our standard timers won't do your job — or one of the 721 combinations we have thus far developed from our 17 basic units — our engineers will go right to work to develop a new combination that's the one for you. That's the way we grow — and we like it.

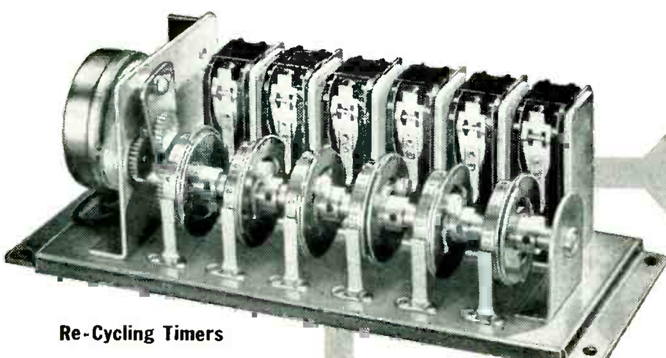
We manufacture a complete line of timers in these 4 broad classifications:

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

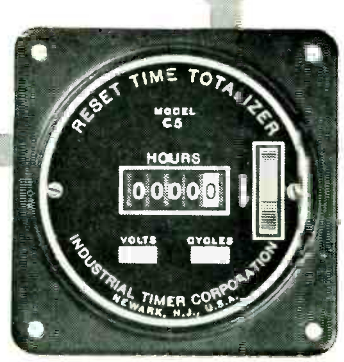
And since we maintain large stocks of our 17 basic units, we can assure you of rapid deliveries — of excellent deliveries even on special orders. So whatever your automatic control problem, you have everything to gain by submitting it to our timer specialists. They'll give you a profitable answer — almost with the speed of automatic control itself.



Interval Timers



Re-Cycling Timers



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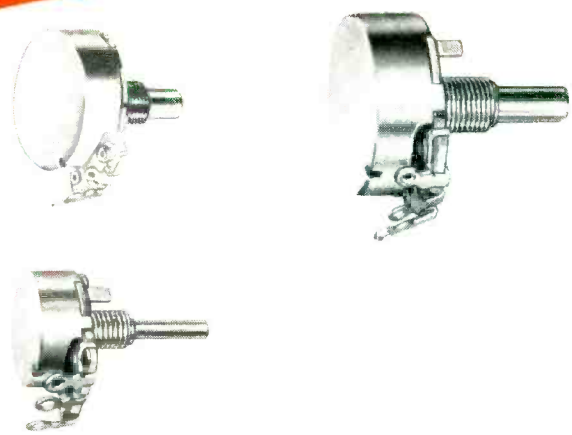
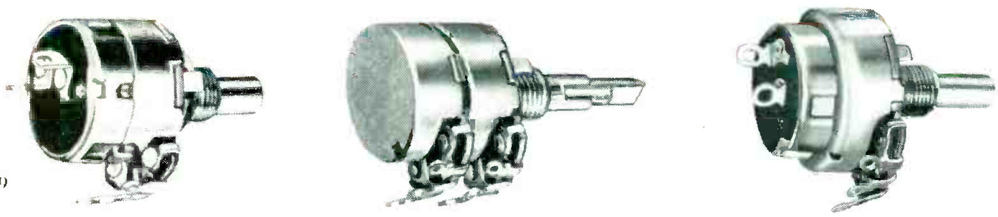


VARIABLE RESISTORS



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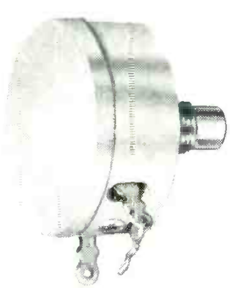

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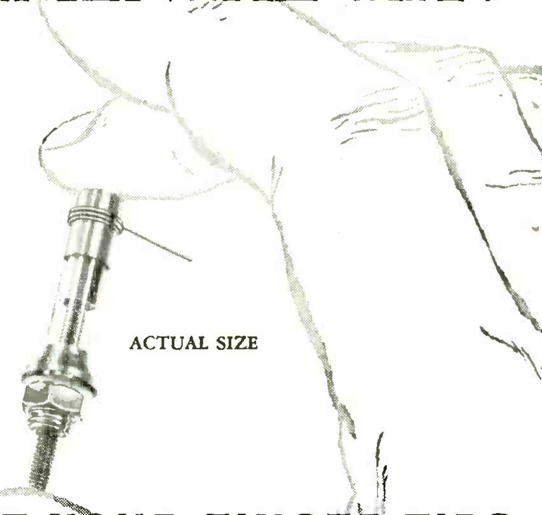

ACTUAL SIZE

AT YOUR FINGER TIPS

10 ASSORTED PISTON CAPACITORS TO HELP SOLVE YOUR DESIGN PROBLEMS

FOR THE EXPERIMENTER AND DESIGNER IN

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NO. **PK10**

THIS KIT CONTAINS THE FOLLOWING 10 JFD PISTON CAPACITORS WITH THE CHARACTERISTICS INDICATED BELOW.

MODEL	CAPACITY RANGE MMF	OPERATING TEMPERATURE RANGE °C	TEMPERATURE COEFFICIENT 1KC P.P.M./°C	Q at 1MC	DIEL.	MOUNTING THREAD SIZE
VC5	.5 to 5	—55° to +200°	Approx. 0	1800	Fused Quartz	¼ — 28
VC11	1 to 10	—55° to +200°	Approx. 0	1800	Fused Quartz	¼ — 28
VC12	10 to 20	—55° to +200°	Approx. 0	1200	Fused Quartz	¼ — 28
VC1G	.5 to 8	—55° to +125°	+50 ±50	600	GLASS	¼ — 28
VC3G	.7 to 8	—55° to +125°	+500 ±100	600	GLASS	¼ — 28
VC4G	1 to 18	—55° to +125°	+500 ±100	700	GLASS	¼ — 32
VC8G	1 to 8*	—55° to +125°	+50 ±50	700	GLASS	¼ — 28
VC11G	.7 to 12	—55° to +125°	+50 ±50	700	GLASS	¼ — 28
VC13G	1 to 10	—55° to +125°	+400 ±100	625	GLASS	¼ — 28
VC30G	1 to 30	—55° to +125°	+100 ±50	600	GLASS	¼ — 28

*For complete physical and electrical data see Engineering Bulletins.

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Here are *10* different, precision quartz and glass dielectric JFD Variable Trimmer Piston Capacitors to speed your research and experimentation—complete with electrical characteristics charted in easy-to-follow tables—characteristics which offer you: Matched temperature coefficients to meet a wide number of requirements . . . incremental adjustment of capacity for highly critical tuning . . . plus a new differential type ideal for oscillator and discriminator network applications. All housed in a handsome, felt-lined, dust-proof styrene container. Better order yours today.

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NOPCO® LOCKFOAM for the radome

because it is uniform, offers better

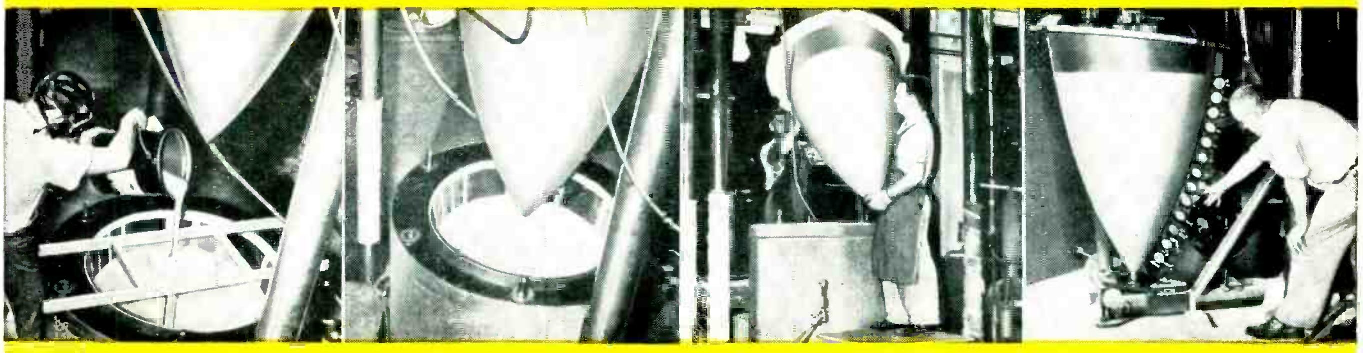
electrical properties, and permits

closer dimensional tolerances"

says **THE BRUNSWICK-BALKE-COLLENDER CO.**

U. S. NAVY'S F3H-2N ALL-WEATHER "DEMON"

single-jet, carrier-based fighter plane made by McDonnell Aircraft Corp., St. Louis, Mo. The "Demon" is an all-weather, high performance fighter combining interceptor speed and fighter maneuverability with the payload of an attack bomber. It utilizes the latest in electronic aiming devices. The high precision radome—one of the largest in commercial production—is made for McDonnell by The Brunswick-Balke-Collender Co., Plastics Division, Marion, Va.



Sequence of photographs showing Nopco Lockfoam being poured into the mold—where it solidifies in a matter of minutes—removed as the finished radome, and inspected. These show some of the reasons for Brunswick's statement that with Lockfoam they have been able to reduce the man-hours needed.

Where you find the most modern in construction, you are very apt to find Nopco Lockfoam being used. And that goes not only for aviation and electronics manufacture, but in many other industries as well. Airplane radomes are but one of the first conspicuous applications which are using to good purpose Lockfoam's excellent electrical properties, its strength-weight ratios, plus Lockfoam's ability to fill exactly the configurations of any cavity into which it is poured.

Nopco's technical staff will cooperate with you to the fullest. Write today for the Nopco Lockfoam booklet. Nopco Chemical Company, 200 Stier St., Harrison, N. J.

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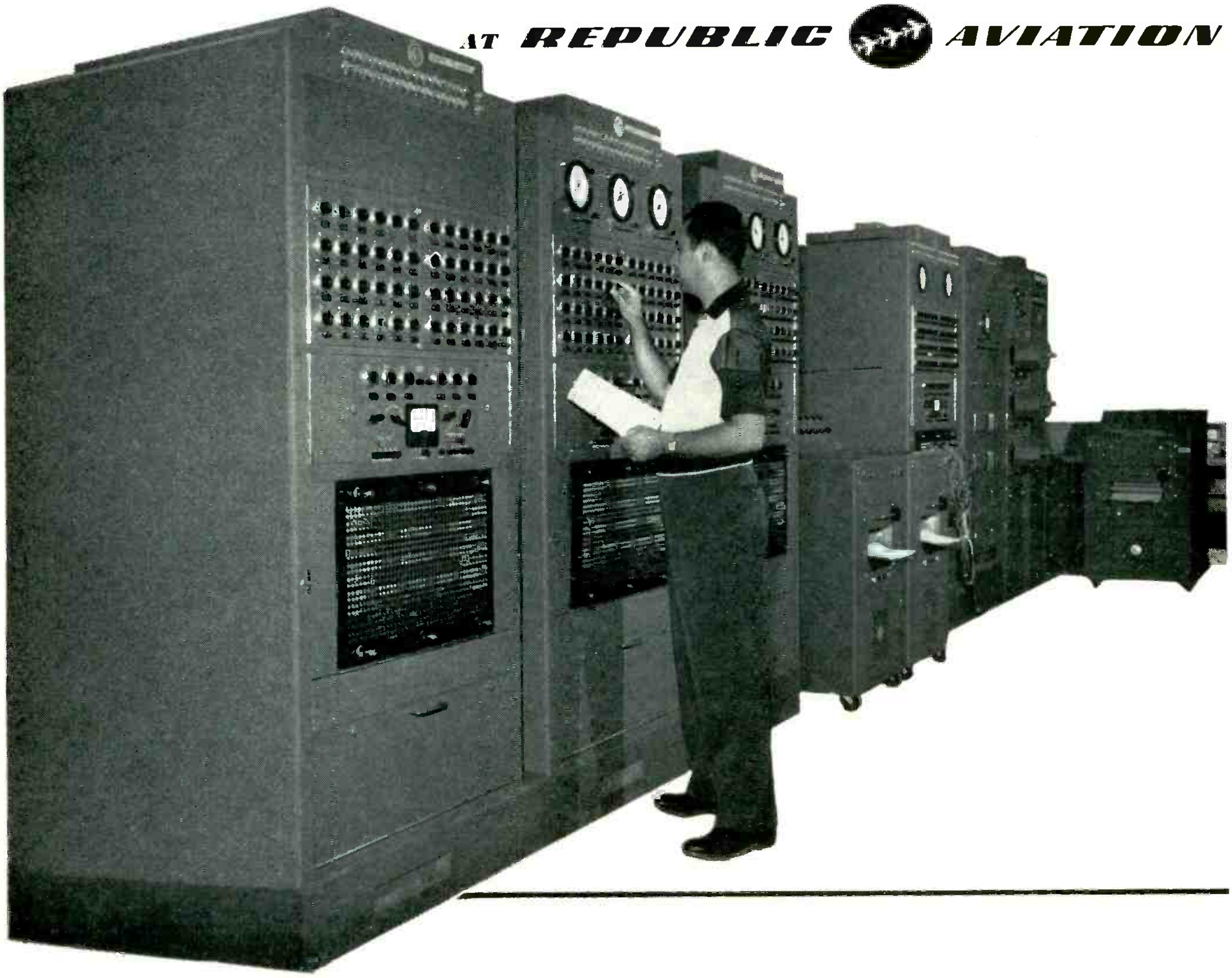

Where huge savings in time and costs will be realized!

Because Republic can "fly" an aircraft or guided missile, including take-off, cruise, landing, maneuvers and emergency conditions right in this computer center. Here, the actual performance is actually and accurately simulated, in a safe and in a relatively inexpensive manner. Here the optimum in design characteristics is determined without endangering human lives or incurring losses of millions of dollars with test flight models.

Every industry that now utilizes test models can save millions of dollars in time and model costs with a Mid-Century analogue computer center. Every industry that needs production or automation controls can do likewise by substituting Mid-Century analogue computers to more easily and cheaply adjust their manufacturing processes to a higher optimum of production with greater uniform quality.

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Ucinite Test Jacks

In addition to Test Jacks with a brass, nickel-plated shell and nut with nylon insulator, Ucinite now offers a less expensive version with all-nylon threaded insulator for low capacity to panel and high voltage breakdown.

These Ucinite Test Jacks — designed for standard .080 phone tips — are available in a variety of colors . . . ideally suited to coded application. Silver-plated, heat treated beryllium copper contact is made in one piece with large terminal ends for easy soldering. The feed through type is provided with a one-piece brass terminal stud, tin-plated.

The specialized abilities and experience of Ucinite's own staff of design engineers are available for work on new and unusual problems. Volume production facilities ensure fulfillment of the largest requirements. For full information, call your nearest Ucinite or United-Carr representative or write directly to us.

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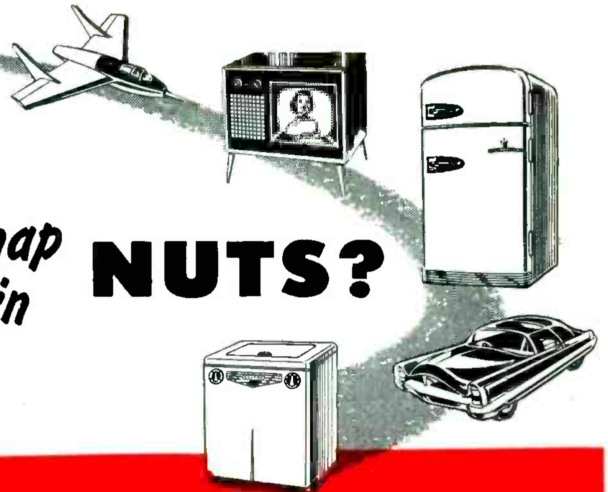
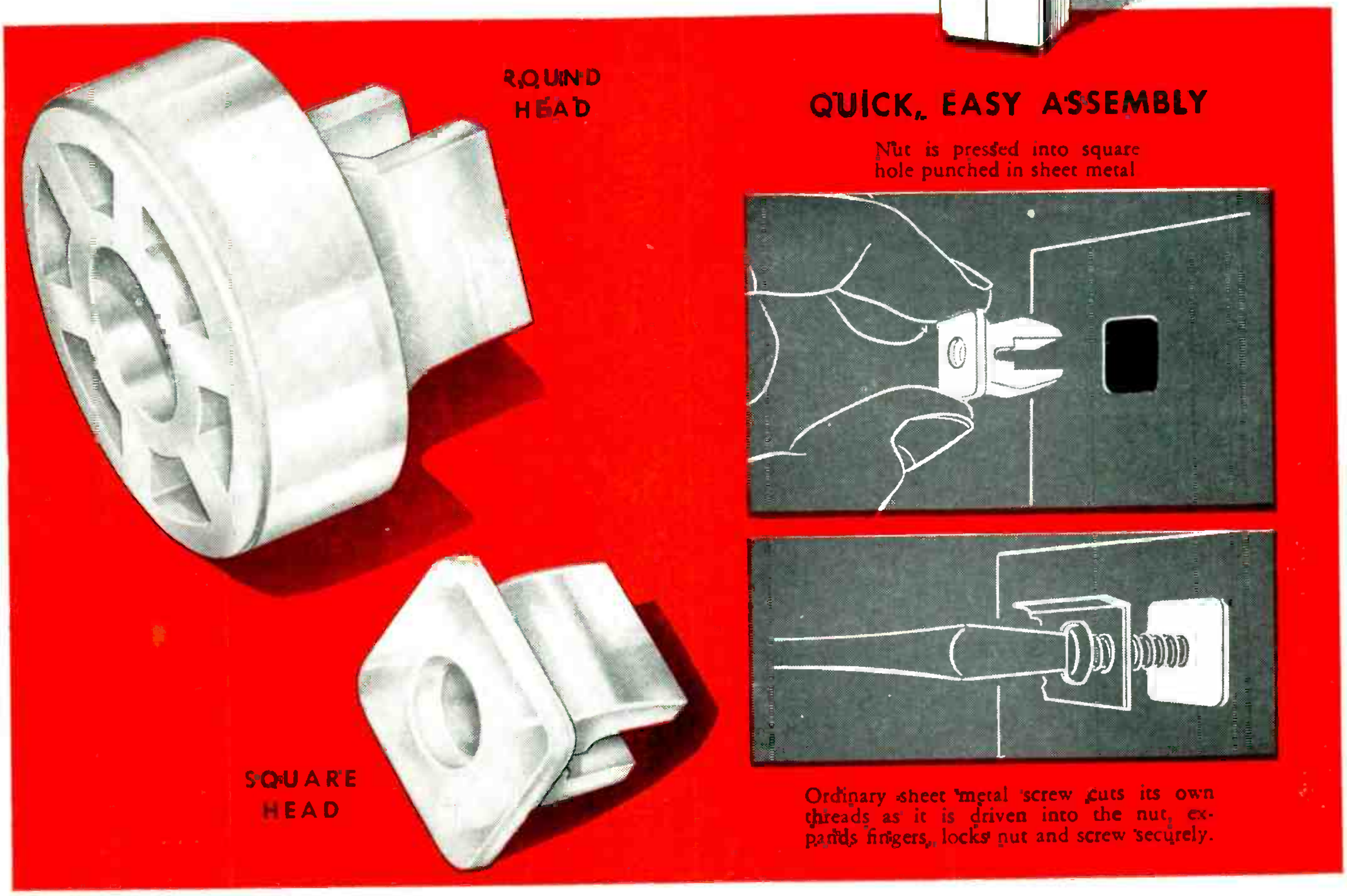
DOT PLASTIC *snap in* NUTS?





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

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

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

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

UNITED-CARR FASTENER CORP.

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MAKERS OF DOT FASTENERS

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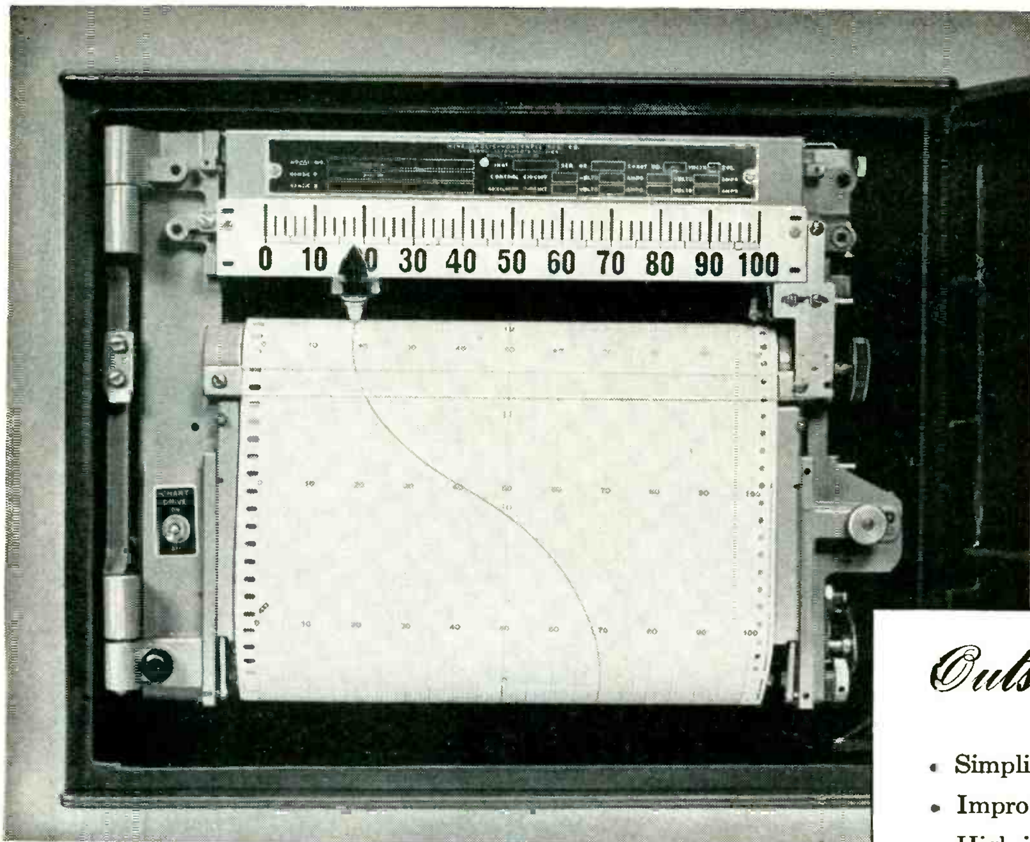

Outstanding

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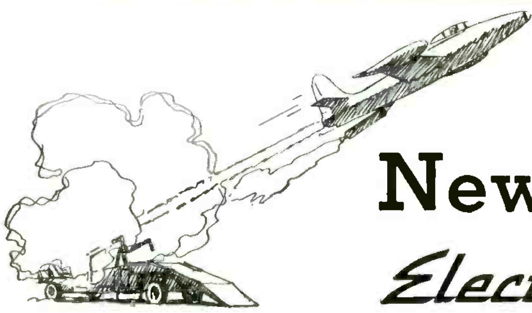

New 1/4-second *ElectroniK* recorder

follows fast-changing variables with split-second response

Designed to meet the special data-recording requirements of experimental stations, laboratories, and research centers, the new 1/4-Second Pen Speed *ElectroniK* Recorder fills an important gap between conventional large-chart recorders and oscillographic instruments.

This new *ElectroniK* Recorder is the *fastest* large-chart instrument available today . . . the perfect solution for high-speed plotting of any function that can be reduced to a d-c millivolt signal. It offers the investigator extreme sensitivity, complete flexibility, laboratory precision . . . plus many *new* features the research man will appreciate:

Easy range change—All components of the potentiometer bridge are located on an interchangeable bakelite card.

New design plug-in amplifier—has many times the power output of standard units . . . features high input impedance, easy accessibility, flexible gain control, and rugged construction.

New pen and carriage designs—prevent pen clogging and paper tearing. Ball point pen easily removed. Transparent cartridge shows ink supply.

New slidewire and contacts—Designed for long life under high speed operation.

Your nearby Honeywell sales engineer will be glad to discuss applications in your research work . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA:**
Write for Instrument Data Sheet No. 10.0-21 "1/4-Second Pen Speed *ElectroniK* Recorder."

MINNEAPOLIS
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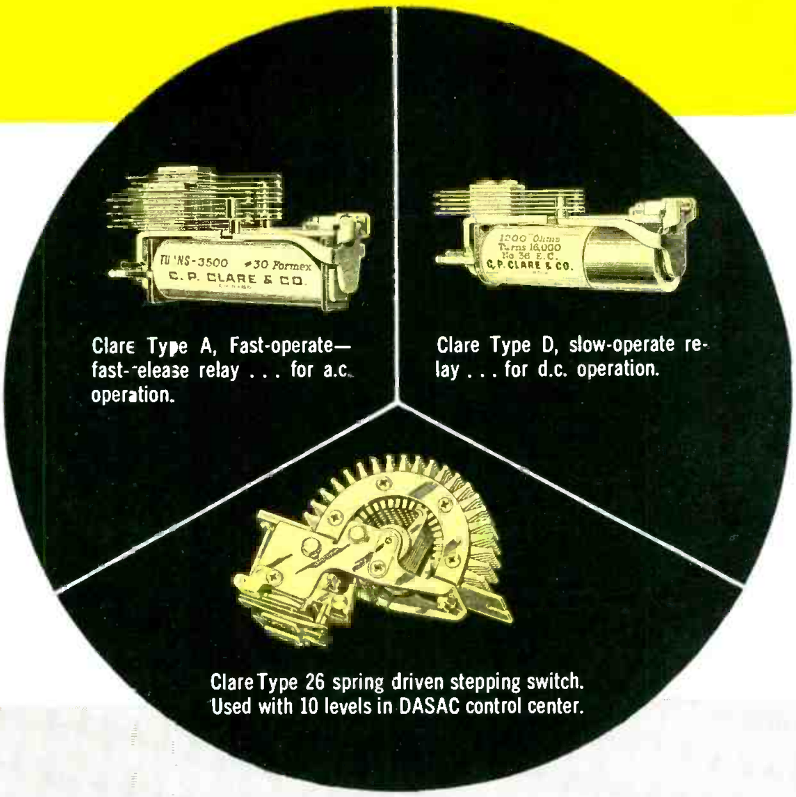
First in Controls

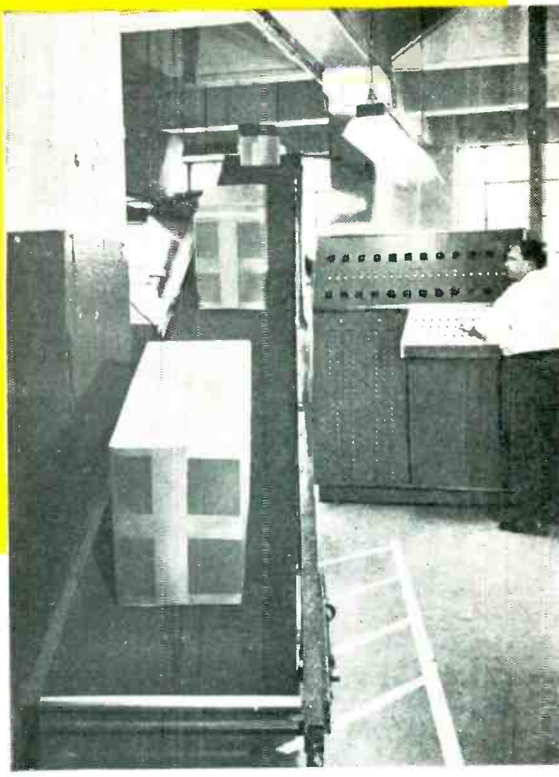
Stability and Reliability make CLARE Relays and Stepping Switches ideal components for DASAC



Clare Type A, Fast-operate—fast-release relay . . . for a.c. operation.

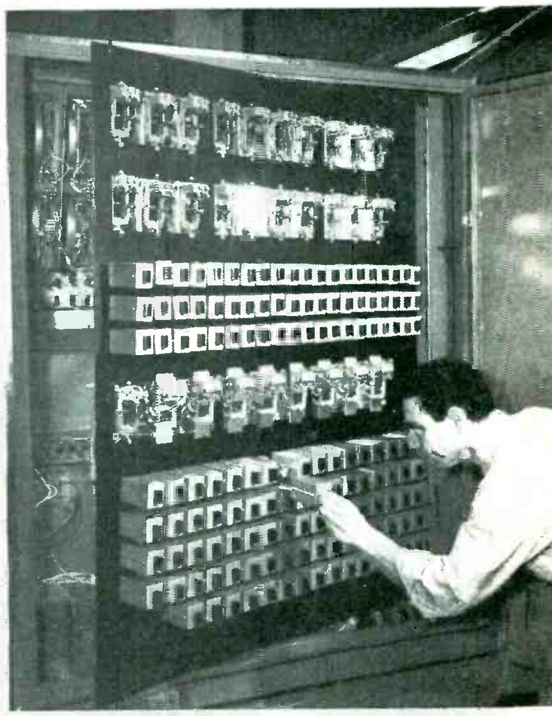
Clare Type D, slow-operate relay . . . for d.c. operation.

Clare Type 26 spring driven stepping switch. Used with 10 levels in DASAC control center.



DASAC Push Button Control Center which uses Clare relays and stepping switches in automatic control of warehouse assorting system.

Rear view of panel shows Clare relays, provided with dust tight covers, accessible for quick inspection and maintenance.



Pushbutton control center of the DASAC warehousing and assorting system makes use of over a hundred CLARE Type A and D relays and CLARE 10 level, 26 point stepping switches.

This device, which speeds and simplifies order picking operations, was developed by New York's Dasol Corporation, consulting engineers, to facilitate the warehouse operations of their client, Judy Bond, Inc., large blouse manufacturer.

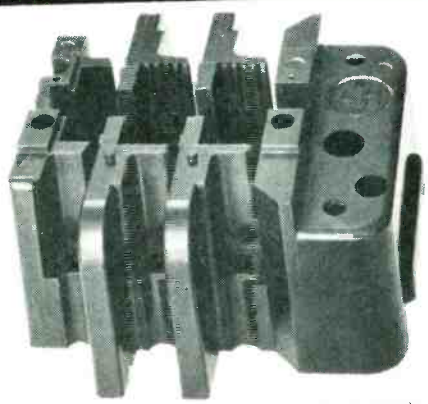
The DASAC Control Center performs three basic functions. These include selection of container destination, "memorizing" the selections in consecutive order and coordinating the information to stop the container at its proper discharge point. "Relay requirements," said Sol Tanne, Dasol Chief Engineer, "above all, demanded stability and reliability. They had to be fast-acting, quiet, stable telephone-type relays which could easily be replaced if necessary."

Ability of CLARE Relays to perform millions—in some cases billions—of trouble-free operations has made them increasingly in demand as reliable components for today's high speed devices. If your design calls for long-life, high-quality relays or stepping switches, it will pay you to bring your problem to CLARE. Experienced field engineers are located near you. Contact them or call C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: Canadian Line Materials, Ltd., Toronto 13. Cable Address: CLARELAY.

CLARE RELAYS

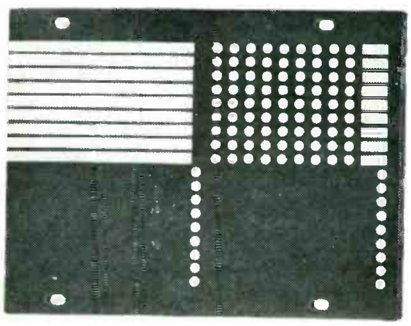
FIRST in the industrial field

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. E12, Springfield 2, Massachusetts.

MONSANTO

Serving Industry . . . which serves mankind

*RESINOX: REG. U. S. PAT. OFF.

For current limiting and for obtaining lagging power factors without distortion —

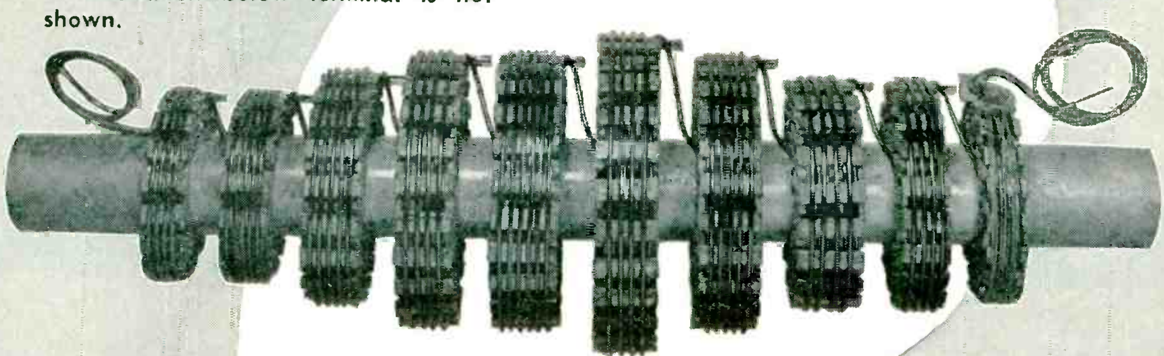
NWL Air Core Reactors

Capacity of ¼ to 2000 Amperes and 25 to 400 cycles.

For lowest possible capacitance and non-resonating peaks —

NWL Radio Frequency (R.F.) Chokes

Available in sizes 1 ampere and larger. In illustration below terminal is not shown.



NWL

ESTABLISHED 1920

NEMA

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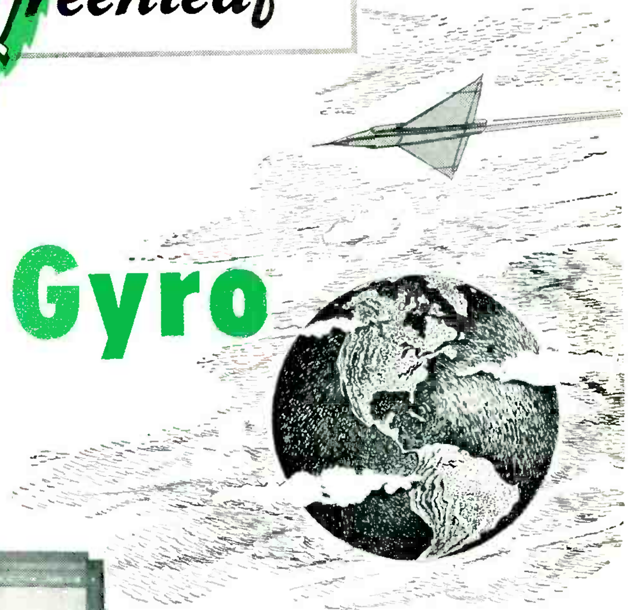
Write for complete information

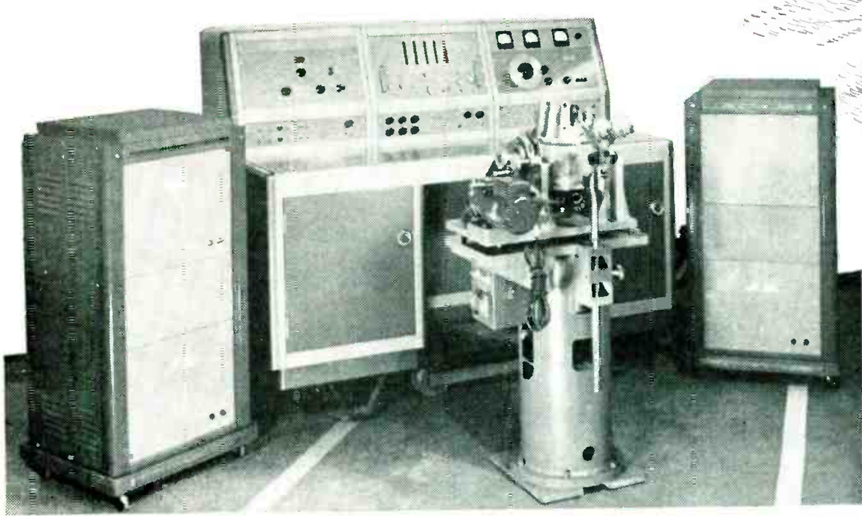
WINDING LABORATORIES, INC.

P. O. Box 455, Dept. 107 TRENTON, N. J.

ANOTHER FIRST BY *Greenleaf*



Dynamic Integrating Gyro Servo Table



Greenleaf Manufacturing Company, as a producer of Integrating Gyros, realized the need for a Dynamic Integrating Gyro Servo Test Table. This Test Table was designed and developed to facilitate the evaluation of Integrating Gyros, and Greenleaf now makes this valuable test unit available to industry.

The Gyro Servo Test Table can measure the following characteristics:

1. The drift rate of the gyro unit.
2. The current product angular velocity sensitivity ratio.
3. The characteristic time.
4. The angular velocity input voltage rate output sensitivity.
5. Minimum rate detectable.
6. High limit angular velocity deviation of performance.
7. Low limit angular velocity deviation.
8. Signal generator linearity.
9. Torque generator linearity.

Since a time interval meter is incorporated in the system, the following data can also be obtained:

10. Spin motor excitation frequency.
11. Spin motor excitation voltage.
12. Spin motor excitation current.
13. Signal generator excitation current.
14. Signal generator null output voltage.

In addition the following tests can be made:

15. Gyro damping gap temperature.
16. Accurate determination of the input axis.

ENGINEERING • DEVELOPMENT • PRODUCTION

THE *Greenleaf* MANUFACTURING COMPANY

7814 Maplewood Industrial Court • St. Louis 17, Missouri

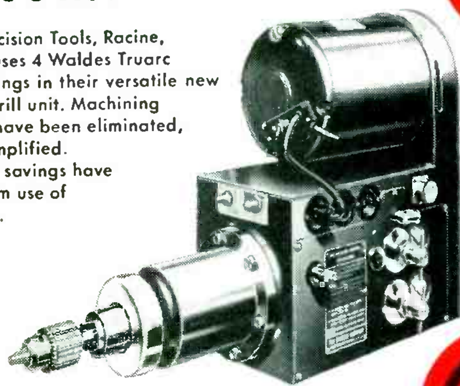
Producers of the HIG-3 and HIG-4 Gyros, Rate and Free Gyros, Differential Pressure Mach Meters, Air Speed Indicators, Computers, Switches and many other precision-built components.

Want more information? Use post card on last page.

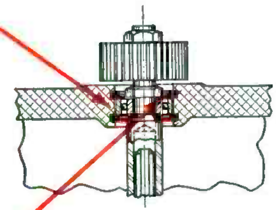
4 Waldes Truarc Rings Cut Costs Drastically, Increase Versatility of Precision Automatic Drill

Dumore's New Automatic Drill

Dumore Precision Tools, Racine, Wisconsin, uses 4 Waldes Truarc Retaining Rings in their versatile new automatic drill unit. Machining operations have been eliminated, assembly simplified. Great labor savings have resulted from use of Truarc rings.

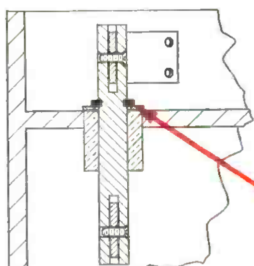


Drive Spindle Assembly



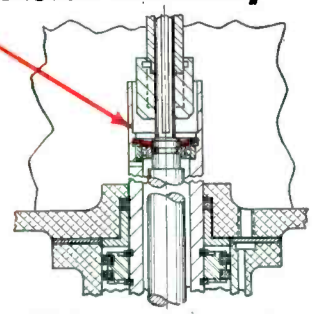
Bearing is held in position by two Waldes Truarc Rings—Standard (Series 5000) and Bowed (Series 5001). Two grooves are turned and housing rough bored in one operation. Alternate method would require at least two additional machining operations. Bowed Truarc ring takes up accumulated tolerances resiliently.

Actuator Lever Shaft Assembly



A Single Waldes Truarc External Retaining Ring (Series 5100) acts as shoulder, holds the lever in position. Labor savings are tremendous—a simple groove cutting operation replaces turning a shoulder, grinding and polishing.

Piston Assembly



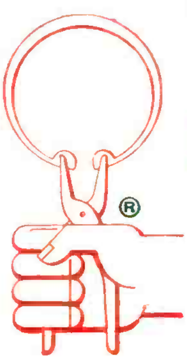
Easy assembly is assured by use of one Waldes Truarc Bowed Ring (Series 5001) to lock the bearing to the piston assembly. When unit is to be used in tapping applications, entire spindle assembly can be removed without disassembly.

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)

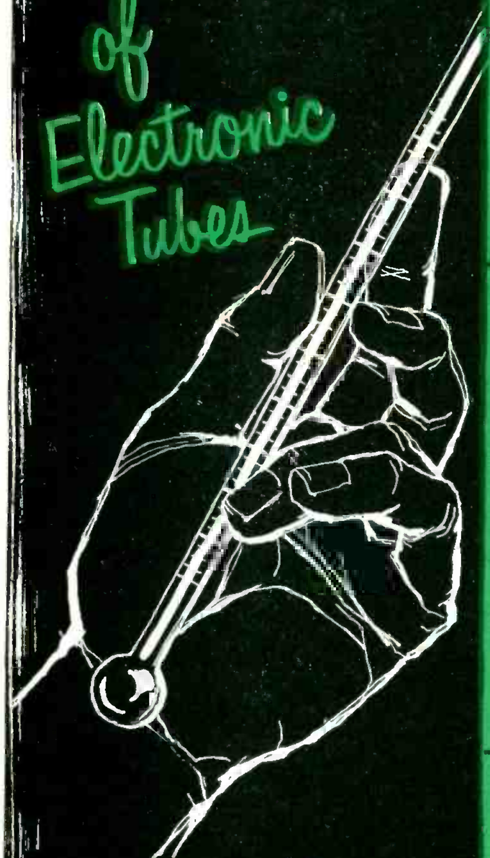
Name.................................
Title.................................
Company.................................
Business Address.................................
City.................... *Zone*...... *State*....................
E 127

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.

Want more information? Use post card on last page.

LIQUID COOLING

of Electronic Tubes



WITH Eastern COOLING UNITS

By a sustained program of research, Eastern continuously extends the uses of the latest units in electronic tube cooling, pressurizing electronic equipment, and pumping fuels and hydraulic fluids. Research and testing laboratories, a model shop, and three manufacturing plants provide the specialized equipment and manpower to turn out fully qualified units to meet appropriate government specifications.

From our extensive line of existing units, adaptations of these units, or completely new designs, Eastern can provide equipment to handle your project well. Your inquiry is welcomed.

EASTERN INDUSTRIES, INC.
100 SKIFF STREET
HAMDEN 14, CONNECTICUT

Eastern Cooling Units provide coolant liquid for maintaining within safe operating temperature limits liquid cooled electronic tubes or similar devices. The units are completely self-contained and usually comprise such components as heat exchangers, fans or blowers, liquid pumps, reservoirs, flow switch, thermostat, etc.

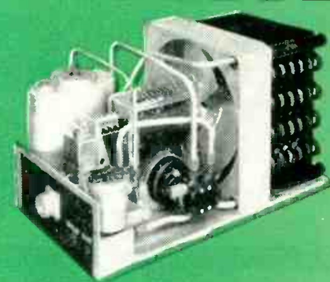
Cooling units can be modified as required for varying conditions encountered in land or sea as well as aircraft service. Almost all units are designed to meet such specification as MIL-E-5400 and MIL-E-5272.

The units shown below are intended only to illustrate the varying requirements which can be satisfied. By utilizing fairly standard components and designs based on broad experience in this field, Eastern is able to provide at minimum cost equipment exactly suiting a specific requirement.

Eastern welcomes your consultation on liquid cooling problems ranging from 200 to 20,000 watts dissipation.

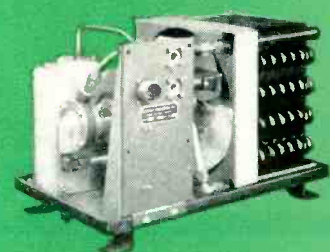
Write for Aviation Products Bulletin 330.

MODEL MB-175, TYPE 200 DISSIPATION: 2,000 watts. ALTITUDE RANGE: sea level to 50,000 feet. POWER REQUIRED: 28 volts D.C. WEIGHT: 25 pounds. SIZE: 10" x 15-15/16" x 10¾" high.



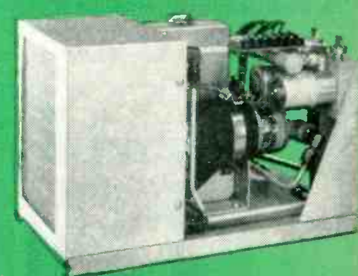
MODEL E/HT-205, TYPE 200A DISSIPATION: 1600 watts. ALTITUDE RANGE: sea level to 5,000 feet. POWER REQUIRED: 28 volts D.C. WEIGHT: 25 pounds. SIZE: 10" x 21" x 10" high.

MODEL MB-177, TYPE 202 DISSIPATION: 1700 watts. ALTITUDE RANGE: sea level to 50,000 feet. POWER REQUIRED: 110 volt, 400 cycle, 3 phase. WEIGHT: 27 pounds. SIZE: 10" x 19 15/32" x 7⅝" high, per JAN-C-1720A, size B1-D1.



MODEL E/HT-210, TYPE 200 DISSIPATION: 1500 watts. ALTITUDE RANGE: sea level to 10,000 feet. POWER REQUIRED: 208 volts, 400 cycle, 3 phase. WEIGHT: 35 pounds. SIZE: 11¼" x 19½" x 12½" high.

MODEL E/HT-200, TYPE 201 DISSIPATION: 1,000 watts. ALTITUDE RANGE: sea level to 50,000 feet. POWER REQUIRED: 28 volts D.C. WEIGHT: 14½ pounds. SIZE: 10" x 10" x 6" high.



MODEL NO. 5-A DISSIPATION: 1,000 watts. ALTITUDE RANGE: sea level to 5,000 feet. POWER REQUIRED: 100 to 110 volts D.C. WEIGHT: 10 pounds. SIZE: 7⅞" x 13½" x 9-1/16" high.

Two Metals
are Better Than One

...and GENERAL PLATE Composite Metals Provide Performance plus Economy

Virgin metals and alloys have their limitations, and to overcome them . . . to get the *exact* performance you want . . . General Plate Composite Metals are the answer. They give you broadened physical and metallurgical characteristics . . . meet your specific requirements closer and do the job better, at lower costs.

For instance — permanently bonded copper to steel gives both high conductivity and extra rigidity. Silver or gold bonded to copper or bronze combines workability with high corrosion resistance. Bronze on copper makes ideal current carrying spring material with higher conductivity. Ferrous and non-ferrous combinations give you composite metals with magnetic and non-magnetic surfaces.

General Plate Composite metals in dozens of combinations eliminate many headaches . . . are the answer to corrosion, conductivity, heat dissipation, cost and many other problems.

General Plate products include . . . precious metals clad to base metals, base metals clad to base metals, thin-gauge rolling, composite contacts, buttons and rivets, *Truflex*® Thermostat Metals, *Alcuplate*®, platinum fabrication and refining, #720 Manganese Age-hardenable Alloy. Write for complete information and Catalog PR-700 today.

You can profit by using General Plate Composite Metals!

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

Variable width — width of each of 5 pulses can be adjusted independently.

Variable delay—delay between each of 5 pulses can be adjusted independently.

CODE MODULATED MULTIPLE-PULSE MICROWAVE SIGNAL GENERATOR Model B

Pulse-time modulation—input provided in each of 5 pulse channels for external pulse-time modulation.

Variable repetition rate—repetition rate of each group of pulses can be varied.

CODE MODULATED MULTIPLE-PULSE MICROWAVE SIGNAL GENERATOR

Model B 950-10,750 mc

Generates multi-pulse modulated carrier for beacons, missiles, radar...provides 5 independently adjustable pulse channels, 4 interchangeable r-f oscillator heads, precision oscilloscope, self-contained power supplies ...all in one integrated mobile instrument.

The Polarad Model B is an essential instrument for testing beacons, missiles, radar, navigational systems such as DME, Tacan, H. F. Loran, etc., where multi-pulse modulated, microwave frequency energy with accurately controlled pulse width, delay, and repetition rate is required for coding.

A fully integrated self-contained equipment with these features:

Four Interchangeable Microwave Oscillator Units — all stored in the instrument... each with UNI-DIAL control... precision power monitor circuit to maintain 1 mw power output reference level... keying circuit to assure rapid rise time of modulated r-f output... non-contacting chokes.

Five Independently Adjustable Pulse Channels —each channel features variable pulse width and delay; has provisions for external pulse-time modulation.

Precision Oscilloscope with Built-In Wide Band RF Detector for viewing the modulation envelope and accurately calibrating the r-f pulse width, delay, and group repetition rate. Equipped with built-in calibration markers.

Self-Contained Power Supplies—Model B operates directly from an AC line through an internal voltage regulator. The coded multi-pulse generator is equipped with an electronically regulated low voltage DC supply. Klystron power unit adjusts to proper voltage automatically for each interchangeable band.

Contact your Polarad representative or write to the factory for detailed information.

SPECIFICATIONS:

Frequency Range:
- Band 1 . . . 950 to 2400 mc
- Band 2 . . . 2150 to 4600 mc
- Band 3 . . . 4450 to 8000 mc
- Band 4 . . . 7850 to 10,750 mc

Frequency Accuracy . . . ±1%

RF Power Output . . . 1 milliwatt maximum (0 DBM)

Attenuator:
- Output Range . . . 0 to −127 DBM
- Output Accuracy . . . ±2db
- Output Impedance . . . 50 ohms nominal

RF Pulse Characteristics:
- a. Rise Time . . . Better than 0.1 microsecond as measured between 10 and 90% of maximum amplitude of the initial rise.
- b. Decay Time . . . Less than 0.1 microsecond as measured between 10 and 90% of maximum amplitude of the final decay.
- c. Overshoot . . . Less than 10% of maximum amplitude of the initial rise.

Internal Pulse Modulation:
- No. of Channels . . . 1 to 5 independently on or off
- Repetition Rate . . . 40 to 4000 pps
- Pulse Width . . . 0.2 to 2.0 microseconds
- Pulse Delay . . . 0 to 30 microseconds
- Accuracy of Pulse Setting . . . 0.1 microsecond
- Minimum Pulse Separation . . . 0.3 microsecond
- Initial Channel Delay . . . 2 microseconds from sync. pulse
- Internal Square Wave . . . 40-4000 pps (separate output)

Pulse Time Modulation:
- Frequency . . . 40-400 cps any or all channels
- Required Ext. Mod. . . . 1 volt rms min.
- Maximum deviation . . . ±0.5 microsecond

Power Input (built-in power supply) 105/125 v, 60 cps 1200 watts.

AVAILABLE ON EQUIPMENT LEASE PLAN | FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

POLARAD PROVEN RELIABILITY **ELECTRONICS CORPORATION** 43-20 34th STREET, LONG ISLAND CITY 1, N. Y.

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Want more information? Use post card on last page.

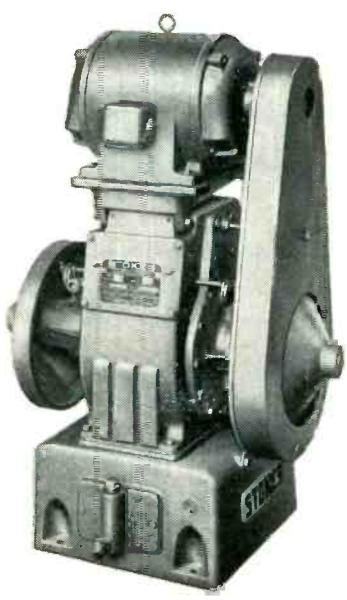
RCA ALUMINIZES TV TUBES ON

Overall view of Stokes continuous vacuum metallizing dolly system for aluminizing TV tubes at RCA's Marion, Indiana plant. Operator is required only to load and unload tubes from the 22 carts.

THE COMPLETE LINE OF STOKES

Stokes manufactures a complete line of vacuum pumping equipment. This includes mechanical vacuum pumps, diffusion and booster pumps, vacuum valves and gages, and complete vacuum instrumentation. In engineered high vacuum equipment, Stokes builds vacuum metallizers, vacuum furnaces and other vacuum processing equipment.

Stokes has for many years been active in vacuum research. Vacuum experience among our engineers covers the range from laboratory equipment to some of the largest vacuum equipment in service. This experience is available to help solve your vacuum problems.



STOKES MECHANICAL VACUUM PUMPS

For vacuum processing systems and for maintaining low forepressures in high-vacuum systems, the Stokes Microvac pump provides efficient, economical operation. Designed with fully automatic lubrication and a long-lasting exhaust valve assembly, every Microvac pump is assured of smooth, trouble-free operation. Six sizes give capacities from 15 to 500 cfm. Gas-ballast available on all sizes. Send for catalog listed.

STOKES METALLIZING DOLLIES

The new Stokes installation at RCA's Marion, Indiana, plant is a valveless, rugged system capable of aluminizing up to 120 TV picture tubes per hour. Low in operating cost, it is by far the least complex continuous aluminizing system available. It is designed without timers, gadgets or intricate accessories, any of which could fail and stall production. The system is so free of vibration that a five-cent piece can be balanced on the dollies while they are in motion.

Operation is simplicity itself: the operator loads one tube to a cart; pressure is automatically reduced to the required vacuum, the filament is automatically flashed and the completed metallized tube delivered to the operator's station.

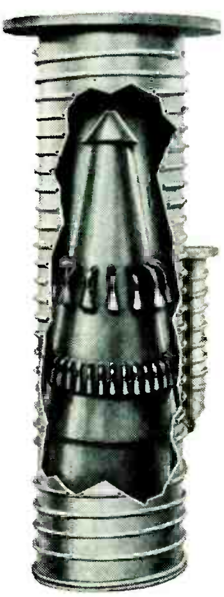
For metallizing COLOR or BLACK AND WHITE TV tubes, Stokes designs and installs automatic or semi-automatic in-line systems or stationary units, in standard designs or to customer's requirements.

F. J. Stokes Machine Company
Philadelphia 20, Pa.

SEND FOR TECHNICAL LITERATURE:

- Microvac Pumps—Catalog 750
- Diffusion and Booster Pump Specification sheets and performance curves
- The Story of the Ring-Jet Pump
- Complete Vacuum Processing Systems—Catalog 730
- How to Care for Your Vacuum Pump—Booklet 755
- Vacuum Impregnation — Catalog 760
- Vacuum Drying—Catalog 720
- Vacuum Furnaces — Catalog 790
- Vacuum Metallizing — Catalog 780
- Vacuum Calculator Slide Rule

VACUUM EQUIPMENT



STOKES RING-JET DIFFUSION AND BOOSTER PUMPS

The new Stokes Ring-Jet Pumps embody a new concept of the diffusion principle. Size for size, they have pumping speeds of 10% to more than 100% above any other diffusion pump for a given heat input. Ring-Jet Diffusion Pumps are available in sizes of 4, 6, 10, 14 and 16 inches; Booster Pumps in sizes of 4, 6, 10 and 16 inches. Send for information listed.

STOKES VACUUM VALVES

To control vacuum safely and surely, Stokes vacuum valves are available in 4, 6, 10 and 16-inch standard flange sizes.

STOKES-McLEOD VACUUM GAGES

For measuring vacuums from fractions of a micron up to 50 mm, Stokes-McLeod gages are the standard of reference. Four sizes available.

STOKES

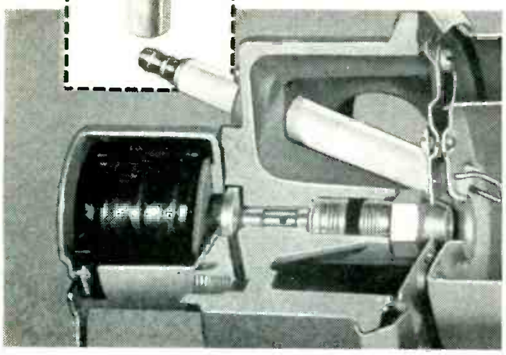
ENGINEERS: Stokes is continually adding to its engineering and technical sales staffs in the high vacuum, industrial tabletting, powder metal and plastics molding fields. If you can qualify, there may be a position for you.

OFFICES IN PRINCIPAL CITIES, REPRESENTATIVES THROUGHOUT THE WORLD

Want more information? Use post card on last page.

To withstand high heat, shock, and continuous off-on cycling . . .

Close-up of Centralab Electrical Porcelain spark-plug body.



Cutaway view of the heat exchanger and burner assembly. Centralab Electrical Porcelain spark plug is in upper left-hand corner. Fuel is ejected through metal nozzle just below spark plug.

Centralab ceramic insulator

used as igniter in new, instant car heater

A newly designed, gasoline-burning, instant heater for passenger automobiles uses the principle of reliable aircraft heaters.

The new heater is an injection-type system which is complete in itself. Ignition is accomplished by a spark plug of Centralab Electrical Porcelain, energized by a separate ignition system.

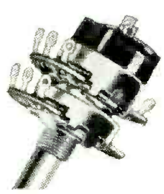
The spark is cycled off and on with the fuel — usually several times per minute, as the off-on cycling modulates heater output. Ignition is instantaneous.

This calls for complete reliability and perfect timing — accomplished with Centralab Electrical Porcelain made for specific heat-range and heat-shock requirements. Like all Centralab ceramics, it has high heat resistance, high dielectric strength, and dimensional stability.

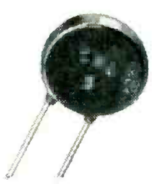
Get the whole story on *all* the Centralab ceramics — including Steatite, Cordierite, Zirconite, and Titanate. Write for Centralab Ceramic Buyer's Guide, Bulletin 42-221. Or refer to it in Sweet's Product Design File.

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

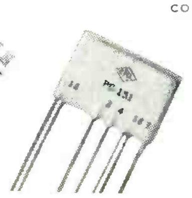


CONTROLS



CERAMIC CAPACITORS

SWITCHES



PACKAGED ELECTRONIC CIRCUITS

CERAMICS

SPECIAL
this month only!

Centralab Sweepstakes

28
Big Prizes!

Nothing to buy!
Nothing to answer!

1st PRIZE — $100.00 Gift Certificate for a Hart-Schaffner & Marx Suit.

2nd PRIZE — Four (4) Arrow Shirts.

3rd PRIZE — Two (2) Arrow Shirts.

Twenty-five (25) 4th PRIZES — One (1) Arrow Tie each.

To be eligible for the grand drawing, simply send us your name and address on your letterhead. Or ask your Centralab rep for an entry blank. Entries must be postmarked no later than midnight, December 31, 1955. Contest not open in states where prohibited.

X-5513

Centralab A DIVISION OF GLOBE-UNION INC.

914L E. Keefe Avenue • Milwaukee 1, Wisconsin
In Canada: 804 Mt. Pleasant Road, Toronto, Ontario

SINCE 1922, INDUSTRY'S GREATEST SOURCE OF STANDARD AND SPECIAL ELECTRONIC COMPONENTS new product information

December, 1955

MP-2

RUGGEDIZED-SEALED METER-RELAYS

These ruggedized versions have the same electrical specifications and use the circuitry shown in Bulletin G-6.

Meter-relays are indicating meters with built-in relay contacts. One contact is carried on the moving pointer. The other is carried on a semi-fixed pointer. When the two pointers meet, the contacts close and lock. Locking coil is wound directly over moving coil. Reset can be manual or automatic. It consists of opening the locking circuit. Spring action in contacts kicks them apart forcefully. There are no pushers nor solenoids inside meter case.

These instruments meet the mounting dimension requirements of MIL M-6A. The degree of resistance to shock and vibration depends upon sensitivity and type of action wanted. In general, the relays will not be permanently damaged by shocks of 100 G's and vibrations up to 2,000 cps at 3-4 G's. The most sensitive relays may close their contacts under these conditions.

Usual meter ranges can be supplied from 0-20 Ua. to 0-50 A., or, 0-5 Mv. to 0-500 V. All ranges can be supplied either AC or DC except low millivolts (under 0-250 Mv.). These come only in DC because of limitations of instrument rectifiers. Higher voltage or current ranges are made with external multipliers.

Contact setting is adjustable from front to any point on scale arc. Or, it may be preset at any fixed point. Contact arrangements are (1) single high (2) single low (3) double, high and low. When used only as relays they can be made to operate on as little as 0.2 microamperes (3000 ohms) or 0.05 millivolts (20 ohms).

All models can be supplied as contact meters, illustrated in the upper photos, or as a panel meter, shown below.

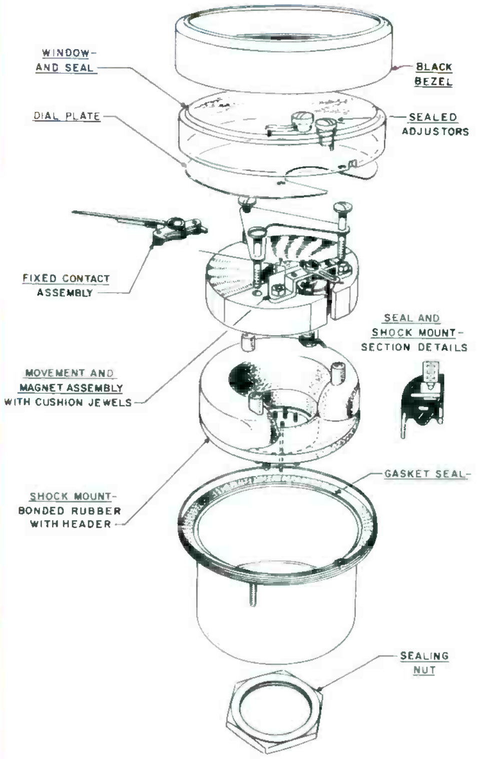
MODEL 255-C 2½ Inch — **Narrow bezel provides same dial area as usual 3½ inch meter.**

MIL M-6A Mounting Dimensions

Black Face

MODEL 355-C 3½ INCH

White Face



MODEL 455, 4½ INCH

The DEW Line:

The Model 255-C meter-relays perform a vital function in DEW Line (Distant Early Warning Radar Screen) equipment manufactured by Raytheon Manufacturing Company, Waltham, Mass., where they meet these specifications:

ELECTRICAL:	0/100 microamperes with specified speed and damping.
SHOCK:	1 and 3-foot drops, 400 lb. hammer, 3 planes.
VIBRATION:	MIL-M-10304 (Sig C)
SALT SPRAY:	QQ-M-151 A
TEMPERATURE:	−30° C to +70° C
SEALING:	MIL-M-6A

CHESTERFIELD CIGARETTES:

Cigarette quality is controlled by the AccuRay Cigarette Gauge-Controller made by Industrial Nucleonics Corporation, Columbus, Ohio. It has appeared in Chesterfield ads in newspapers and magazines, and on the Dragnet, Gunsmoke, and Warner Brothers Presents television shows. The Model 355-C double contact meter-relay is a basic component of this automatic process control.

ASSEMBLY PRODUCTS, INC.

Wilson Mills Road
Chesterland 4, Ohio
Telephone (Cleveland, Ohio)
HAmilton 3-4436

Or

69-873 Dillon Road
P. O. Box 308
Desert Hot Springs 1, California
Telephone 4-2468

RUGGEDIZED-SEALED METER-RELAYS

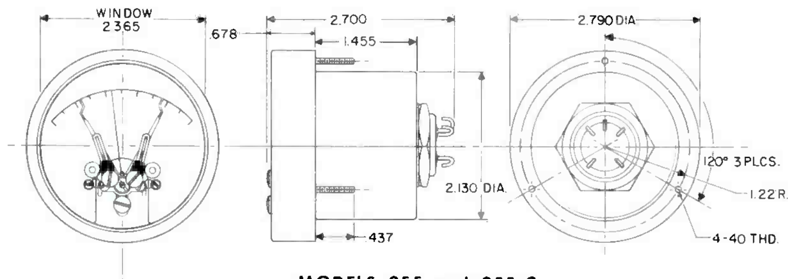
DATA SHEET

Ordering Specifications

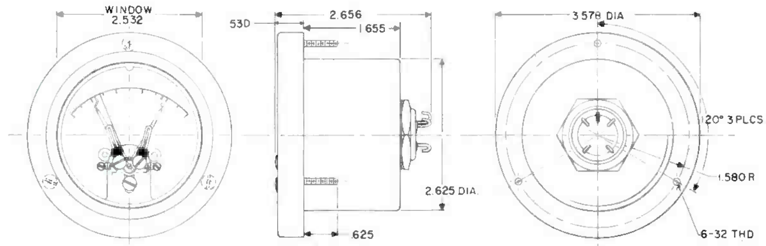
CONTACTS: The same size contacts (platinum-iridium) are used for all contact ratings. Locking coil turns vary for different ratings. Standard rating 5 - 25 DC milliamperes, 75 - 125 volts. Other ratings to 100 Ma.

- ☐ HIGH LIMIT CONTACTS: Standard.
- ☐ LOW LIMIT: Same price, specify "Low Limit".
- ☐ DOUBLE CONTACT: Add $10.00.
- ☐ FIXED CONTACT: Single ☐ deduct $2.00.
  Double ☐ deduct $3.00.
- ☐ ISOLATED COILS: (Maximum insulation 50 volts) add $5.00.
- ☐ DOUBLE LOCKING COIL: (for same contact polarity on both high and low limits) add $5.00.
- ☐ SUPPRESSED ZERO: (scale 40-80 etc.) add 10%. (Specify range).
- ☐ AC METER-RELAYS: (rectifier type) add $5.00 and specify AC (minimum volts range 0/250 AC millivolts).
- ☐ SPECIAL CONTACT RATING: ____________ DC volts,
  ____________ DC milliamperes.
- ☐ MOUNTING: Will be mounted in steel ☐
  or non-magnetic material ☐

RANGE: ______________________________



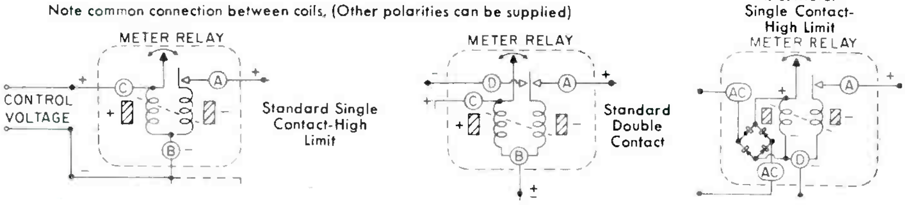
MODELS 255 and 255-C

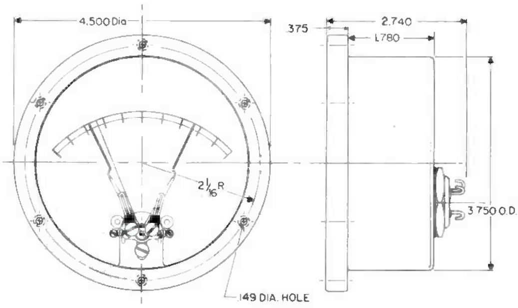


MODELS 355 and 355-C

POLARITY

Note common connection between coils. (Other polarities can be supplied)





MODELS 455 and 455-C

RUGGEDIZED-SEALED METER-RELAY PRICES

	Ohms	Model 255-C 2½ Inch	Model 355-C 3½ Inch	Model 455-C 4½ Inch
DC Microamperes				
0—20	3,000	$63.25	$68.25	$73.25
0—50	3,000	51.00	56.00	61.00
0—100	950	46.00	51.00	56.00
0—250	650	43.00	46.00	51.00
0—500	100	41.00	45.50	49.00
(Intermediate and higher ranges priced same as nearest listed)				
DC Milliamperes				
0—1 to 0—50 (Approx. 100 Mv.)		$40.00	$44.50	$48.00
0—55 to 0—1000 (Approx. 50 Mv.)		45.00	49.00	53.00
DC Amperes				
0—1 to 0—50 (Approx. 50 Mv.)		45.00	49.00	53.00
(External shunt required for ranges over 50 Amperes)				
DC Millivolts	**Ohms**			
0—5	20	$63.25	$69.00	$75.00
0—10	40	51.00	56.00	61.00
0—25	100	45.00	50.00	55.00
0—50	50*	41.00	46.00	51.00
*(Supplied as standard. 5 ohms, 200 ohms, and other resistances available.)				
(Intermediate and higher ranges priced same as nearest listed)				
DC Volts				
0—1 to 0—500 (Approx. 1000 ohms per Volt. Other sensitivities available.)		$42.50	$47.00	$50.50
(External resistor required for ranges over 500 volts)				

QUANTITY DISCOUNTS

Meter-Relays and Contact Pyrometers

Quantity	Discount
1—4	Net
5—24	15%
25—49	20%
50—99	22½%
100—199	25%

200 up request quotation.

For one range of one model only.

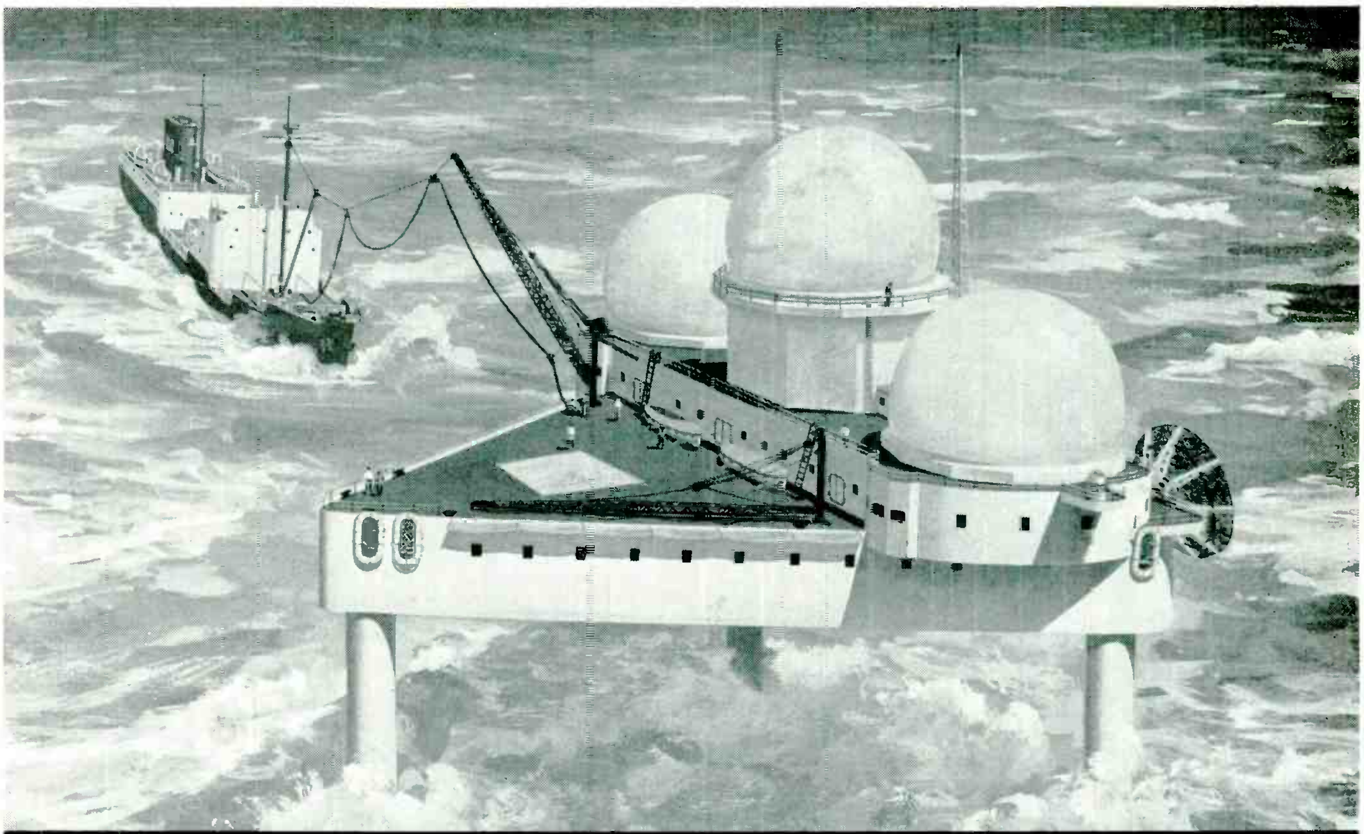
CONTACT PYROMETER PRICES (4 ohms/millivolt with bimetal compensation)

		Int. Res.	Ext. Res.	Thermo-couple	Model 255-C 2½ Inch	Model 355-C 3½ Inch	Model 455-C 4½ Inch
0—3000°F	0—1650°C	70	10	Pt 13% Rh	$46.00	$51.00	$56.00
0—2500	0—1370	212	10	C/A	41.00	46.00	51.00
0—2000	0—1100	172	10	C/A	41.00	46.00	51.00
0—1500	0—800	179	10	I/C	41.00	46.00	51.00
0—1000	0—500	112	10	I/C	44.00	49.00	54.00
0—750	0—400	81	10	I/C	46.00	51.00	56.00
0—500	0—260	52	10	I/C	49.00	54.00	59.00
0—300	0—150	22	10	I/C	54.00	59.00	64.00
−75 to +225	−60 to +110	22	10	I/C	54.00	59.00	64.00
−200 to +100	−130 to +40	22	10	C/C	59.00	64.00	69.00

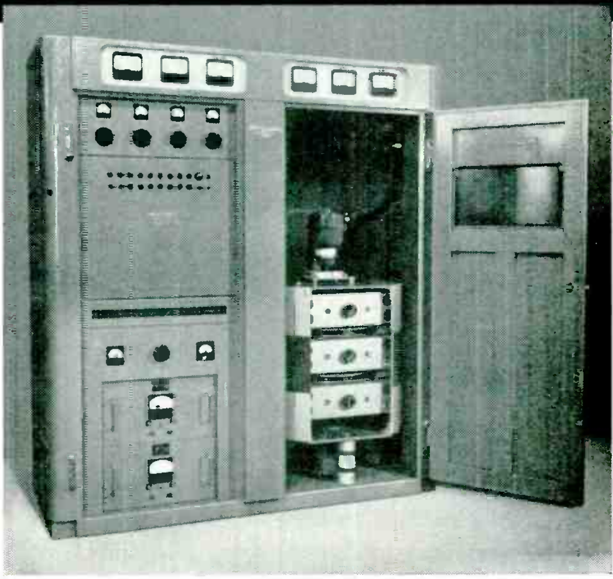
Thermocouples shown are standard. Pyrometers can be calibrated for use with most other types at extra charge. Ranges listed are standard. Special ranges made to order.

ASSEMBLY PRODUCTS, INC.
Wilson Mills Road
Chesterland 4, Ohio
Telephone (Cleveland, Ohio)
HAmilton 3-4436
Or
69-873 Dillon Road
P. O. Box 308
Desert Hot Springs 1, California
Telephone 4-2468

Litho in U. S. A.



EIMAC KLYSTRONS are used in Texas Towers forward-scatter communications system



National Company two, ten and fifty kilowatt transmitters employing Eimac klystrons and circuit components are among the pacesetters in the revolutionary art of forward-scatter propagation.

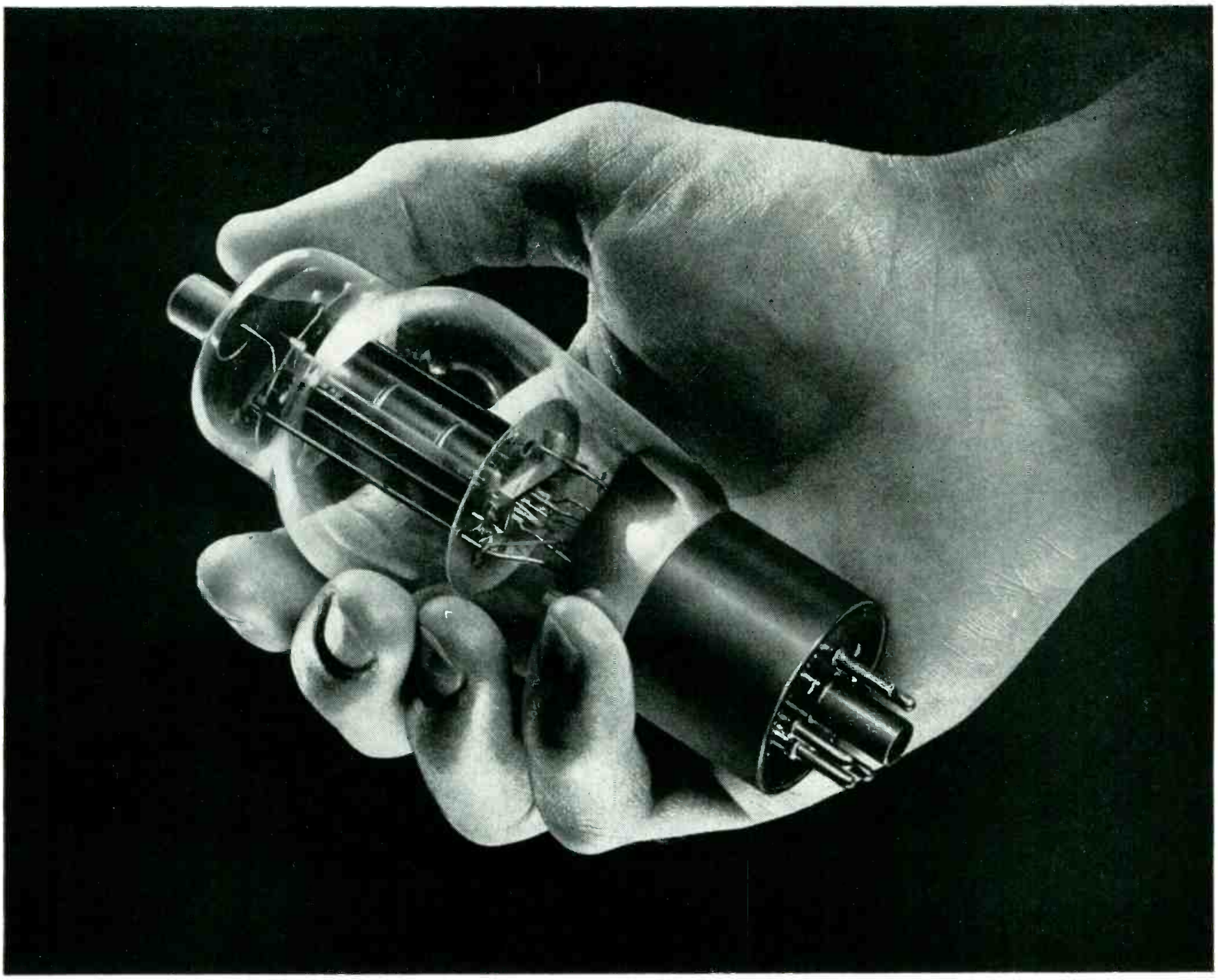
High power UHF/microwave forward-scatter transmitters by National Company are an example of reliable National equipment designed to meet the most exacting requirements. From the first National Company forward-scatter development link to the advanced Texas Tower communication net, Eimac klystrons have been used exclusively as high power final amplifier tubes. Eimac amplifier klystrons provide the power necessary to make long distance communication through forward-scatter techniques practical at microwave frequencies.

- *Second in a series of advertisements emphasizing the extensive application of Eimac amplifier klystrons and circuit components by the leading manufacturers of forward-scatter UHF/microwave transmitters.*

Eimac
THE POWER FOR FORWARD-SCATTER

EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA
The World's Largest Manufacturer of Transmitting Tubes

Want more information? Use post card on last page.

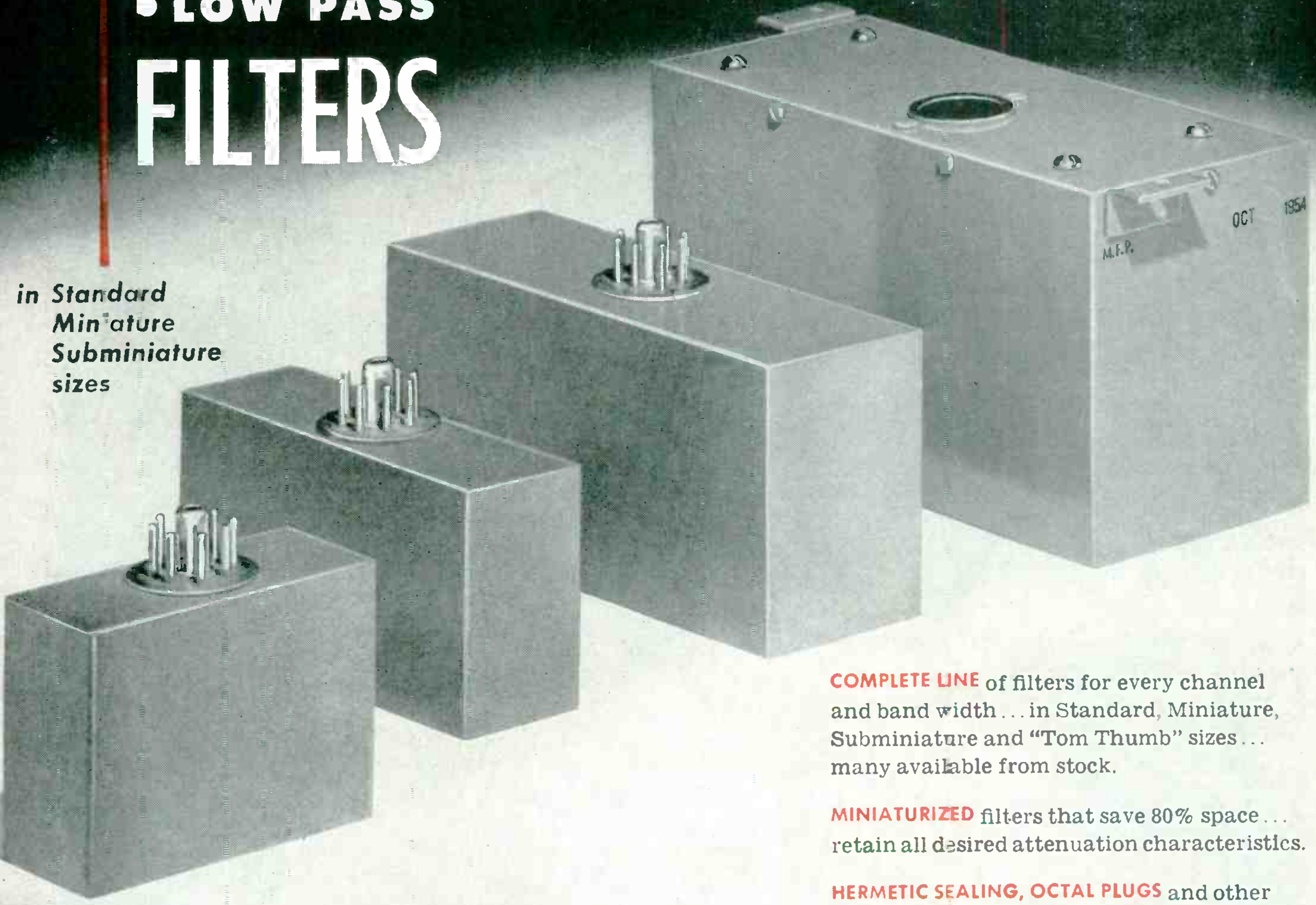


TELEMETERING

• BAND PASS
• LOW PASS

FILTERS

in Standard
Miniature
Subminiature
sizes



COMPLETE LINE of filters for every channel and band width . . . in Standard, Miniature, Subminiature and "Tom Thumb" sizes . . . many available from stock.

MINIATURIZED filters that save 80% space . . . retain all desired attenuation characteristics.

HERMETIC SEALING, OCTAL PLUGS and other new features.

only Burnell offers you . . .

SPECIAL PHASE LINEARITY characteristics to conform to new concepts of high accuracy telemetering practice.

SPECIFICALLY DESIGNED for telemetering, these filters have found great utility in a wide variety of communications and control applications.

APPLICATION ENGINEERING service plus complete technical literature. Write Dept. C-12 for Catalog 102A.

PARTIAL LISTING OF MINIATURE TELEMETERING BAND PASS FILTERS

Channel Freq.	15% Band Width	30% Band Width	Case Size	Approx. Weight	Attenuation	
	Type No.	Type No.	W- L- H-		15% B. W.	30% B. W.
400 CPS. 560 " 730 " 960 "	S-15456 S-15457 S-15458 S-15459	S-15477 S-15478	2 x 6 x 2¾	3 lbs.	4DB — 15% 20DB — 23% 40DB — 27%	4DB — 30% 20DB — 46% 40DB — 54%
1300 " 1700 " 2300 "	S-15460 S-15461 S-15462		1⅜ x 4½ x 2¼	1 lb. 7 oz	3.5DB — 15% 20DB — 23% 40DB — 27%	3.5DB — 30% 20DB — 46% 40DB — 54%
2570 " 3000 " 3900 " 4500 " 5400 " 7350 " 10500 " 12300 " 14500 " 22000 " 27000 " 30000 " 40000 " 52500 " 70000 "	S-15463 S-15464 S-15465 S-15466 S-15467 S-15468 S-15469 S-15470 S-15471 S-15472 S-15473 S-15474 S-15475 S-15476	 S-15479 S-15480 S-15481 S-15482 S- S-15483 S-15484 S-15485 S-15486 S-15487 S-15488	1⅜ x 3 x 2¼	9¾ oz.	3DB — 15% 20DB — 23% 40DB — 26%	3DB — 30% 20DB — 46% 40DB — 52%

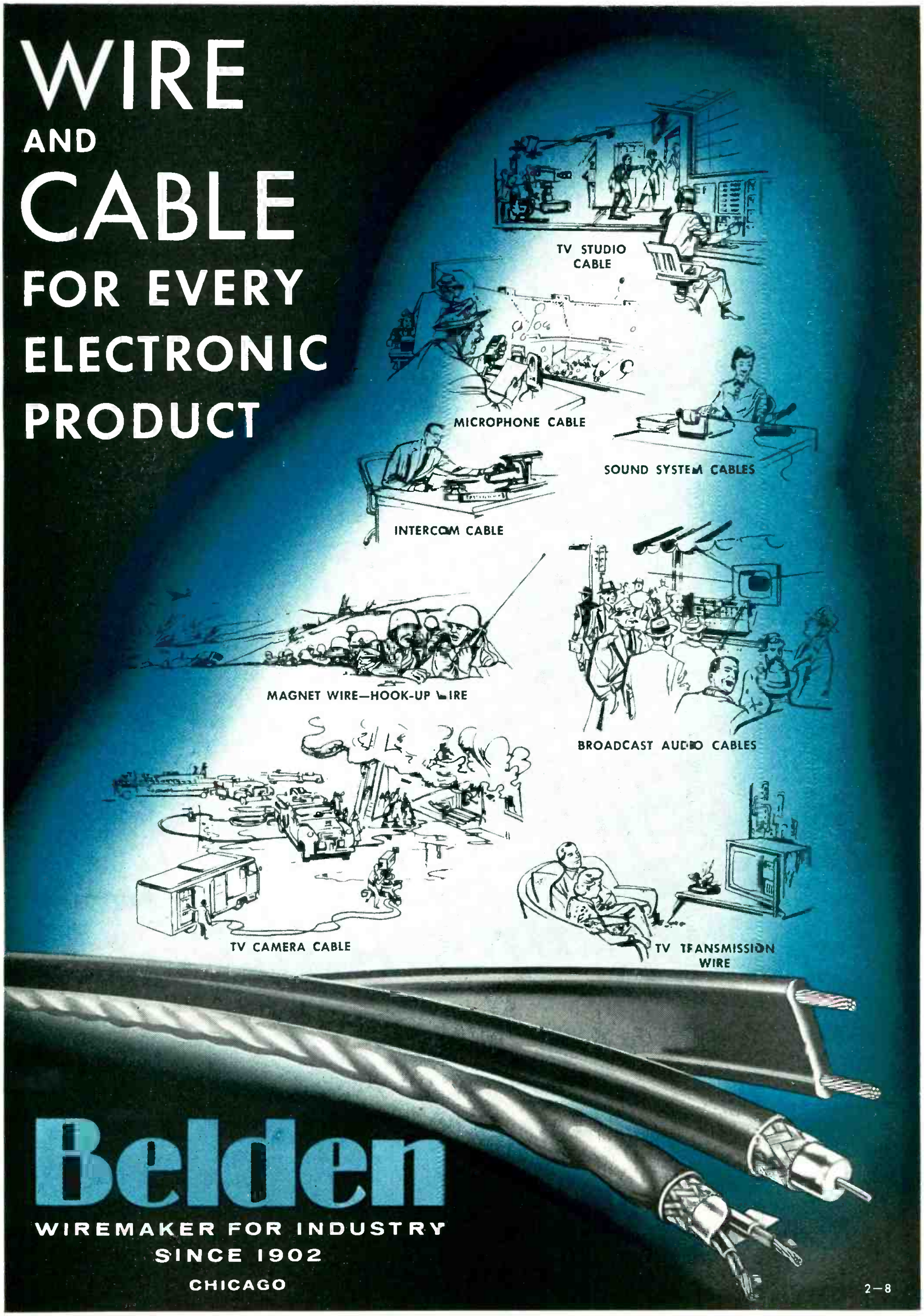
OPTIMUM OPERATING IMPEDANCES SOCKET TERMINAL CONNECTIONS

INPUT		OUTPUT	
Terminals 1 & 2	500 ohms	Terminals 1 & 6	500 ohms
Terminals 1 & 3	10000 ohms	Terminals 1 & 7	50000 ohms

Teletype: Yonkers, N. Y. 3633

BURNELL & CO., INC.
YONKERS 2, NEW YORK
Pacific Division: 720 Mission St., S. Pasadena, Calif.

FIRST IN TOROIDS, FILTERS AND RELATED NETWORKS



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The National Merit Scholarship Corporation

Business is Offered Big Dividends on Investment in Higher Education

Business firms searching for a satisfactory avenue to provide financial aid for our colleges and universities now have a new opportunity of major importance. It is provided by the National Merit Scholarship Corporation, which has offered to devote $8 million to matching, dollar for dollar, gifts by business firms for college scholarships and supplemental gifts to the institutions where the scholarships are used.

The McGraw-Hill Publishing Company is availing itself of the opportunity to establish ten National Merit Scholarships. They will be known as the McGraw-Hill Merit Scholarships. The scholarships are to be awarded to qualified candidates for a four-year college course in the fields of science, engineering and the other professions and the liberal arts. There will be no limitation, beyond the appropriate professional accrediting, on the college or university selected by a successful candidate. As part of a continuing program to aid higher education and educational institutions, McGraw-Hill is happy to be able to share in what it believes to be the constructive educational endeavor of the National Merit Scholarship Corporation.

The National Merit Scholarship Corporation, an independent agency financed initially by gifts of $20 million from the Ford Foundation and $500,000 from the Carnegie Corporation, has three major purposes which are closely related. They are:

1. To locate those of the nation's young men and young women who are best equipped to go to college.

2. When necessary, to help these young people go to college by giving them financial aid.

3. To help colleges and universities meet the full cost of the instruction of those to whom National Merit scholarships are granted.

At present about half of the nation's top high school graduates do not go to college. The principal reason is that they do not have the money required.

To Save Unused Brain Power

The National Merit Scholarship Corporation will strive to eliminate this dangerous neglect of top-flight ability. To this end it is inviting the nation's high schools, numbering more than 24,000, to participate in its program by designating as available candidates for National Merit scholarships the top 5 percent of their senior classes. Those so designated are then invited to take a series of tests and to submit reports designed to assure selection of the very best talent in each state. The number of scholarships to be allotted to each state will be proportionate to the number of high school graduates in the state.

The winners, the total number of whom will be determined by the amount of money the Scholarship Corporation has available, will be eligible for awards. For those who need no financial help to go to college there will be honorary awards of $100. For those who must have help the Corporation will grant scholarships covering as much as necessary of the cost of instruction and living expenses for a four-year college course.

Colleges Get Financial Help

The provision of funds to cover the students' expenses does not, however, solve the financial problems faced by many colleges. That is because the tuition charges paid by the students do not cover the cost of the instruction. The deficit must be met by drawing upon endowment funds, gifts, grants, and other available sources.

Consequently, to prevent holders of National Merit scholarships from imposing any additional financial burden on the colleges and universities they elect to attend, the Corporation will make a supplementary grant to these institutions. The supplementary grant will be the equivalent of regular tuition charges made by the school, with a top limit of $1,500 a year for both the tuition and the supplement.

As the scholarship grants to the winning students will vary, depending upon how much financial help they need, so will the supplementary grants vary from one college to another, depending on their regular tuition charges. However, it is anticipated that on the average the full cost of a National Merit scholarship—including aid to the student and the supplement to the college—will be about $1,500 a year.

Many business firms will find a compelling appeal in a program which is designed at once to mobilize the nation's intellectual resources more effectively and, in the process, give very badly needed financial help to our colleges and universities.

Two For One Return Offered

However, there are numerous other inducements to business firms to finance National Merit scholarships. These scholarships may:

1. Carry the name of the firm or be named in honor of someone designated by the firm.

2. Be limited to use in types of colleges of particular interest to the sponsoring firm.

3. Be limited to a college course, such as science, engineering or liberal arts, of special concern to the sponsor.

4. Be restricted to candidates or institutions in geographic areas specified by the sponsor.

In addition to these advantages there is a special financial inducement to help the Merit Scholarship program. It is that for every Merit scholarship a firm or individual finances, the Corporation will, up to the limit of $8 million, match the funds and make another National Merit scholarship available.

There are many good ways of helping our financially beleaguered colleges and universities, and many corporations are already using one or more of them.* For those companies that can do so without embarrassing complications one of the best ways is to make unrestricted gifts directly to the institutions. But this new way provided by the creation of the National Merit Scholarship Corporation (Address: 1580 Sherman Avenue, Evanston, Illinois) has the broad appeal of serving two purposes of transcendent importance simultaneously. The purposes are to see that our best brains are fully trained and utilized and that our colleges and universities, crucial contributors to this process, are helped at the same time. Business will serve the nation and its own community well by giving the National Merit Scholarship Corporation generous help.

---

* These, as well as the plight of our colleges and universities, are discussed in a pamphlet, "Business Aid to Our Colleges and Universities," which embodies a series of five editorials which appeared in all McGraw-Hill publications. Copies of the pamphlet can be obtained without charge by addressing the Department of Economics, McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York 36, New York.

Methods of helping our colleges and universities financially are also outlined and discussed in a pamphlet, "Aids to Corporate Support of Higher Education," which may be obtained without cost by addressing the Council for Financial Aid to Education, 6 East 45th Street, New York 17, New York.

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

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Donald C McGraw

PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.


Farnsworth
IS EXPERIENCE!
MISSILES
INDUSTRIAL ELECTRONICS
RADAR
ELECTRON TUBES
RESEARCH
FOR OVER 10 YEARS . . . .
Since the beginning of our country's missile activity . . . Farnsworth has participated in the design, development and production of electronic equipment for such missiles as Terrier, Talos, Sparrow and others. This tremendous background of technical skills and know-how qualifies Farnsworth — uniquely — to cope with all phases of a missile program.
FOR OVER 30 YEARS . . . .
Farnsworth has carried on an unbroken tradition of achievement in defense and industrial electronics. The genius that created electronic television, pulse techniques, electron optics and photomultipliers, continues to lead advances in radar, special purpose tubes and electronic research.
This is Farnsworth . . . pioneer in electronics . . . dedicated to the extension of man's VISION beyond the range of sight.
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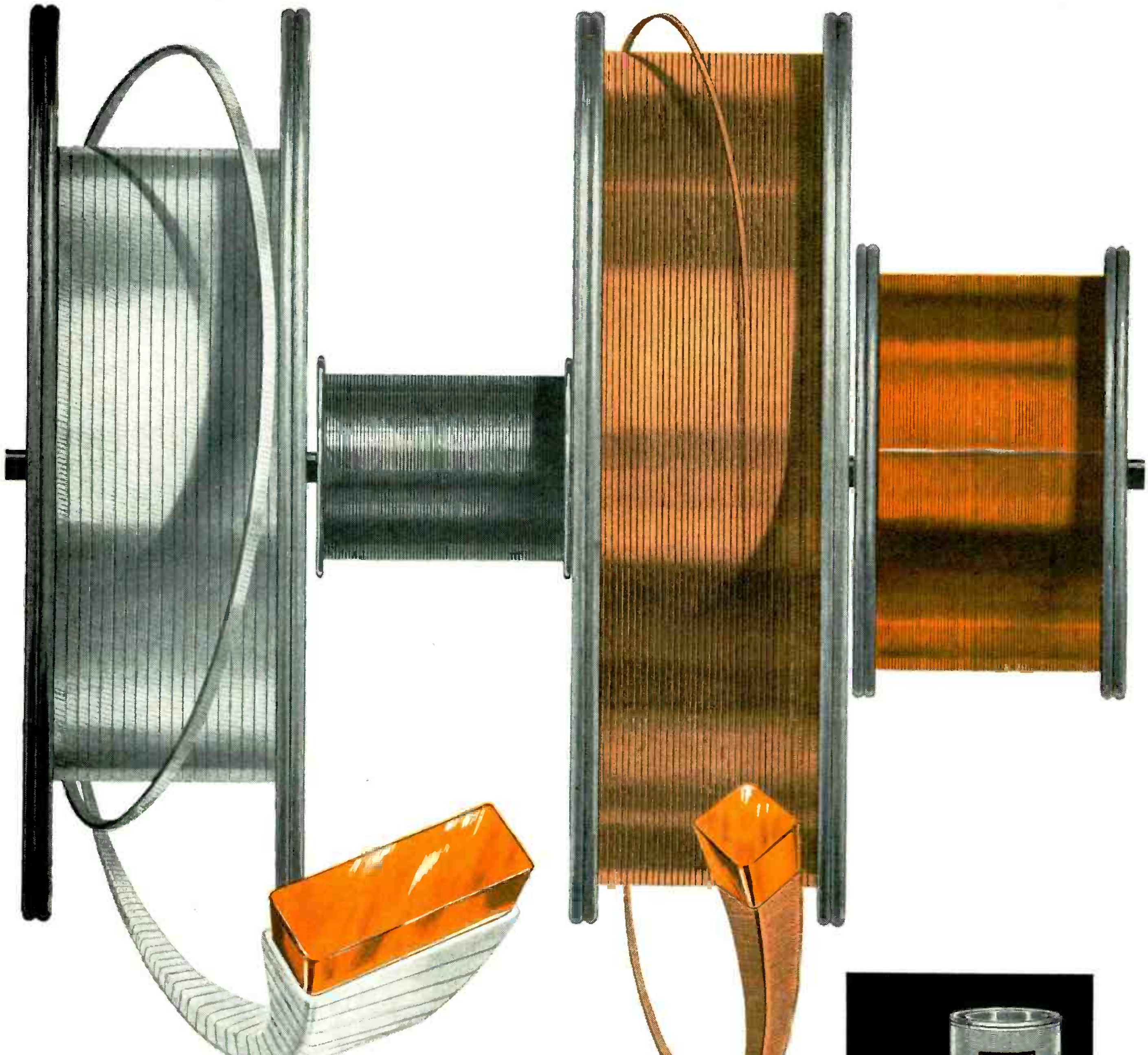
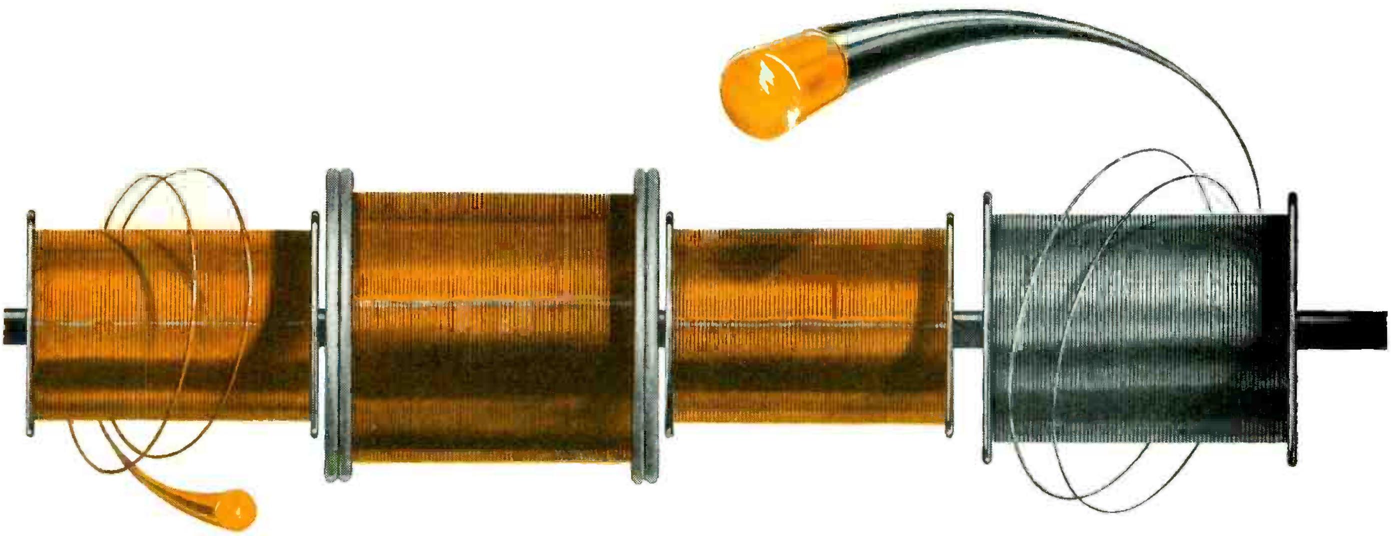
FORT WAYNE, INDIANA



Wire packaged in Phelps Dodge special "Pakeze" containers if required.

First for Lasting Quality—from Mine to Market!



If it Calls for **MAGNET WIRE**—*Call on* **PHELPS DODGE** *for*

INDUSTRY'S MOST COMPLETE, MOST UP-TO-DATE LINE!

- Every type of insulation to meet design requirements.
  Enamel • Formvar • Sodereze® • Bondeze® • Daglas® • Thermaleze®
  Silicone • Paper • Cotton • Multiple Combinations.
- Available in all sizes and shapes—round, square, rectangular.
  Over 400 different types!
- Special emphasis on research and development—your assurance of the latest advances in magnet wire.
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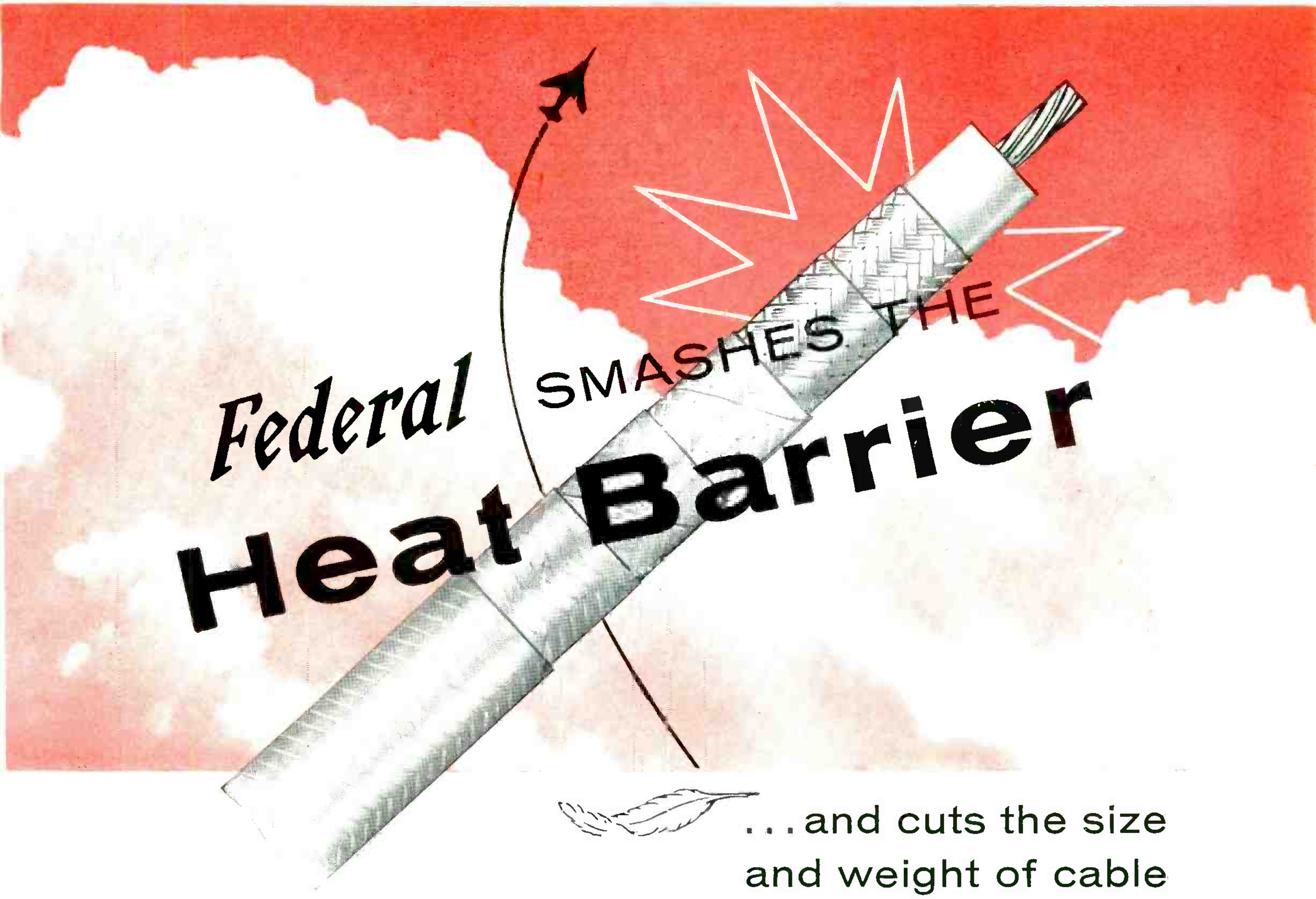

...and cuts the size and weight of cable

Federal's miniature coaxial cables—about ¼ the size of comparable RG types—save critical space and weight in aircraft and instrument uses.

Challenged by the high temperature and minimum weight requirements of jet aircraft and guided missiles, Federal has designed RG cables that perform perfectly at a blistering 500° F.! New Federal miniature coaxials have a top temperature rating of 150° C. . . . up to 200° C. with an impregnated fiber glass jacket!

The key to these new cable developments lies in advanced designs.

Based on utilization of "Teflon," this superior dielectric maintains its excellent low loss and high voltage characteristics through a temperature range of 500° F. to −100° F. "Teflon" has no measurable water absorption; it is chemically inert . . . unaffected by alkalies, acids, aromatic fuels, aromatic organic solvents, and highly corrosive aviation hydraulic fluids.

If your cable problems involve heat, space or weight, it will pay you to consider Federal's new "Teflon" insulated cables. For information, write Dept. D913.

"TEFLON" HIGH TEMPERATURE CABLES

RG-87 A/U 50 ohms; 69.5% V.P.; 29.5 mmfd/ft. Cap; 4,000 operating volts.

RG-140/U 75 ohms; 69.5% V.P.; 29.5 mmfd/ft. Cap; 1,700 operating volts.

RG-141/U 50 ohms; 69.5% V.P.; 29.0 mmfd/ft. Cap; 1,500 operating volts.

"TEFLON" MINIATURE COAXIAL CABLES

K-256 50 ohms; 29 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 13 db/100 ft. Atten. at 400 mc; 0.095 O.D. dielectric; 7/30 silver-plated Copperweld conductor; 0.135 O.D. jacket.

K-257 70 ohms; 21 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 14 db/100 ft. Atten. at 400 mc; 0.095 O.D. dielectric; 7/34 silver-plated Copperweld conductor; 0.135 O.D. jacket.

K-258 93 ohms; 16 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 15 db/100 ft. Atten. at 400 mc; 7/38 silver-plated Copperweld conductor; 0.135 O.D. jacket.

"TEFLON" HOOK-UP WIRE—Type E, EE and FF Hook-Up Wires meet MIL-W-16878A. Available in all standard colors.

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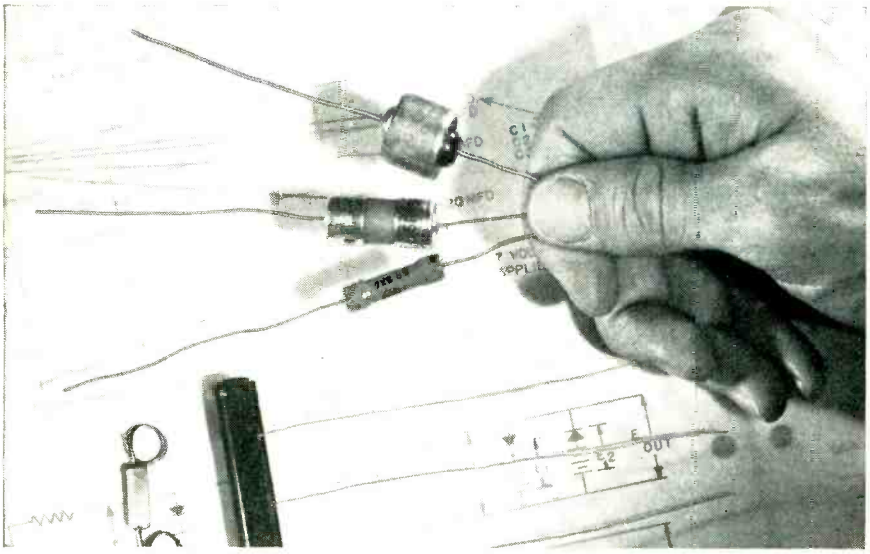
Federal Telephone and Radio Company
A Division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
COMPONENTS DIVISION • 100 KINGSLAND ROAD • CLIFTON, N. J.

In Canada: Standard Telephones and Cables Mfg. Co. (Canada) Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., New York

DESIGNER'S

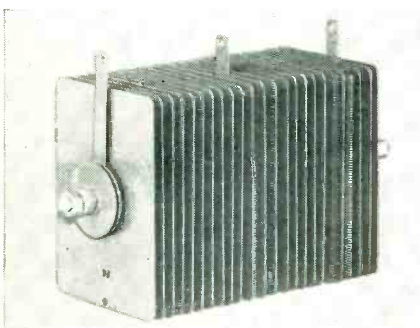
New G-E *Vac-u-Sel** component rectifiers top 80,000-hour-life expectancy



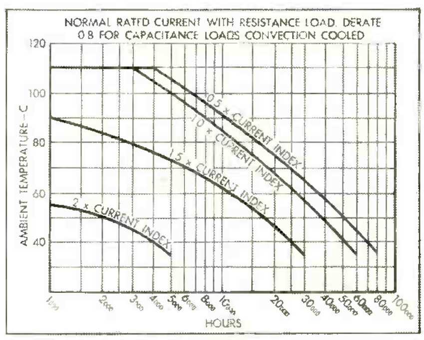
Life expectancy has now been raised from 60,000 to over 80,000 hours for General Electric's new miniature Vac-u-Sel rectifier stacks. Achieved by constantly improving processing techniques, this 20,000 hour increase in life is backed up by laboratory tests. Developed for electronic, industrial-control, and power applications, these units offer compactness and stability of electrical characteristics. Ambient temperature range is broad — −65 C to 130 C—and a wide variety of sizes, housings and finishes are available.

The "Selecto-Chart" shown below is part of a new application approach developed by G.E. It gives you greater freedom of design in selecting from the many rectifier sizes and types. Send for GEA-5935A, GEA-6273.

*Registered trade-mark of General Electric Co.



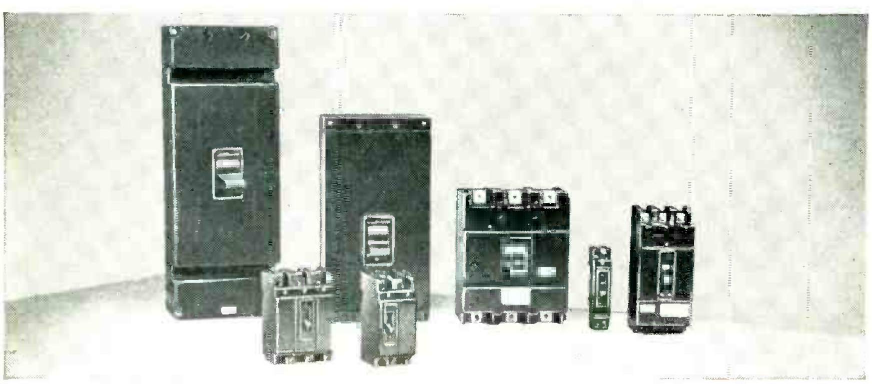
COMPACT RECTIFIER STACKS offer designers stable electrical characteristics.



INCREASE IN LIFE EXPECTANCY is shown in typical curves for 45-volt cells.

SELECTION IS EASY with new G-E Vac-u-Sel rectifier "Selecto-Chart."

G-E molded-case circuit breakers provide safe fuseless circuit protection



Thermal-magnetic trip elements in G-E molded-case circuit breakers help guard conductors against short circuits and sustained overloads. Operation is cool, life is lengthened through de-ionizing arc quenchers that quickly dissipate arcs.

Extra safety results from trip-free operating mechanism that opens contacts against overcurrents even if handle is held closed. Solderless lugs, straight-in wiring make installation simple.

Ratings from 10 through 600 amperes for circuits of 120, 240, 480, 600 volts a-c, and for 125, 250 volts d-c. GEC-1032.

GENERAL ELECTRIC

DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS

G.E. cuts radar transformer weights up to 35%

Small or large, narrow or wide, light weight, long life—whatever your requirements, General Electric will build high-voltage, oil-filled transformers and inductors to your specifications. The picture at left, for example, shows how G.E. cut 61 pounds from a typical radar power supply by redesigning with smaller embedded-layer coil. These corona-free components are suitable for many electronic applications other than radar.

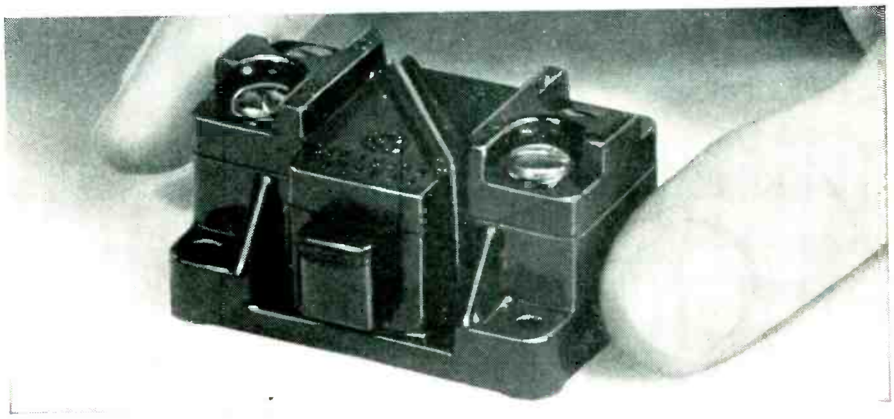
Among the advantages of these smaller and more reliable G-E components are: (1) more efficient cores permit weight savings to 11%, (2) alumina terminals add reliability, and (3) the use of Formex* wire and new embedded-layer winding techniques reduce coil sizes as much as 53%.

All G-E radar components are designed for compact installation. All can be manufactured to MIL-T-27 specifications. All have characteristics and features to meet a wide range of requirements. G.E.'s fully equipped model shop pools engineering and manufacturing skill to fulfill your needs. The shop can deliver prototype units for your experimental or system development projects—in a hurry—because work on your jobs begins immediately. Testing is strict. Vibration, thermal-cycling and moisture resistance tests are extra steps that can be taken by G.E. to assure components of the highest quality. Ask for Bulletin GEA-5963.

*Registered trade-mark of G.E. Co.

Two oz. switchette operates up to 50,000 ft. alt., from −70° F to 200° F

Versatile, corrosion-resistant and compact, General Electric Size 2 switchettes perform perfectly under extremes of altitude and temperature, combine low-inertia moving parts with high contact-tip force. Totally enclosed contact structure protects it from tampering and dirt. Screw-type terminals simplify wiring. For aircraft use where vibration is severe and space limited, its snap action and double-break-contact construction are especially valuable. Spring-return button on the housing can be actuated by lever, bellows, or other means. Bulletin GEC-207A.



EQUIPMENT FOR ELECTRONIC MANUFACTURERS

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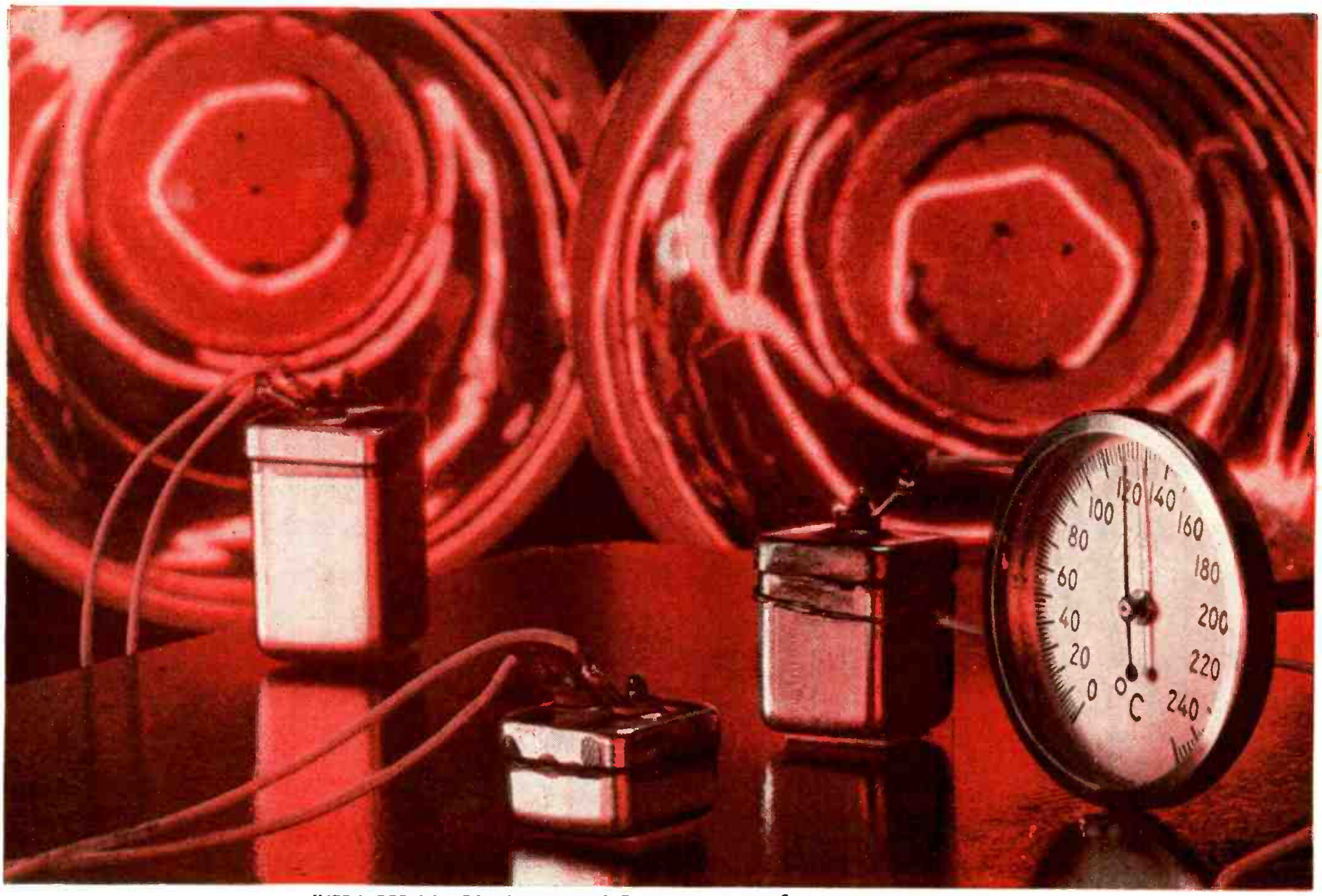
☐ GEA-5963 Radar Transformers
☐ GEC-207A Switchettes
☐ GEC-1032 Molded-case Circuit Breakers
☐ GEA-5935A Miniature Vac-u-Sel Rectifiers
☐ GEA-6273 New Vac-u-Sel Component Rectifiers

Name ....

Company ....

City .... State ....

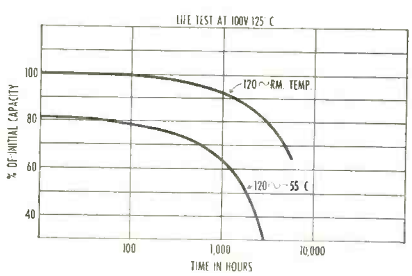
TURN PAGE FOR MORE G-E COMPONENT HIGHLIGHTS



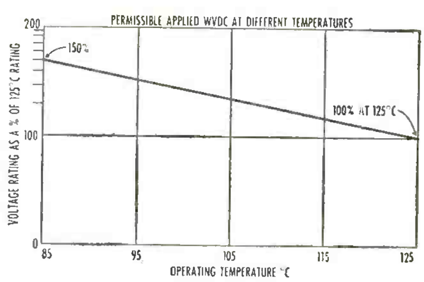
INFRA-RED LAMPS subject new G-E capacitor to 125° C ambient temperature.

New G-E high-temperature Tantalytic* capacitors operate in +125° C ambient at full voltage

Where quality, long life and small size are required in high-temperature, miniaturized, high-reliability equipment, specify General Electric's new 125° C Tantalytic capacitors. Designed to operate at full voltage in high temperature, they meet the tough requirements of miniaturized military equipment: energy storage, filtering, or by-pass applications in electronic ordnance, guided missile, navigation, communication, and control equipment.



LONG LIFE of G-E 125° C Tantalytic capacitors is shown by graph of life vs. loss of capacitance for typical 100-v d-c unit.



HIGHER VOLTAGES than 100 VDC can be applied with no life loss at ambients below rated +125° C as shown above.

Three rectangular case sizes permit ratings from 36 uf at 100 volts d-c to 180 uf at 30 volts d-c. All three sizes have same square base, varying only in height to maintain high volumetric efficiency at lower ratings.

Features: low leakage currents, long shelf and operating life, availability in polar and nonpolar construction for use in both a-c and d-c circuits. When operated at ambient of 125° C at rated voltage, units meet qualification requirements of 1000 hours with not more than 20 per cent loss in initial 25° C capacitance.

Unlike other types of Tantalytic capacitors, the foil construction offers chemically neutral electrolyte to minimize corrosion danger, plus excellent mechanical stability and freedom from electrical noise under shock or vibration. Ask for Bulletins GEA-6258 and GED-2620.

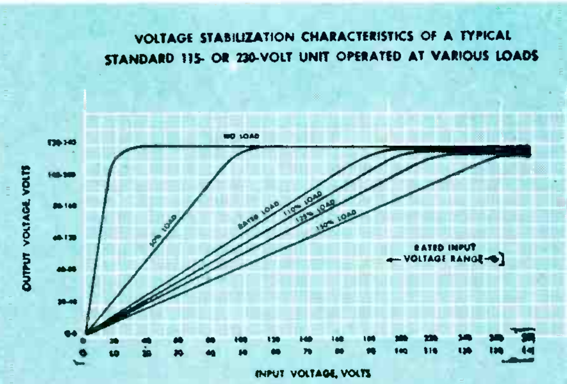
GENERAL ELECTRIC

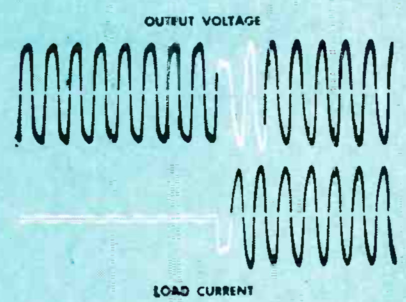
Want more information? Use post card on last page.

DESIGNER'S DIGEST

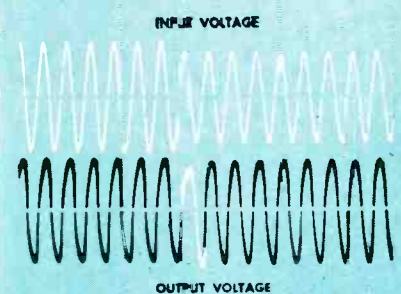
TIMELY HIGHLIGHTS ON G-E COMPONENTS

G.E. protects equipment with instantaneous voltage stabilization within ±1%

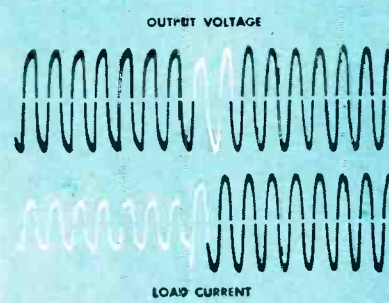




Output voltage is stabilized within two cycles as load current jumps from 0 to full load.



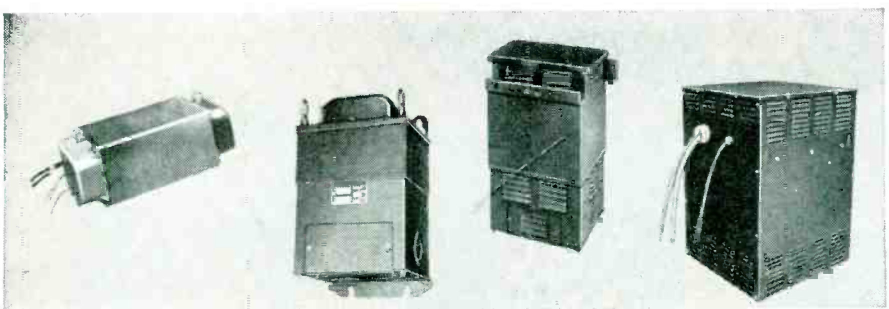
Output voltage is stabilized in less than 1½ cycles as input drops from 130 to 100 volts.



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

General Electric voltage-stabilizing transformers are completely automatic. The compact units offer low losses, high input factor, fast response. They are easily installed, have no moving parts, and need virtually no maintenance. Often designers find standard units most satisfactory, either incorporated in new equipment or adapted to existing circuits. If special units are required, G-E engineers will co-operate in finding solutions for you. You can use them in literally hundreds of types of equipment. New applications and new methods of applying these voltage-stabilizing transformers are continually being discovered. The rapid responses of control with these units are shown graphically in the three curves at right, and typical characteristics above. Bulletin GEA-5754A.

G-E saturable reactors control individual power loads at low cost



Faced with fixed power sources, application and design engineers can draw on General Electric's "design pool" of more than 1000 different saturable reactor designs. This will simplify solving the problems they often face of controlling individual power loads manually or automatically at low cost. Very efficient even at light loads, a G-E saturable reactor provides control in an a-c circuit by direct current. Adjustment is smooth all the way. They can be satisfactorily utilized in a wide range of applications, including electrically heated furnaces and boilers, or milk pasteurizers and X-ray equipment. Apply them, too, in reduced-voltage starting, or continuously adjustable reactive load banks. G.E. can design them in a wide variety of a-c and d-c ratings to meet your special application needs. Bulletin GEA-6354.

General Electric Company, Apparatus Sales Division
Section B667-32
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☐ GEA-6258 125C Tantalytic Capacitors
☐ GED-2620 Capacitors for Electronics
☐ GEA-6354 Saturable Reactors
☐ GEA-5754A Voltage Stabilizers

For information on other products, contact your nearest G-E Apparatus Sales Office.

Name ....
Company ....
City .... State ....

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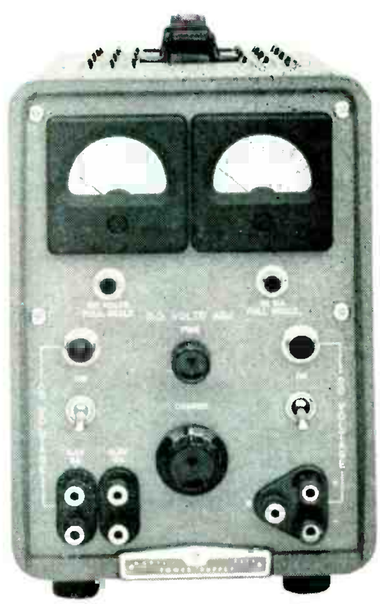
why fiddle and fuss?

New *-hp-* 711A Power Supply makes it *easy* to power experimental and bench setups



0-500 volts dc, 6.3 v ac
High regulation
Current, voltage meters
Overload protection
All-purpose utility

The new *-hp-* 711A was developed to do just one thing—simplify your job of powering all kinds of electronic circuitry in laboratory, field and factory.

This compact (18 lbs.) instrument is ideal for driving low level amplifiers, constant frequency oscillators and similar jobs where highly stable voltage is essential. Voltage range is very broad—0 to 500 volts. No-load to full-load regulation is better than ± 0.25% or 0.5 volts. Ripple is less than 1 millivolt.

For added convenience, there are separate current and voltage meters with new push-button range switching for accurate measurement of small voltages and currents. Other features include overload protection and grounding on either positive or negative dc terminals. The price is $225.

Electronic instruments for complete coverage, quality, convenience

HEWLETT-PACKARD COMPANY
3332A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.,
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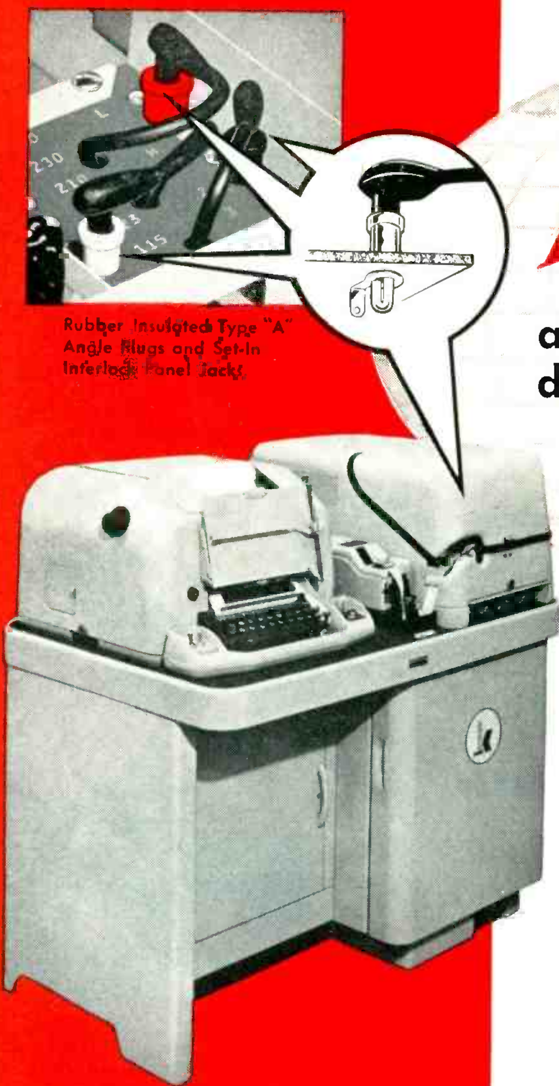
AT HOME ANYWHERE . . .

HUBBELL *Interlock*

TRADE MARK



Rubber Insulated Type "A" Angle Plugs and Set-In Interlock Panel Jacks

automatic locking . . . quick disconnect plugs make Voltage Tap Panel more flexible on

KLEINSCHMIDT TELEPRINTERS

Anywhere in the world Kleinschmidt Teleprinters are set up, they're completely at home! Designed to operate on alternating current, these modern teleprinter machines are quickly and easily adapted to use from 95 to 250 volts, simply by plugging the specially designed Interlock Angle Plugs into the proper receptacle on its voltage tap panel — an ideal arrangement when machines are moved from place to place.

While connected, Interlock plugs provide a constant, low resistance contact that cannot disconnect accidentally. A vibration and impact proof contact is made on two surfaces under constant coil spring pressure, which adjusts automatically with changes in pressure or temperature.

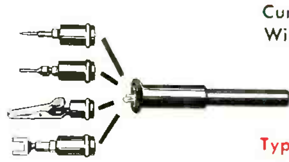
There is . . . or can be designed an INTERLOCK CONNECTOR For Every Wiring Problem

Type "A" Plugs and Jacks Insulated and Non-Insulated. Current Cap. — 10 amps., Wire Sizes #14 to #18

Type "B" Plugs and Jacks (Miniature) Insulated and Non-Insulated. Current Cap. — 5 amps. Wire Sizes #18 to #22

Type "C" Plugs and Jacks (Sub-miniature) Current Cap. — 1 ampere. Wire Sizes #20 to #22 or smaller

Type "S" Plugs and Jacks
Current Cap. — 15 amps.
Wire Sizes #14 to #18



Type "S" 4 in 1 Test Prod Kit
(8 interchangeable test tips)

For Further Information, Write Dept. A:

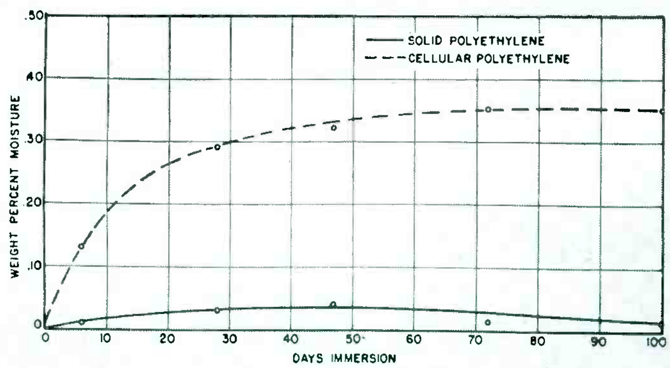
HUBBELL REG. U.S. PAT. OFF.

HARVEY HUBBELL, INC.

Interlock Electronic Connector Dept., Bridgeport 2, Conn.

SELF-LOCKING HUBBELL INTERLOCK SYSTEM CONNECTORS
Pats. & Pdg. Pats.

FACTS YOU SHOULD KNOW ABOUT CELLULAR



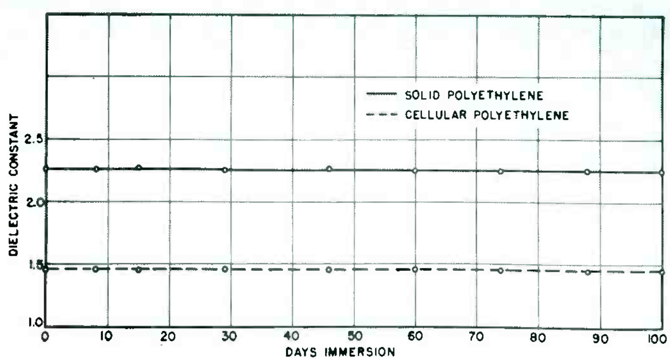
1. Moisture absorbed vs. days of immersion in tap water at 23 deg. C. Since BAKELITE Cellular Polyethylene is made up of hollow cells completely separated by walls of BAKELITE Polyethylene, its moisture absorption is low.

BAKELITE Brand *Cellular* Polyethylene for wire and cable insulation is a superior low-loss plastic that consists structurally of unconnected hollow cells. It is produced by the formulation of solid polyethylene with a foaming agent which, at the time of extrusion causes expansion to a cellular form. Properly extruded, the material will expand 100 per cent, giving a density about half that of solid polyethylene.

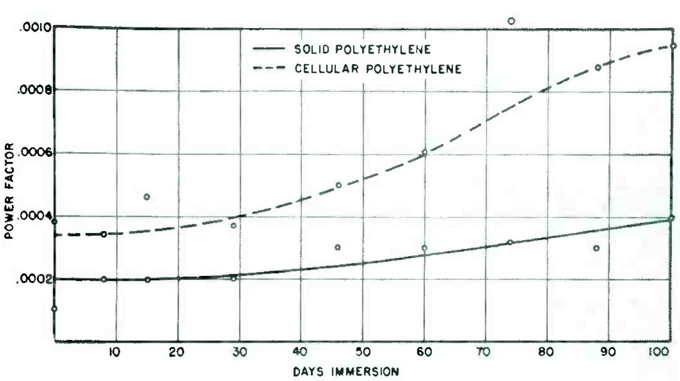
These are the principal advantages of BAKELITE Cellular Polyethylene for high-frequency electronic service:

- **Low order of moisture absorption (Fig. 1).**
- **Lower dielectric constant than that of solid polyethylene (Fig. 2).**
- **Low power factor, comparable to that for solid polyethylene (Fig. 3).**
- **Dielectric constant directly related to density formulation, while power factor remains uniform (Fig. 4).**
- **Uniformly low power losses over a broad frequency range (Fig. 5).**
- **Minimal power losses over wide temperature range (Fig. 6).**

For more information on the properties, fabrication, and use of BAKELITE Cellular Polyethylene, write Dept. ME-50.



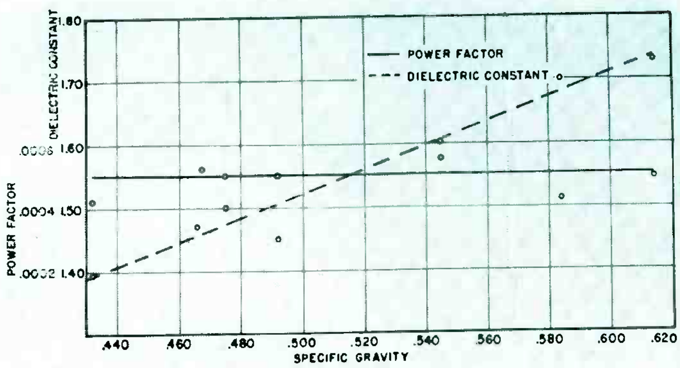
2. Dielectric constant at 1 megacycle vs. days of immersion in tap water at 23 deg. C. Note that BAKELITE Cellular Polyethylene retains its dielectric constant—considerably lower than that of solid polyethylene—throughout long immersion periods. The lower dielectric constant results in insulated conductors with a lower capacitance per foot than when the solid material is used.



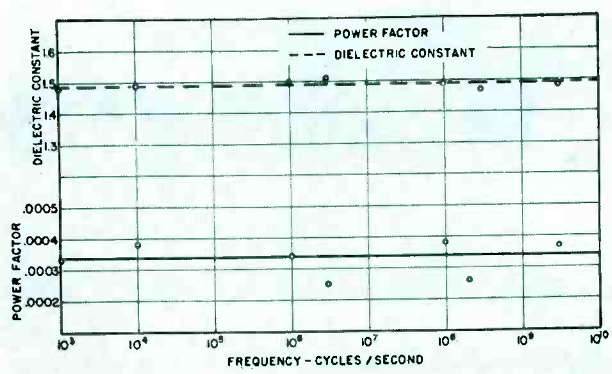
3. Power factor at 1 megacycle vs. days of immersion in tap water at 23 deg. C. Even after extended periods of water immersion, BAKELITE Cellular Polyethylene demonstrates a low power factor.

POLYETHYLENE

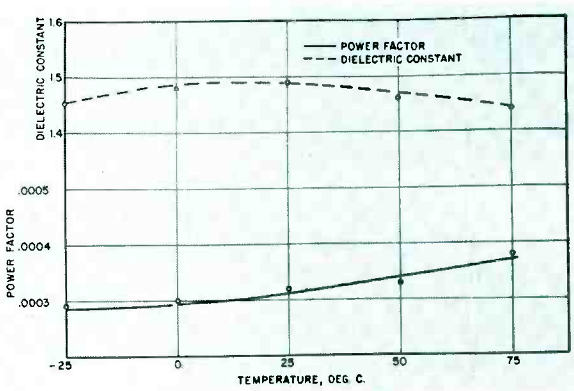
FOR WIRE AND CABLE INSULATION



4. Power factor and dielectric constant at 1 megacycle vs. specific gravity. BAKELITE Polyethylene has a dielectric constant about midway between that of solid polyethylene (2.3) and that of the inert gas yielded by the blowing agent (1.0). Its value depends on the degree of expansion of the foam. The low power factor remains uniform.



5. Power factor and dielectric constant vs. frequency. Both the power factor and dielectric constant of BAKELITE Cellular Polyethylene are relatively unchanged over a broad frequency range, indicating that power losses will be uniformly low.

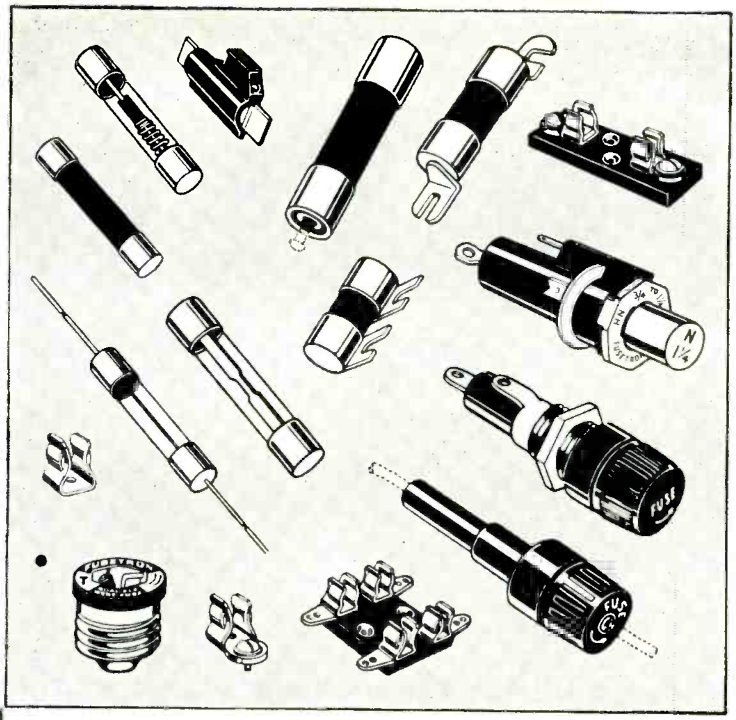


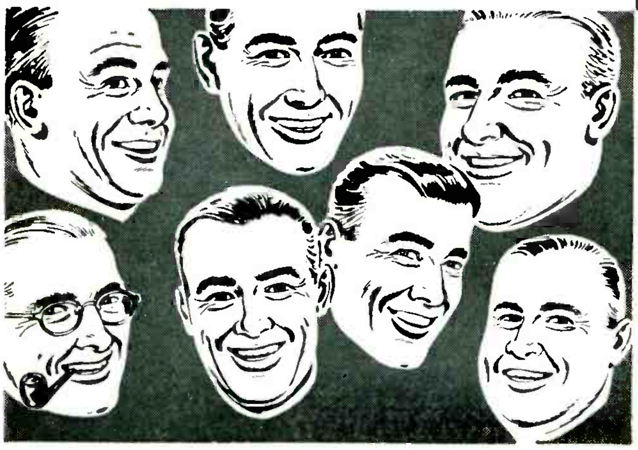
6. Power factor and dielectric constant at 1 megacycle vs. temperature. These properties of BAKELITE Cellular Polyethylene are consistent over a considerable operating temperature range, indicating minimal power losses due to seasonal variations.

BAKELITE
BRAND
POLYETHYLENE

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.
In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario
The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

The unfailing Dependability of BUSS FUSES . . .





helps you keep customers satisfied !

By operating properly under all service conditions — BUSS fuses can help safeguard the reputation of your product or service against loss of customer good will.

When there is an electrical fault — BUSS fuses open and prevent further damage to equipment, saving users the expense of replacing needlessly burned out parts.

And just as important, BUSS fuses won't give a false alarm by blowing when trouble doesn't exist. Useless shutdowns caused by poor quality fuses blowing needlessly are not only irritating to customers — but customers' confidence in your product or service could be jolted.

Every BUSS fuse is electronically tested to assure "trouble-free" operation.

Every BUSS fuse normally used by the Electronic Industries is electronically tested. A sensitive device automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

With a complete line of fuses, fuseholders and fuse blocks available — it is just good business to standardize on BUSS.

For more information on FUSETRON and BUSS small dimension fuses and fuseholders . . . Write for bulletin SFB.

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

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

BUSSMANN MFG. CO.
(Division of McGraw Electric Co.)
UNIVERSITY AT JEFFERSON
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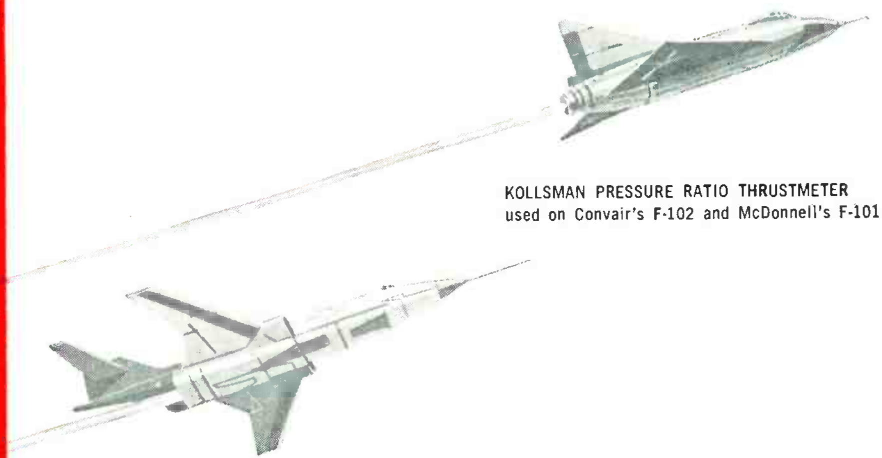
BUSS FUSES ARE MADE TO PROTECT — NOT TO BLOW

which way* to measure jet engine performance?



KOLLSMAN PRESSURE RATIO THRUSTMETER
used on Convair's F-102 and McDonnell's F-101

thrustmeters

to indicate PRESSURE RATIO... to indicate DIFFERENTIAL PRESSURE

Actual photograph

KOLLSMAN is in production...

on components for BOTH TYPES—for Remote or Direct reading

For over a quarter century, Kollsman has been making precision pressure sensitive mechanisms using displacement type diaphragms. This diaphragm can be called the heart of a thrustmeter pressure indicating system.

> Our long experience making displacement type diaphragms guarantees reliable thrustmeters.

Proven Kollsman displacement type diaphragms, when fitted with Kollsman Synchrotels, comprise the transmitters for remote indicating types. Thousands of Synchrotels are now in use in other applications equally demanding of accuracy and durability.

Tailor-made Thrustmeters can be supplied for any engine-airplane combination. Write for complete technical information.

TYPICAL SYSTEM OPERATIONAL DATA

1. Accuracy: .015 in 100% of readings at room temperature.
   .025 in 85% of readings at −55°C and +70°C.
   .035 in 15% of readings at −55°C and +70°C.
2. Altitude: No specific limitation.
3. Power: 115V, 400CPS, single phase, 18VA
4. Pressure Ratio Range: 1.2 to 3.4
5. Pressure Ranges (operating):
   Pt_2=2 to 50" Hg. Abs.
   Pt_7=2.4 to 100" Hg. Abs.
   Pt_7—Pt_2=0.4 to 70" Hg.
6. Temperature Range: −55°C to +120°C
7. Weights:
   Transmitter: 2.2 lbs.
   Indicator (including integral amplifier): 1.8 lb.
8. Response: Full Range in 7 seconds.

**The Pressure Ratio System has advantages for indicating optimum climb and cruise throttle setting, whereas the Pressure Differential System has a definite advantage at take-off.*

Kollsman activities cover these seven fields:

AIRCRAFT INSTRUMENTS • PRECISION CONTROLS
PRECISION COMPUTORS AND COMPONENTS • OPTICAL COMPONENTS AND SYSTEMS
RADIO COMMUNICATIONS AND NAVIGATION EQUIPMENT • MOTORS AND SYNCHROS
INSTRUMENTS FOR SIMULATED FLIGHT TRAINERS

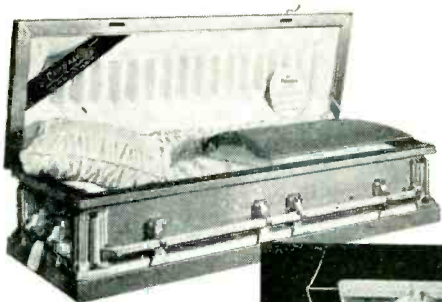
kollsman INSTRUMENT CORPORATION

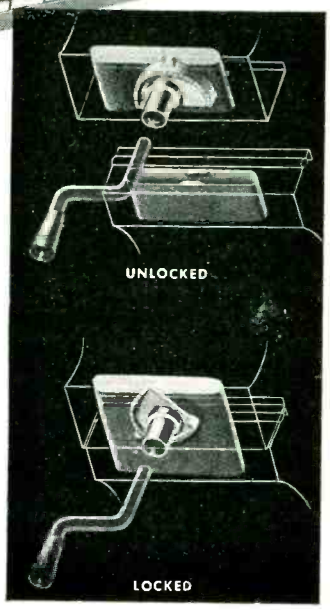
80-10A 45th AVE., ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF Standard COIL PRODUCTS CO. INC.

Want more information? Use post card on last page.

"Nothing can go wrong with Roto-Lock performance"

Says Elgin Metal Casket Company





Roto-Lock operation is simple: Serrated, tapered cam engages latch — draws panels tightly together when turned by crank or other hand tool.

Simmons Roto-Lock Fasteners are used by Elgin Metal Casket Co., of Elgin, Illinois, to give its Permaseal Caskets a perfect hermetic seal against air and water. Drawn down with a pressure of up to 1500 lbs., Roto-Lock guarantees an absolutely tight seal and strength far beyond requirements.

President E. B. Stewart of Elgin says: "Roto-Lock worked out particularly well because of the simplicity of its construction, and the fact that it was a lock already in a housing which could readily be sealed. Functionally the lock is very good since it pulls the lid down with ease and is a quick-operating mechanism. In other words, *the locking and sealing operation can be accomplished quickly and easily in a matter of seconds.* Since the whole locking and sealing mechanism contains only one moving part, *there is nothing that can go wrong with the performance of the lock.* Of course, this is important since mal-function at a funeral service would be a serious matter."

and there's a Roto-Lock application to improve your product

Roto-Lock, which makes butt or right-angle joints quickly, is finding wide application in portable shelters, air freight and cold storage shipping containers, walk-in coolers, demountable furniture and scaffolding. It fastens in any misaligned or semi-open position and recesses completely into panels. *Wherever* demountability is important, there's a Roto-Lock application.

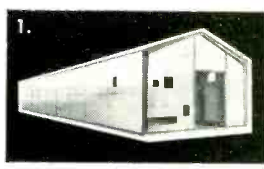
Write today for our 36-page catalog. It's filled with applications of Roto-Lock and Simmons' four other special fasteners engineered to improve products and reduce assembly costs.

SIMMONS FASTENER CORPORATION
1750 N. Broadway, Albany 1, New York

Simmons

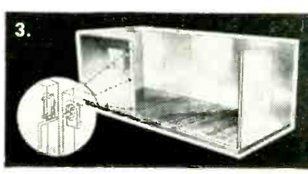
QUICK-LOCK · SPRING-LOCK · ROTO-LOCK · LINK-LOCK · DUAL-LOCK

FASTENERS WITH USES UNLIMITED

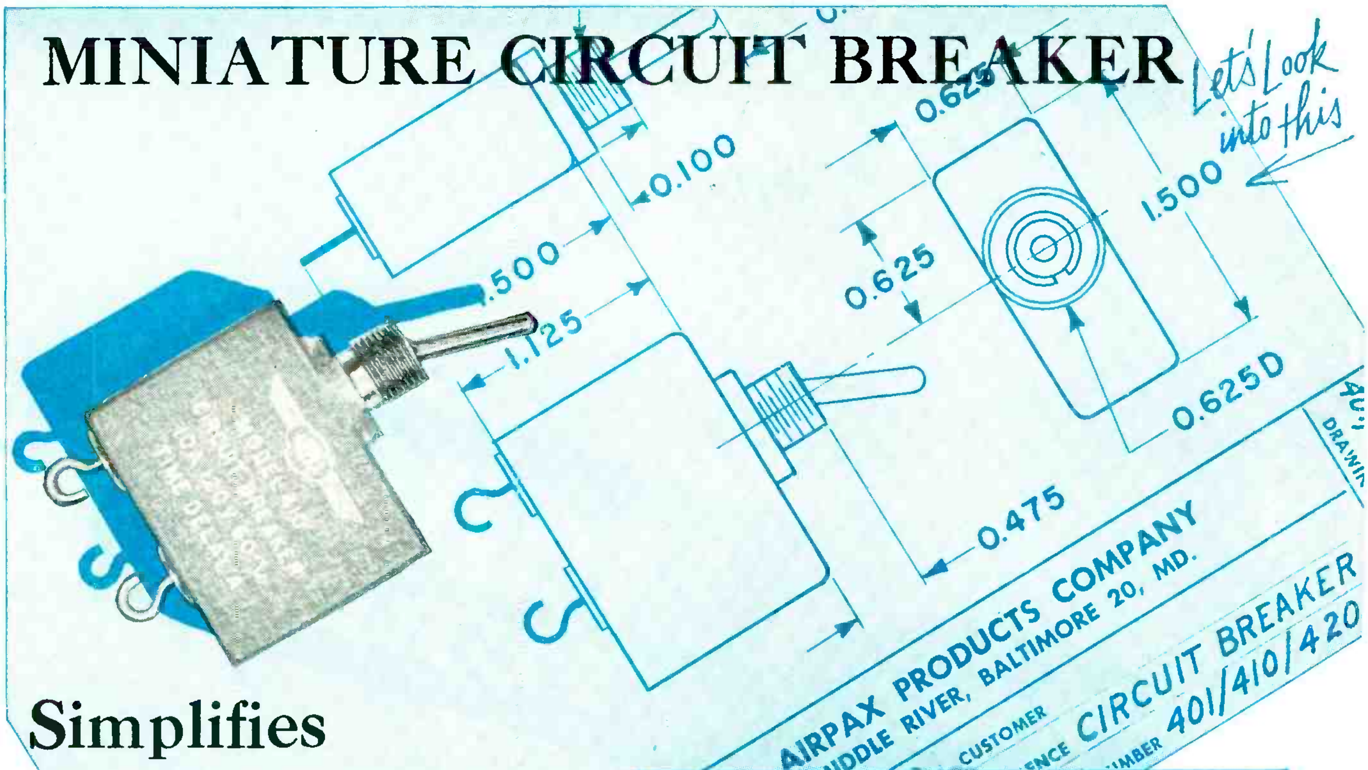


Some applications of Roto-Lock:

1. Portable Shelter
2. Partition
3. Demountable Refrigerator Unit
4. Demountable Desk



MINIATURE CIRCUIT BREAKER



Simplifies Circuit Design

You can now perform the *two* functions of power ON-OFF control and circuit protection with *one* miniature fully magnetic time-delay trip-free circuit breaker. Save space (see diagram above); save weight (weighs less than 2 oz). The characteristics (tabulated at right) of this new Airpax component show it to be a significant advance in power control; just what you need.

Handle has ON and OFF positions; it moves to OFF position when breaker trips, yet breaker cannot be prevented from tripping by holding handle in ON position. Stable tripping mechanism assures reliable operation even under adverse temperature and vibration. Give your equipment the protection it deserves.

To restore service after fault has been removed, simply reset the breaker. A breaker having a 30-sec time delay recovers full delay in about 20 sec.

To receive complete engineering data, simply write to

CHARACTERISTICS

RATINGS: 0.05 amp to 10 amp at 50 V DC or 1.0 to 10 amp at 120 V AC

MINIMUM TRIP: 125% of rated load

INSTANTANEOUS TRIP: 1,000% of rated load

INTERRUPTING CAPACITY: a typical value is 500 amp at 30 V DC

POWER CONSUMPTION: 0.6 watt in lower current ratings, rising to about 2 watts at 10 amp rating

SHOCK: resists 50 g in all directions

VIBRATION: 10 to 55 CPS at 0.06 in. total excursion in all directions

TEMPERATURE: −40 C to +100 C

LIFE: 10,000 operations at rated current into resistive load

ENCLOSURE: hermetically sealed

AIRPAX

ENGINEERS DESIGNERS

MIDDLE RIVER BALTIMORE 20, MD.

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The greatest Names in British Electronics use

Mullard TUBES

British equipment manufacturers are making a vital contribution to the developement of electronics in all fields of application.

Their products are being exported to every corner of the world, earning a universal reputation for advanced techniques and excellent performance.

The majority of these electronic equipment manufacturers consistently use Mullard tubes. This choice is decided upon because they prefer the greater assurance of efficiency and dependability, and because the vast manufacturing resources of the Mullard organisation guarantee ready availability of Mullard tubes wherever they are needed.

Supplies of Mullard tubes for replacement in British equipments are available from the companies mentioned below:—

In the U.S.A. International Electronics Corporation,
Department E12,
81, Spring Street, N.Y. 12.
New York, U.S.A.

In Canada Rogers Majestic Electronics Limited,
Department ID,
11-9 Brentcliffe Road,
Toronto 17, Ontario, Canada

Mullard

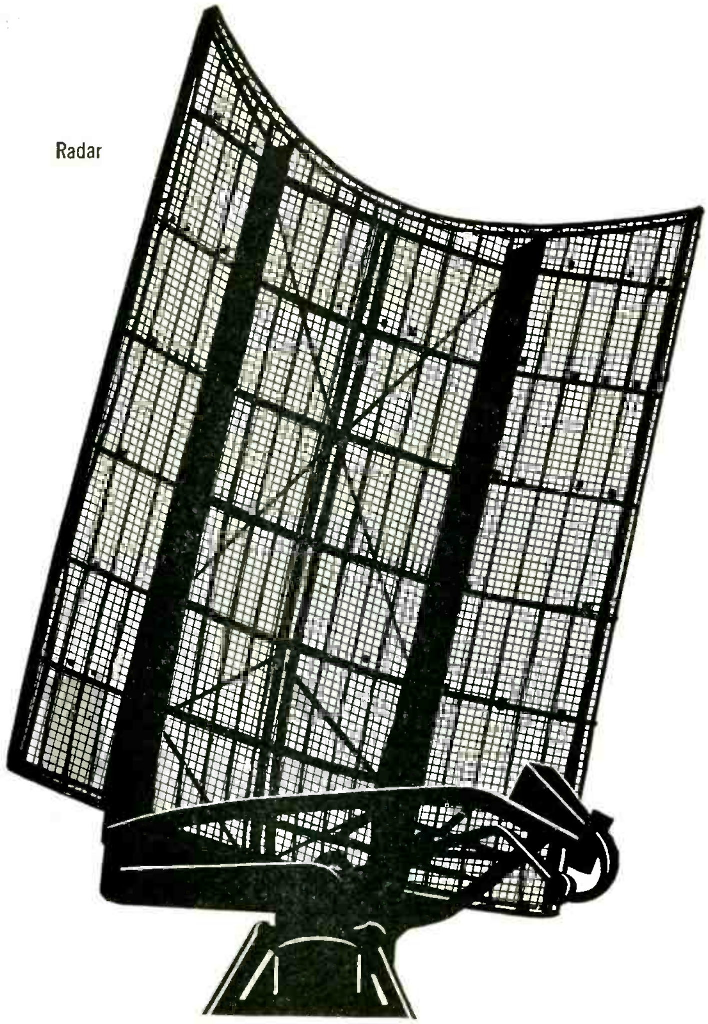
Electronic Tubes—used throughout the world

MULLARD OVERSEAS LTD., CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, ENGLAND.

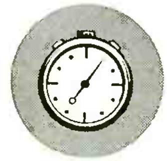
Mullard is the Trade Mark of Mullard Ltd. and is registered in most of the principal countries of the world

MEV32

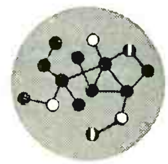
Radar



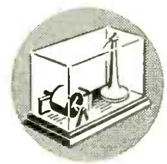
Navigation



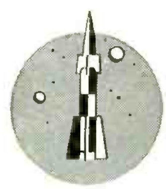
Timing



Nucleonics



Geophysics



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FOR GENERAL-PURPOSE LABORATORY USE

Generates pulses accurately spaced in time with respect to an internally generated reference pulse—range 0 to 100,000 microseconds

Complete generality permits numerous and varied uses such as radar range calibration, target simulation, generation of secondary frequency standards, elapsed time measurements, phase measurements, etc. Fields of application include Radar, Navigation, Telemetry, Nuclear Studies, Computor Research, Geophysics, Ordnance, and any other fields in which timing is significant.

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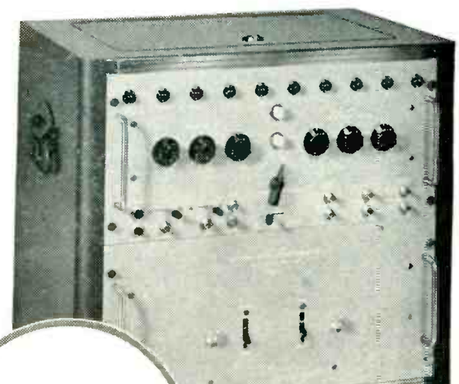
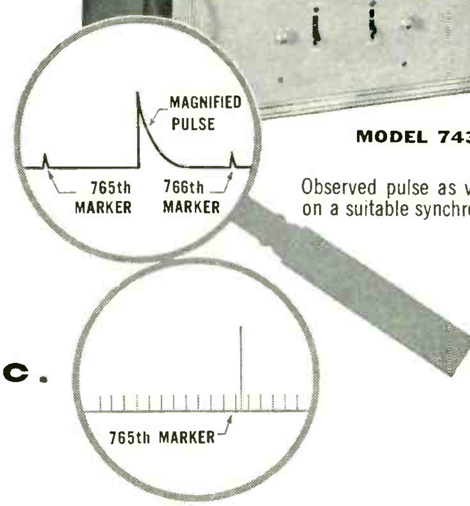
Pulses can be supplied under either one-shot conditions or at variable repetition rates. Both pulse delay and repetition period can be established in increments as small as 1 microsecond.

The repetition period can also be externally triggered, in which case two independently variable delayed pulses are available. Accuracy of both repetition period and pulse delay are held to one part in 10^6 by the thermostatically controlled crystal oscillator. The digital circuitry and the built-in self-checking features make continuous calibration unnecessary.



MODEL 743



Observed pulse as viewed on a suitable synchroscope

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8 Dependable Solutions

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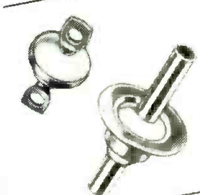

SEALED TERMINALS—Featuring cushioned glass construction, high thermal shock resistance. Available in economical preferred types and special designs.

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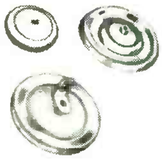

END SEALS—For condensers, resistors and other tubular components. Completely strain-free and provide a permanent hermetic seal. Standardized, economical types.

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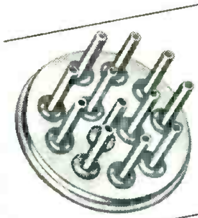

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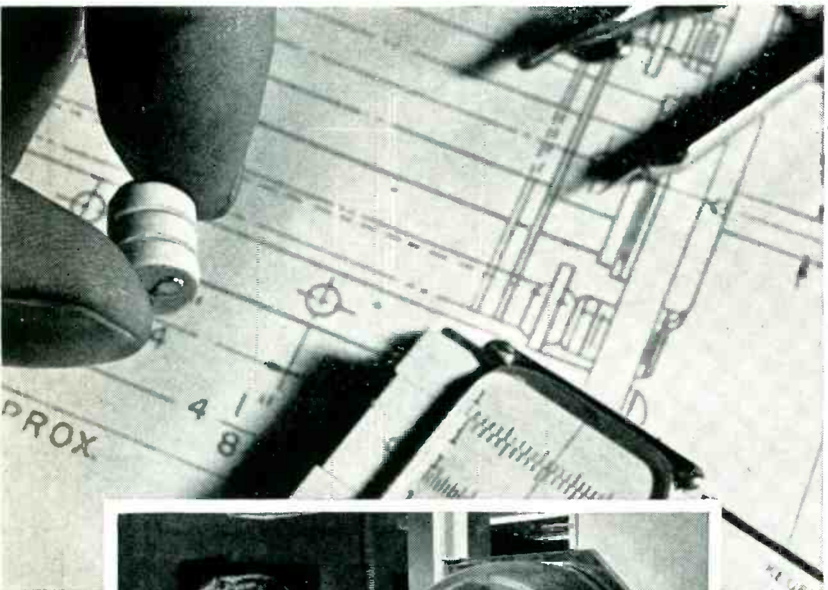
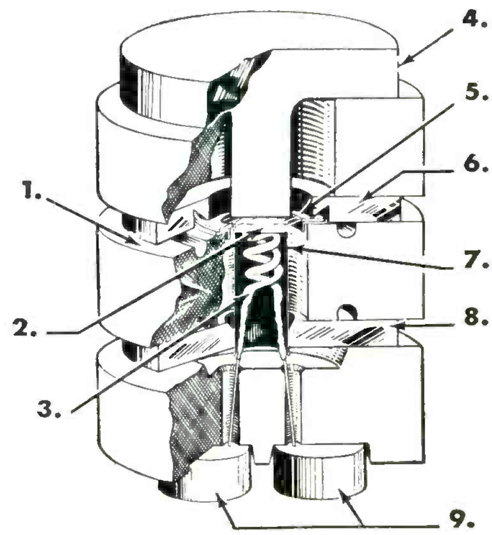




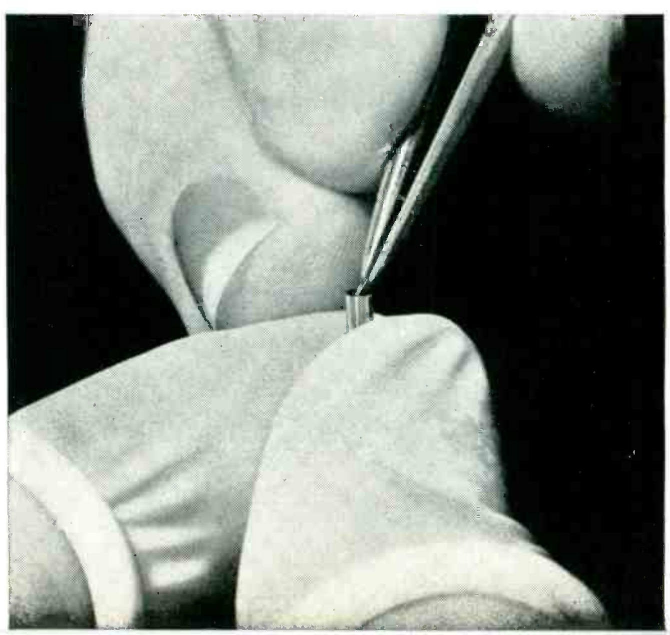
ONLY 3/8" HIGH! THE 6BY4 IS G.E.'S ULTRA-COMPACT NEW METAL-CERAMIC R-F AMPLIFIER TRIODE FOR UHF-VHF TV TUNERS.

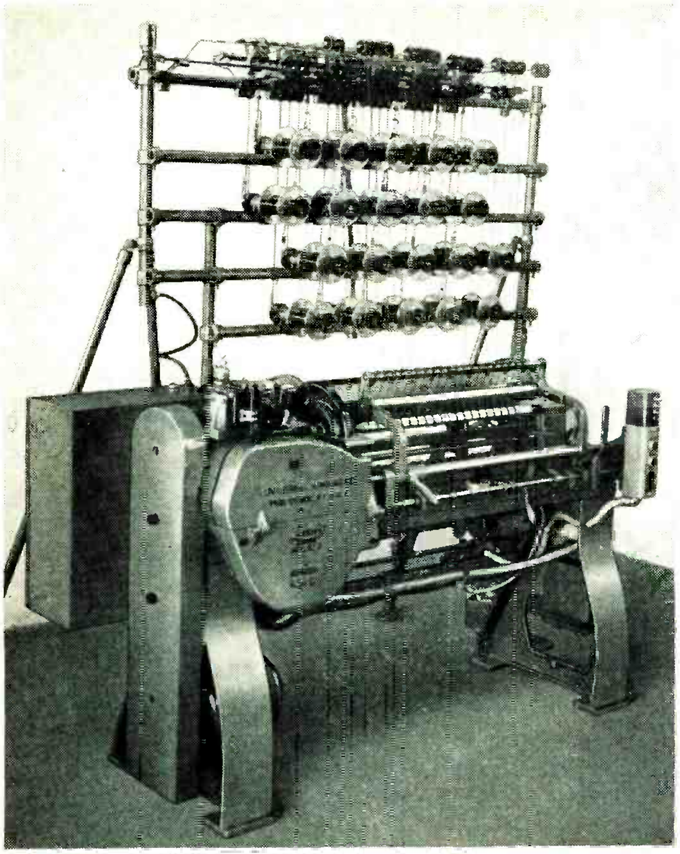
Installs in a fraction of the space required by other tuner tubes—yet out-performs them! At 900 mc operation with 10 mc bandwidth, new tube has the low noise factor of approx 8 db, and a power gain of approx 15 db. Filament and plate voltages, 6.3 v and 200 v . . . amplification factor, 100. The metal-ceramic, parallel-plane design as illustrated in the cutaway, gives the new 6BY4 short electron transit time and an extremely low r-f loss; also high structural rigidity. In type 6BY4 this rigidity is employed to attain minimum microphonics rather than maximum tube resistance to shocks and vibration, since TV circuits do not undergo the same physical hazards as military and commercial airborne and mobile equipment.

1. Reference plane	**4. Anode**	**7. Support cylinder**
2. Oxide-coated cathode	**5. Grid**	**8. Cathode ring**
3. Heater	**6. Grid ring**	**9. Heater buttons**

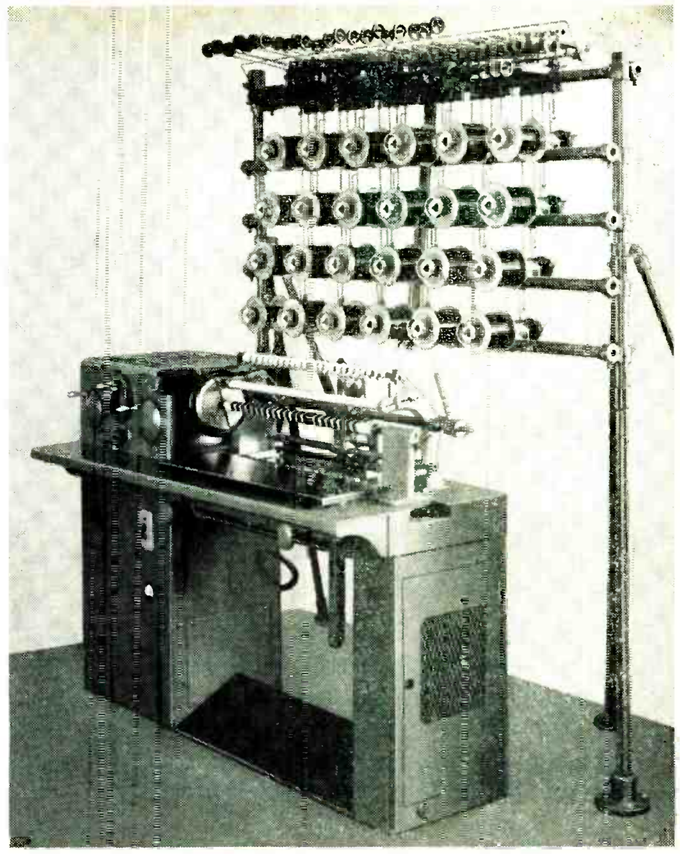
Above: metal parts for G-E micro-miniatures are fired in a high-vacuum furnace. Titanium is employed—this substance has the unique advantage of freeing virtually all its own gases when fired to 700 C. Result of using pre-fired titanium parts: there is no subsequent vacuum contamination from metal-liberated gases when tubes operate at high temperatures. Instead, titanium serves as a gas absorber!

Right: in an operation calling for utmost delicacy, the tube's cathode disc is fitted into the support cylinder. Note rubber finger cots on the fingers holding the tiny cylinder! Changed hourly, these finger cots help ward off dirt and moisture—are worn when handling all micro-miniature tube parts, to keep the parts scrupulously clean. Other G-E aids to cleanliness are air-pressuring, air-conditioning, and lint-free Nylon and Dacron uniforms.





Fully Automatic. The Leesona No. 107 Automatic-Feed Coil Winder provides the quickest, easiest way to wind paper-insulated coils accurately. Winds four to thirty coils in stick form simultaneously. Safely handles wire sizes from No. 19 to No. 42 (B&S). Electronic drive assures a slow, smooth start that minimizes breakage when winding fine wires.



Meets Many Needs. The Leesona No. 108 Coil Winder is the most efficient and economical hand-feed coil winder ever designed. Winds four to thirty paper-insulated coils in stick form simultaneously. Reduces set-up time and cuts winding time and costs on long or short runs, for a wide variety of coils.

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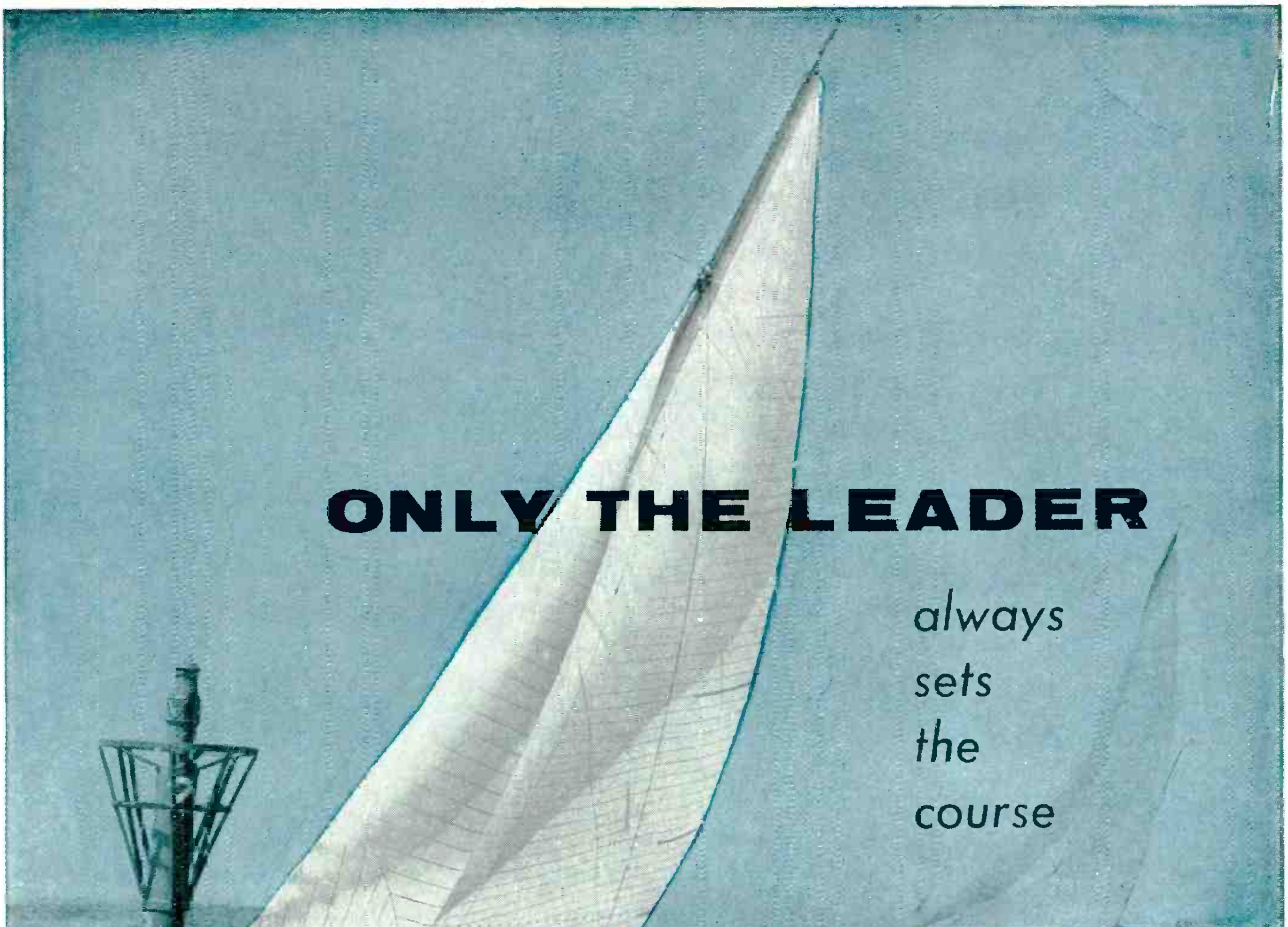

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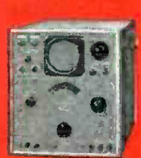
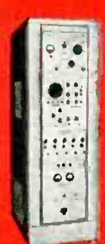


TSA SPECTRUM ANALYZERS 10 to 44,000 MC

MODEL R MICROWAVE RECEIVERS 950 to 11,260 MC



MODEL B MULTIPLE PULSE SIGNAL GENERATOR 950 to 10,750 MC

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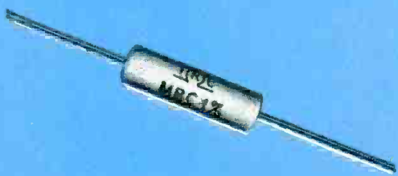

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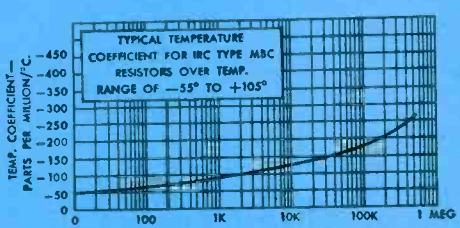
TYPICAL TEMPERATURE COEFFICIENT



Wire Wound

IRC's winding skills and automatic assembly equipment provide precision windings to exacting standards. Continuous inspections at every stage of manufacture assure maximum reliability in each finished resistor. IRC Mil Type precision wire wounds meet all requirements of MIL-R-93A specification. In addition to 6 Mil sizes, IRC supplies tiny Type WW10J—13/32 x 9/32''. Standard tolerance ±1%; minimum tolerances are shown below.

Minimum Tolerances

Resistance	IRC MIL TYPES	TYPE WW10J
10 ohms & up	0.1%	
5 ohms & up	1.25%	
1 ohm & up	0.5%	
1500 ohms & up		0.1%
200 ohms & up		0.25%
65 ohms & up		0.5%

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Tru-Mite encapsulated wire wound precision resistors are produced to IRC's high standards by its West Coast subsidiary, IRCAL INDUSTRIES. Available in 11 sizes and axial lead or lug types. Standard tolerance ±1%; also ±½, ¼, 1/10 and 1/20% tolerances can be supplied. Tru-Mite core material is the same epoxy resin as is used for the embediment. This eliminates the normal effects of temperature and moisture. Tru-Mite resistors exceed MIL-R-93A specifications.

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- ★ Slow tuning rate . . . long tuning life . . . single shaft tuner adapts easily to motor tuning.
- ★ Withstands 50 to 100 G shocks (up to 250 G's for the VA-201)
- ★ VA-203 weighs less than 4 ounces. Both tubes mate directly to standard waveguide flanges.

GUARANTEED SPECIFICATIONS

8500 to 9600 mc	VA-203	VA-201
Resonator Voltage	300 V	250 V
Heater Voltage	6.3 V	6.3 V
Heater Current	0.45 Amp	1.2 Amp
Power Output	20mW, Min	15mW, Min
Electronic Tuning Range	30 Mc, Min	30 Mc, Min
Vibration FM at 10 G	1 Mc, p-p, Max	0.2 Mc, p-p, Max

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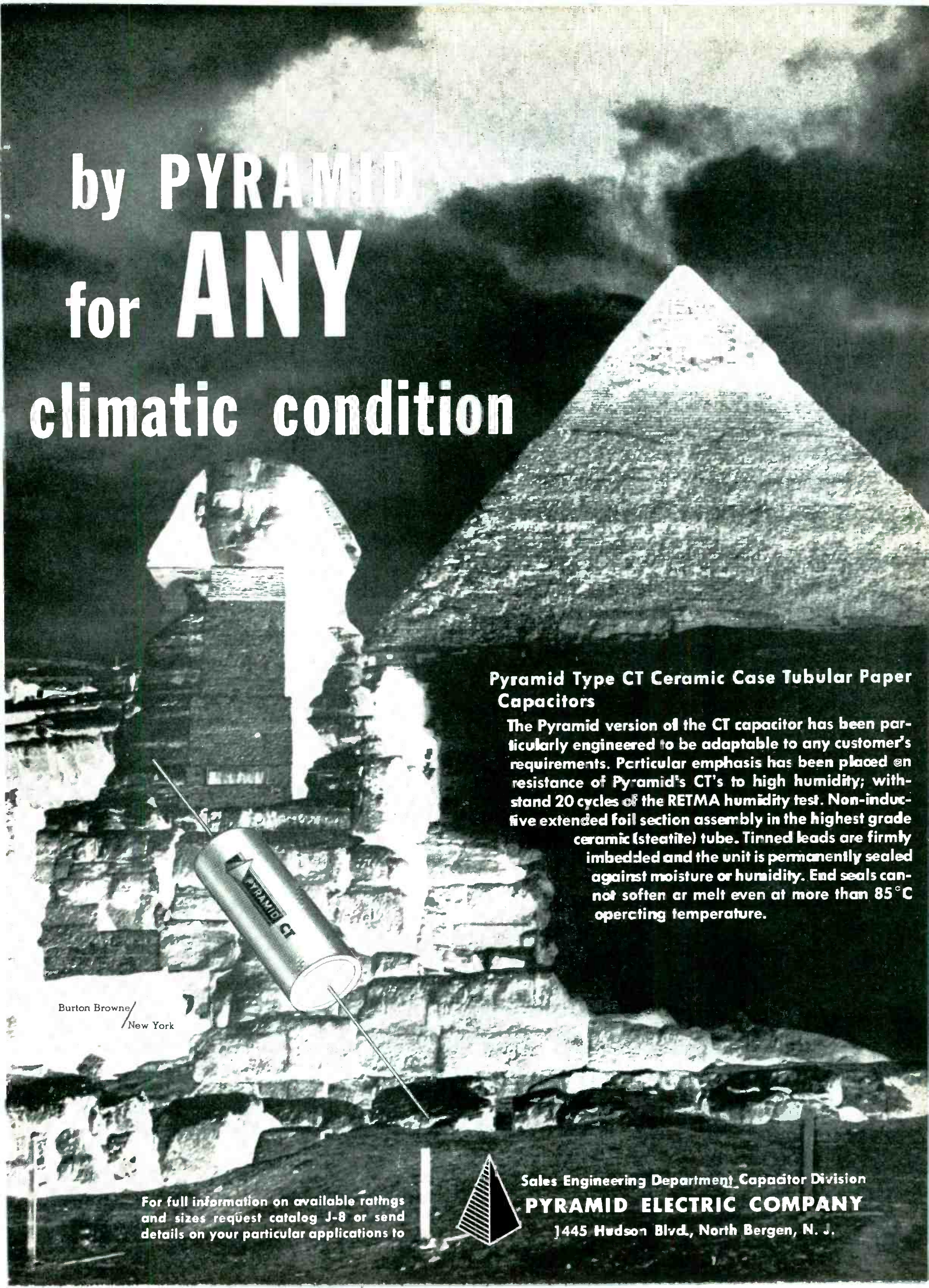
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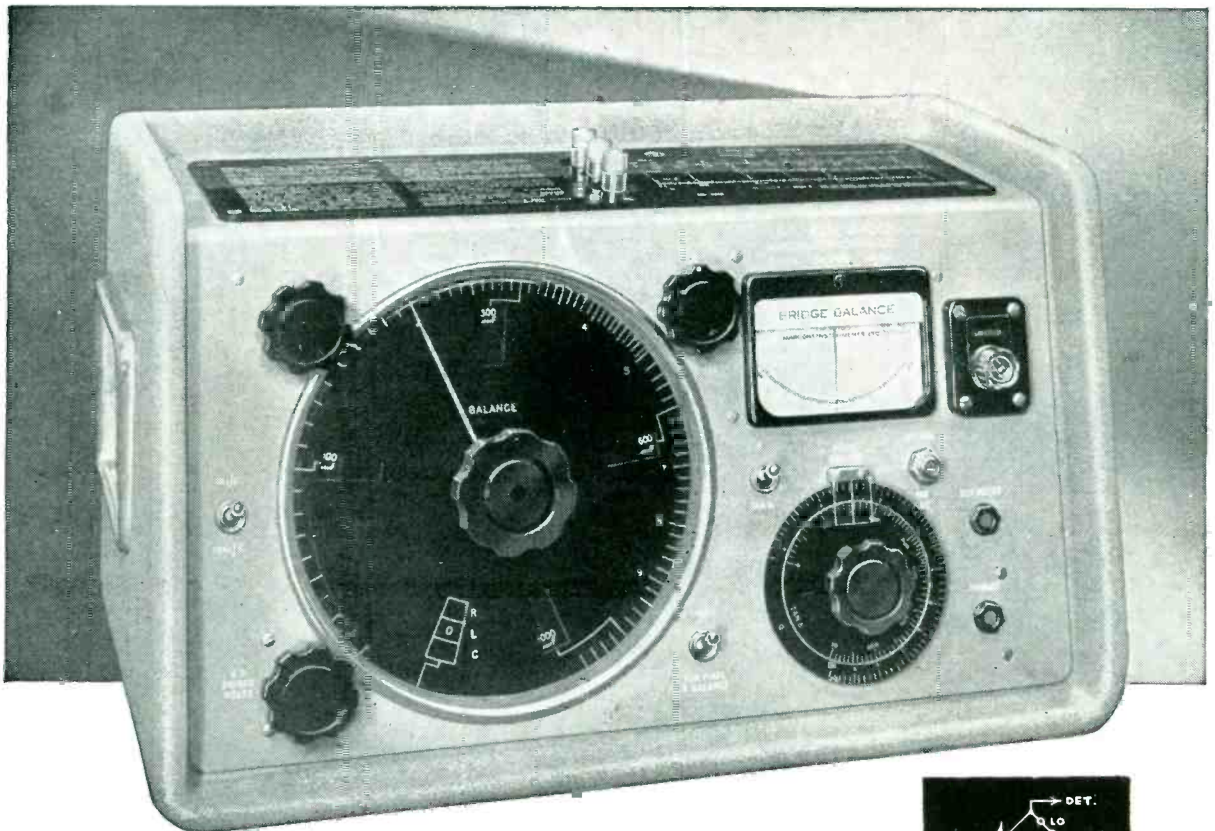
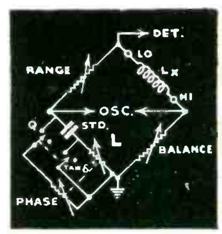
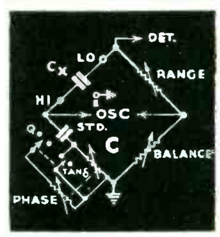




ACCURATELY MEASURED

- **L - AT 1 OR 10 kc**
- **C - AT 1 OR 10 kc**
- **R - AT D.C.**



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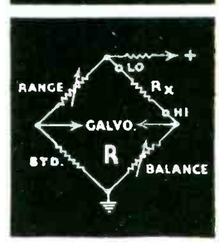
Single direct reading L.C.R. dial — no multiplying factors involved.

Continuously variable a.c. bridge voltage and automatic detector sensitivity control.



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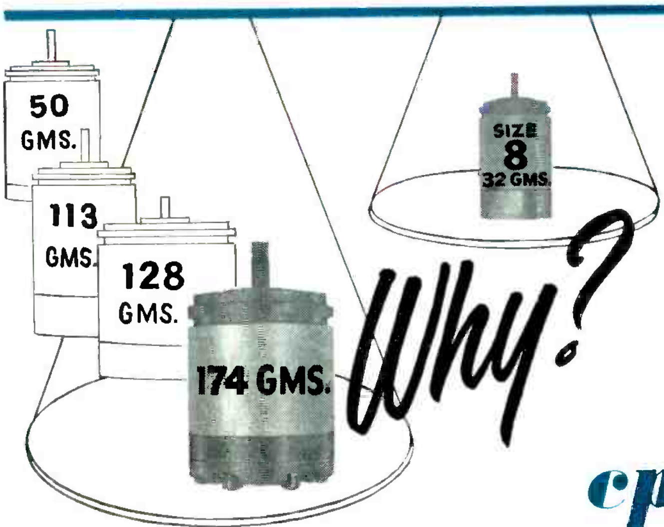
Function	Type Number	Primary Element	Excitation Voltage 400 cy.	Input Current (ma.)	Input Power (Watts)	Primary Impedance Secondary Open (Phase)	Primary Resistance (line)	Secondary Element	Output Voltage	Secondary Impedance Primary Open (Phase)	Secondary Impedance Primary Shorted	Secondary Resistance (line)	Phase Shift Degrees	Sensitivity mv./deg.	Accuracy Minutes Max.
Transmitter	CGC-8-A-7	Rotor 1 Phase	26	100	.50	54+ j260	37.0	Stator 3 Phase	11.8	12+ j45	15+ j3.5	11.8	8	200	7
Control Transformer	CTC-8-A-1	Stator 3 Phase	11.8	90	.230	28+ j110	24.7	Rotor 1 Phase	23.6	220+ j740	246+ j60	143	8.5	400	7
Control Transformer	CTC-8-A-4	Stator 3 Phase	11.8	37	.091	67+ j270	59.5	Rotor 1 Phase	24	508+ j1680	640+ j190	381	9.2	400	7
Resolver	CSC-8-A-1	Stator 2 Phase	11.8	84	.268	38+ j136	27.0	Rotor 2 Phase	23.2	280+ j600	344+ j75	230	11	400	7
		Rotor 2 Phase	26	39	.430	280+ j600	230.	Stator 2 Phase	10.6	38+ j136	70+ j29	27.0	20	180	7
Repeater	CRC-8-A-1	Rotor 1 Phase	26	100	.50	54+ j260	37.0	Stator 3 Phase	11.8	12+ j45	15+ j3.5	11.8	8	200	30*
Differential	CDC-8-A-1	Stator 3 Phase	11.8	85	.21	27+ j120	25.0	Rotor 3 Phase	11.8	38+ j122	47+ j14	36	9	200	7 Rotor 7 Stator

Total Null max. 20mv for each unit

*Torque 2600 mg.-mm./degree from CGC-8-A-7

Also available in 115v 400 cy. primary, 90v secondary Transmitters, C.T.'s, Receivers



WHY USE 1945 SYNCHROS IN 1956 DESIGNS?

Clifton's new Size 8's can take the place of larger units at very significant saving in bulk and *weight*.

These new Size 8's are now in use in some of the latest and *lightest* avionic equipment. In equipment which must be flown, why load on extra weight?

Samples are available from stock, quantities from the production line.

LOOK TO CPPC FOR SYNCHRO PROGRESS

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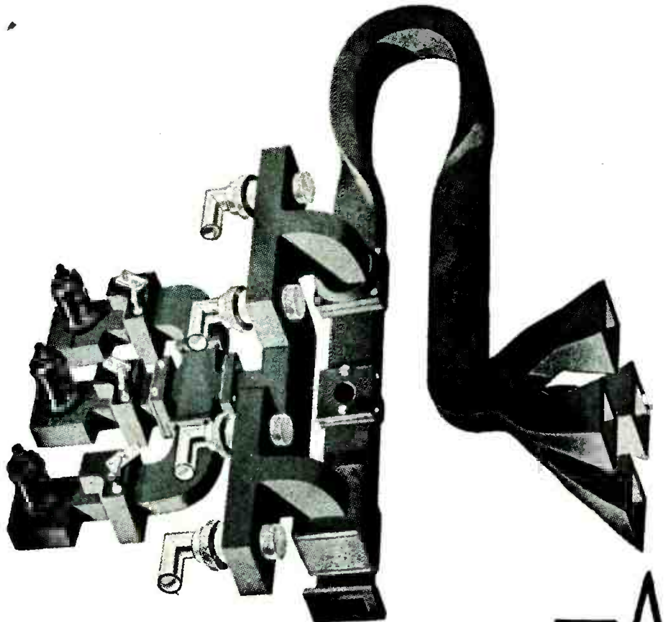

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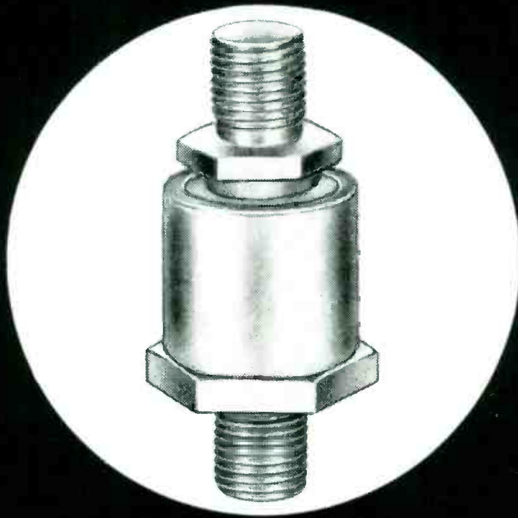

is actual size

a silicon
power rectifier
with an overall dimension of only two inches that will operate at currents in excess of
50 amperes
and in ambient temperatures up to 200°C with suitable derating

National Semiconductor's new silicon power rectifier is designed to provide high power output and reliability in the extremely high temperature ranges.

The rectifier is housed in a rugged, shock and vibration resistant case measuring only 1 ⅛" diameter and 1 ¼" high. Including threaded mounting studs, the unit measures approximately two inches. Total weight is 4 ounces. The light weight, compact design and stable peak inverse voltage characteristics at high temperatures makes this unit especially adaptable for use in supersonic aircraft and guided missiles.

Write for your copy of detailed operating characteristics

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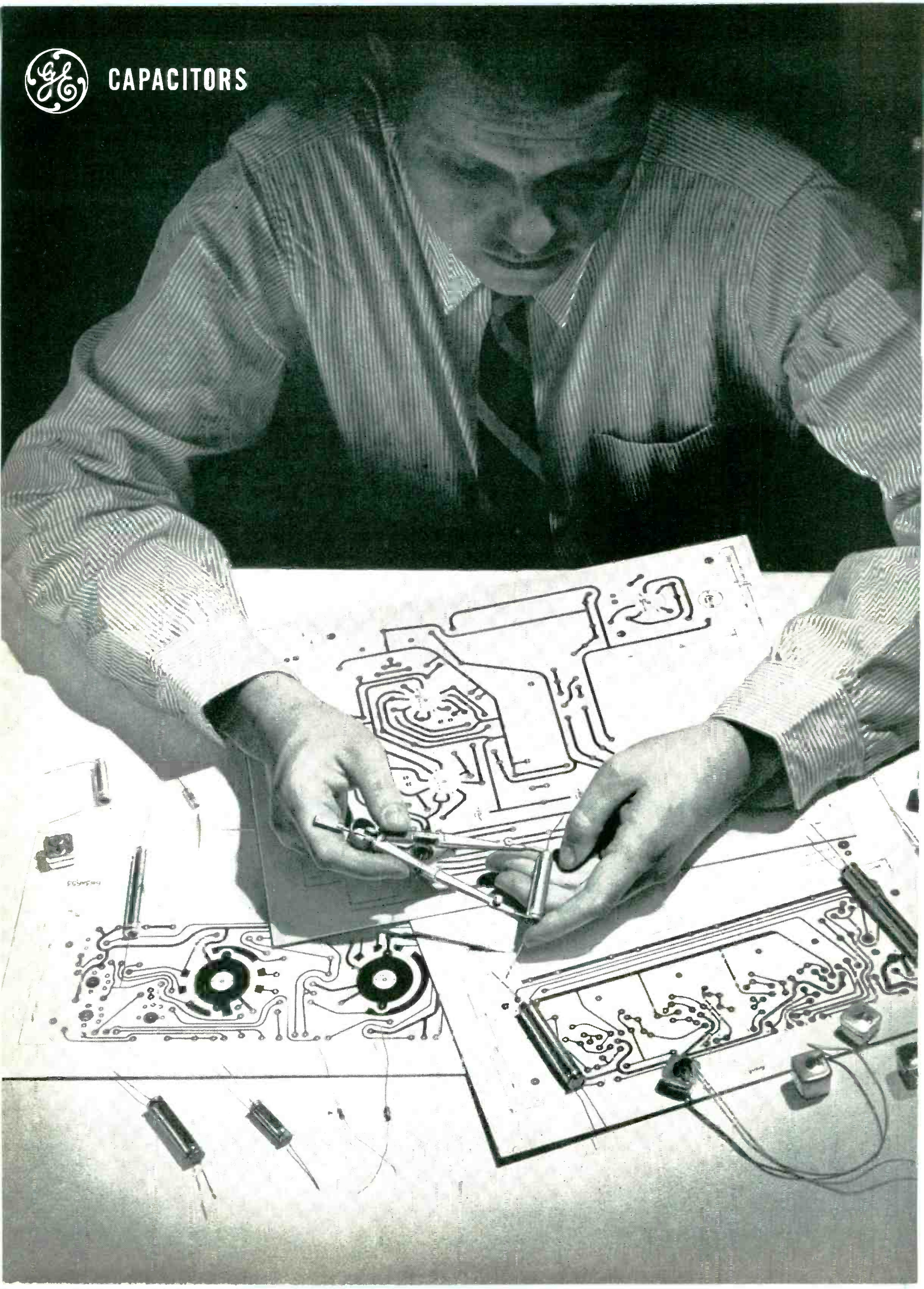

How G-E Tantalytic* Capacitors help solve your critical design problems

Three separate lines of G-E tantalum electrolytic capacitors to meet your size and temperature needs

No matter what capacitor problems you face in your most critical electronic applications, you're almost sure to find an answer in the three proven lines of Tantalytic capacitors now offered by General Electric.

Is size your problem? G-E Tantalytic capacitors carry extremely high uf ratings per cubic centimeter, especially in the 0-150 VDC range. In some ratings, Tantalytic capacitors are actually less than 1% the size of comparably rated paper capacitors.

Is high reliability your problem? Where small size and high reliability are "musts," as they are in communications equipment for example, G-E Tantalytic capacitors meet the challenge. Their high quality assures long, more reliable operation —at a real saving in circuit space.

Is high temperature your problem? For extremely high ambient temperatures, as found in high-speed aircraft and guided missile applications, you can count on G-E high-temperature Tantalytic capacitors. They operate at full rated voltage from −55C to +125C. Rectangular and tubular designs are available to meet the varying requirements of modern electronic design.

General Electric engineers have accumulated a wealth of life test and other data through a long period of testing tantalum capacitors under every conceivable condition of operation. As a result, G-E Tantalytic capacitors may be relied upon for mechanical and electrical stability and maximum efficiency in operation.

Let your G-E Apparatus Sales Representative show you how these capacitors can answer your particular problems. Or, if you would like further information (ratings and specifications) on G-E Tantalytic capacitors write directly to the General Electric Company, Section 442-30, Schenectady 5, N. Y.

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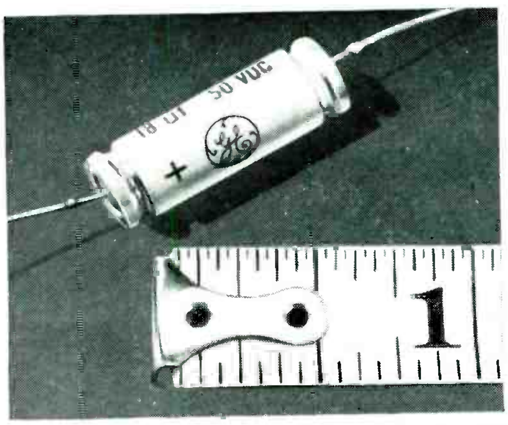
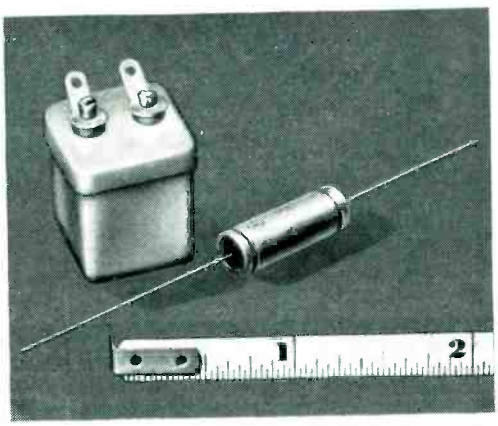
Progress Is Our Most Important Product

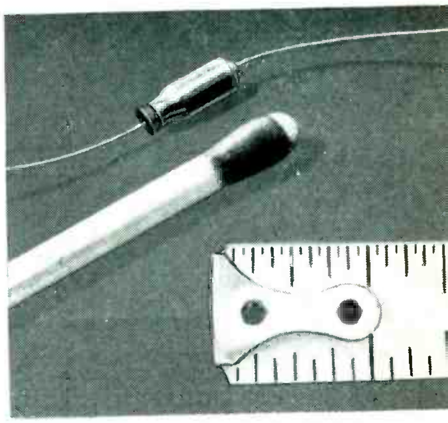
GENERAL ELECTRIC



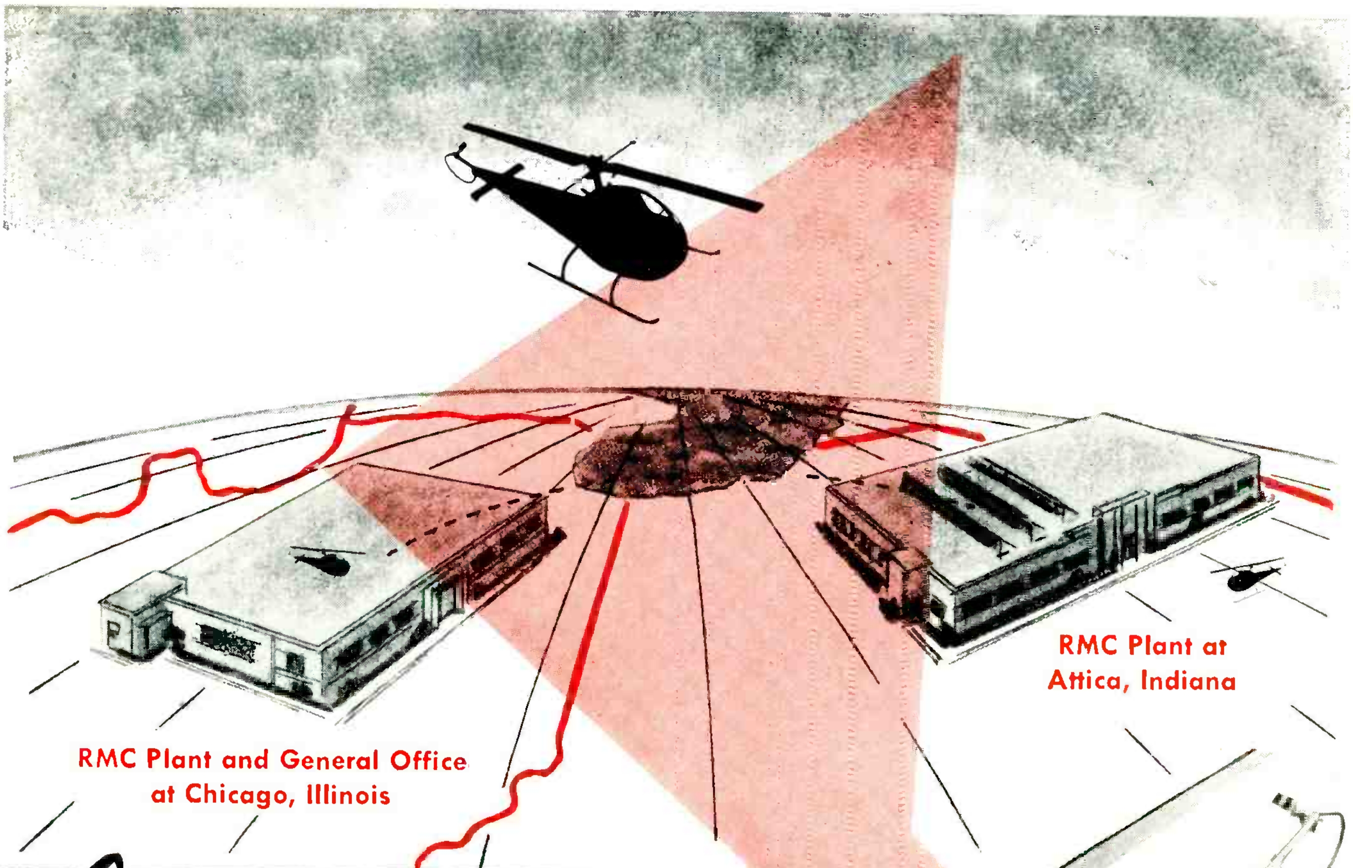
85 C TANTALYTIC CAPACITORS for circuits requiring low leakage current, long shelf life. Available in polar or non-polar types for a-c and d-c. Ratings 0.25–580 uf, 3.75–150 v. Tol. ±20% (plain foil), −15 to +75% (etched). Temp. range −55 to +85 C. Write for Bulletins GEC-808 and GET-2333.



125 C TANTALYTIC CAPACITORS for high-speed aircraft and guided missile electronic systems where quality, long life, small size are main requirements. Available in plain or etched foil, in rectangular or tubular designs. Ratings 0.25–180 uf, 10–100 v. Tol. ±20% (plain foil), −15 to +75% (etched). Temp. range −55 to +125 C. Write for Bulletins GEA-6258, GET-2502, and GET-2513.

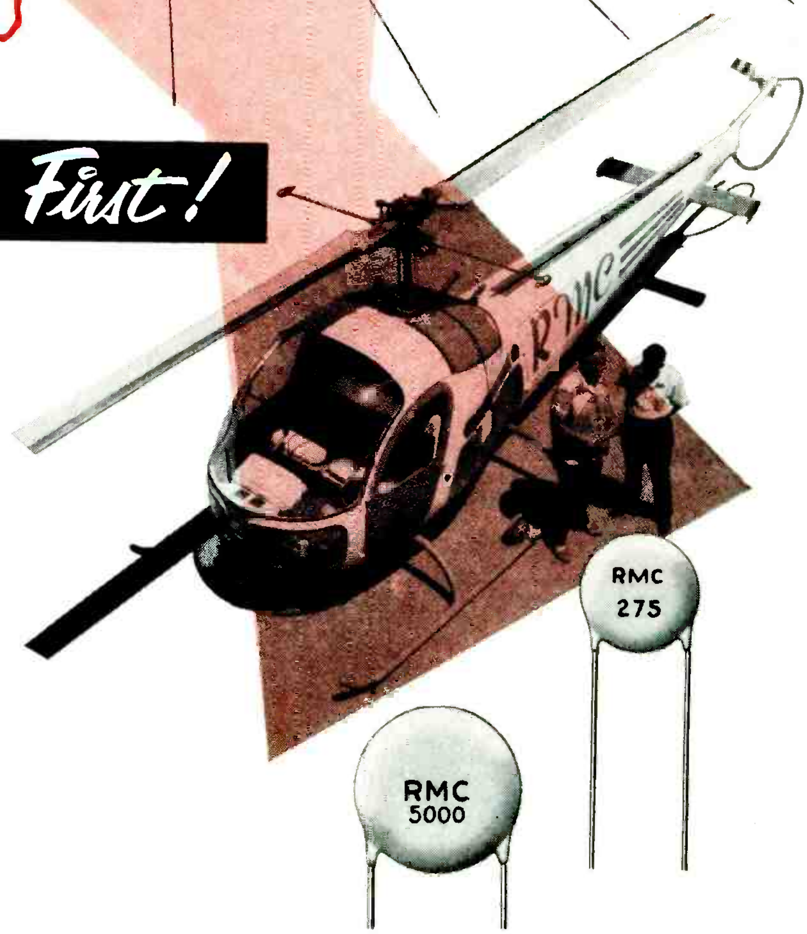


MICRO-MINIATURE TANTALYTIC capacitors for low-voltage d-c, transistorized electronic equipment such as hearing aids, pocket radios. Ratings 1–8 uf at 4 VDC, 1 uf at 8 VDC, 0.5 uf at 16 VDC. Tolerance −0 to +200%. Temperature range −20 to +50 C. Bulletins GEA-6065 and GET-2405.



Another RMC *First!*

Plant to Plant Helicopter Service



The tempo of RMC service has always been geared to the needs of important customer production schedules. Now RMC's modern manufacturing facilities at Chicago, Illinois and Attica, Indiana are provided with fast, dependable helicopter flights, enabling executive and engineering personnel to travel door to door in slightly more than one hour as compared to a previous four hours.

The new Bell 47H helicopter makes regular flights unhampered by weather and traffic. RMC is the first in the electronics industry to use this new mode of travel.

Now you, as an RMC customer, are assured of even faster service on your production and engineering requirements.

If you are now using any type of ceramic capacitor in the manufacture of your products, it will pay you to investigate DISCAPS...and the many other advantages offered by RMC.

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CERAMIC
CAPACITORS

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RADIO MATERIALS CORPORATION
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.
Two RMC Plants Devoted Exclusively to Ceramic Capacitors
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

you can't match TRIPLETT *model 630 VOM*

for **SPEED**
ACCURACY
DURABILITY
CONVENIENCE!

heavy molded case

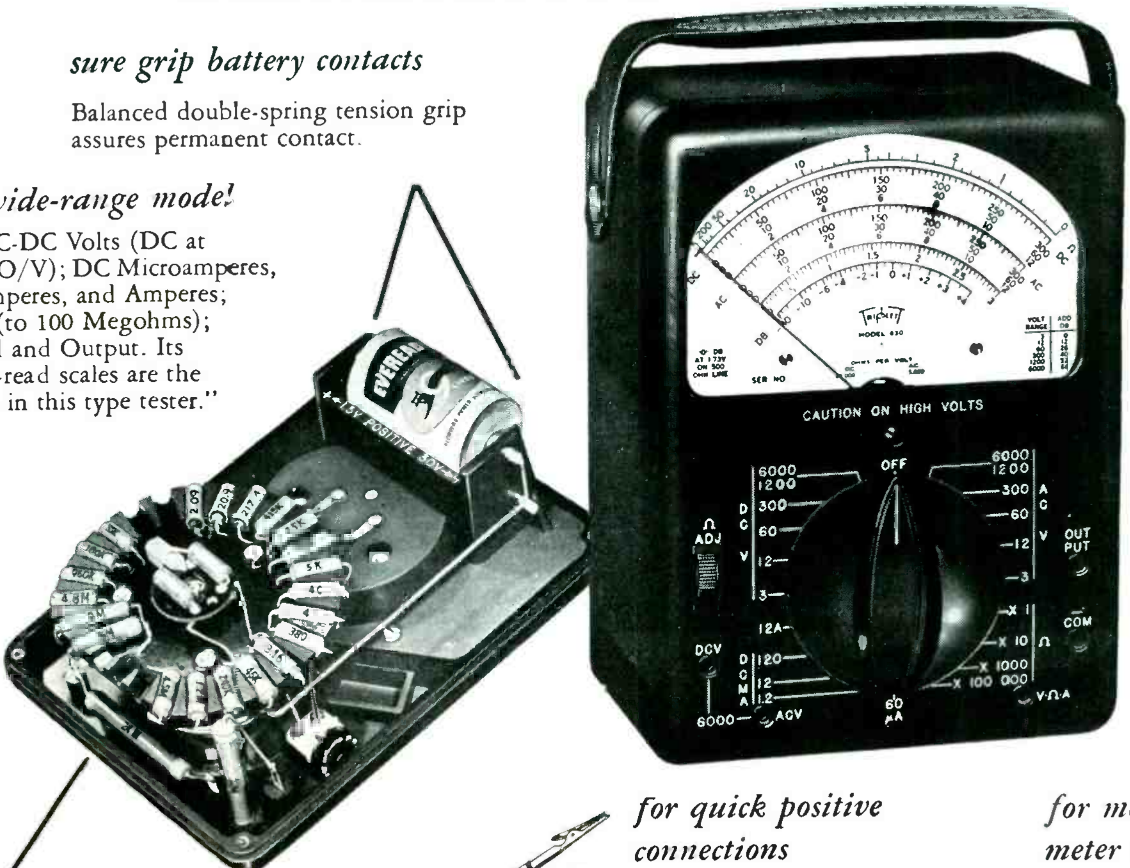
—¼" thick for high impact. Fully insulated.

sure grip battery contacts

Balanced double-spring tension grip assures permanent contact.

"this wide-range model

tests AC-DC Volts (DC at 20,000 O/V); DC Microamperes, Milliamperes, and Amperes; Ohms (to 100 Megohms); Decibel and Output. Its easy-to-read scales are the longest in this type tester."

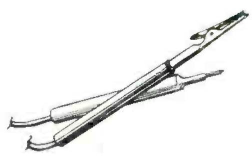


streamlined design

No protruding knobs on switch or ohms control—both are flush with the panel.

king size recessed knob

—Only one switch; (fully enclosed) selects both circuit and range. Just turn the switch and make your reading.

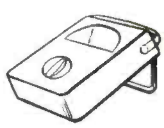


for quick positive connections

—Banana jacks and plugs on test leads are best. Alligator clips are provided to slip on test prods for extra convenience.

for most efficient meter use

—With every Model 630 you receive complete, simplified instructions on how to use and maintain most efficiently.



for convenience in reading

—Available as an extra (only 50c), this special stand tilts meter at best angle for easy reading

no slip feature

Four rubber feet furnished as standard equipment fit in back of the case to prevent slipping on smooth surfaces.

advanced engineering

—Molded mounting for resistors and shunts allow direct connections without cabling. No chance for shorts. Longer life and easy-to-replace resistors in their marked positions.

MODEL 630 | $39.50

TRIPLETT ELECTRICAL INSTRUMENT CO.
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THE MIGHTY NINE VOM LINE

631 Combination V-O-M—VTVM	**630-NA** For Best Testing Around The Lab, Production Line or Bench	**630** The Popular All-Purpose V-O-M	**630-A** A Good Lab and Production Line V-O-M	**310** The Smallest Complete V-O-M With Switch	**630-T** For Telephone Service	**666-HH** Medium Size For Field Testing	**625-NA** The First V-O-M With 10,000 Ohms/Volt AC	**666-R** Medium Size With 630 Features

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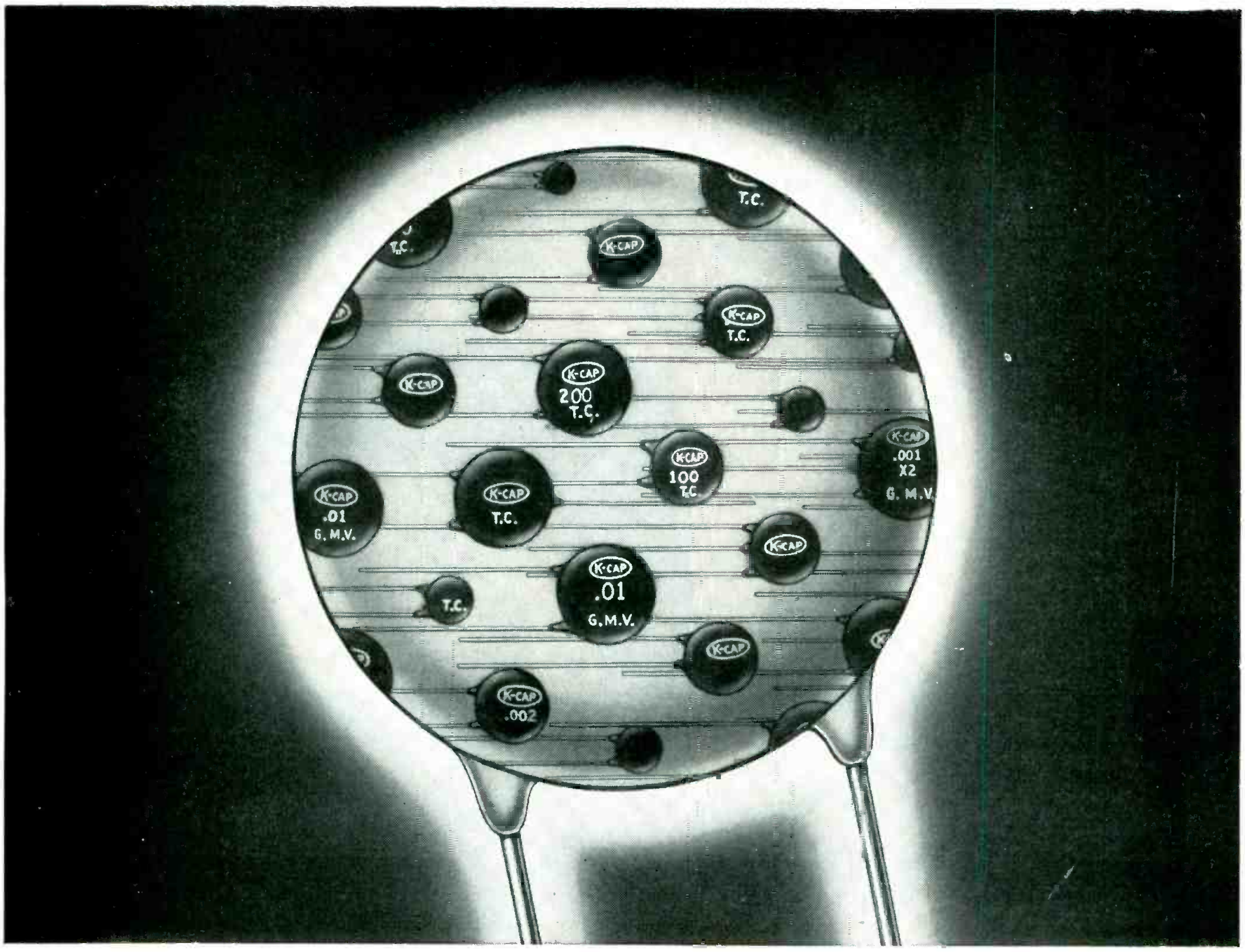

Did you know that only AUTOMATIC *makes K-CAP Ceramic Disc Capacitors?*

K-CAP* Ceramic Disc Capacitors are another mass produced electronic product made by Automatic Manufacturing Corporation, originators of the famous K-Tran* and J-Tran* I.F. Transformers...the first standardized I.F.'s in the industry.

K-Cap capacitors, like K-Tran and J-Tran, are manufactured completely within our own plant from the basic powders to the completed capacitor. The high K ceramic bodies are developed in our own modern laboratory and produced under the exacting supervision of our quality control engineers. The silvering process is done by men with more than 20 years experience in silvering trimmers and condensers.

K-Cap Ceramic Capacitors are distinguished by their black, wax impregnated, phenolic coating, stamped with red markings. All bear the registered trade mark K-Cap.

They are made in 4 standard types:

GUARANTEED MINIMUM VALUE
for bypassing, etc.

GENERAL PURPOSE
for coupling, etc.

TEMPERATURE COMPENSATED
in a range of T.C. from N.P.O. through N2200

HIGH STABILITY
for elimination of drift

Available in either single capacitor, dual capacitor unshielded, and dual capacitor shielded, in a range from 2. uuf to .02 uf.

☆ ☆ ☆

For more information about K-Cap, K-Tran and J-Tran, write for a copy of the K-Tran—K-Cap Manual—56 pages of engineering information, most valuable to you in Electronic designing.

Every part Automatic uses ...Automatic makes.

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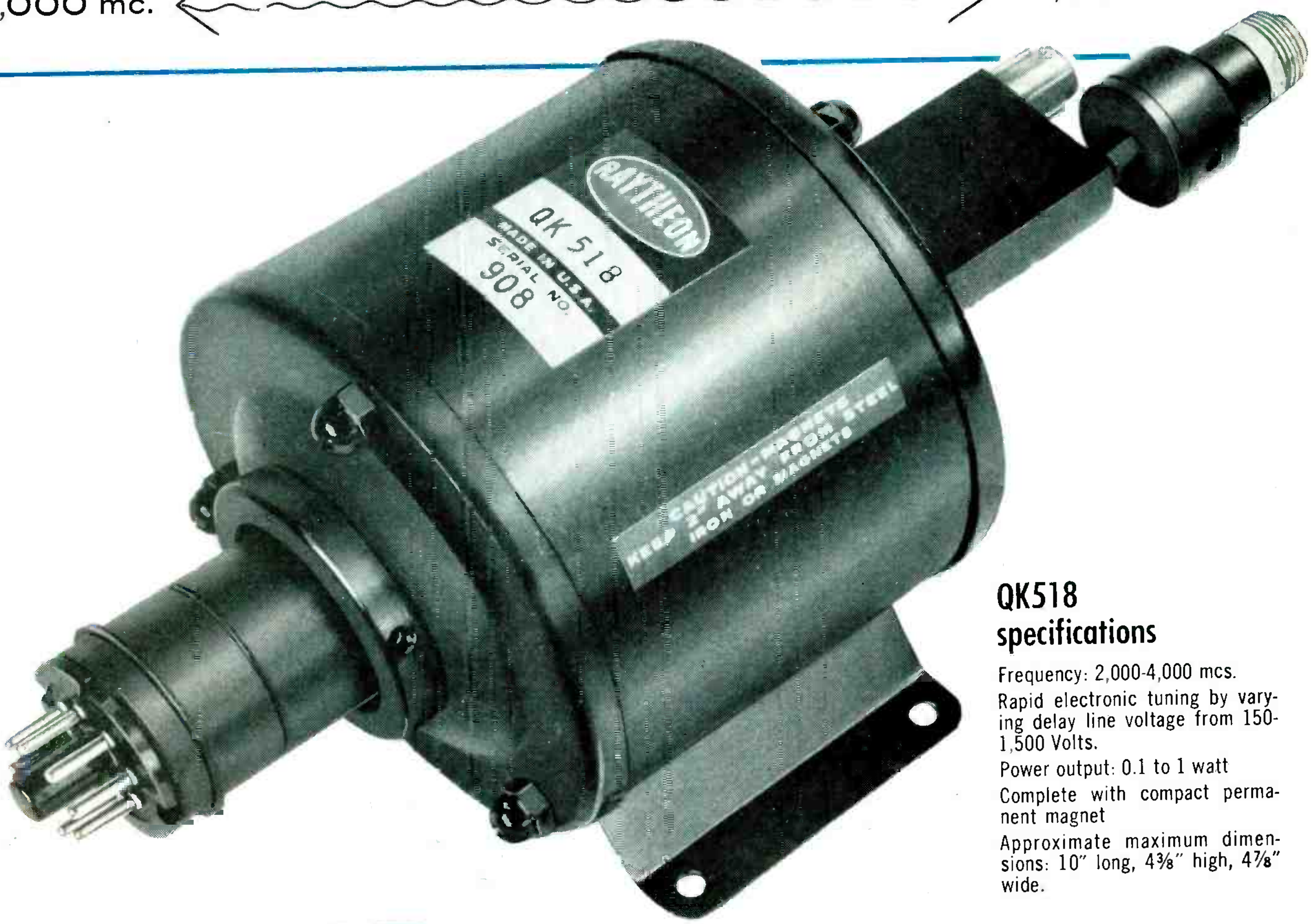
Raytheon — World's Largest Manufacturer of Magnetrons and Klystrons

VOLTAGE TUNABLE

1,000 mc. ⟵ ⟶ 16,000 mc.



QK518 specifications

Frequency: 2,000-4,000 mcs.

Rapid electronic tuning by varying delay line voltage from 150-1,500 Volts.

Power output: 0.1 to 1 watt

Complete with compact permanent magnet

Approximate maximum dimensions: 10" long, 4⅜" high, 4⅞" wide.

NEW Raytheon Backward Wave Oscillator Series

for wide, rapid electronic tuning—1,000 mc. to 16,000 mc.

The tubes in this revolutionary new line of Raytheon Backward Wave Oscillators give you four outstanding performance advantages:

1. Electronically tunable over an *extremely* wide range of frequencies
2. Frequency insensitive to load variations
3. High signal-to-noise ratio
4. Can be operated under conditions of amplitude or pulse modulation

These new tubes are finding fast-growing applications in microwave equipment, including radar and signal generators.

Write today for free Data Booklet on the QK518 (above) which is available for delivery. We'll also be happy to answer any questions you may have on this new line.

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RAYTHEON

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Excellence in Electronics

Raytheon Makes: Magnetrons and Klystrons, Backward Wave Oscillators, Traveling Wave Tubes, Storage Tubes, Power Tubes, Receiving Tubes, Transistors

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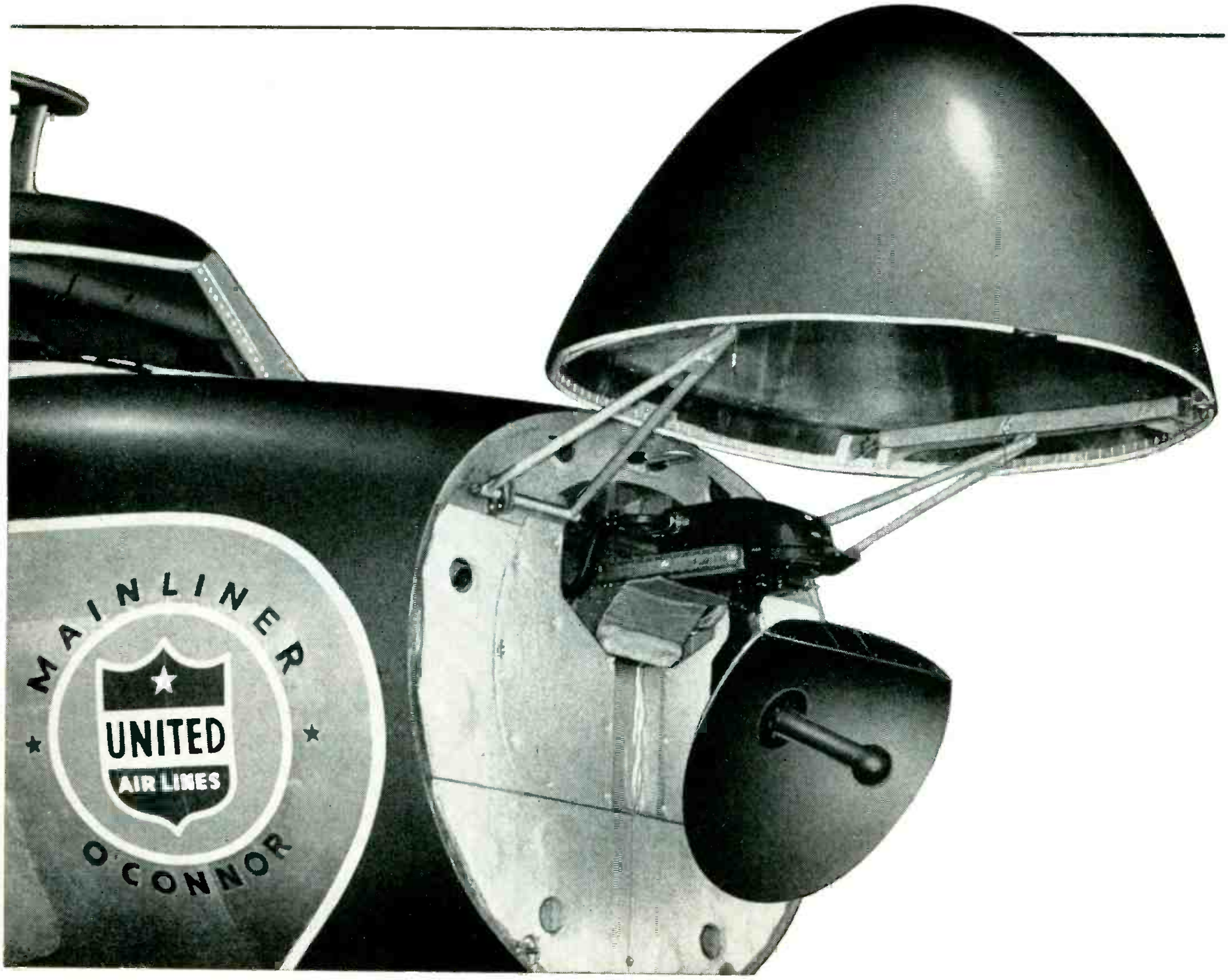
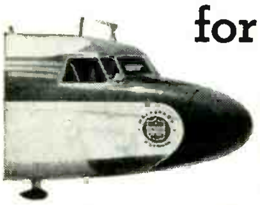
KOCH ...*World's largest fabricator of moulded Fiberglas products*



How Convair 340's Solve a Housing Problem for United Air Lines' All-Weather Radar



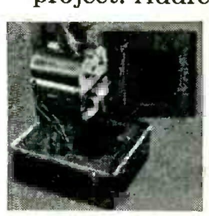
The nose knows when and where bad flight weather threatens! Radar weather-spotting equipment in the nose of United's Convair 340 now sees through a Koch Fiberglas Radome.

When Convair received United's order for radar-equipped 340's, they naturally turned to Koch, world's largest fabricator of moulded Fiberglas, for domes to house the radar.

The life expectancy of the Koch Radome is many, many times that of any other Radome. This Radome is made possible only by Koch's own exclusive method of moulding.

W. J. Flanagan, Convair Purchasing Agent, wrote Koch upon completion, "You have made substantial contributions to this industry by proposing and successfully applying new departures and moulding technique."

If you are a plane manufacturer, or if you install airborne radar, investigate Koch's Moulded Fiberglas Radome. If you manufacture any equipment that needs special protection, ask the people who know the most about Fiberglas fabrication. We will be glad to confer with you about your project. Address Dept. EKE.



KOCH *Fiberglas*

PRONOUNCED "KOKE"

Pioneer in industrial products of moulded Fiberglas

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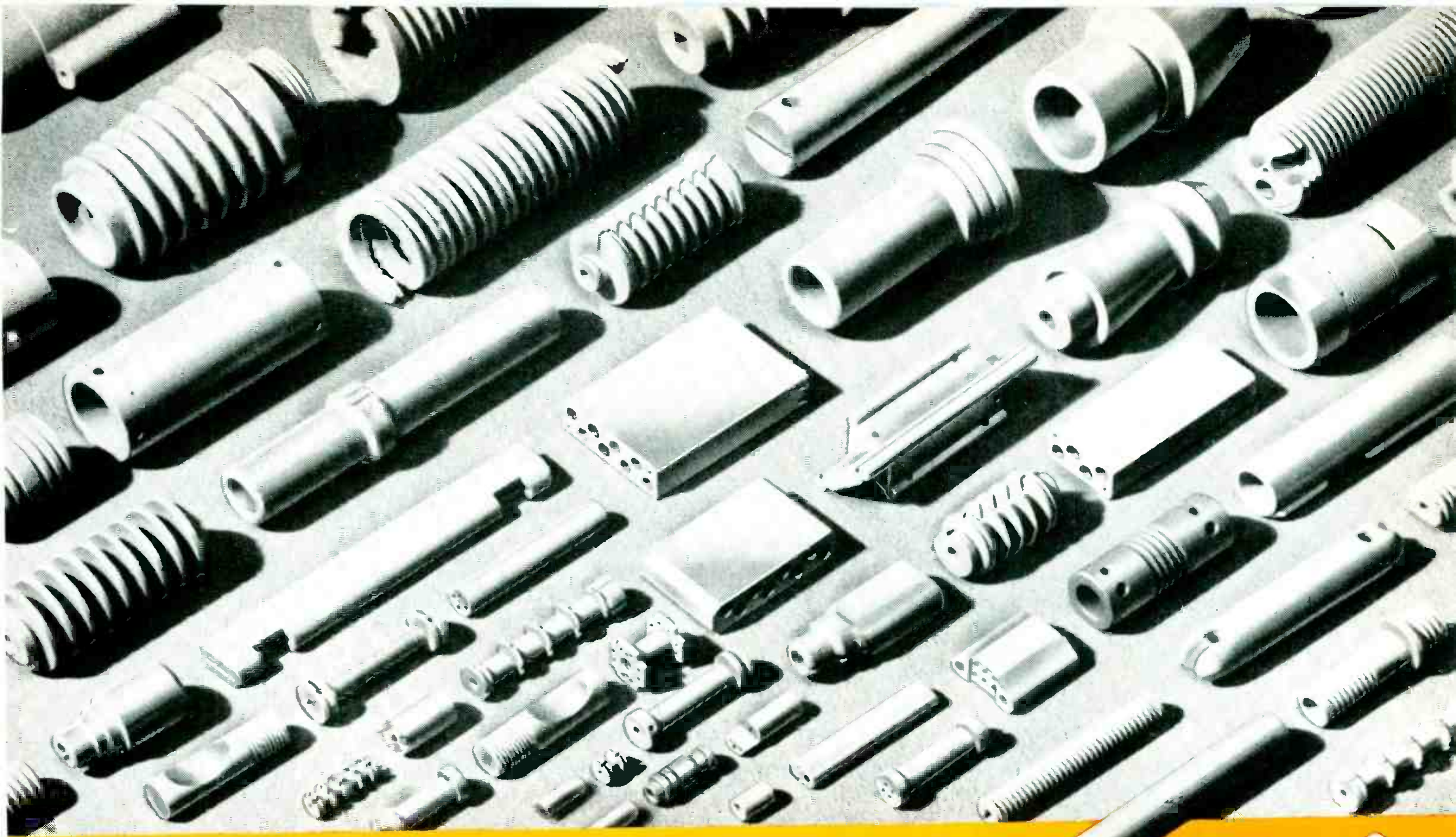

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speed production .....

FASTER DELIVERY. Four things are vital to quick ceramic deliveries: Plenty of Materials, Machinery, Firing Facilities and "Know How." You'll find all four in greater abundance where AlSiMag is made.

SIMPLIFIED ASSEMBLY. Versatile AlSiMag extrusions can often be chosen or designed to combine several functions, thus eliminating costly production steps. Wider range of shapes, sizes and cross sections.

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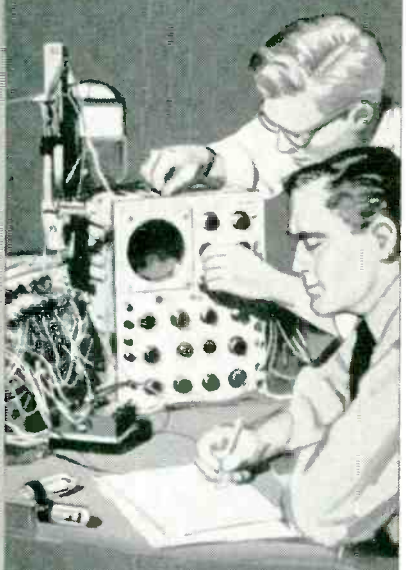
DATA FOR

SOLID-STATE ELECTRONICS . . . AT RCA

For many years the Radio Corporation of America has been actively engaged in a broad program of research, development, and production of solid-state materials and devices.

Many of the electronically active solids under study and development at RCA have opened or are opening the way for new products and circuits. For example, photo-emissive and secondary-emissive materials have made possible the Image Orthicon and the multiplier phototubes. Photoconductive materials are used as light-sensitive elements in the compact Vidicon camera tube; and in new developments, they are making possible sensitive photoconductive cells for a host of potential applications.

RCA work on cathodoluminescent materials so widely used for the screens of cathode-ray tubes is being extended to find new applications for these materials; in addition, the newer electroluminescent materials are also being investigated to determine potential fields of application. By combining photoconductive and electroluminescent materials, RCA Laboratories are developing the light amplifier for intensifying images.



RCA advances in the understanding of semiconductors have resulted in important improvements in transistors. In addition to its commercial line of precision-made transistors and germanium point-contact crystal diodes, RCA has under development other types which will open new avenues of circuit design.

New ferromagnetic and ferroelectric materials under study are expected to facilitate the construction of miniature components for transistorized equipment . . . for electronic computers and business machines . . . and for many other applications symbolic of electronic progress.

Both in research and production, RCA is geared to contribute to the needs of industry for new and better products for expanding markets.

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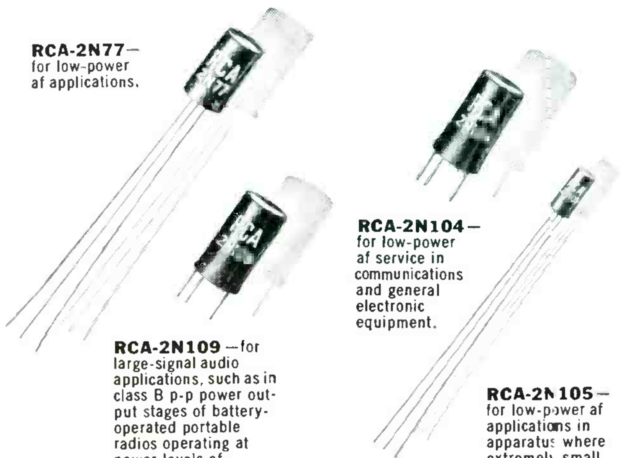
RCA TRANSISTORS FOR AF APPLICATIONS



RCA-2N77—for low-power af applications.

RCA-2N104—for low-power af service in communications and general electronic equipment.

RCA-2N109—for large-signal audio applications, such as in class B p-p power output stages of battery-operated portable radios operating at power levels of approx. 160 milliwatts.

RCA-2N105—for low-power af applications in apparatus where extremely small size is required.

	RCA-2N77	RCA-2N104	RCA-2N105	RCA-2N109
MAX. RATINGS (Absolute Values):				
Collector Volts	−25	−30	−25	−25
Collector Ma	−15	−50	−15	−70
Collector Dissip. (mw)	35	up to 150*	35	50
Operating Temperature (°C)	50	70	50	50
TYPICAL OPERATION:†				
Collector Volts	−4	−6	−4	−9
Collector Ma	−0.7	−1	−0.7	−13
Alpha (Collector-to-base connection)	−55	−44	−55	70††
Power Gain (db)	44	41	42	33**
Power Output (mw) Approx.	—	—	—	160**
Source Imped. (ohms)	1980	1400	2300	375 per base connection
Load Imped. (ohms)	100,000	20,000	20,000	200 per collector
Noise Factor (db)	6.5 av.	12 max.	4.5 av.	—
Cutoff Freq. (Kc)	700	700	750	—
Figure of Merit for High Frequency Performance (Mc)	1.7	1.6	2.6	—

* Depends on temperature and circuit parameters †† Large-Signal
† In common-emitter circuit at ambient temperature of 25° C.
** For 2 transistors in class B af circuit; distortion of less than 10 percent

RCA Transistors listed below are germanium, p-n-p, alloy-junction, hermetically sealed types, in insulated metal jackets. These high-quality transistors are designed specifically for applications where extreme stability and exceptional uniformity of characteristics are paramount—initially and throughout life—and for circuits where very low collector cutoff current is essential. In addition to the units described here, RCA is developing new transistor types which will broaden transistorization of electronic equipment.

NEW SOLID-STATE DEVICES UNDER DEVELOPMENT

Ferrites

RCA has an extensive background of more than 5 years in the design, development, and manufacture of ferrites. Under development for a great diversity of electronic applications are the following four categories of ferrites:

1. Hard—displaying a large hysteresis loop, as in permanent magnets; 2. Soft—having small hysteresis losses, as required in deflection-component cores and high-frequency transformers; 3. Square Loop—with "square" hysteresis loops, as used in computer memory devices and high-speed switching circuits; 4. Magnetostrictive—exhibiting change in physical dimensions when placed in a magnetic field, as in transducers.

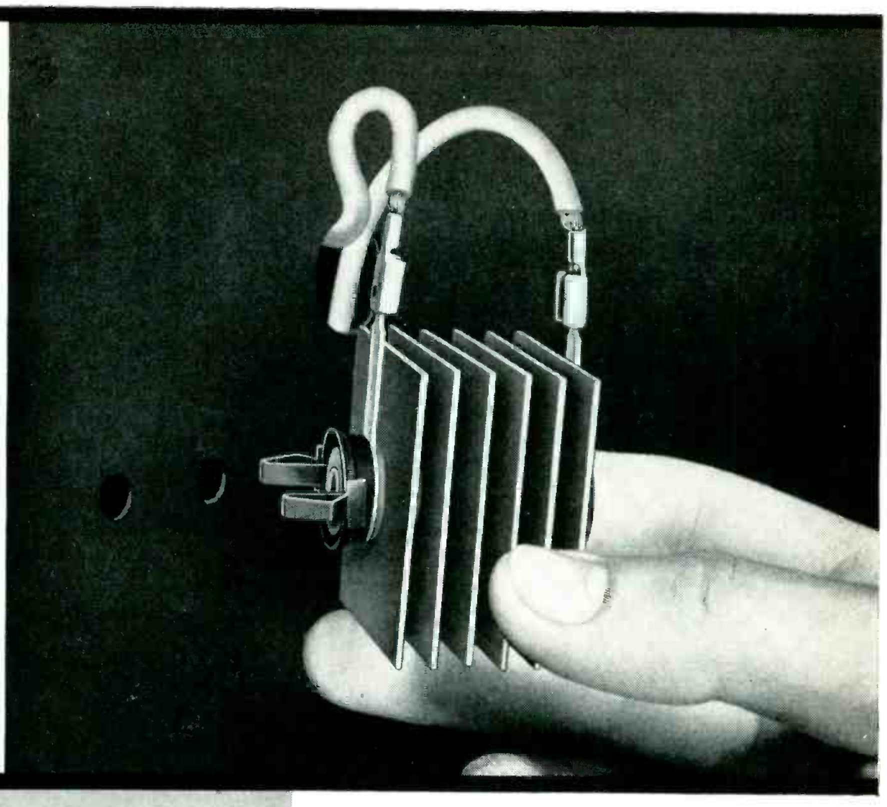
Semiconductor Photocells

RCA's many years of experience in solid-state electronics serves as excellent background for its developmental programs in semiconductor photocells. When such cells become commercially available, it is expected that they will find application in street-lighting control, headlight-dimming control, animated-sign control, computer and business-machine reading devices, and other light-actuated devices.

RADIO CORPORATION of AMERICA
TUBE DIVISION HARRISON, N. J.

Want more information? Use post card on last page.

Radio Receptor's NEW money saving rectifier mounting!

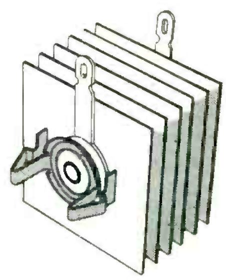


"QUI-KLIP" *snap-in type*

SELENIUM RECTIFIERS

QUICK MOUNTING! QUICK REMOVAL!

Spring steel clips with safe edges snap into two round, large tolerance holes in chassis (approx $\frac{3}{16}$" dia., $\frac{3}{4}$" c. to c.). Solderless connectors as shown, when used, simplify servicing



Radio Receptor's unique QUI-KLIP rectifiers will soon make their debut in TV sets produced by one of the country's leading manufacturers, saving them countless dollars in production costs.

QUI-KLIP requires no tools or sockets for mounting. There are no studs to break or threads to strip and the locating tab is now unnecessary. QUI-KLIP provides a positive seat for the rectifier – no rocking. Yet any serviceman can remove the stack quickly by squeezing the QUI-KLIP prongs with his fingers and removing the solderless connectors.

Let us show you how to put the cost saving QUI-KLIP selenium rectifiers to work in *your* production . . . Available in most popular sizes with cells from 1" square to 2" square, for radio, TV and other electronic circuits. For detailed information, write Dept. E-13.

- Speeds assembly time.
- Slashes production costs.
- Simplifies assembly.
- Eliminates stud rejects (No studs or nuts needed.)
- Permits easier replacement in the field.

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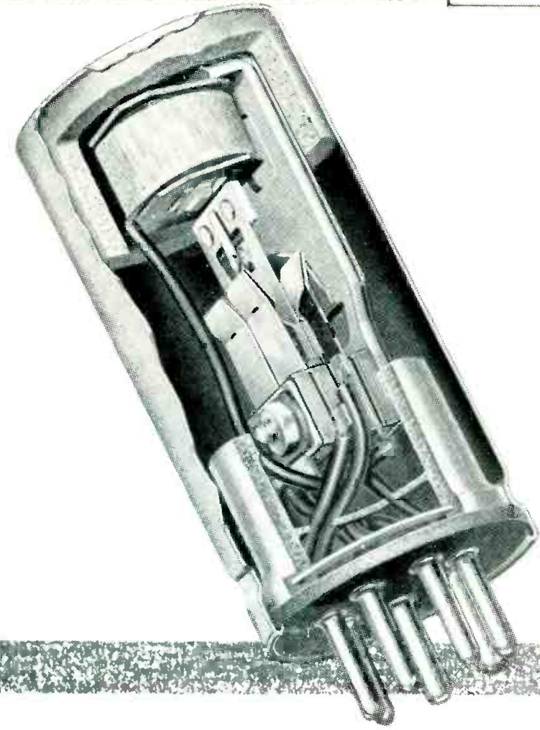
MALLORY



New 1700 series Mallory split-reed vibrator uses special alloy leaves which serve both as contacts and as springs . . . eliminating usual button contacts. Life is greatly increased, constancy of output improved, and driving power reduced.*

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CROSS TALK

► **CONVERSATIONAL SERVICE** . . . Following up last month's editorial entitled D.O.A., we call attention to a particular kind of repair work that often goes hand in hand with skimped products.

The essential tool is the tongue rather than the test set. From the tip of this instrument, firmly embedded in cheek, rolls such phrases as "They all work that way in this neighborhood," or "That's the way it's supposed to work," or "I don't see nuthin' wrong with it," or "There, that's a little better."

Much of this goes back to the fact that a man cant fix what isn't there. And so we repeat: There should be more design margin . . . *and men with a conscience.* More rugged assembly . . . *and men with a conscience.* More careful adjustment . . . *and men with a conscience.* More critical testing . . . *and men with a conscience.*

People are getting tired of being talked out of it.

► **SEGREGATION** . . . Because the electronics industry continues to grow and diversify, it is inevitable that from time to time someone will suggest further grouping of like exhibits at trade shows. Component parts would all be together in one area, instruments in another, transmitters in another, industrial controls in another and so on. This would permit highly specialized technicians to concentrate upon areas containing products of obvious immediate interest, therefore the suggestion has some merit.

Similar segregation of printed pages has several times been suggested to ELECTRONICS magazine. We have weighed the pros and cons, and continue to resist because ideas generated in one branch of this business have a habit of solving problems in other branches. Anything tending to reduce the exposure of the audience to overall technical advances would reduce the idea carryover.

We think, too, that while segregation might be neat it also could be deadly dull.

► **PORTICO** . . . Speaking of shows, we were intrigued enroute to the huge WESCON meeting in San Francisco by a program note that said exhibits would be in the Civic Auditorium and an adjacent *portico.*

Were it not for the fact that our dictionary says a portico is "a structure consisting of a roof supported by columns or piers," and the absence of tanbark on the ground, we would have sworn it was a tent.

► **BOUNCE** . . . You can knock a New Englander down but it is hard to knock him out. A manufacturer in the flooded northeast fished some equipment out of the drink the other day and noted that several panel meters were filled with water. "That," he remarked," is what I call optimum damping."

LOOKING AHEAD . . .

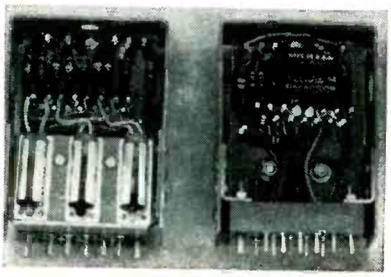
Transistor production techniques quite different from those currently in use are well along in an advanced laboratory stage, may late next year radically reduce waste, cut costs, expand applications

Earth's magnetic field can displace a tv picture a fraction of an inch when a set is moved. Not noticeable with monochrome, but suggests need for easily accessible adjustment when dealing with color

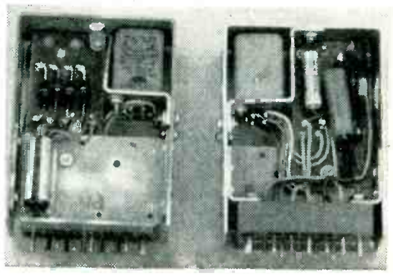
Watch for announcement of less complex color tube shadow mask, expected momentarily

Machines that type words instead of letters of the alphabet are already in experimental use. Next step will be broadening of vocabulary by means of magnetic storage. Ultimate may be typewriter you just talk to

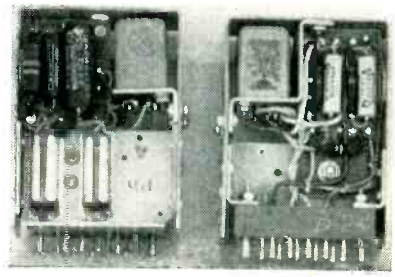
Industrial process control is simplified when . . .



Operational d-c amplifier



Modulator



Demodulator

Basic Control Circuits

SUMMARY — These basic circuits will solve more than 75 percent of an industrial control engineer's electronic problems. When the circuits are built up in plug-in form and stocked, relatively complex systems can be assembled off-the-shelf

AUTOMATIC CONTROL in industry requires many mechanical, electromechanical and electronic subassemblies. To develop a new control system, it would be desirable to have an on-the-shelf stockpile of building blocks to perform the various functions required.

Development time could be reduced considerably. All that would be required would be to connect these building blocks to satisfy the specified requirements. There will always be a few specialized items in each system that must be developed to satisfy a particular need. However, these cases represent only 10 to 15 percent of the total system.

Circuits Required

Amplifiers, power supplies, modulators and demodulators represent over 75 percent of the units required for an automatic control system.

The specifications for an amplifier, modulator or demodulator should include: gain, frequency response, phase shift, drift stability, linearity, input, output and load impedance, maximum linear voltage output swing, output voltage with zero input voltage and power.

The specifications for a power supply should include: nominal output voltage, output current range, load-change and line-change regulation, output impedance and power.

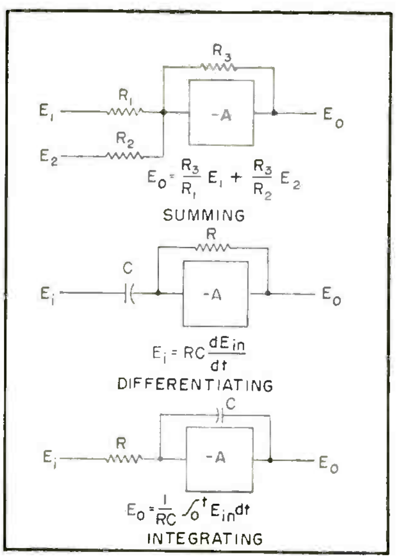


FIG. 1—Operational amplifiers sum, differentiate and integrate

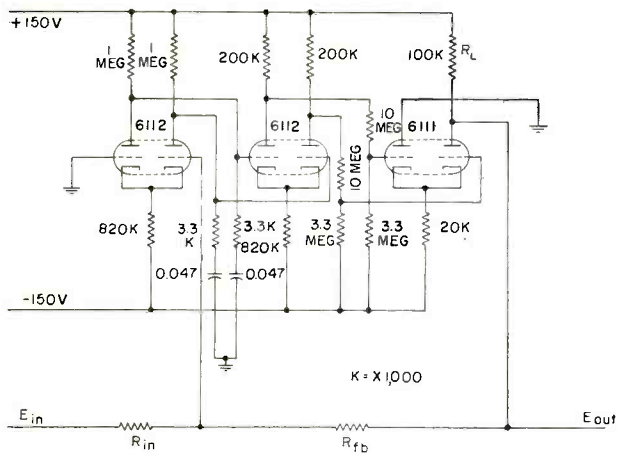
D-C Amplifier

There are as many types of amplifiers as there are electronic engineers. However, the most versatile type of amplifier may be used for adding, subtracting, integrating or differentiating. This amplifier is usually direct coupled as found in analog computers. But it may be an a-c amplifier if only addition or subtraction is required and extreme simplicity as well as long-time high-gain drift stability are desirable.

The theory of operational amplifiers is available in many textbooks.[1]

Figure 1 illustrates the basic operations that may be performed by operational amplifiers. Figure 2 is the schematic for a d-c operational amplifier with the specifications listed in the accompanying table.

Closed-loop gain may be adjusted by varying the ratio R_{fb}/R_{in}. The values of the cathode resistor and



Open-loop gain	4,500
Frequency response	
open loop	3 db down at 50 cps
closed loop (R_{fb}/R_{in}) = 10	3 db down at 50,000 cps
Phase shift	
open loop	135 deg at 50 cps
closed loop (R_{fb}/R_{in}) = 10	135 deg at 50,000 cps
Drift	20 mv referred to input grid
Gain linearity (R_{fb}/R_{in}) = 10	0.22 percent
Input impedance	dependent on R_{in} and R_{fb}
Output impedance	
open loop	33,000 ohms
closed loop (R_{fb}/R_{in}) = 10	73 ohms
Optimum load impedance	greater than 10,000 ohms
Max output swing (50,000-ohm load)	±50 v

FIG. 2—Circuit and specifications for a d-c operational amplifier such as used in analog computers

Are Packaged

By L. S. KLIVANS*

Northrop Aircraft, Inc.
Inglewood, California

R_L at the output are a function of the load impedance and the maximum desired output voltage swing. A plug-in version of this amplifier is shown in a photograph.

A-C Amplifier

Figure 3 is a schematic of an a-c operational amplifier with the specifications listed in the table.

Closed-loop gain may be adjusted by varying the ratio R_{fb}/R_{in}. The values of R_k and R_L at the output are a function of the load impedance and the maximum desired linear output voltage swing.

Servo Amplifier

Figure 4 is a schematic of a 60 or 400-cps servo amplifier. Although both of the operational amplifiers can be used also as servo amplifiers if a large number of inputs and low gain as well as power output is required, in general this is not the case. For simplicity, as well as increased performance, it is desirable to have a servo amplifier building block.

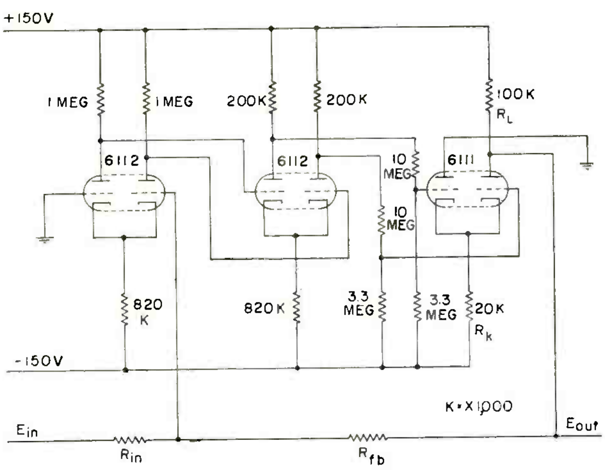
Servo amplifier gain may be adjusted by varying the ratio R_{fb}/R_{in}.

The output transformer is chosen to match load impedance characteristics. It was selected to drive a Transicoil 11MG 400-cycle induction motor-generator.

Power Supplies

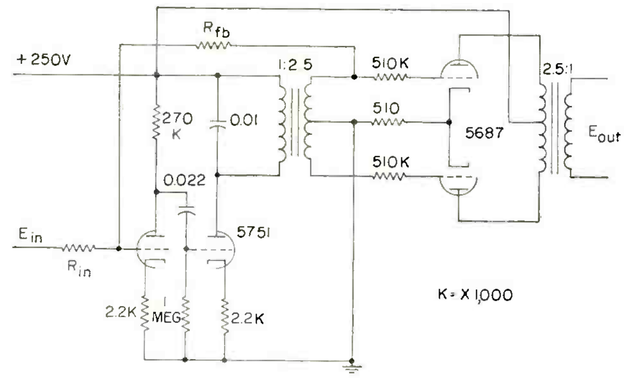
A series-regulated power supply package is excellent for the 0.5 to 1-

* Now with Radioplane Co., Van Nuys, California.



Open-loop gain	4,500
Frequency response	
open loop	3 db down at 4,000 cps
closed loop (R_{fb}/R_{in}) = 10	3 db down at 40,000 cps
Phase shift	
open loop	135 deg at 5,000 cps
closed loop (R_{fb}/R_{in}) = 10	135 deg at 24,000 cps
Gain linearity (R_{fb}/R_{in}) = 10	0.22 percent
Input impedance	dependent on R_{in} and R_{fb}
Output impedance	
open loop	33,000 ohms
closed loop (R_{fb}/R_{in}) = 10	73 ohms
Optimum load impedance	greater than 10,000 ohms
Max output swing (50,000-ohm load)	30 v rms
Output with zero input	30 mv rms

FIG. 3—Long-time high-gain drift stability characterizes this a-c operational amplifier



Open-loop gain	2,100
Frequency response, open loop	flat to 20 cps
Phase shift, open loop	0 deg at 20 cps
Linearity	±5 percent to 80 v rms output
Input impedance	dependent on R_{in} and R_{fb}
Output impedance	5,000 ohms
Max output swing (Transicoil 11MG motor)	110 v rms
Output with zero input	0.85 v rms
Max power requirements	6.3 v at 1.25 amp 250 v d-c at 25 ma

FIG. 4—Servo amplifier for 60 or 400 cps features simplicity and increased performance over operational types

percent regulation range. Where 2 to 5-percent regulation is satisfactory, simplicity may be gained by utilizing voltage-regulator tubes. The latter category is suitable for servo amplifiers. The former is recommended for operational amplifiers to insure long-time drift stability.

Figure 5A is a schematic of a subminiature plug-in series-regulated power supply utilized with the operational amplifiers shown in Fig. 2 and 3.

Figure 5B shows a regulated power supply utilizing voltage-regulator tubes. This power supply will suffice for servo amplifiers or applications where 2 to 5-percent supply changes are not detrimental. The specifications for the two supplies are listed in the table.

Modulators

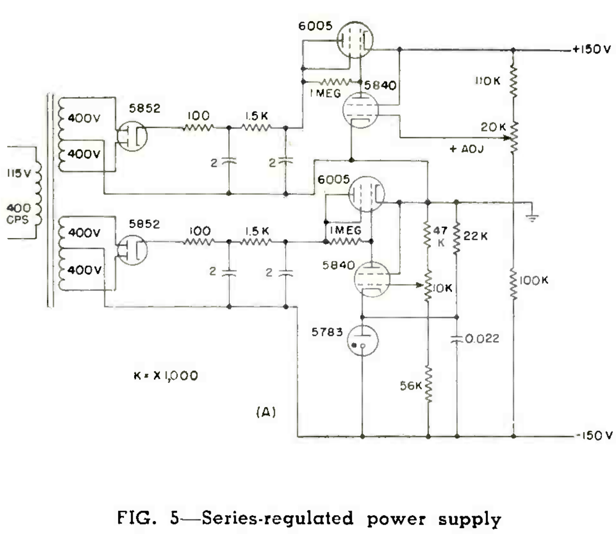
Modulators and demodulators are necessary in an automatic control system to convert from d-c to a-c or a-c to d-c.[2] In a modulator, the a-c output will be proportional to the d-c input and the phase will depend on the polarity of the input signal. For the demodulator the d-c output will be proportional to the a-c input and the polarity will depend on the phase of the input signal.

The decision as to which type of signal will be used arises from characteristics of the control sensor (pressure transducer, accelerometer, strain gage, phototube, etc) and the power actuation system. Where one is d-c and one is a-c, it is necessary to convert the signals.

Where it is desired to convert an a-c signal to phase sensitive d-c, a demodulator is used. Figure 6 is the schematic of a 400-cps demodulator with the specifications listed in the table.

Figure 7 is the schematic of a 400-cps modulator with specifications as given.

This modulator is designed to be utilized in the error portion of the control system. Therefore linearity and maximum output swing requirements are not excessive. An electromechanical chopper is recom-



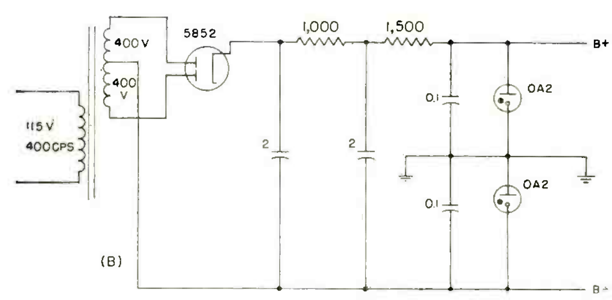
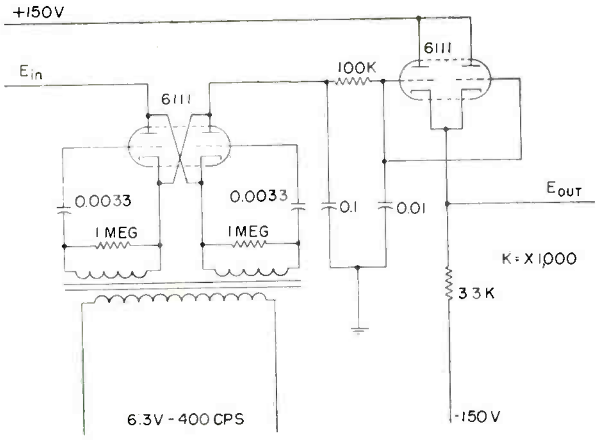


FIG. 5—Series-regulated power supply (A) has excellent regulation; power supply using VR tubes (B) provides 2-to-5 percent regulation

	Series (A)	Volt. Reg (B)
Nominal output	±150 v	±150 v
Output current range	0–50 ma	35–60 ma
Load-change regulation (n-l to f-l)	0.7 percent	2 percent
Line-change regulation (105–125 v)	0.8 percent	3 percent
Output impedance	20 ohms	100–200 ohms
Ripple voltage	0.02 v rms	0.2 v rms
Max power requirements	115 v, 400 cps at 0.9 amp	115 v, 400 cps at 0.38 amp



Gain	1.3 to 1.4
Frequency response	2 db down at 20 cps
Phase shift	50 deg lag at 20 cps
Drift	0.062 v at output
Linearity (100,000-ohm load)	±2 percent
Input impedance	35,000 ohms
Output impedance	300 ohms
Load impedance	greater than 10,000 ohms
Max linear output swing	
100,000-ohm load	±100 v
10,000-ohm load	+100 v, −25 v
Output ripple with zero input	0.01 v, 400 cps
Max power requirements	6.3 v at 0.6 amp
	+150 v at 6 ma
	−150 v at 6 ma

FIG. 6—Demodulator is used to convert a-c signal to phase-sensitive d-c

mended where low drift rates, large voltage swings and high signal-to-noise ratios are required.[3] A subminiature plug-in modulator is shown in a photograph.

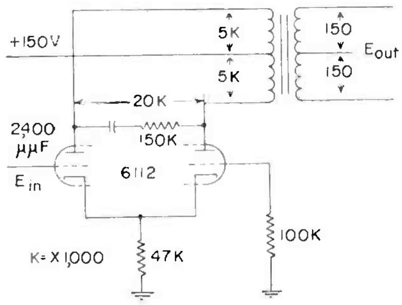
The modulator and demodulator may be utilized with different carrier frequencies with minor circuit changes. A subminiature plug-in phase-sensitive demodulator is shown in a photograph.

Pressure Control

Figure 8 illustrates an automatic system to control pressure accurately with reference to a pressure at a remote location. The reference pressure transducer transmits a low-level a-c voltage proportional to pressure. It is necessary to amplify this signal to drive a hydraulic control valve and actuator to displace a bellows that produces a pressure equal to the reference pressure.

A pressure transducer equal in characteristics to the reference transducer generates the feedback signal. Three of the building blocks are utilized. An a-c operational amplifier amplifies the error signal from the two transducers. A demodulator converts this error signal to d-c. A d-c operational amplifier provides error-network equalization to improve system stability and response and drives the electrohydraulic control valve of the hydraulic actuator.

The overall system could be put together and checked out in a matter of days utilizing the building-block techniques rather than in the weeks or even months that normally would be required if the electronic circuitry had to be developed to satisfy the requirements.



Gain	0.75 to 1.0
Frequency response	flat to 20 cps
Phase shift	30 deg to 20 cps
Drift	0.01 v at output
Linearity	±5 percent
Input impedance	10 meg or greater
Output impedance	4,000 ohms
Max output swing	0.8 v rms
Null level	0.01 v rms
Max power requirements	6.3 v at 0.3 amp
	+150 v at 0.2 ma

FIG. 7—Modulator for error portion of control system converts from d-c signal to a-c

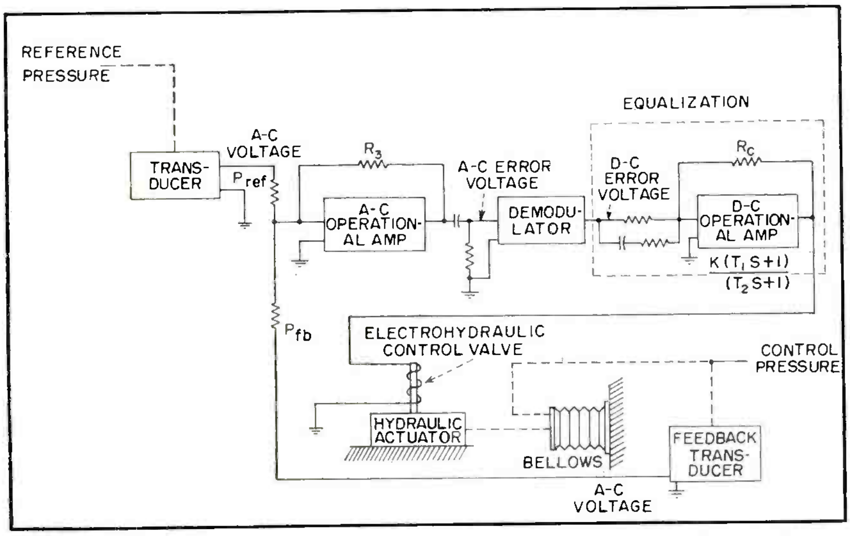


FIG. 8—Pressure regulating system uses three plug-in units: a-c amplifier, modulator and d-c amplifier

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(2) I. A. Greenwood, Jr., J. V. Holdam, Jr. and D. Macrae, Jr., "Electronic Instruments", p 375, McGraw-Hill Book Company, Inc., New York, 1948.
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Designing Over-Horizon

SUMMARY —— Long-distance, wide-band circuits are possible using the phenomenon of tropospheric propagation provided high transmitter power and diversity receiving equipment are used. Design considerations, including antenna gain and order of diversity, show how to set up a working system with a given percentage of reliability

POINT-TO-POINT communication with ultrahigh and super-high frequency transmissions has always appeared attractive because of three important considerations: high reliability as a result of freedom from ionospheric, atmospheric and geomagnetic disturbances; large information bandwidths; and privacy.

For many years these transmissions were believed to be of service only within or slightly beyond the radio horizon, although Marconi refused to recognize this limitation. However, with advances in transmission and reception techniques and in the technology of materials, it was demonstrated that useful signals could indeed be propagated well beyond the horizon, for distances of several hundred miles, possibly by a forward-scattering mechanism or by progressive partial reflections within the troposphere.

The discussion presented here outlines briefly the design of typical point-to-point over-the-horizon circuits, with emphasis on the operating margins that must be incorporated for accommodation of various types and grades of service.

Frequency Range

The frequency range from 100 to 5,000 mc is best suited for point-to-point over-the-horizon (o-h) transmissions. The propagation mechanism still operates at frequencies as low as 30 mc, but difficulties in achieving narrow-beam antennas and intrusion of ionospheric effects raise the lower limit to about 100 mc.

The upper frequency limit is established by the heavy absorption of very short microwave radiation by water vapor in the atmosphere. Accordingly, the relationships that will be employed in discussing various system parameters as a function of frequency will be treated as valid only in the range 100 to 5,000 mc.

The path loss between two points connected by an o-h link consists of two major contributions, a free-space loss and an over-the-horizon loss. This breakdown of the total loss is purely a bookkeeping convenience, since experimentally only the total loss can be measured. The free-space loss contains the frequency dependence, while the o-h loss (in the 100-5,000 mc range under discussion) is substantially independent of frequency.

Both losses, however, are dependent upon distance, with the o-h loss exacting the greater toll at long distances. The free-space loss represents the reduction in power density with increasing distance in free-space from the source of radiation. The frequency dependence of the free-space loss stems from the variation in collecting area (expressed in square wavelengths) of any receiving aperture of given gain as the frequency is altered.

The o-h loss is the loss remaining when the free-space loss expressed in decibels is subtracted from a median total loss (also in db) determined by a number of experiments[1,2,3] over the frequencies and distances of interest. Various theoretical foundations for the form of the o-h loss[4-7] have been given. It is the experimentally determined path loss that must be principally considered in the design of point-to-point o-h links.

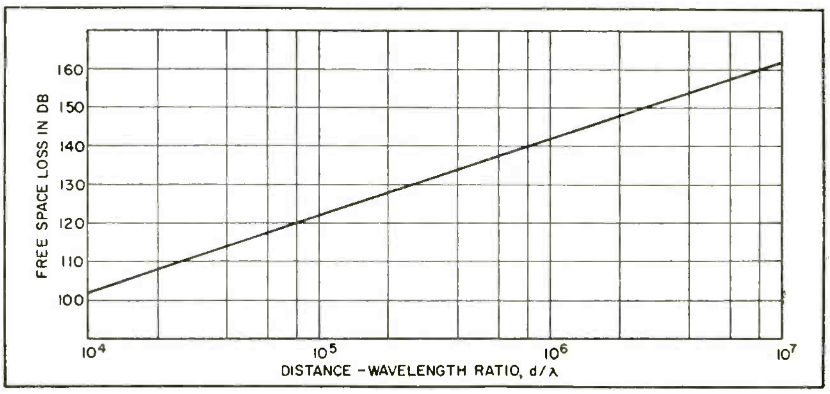

FIG. 1—Free-space loss is dependent upon distance and wavelength

Free-Space Loss

The free-space loss, L_{fs}, when expressed in decibels, takes the form

$$L_{fs} = 10 \log_{10} \frac{G_r G_t}{P_r / P_t} = \qquad (1)$$

$$20 \log_{10} \left(\frac{4\pi d}{\lambda} \right) = 22 + 20 \log_{10} (d/\lambda)$$

Communications Links

By DAVID DAVIDSON and ALFRED J. POTÉ

Hycon Eastern, Inc.
Cambridge, Mass.

where P_r is the received power at a receiving antenna of gain G_r in the direction of the link, P_t is the transmitted power delivered to an antenna of gain G_t in the direction of the link, d is the distance between terminals and λ the wavelength. Note that it is the ratio d/λ, the distance in wavelengths, that determines the character of the free-space loss as shown in Fig. 1.

Over-Horizon Loss

Path loss L_p is the sum of L_{fs}, the free-space loss and L_{oh}, the o-h loss, all quantities being expressed in decibels. The empirical formulation of L_{oh} is

$$L_{oh} = A + B\,(d - d_o) \qquad (2)$$

where A is the o-h loss associated with the distance d_o and B is the rate at which the o-h loss accrues with distance (attenuation rate). For present purposes, d_o will be taken as 100 miles; the expression then becomes

$$L_{oh} = 57 + 0.13\,(d_{mi} - 100) \qquad (3)$$

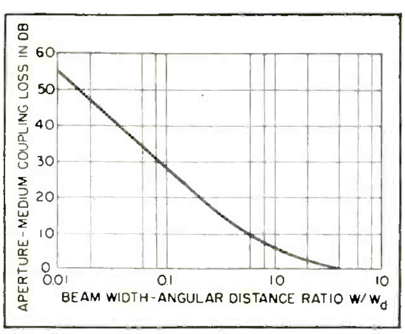

FIG. 3—Aperture-to-medium coupling loss results from failure to realize plane-wave antenna gain

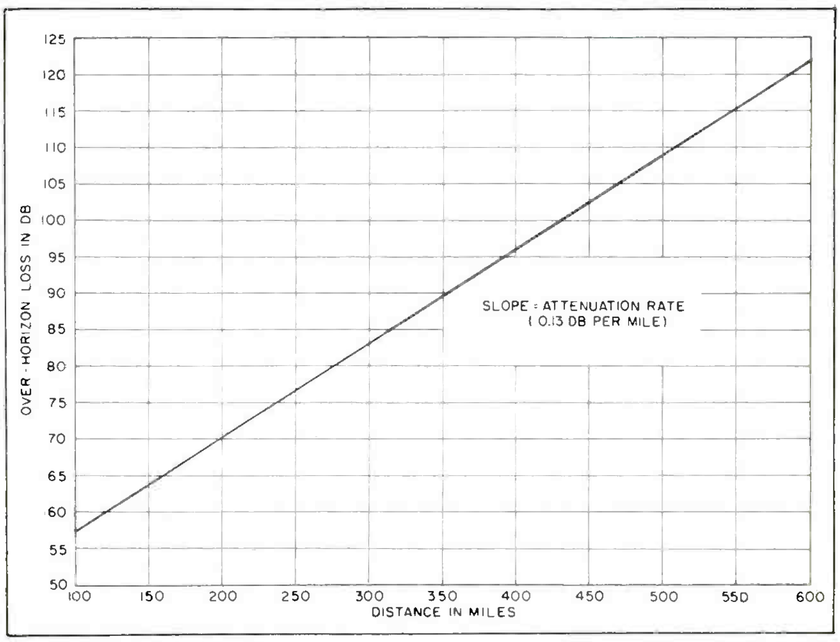

FIG. 2—Over-horizon loss for typical northern U. S. overland transmission

where d_{mi} indicates that distance should be entered in miles. The attenuation rate B is dependent on the average refractive properties of the atmosphere for the path under discussion. The value 0.13 db per mile is taken as typical for overland transmission in northern U. S. A. and southern Canada. It may be as low as 0.11 db per mile for semitropical, over-water paths and as high as 0.15 db per mile for dry, arctic conditions.

Parameter L_{oh} is plotted in Fig. 2 for the case of $B = 0.13$ db per mile. For other values of B, some adjustment might be necessary for the value of A.

Total path loss L_p in decibels, can then be written as

$$L_p = L_{fs} + L_{oh} + 79 + 20 \log_{10} (d/\lambda) + 0.13\,(d_{mi} - 100) \qquad (4)$$

Antennas

The ratio of antenna gains to the ratio of received and transmitted powers, as shown in Eq. 1, implies that transmitted power may, up to a point, be exchanged for antenna power gain. Since increasing the antenna gain results in a narrowing of the antenna beam, an exchange of transmitted power for antenna gain is accompanied by increased privacy. This is not directly evident from Eq. 1.

Assuming that paraboloidal reflector antennas of diameter D are used, with illumination efficiencies of 64 percent, numerical power

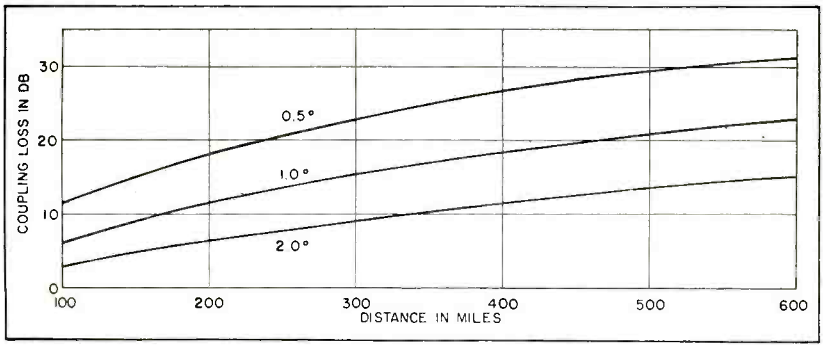

FIG. 4—Coupling loss for three different beam widths

gain is given by

$$G = 2\pi\,(D/\lambda)^2 \qquad (5)$$

The half-power beam width in degrees, $w°$, is given[1] by

$$w° = 70\lambda/D \qquad (6)$$

The net path loss L_{net} can then be expressed in decibels as

$$L_{net} = L_{fs} - G_s + L_{oh} \qquad (7)$$

where G_s is the system gain and is the sum of the terminal antenna gains expressed in decibels. That is, for similar antennas

$$G_s = 20\log_{10} 2\pi\,(D/\lambda)^2 \qquad (8)$$

The relation of system gain to beam width can be expressed in decibels as

$$G_s = 89 - 40\log_{10} w° \qquad (9)$$

For example, with a beam width of 1°, G_s equals 89 db; with a beam width of 2°, G_s falls to 77 db.

Thus far, the effect of increased antenna gain has been related to increased privacy and a reduction in the net path loss. When the antenna beams become extremely narrow (large apertures), the volume of the atmosphere intercepted by the beams does not contribute as much to the scattering process[8] as it would with wider beams. The result can be regarded as an increase in o-h loss or as a failure to realize the full plane-wave antenna gain; the latter view is presently more prevalent.

This aperture-to-medium coupling loss L_c has been defined theoretically[2] under the assumption of identical terminal antennas. The magnitude of L_c depends on antenna beam width and distance between stations. As shown in Fig. 3, L_c is a function of w/w_d, where w is the beam width and w_d the angular distance between stations for an assumed radius of the earth of 5,000 miles. Loss L_c is a function of distance only for a given antenna beam width.

An example of this dependence on distance is given in Fig. 4 for beam widths of 0.5, 1.0 and 2.0 degrees. It is difficult to determine L_c experimentally, but this has been done[9] by Lincoln Laboratory, M.I.T. The results indicate that L_c is generally several decibels lower than predicted in Fig. 3 and 4. Temporal variations noted in L_c are indicated in Fig. 8 of Reference 9.

Besides increasing privacy, the narrowing of an antenna beam provides increased protection from the strong, interfering reflections caused by aircraft flying in or near the path. These reflections produce violent, rapid fading and furthermore, introduce multipath distortion that may be extremely deleterious to certain pulse transmissions and which may also restrict the effective information bandwidth.

A radio receiver amplifies and demodulates not only the input signal but also the noise voltages generated in the antenna and in its own resistances and tubes. Since all antennas generate noise, all received signals are inherently contaminated by noise. To this minimum noise the receiver adds its own noise. As a practical matter, only the first two stages of a receiver contribute significantly to the noise output.

A measure of this additional noise output is the so-called noise factor that may be defined as the quotient of the s-n ratio at the receiver input terminals and the s-n ratio at the receiver output. When expressed in decibels it is called the noise figure F_n. The minimum attainable noise figure in a receiver depends largely on the state of the art. In general, the figure increases with frequency.

For receivers of current design, at frequencies above 100 mc, a conservative estimate of the noise figure in decibels is

$$F_n = 5.3 + 3.6\log_{10}(f_{mc}/100) \qquad (10)$$
$$= 3.6\log_{10} f_{mc} - 1.9 \qquad (f_{mc} \geq 100)$$

where f_{mc} is the frequency in mc.

For a frequency of 2,000 mc Eq. 10 yields $F_n = 10$ db, a figure that agrees well with recent developments[10] in r-f amplifier design.

Noise appearing in a receiver when an antenna is connected may be considered as arising in a resistance equal to the radiation resistance of the antenna, assuming the antenna is not trained on a cosmic noise source. This thermal noise power as it affects the receiver output is

$$P_n = k\,T\,B \qquad (11A)$$

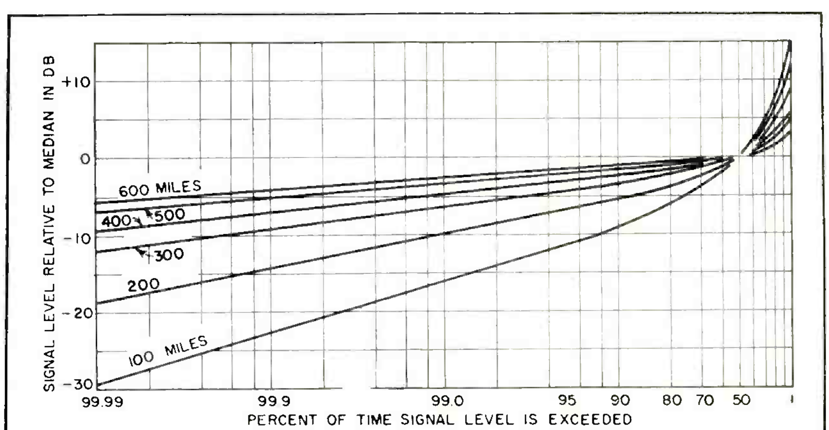

FIG. 5—Long-term fading characteristic based on 100-mc data

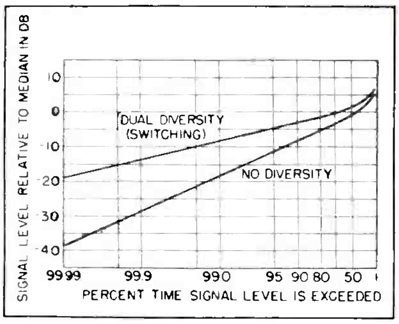

FIG. 6—Short-term fading characteristic taking place within an hour

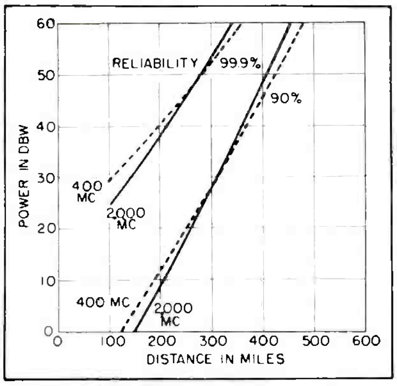

FIG. 7—Required power depends upon reliability desired

where P_n is the noise power in watts, k is Boltzmann's constant, T is the absolute temperature and B is the receiver i-f bandwith in cps.

The minimum noise output of a receiver is proportional to the i-f bandwidth. Hence, for low noise output, the receiver must be designed for the minimum bandwidth commensurate with the rate of information involved.

As an example, assume that a proposed link is to handle a single teleprinter channel at 60 words per minute.

While in an ideal wire circuit a 60 wpm transmission would require a bandwidth of only 22.5 cps, the characteristics of practical wire transmission circuits are such that 100 cps is necessary. In a radio link more bandwidth may be used to give the required reliability in the presence of fading. For conventional frequency-shift (fsk) systems a bandwidth of about 1,000 cps is needed for a 60-wpm circuit. This value of 1,000 cps will be used as reference bandwidth B_o.

In Eq. 11A the noise introduced by the antenna in the range of frequencies discussed is described by a temperature T which is customarily taken as 60 F (289 degrees absolute). Since then $kT = 4 \times 10^{-21}$ watt-seconds, Eq. 11A becomes, if all figures are expressed in decibels

$$P_n\ (60F) = 10 \log_{10} B - 204 \qquad (11B)$$

For the reference bandwidth B_o Eq. 11B becomes (relative to 1 watt)

$$P_n\ (60F) = -174 \text{ dbw} \qquad (11C)$$

For any other bandwidth simply add 10 $\log_{10}$ (B/B_o) to the right hand side of Eq. 11C. Some typical services with corresponding bandwidth figures are listed in Table I.

Signal-to-Noise Ratio

In a communications link, the transmitter not only must deliver enough signal power to overcome noise in the receivers; it must also provide enough additional signal power for acceptable readability. Readability depends upon the signal-to-noise ratio at the detector input and upon the possible improvements achieved by the method of detection for some systems[13] of modulation.

With frequency modulation, for example, the improvement is proportional to the square of the modulation index. For a given information rate the latter can be increased only at the expense of greater bandwidth, which in turn involves more thermal noise and hence raises the level to which a signal must rise before the improvement can be realized.

In the examples in this discussion it is assumed that an input signal-to-noise ratio of 10 db is just acceptable for reception of 60-wpm teleprinter. With other systems an adjustment of this figure will be necessary; for example, in commercial (a-m) television a signal-to-noise ratio of at least 40 db is required for high-grade service.

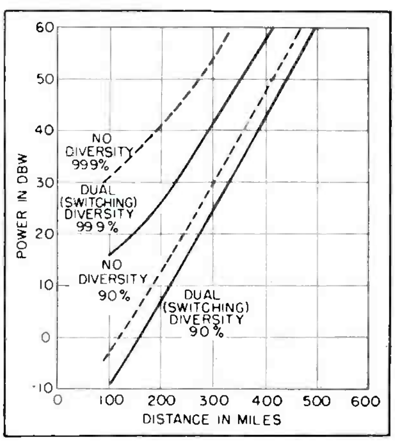

FIG. 8—Advantage of dual diversity for teleprinter channel

Table I—Teleprinter and Voice Requirements

Teleprinter, 60 wpm, fsk 425 cps		i-f bandwidth [11]	db added to −174 dbw (Eq 11C)
1 channel		1,000 cps	0
4 channels		1,700	2.3
12 channels		3,400	5.3
Voice, 4 kc per channel	Subcarrier modulating frequency	i-f band width [12] (mod index = 1.5)	db added to −174 dbw (Eq 11C)
12 channels	12– 60 kc	468 kc	26.7
24 channels	12–108 kc	842 kc	29.3
36 channels	12–156 kc	1,220 kc	30.9

Fading Safety Margins

The o-h loss L_{oh} shown in Fig. 2 represents a median value obtained from experimental data. There is a long-term, seasonal fading that is not yet completely known for the entire frequency range 100-5,000 mc. However, some very complete data[1] have been obtained through transmissions in the commercial f-m band centered at 100 mc. It is this long-term fading characteristic that is displayed in Fig. 5.

Other experimental evidence indicates that the 100-mc information may be applied to much of the uhf range. As Fig. 5 shows, the long-term fading becomes less and less pronounced as the length of the link is increased. For 99-percent reliability on a long-term basis it is necessary to supply a margin of about 11 db to the median o-h loss for a path 200 miles long, while at 400 miles only 5.0 db need be supplied.

Short term, within-the-hour, fading follows a Rayleigh law; this is shown in Fig. 6 for a nondiversity system, and for a dual-diversity system that merely utilizes the better of two signals received in widely separated antennas. This technique is known as switching diversity and is less effective than combining diversity.[14]

In computing the total safety margin for fading, it is well to note that long-term and short-term fading are essentially independent. Long-term fading establishes the immediate median level upon which within-the-hour fading is superimposed. It is thus reasonable to strive for a system that will possess a given signal-to-noise ratio for at least a certain percentage of time on a long-term basis and in addition will provide perhaps equal protection on a short-term basis.

Whatever combinations of fading margins are used, there will be periods of the year characterized by low path loss during which most of the fading margin incorporated results in the realization of an unusually high within-the-hour reliability. Weighting of the two types of fading margins will be influenced by the kind of information to be transmitted and whether errors will accumulate often enough to be objectionable.

A complete consideration involves not only the fading statistics shown in Fig. 5 and 6 but also the effect of the rate of fading upon the transmitted information. The fading rate increases with frequency.[1]

In an illustrative example reliability will be assumed for q percent of the time on a long-term basis along with reliability p percent of the time on a short-term basis. The two fading margins are simply added.

Terminal Loss and Site Noise

Certain other losses are always considered when designing o-h links. These are losses in transmission lines and connectors at each terminal and losses in effective operating margins owing to site noise.

Transmission line and connector losses arise from the attenuation characteristics of the lines connecting transmitter to antenna, antenna to receiver, from the power wasted in impedance mismatches at each terminal and from power lost to connector junctions. These losses generally increase with frequency. The losses at transmitter and receiver may be conveniently grouped together and denoted by L_j. A typical behavior of this loss in decibels is

$$L_j = 5 \log_{10} (f_{mc}/100) = 5 \log_{10} f_{mc} - 10 \quad (12)$$

The losses L_j should be evaluated

Table II—System Parameters At 400 Mc

Item	100 mi	200 mi	300 mi	400 mi	500 mi	600 mi	Remarks
$L_{fs}+L_{oh}$	185	20	221	239	257	275	Eq 2 and 3
L_j	3.0	3.0	3.0	3.0	3.0	3.0	Eq 10
G_s	−52	−52	−52	−52	−52	−52	20-ft dish
L_c	0	0.9	1.8	2.7	3.6	4.5	from Fig. 3
s/n	10	10	10	10	10	10	acceptable teleprinter
F_n	7.5	7.5	7.5	7.5	7.5	7.5	Eq 8
$10 \log_{10} B$	30	30	30	30	30	30	$B = 1{,}000$ cps
$10 \log_{10} kT$	−204	−204	−204	−204	−204	−204	$T = 60$ F dbw
P_m	−20.5	−1.6	17.4	36.2	55.1	75.0	median
ML_{90}	9.0	5.5	3.5	2.5	2.0	1.8	based on 100-mc data (Fig. 5)
MS_{90}	8.0	8.0	8.0	8.0	8.0	8.0	no diversity Fig. 6
P_{90}	−3.5	11.9	28.9	46.7	65.1	83.8	plotted in Fig. 7
$ML_{99.9}$	22.5	14	8.5	7.0	5.0	4.0	based on 100-mc data (Fig. 5)
$MS_{99.9}$	28	28	28	28	28	28	no diversity Fig. 6
$P_{99.9}$	30.0	40.4	53.9	71.2	88.1	106	plotted in Fig. 7
$P^{(2)}_{90}$	−8.8	6.6	23.6	41.4	59.8	78.5	dual diversity switching Fig. 6
$P^{(2)}_{99.9}$	15.2	25.6	39.1	56.4	73.3	91.2	dual diversity switching Fig. 6

Table III—System Parameters At 2,000 Mc

Item	100 mi	200 mi	300 mi	400 mi	500 mi	600 mi	Remarks
$L_{fs}+L_{oh}$	199	216	235	253	271	289	Eq 2 and 3
L_j	6.5	6.5	6.5	6.5	6.5	6.5	Eq 10
G_s	−80	−80	−80	−80	−80	−80	20-ft dish
L_c	3	7	10	13	15	16	from Fig. 3
s/n	10	10	10	10	10	10	acceptable teleprinter
F_n	10	10	10	10	10	10	Eq 10
$10 \log_{10} B$	30	30	30	30	30	30	$B = 1{,}000$ cps
$10 \log_{10} kT$	−204	−204	−204	−204	−204	−204	$T = 60$ F; dbw
P_m	−25.5	−4.5	17.5	38.5	58.5	77.5	median
ML_{90}	9.0	5.5	3.5	2.5	2.0	1.8	based on 100-mc data Fig. 5
MS_{90}	8.0	8.0	8.0	8.0	8.0	8.0	no diversity Fig. 6
P_{90}	−8.5	9.0	29.0	49.0	68.5	87.3	plotted in Fig. 7
$ML_{99.9}$	22.5	14.0	8.5	7.0	5.0	4.0	based on 100-mc data Fig. 5
$MS_{99.9}$	28	28	28	28	28	28	no diversity Fig. 6
$P_{99.9}$	25.0	37.5	54.0	73.5	91.5	99.5	plotted in Fig. 7
$P^{(2)}_{90}$	−13.8	3.7	23.7	43.7	63.2	82.0	dual switching diversity Fig. 6
$P^{(2)}_{99.99}$	10.2	22.7	39.2	58.7	76.7	94.7	dual switching diversity Fig. 6

carefully for a given equipment, transmission line and operating condition. In practice, these losses may be found to be greater than that indicated by Eq. 12 and frequently losses that are charged mistakenly against the propagation path will be found to occur at the terminals.

At any appreciable distance from a terminal the cross section of even a narrow antenna beam is large, so that the system may become vulnerable to impulse noise generated near the path by a city, a town, a manufacturing activity or a radar transmitter. In that event, an additional amount of power may be required for the link to overcome this site noise. No simple rule exists for the margin to be allowed for this kind of noise, since this will depend on the character of the noise and the way in which the improvement normally afforded by the modulating method[11, 15] is degraded in its presence.

Illustrative Example

An organization wishes to provide over-the-horizon communication for a number of links of various lengths and has two frequency allocations at its disposal, 400 mc and 2,000 mc. Equipment can be obtained for these frequencies. The paraboloidal antenna aperture must not exceed 20 feet in diameter because of cost and mounting difficulties. It is desired to determine the power required for both 90 and 99.9-percent reliability, for 60-wpm teletype, single channel, fsk, with a frequency shift of 425 cps.

The power required, in decibels above 1 watt, for median service, 50-percent the time, is given by

$$P_m = L_{fs} + L_{oh} - G_s + L_c + L_j + F_n + (s/n) + 10 \log_{10} B_o - 204 \qquad (13)$$

The symbols have the same meanings as before and s/n is the signal-to-noise ratio expressed in decibels. For service at least q percent of the time on a short-term and a long-term basis

$$P_q = P_m + ML_q + MS_q \qquad (14)$$

where P_q is the power required for q percent reliability, ML_q is the long-term fading margin for q percent reliability and is a function of distance, MS_q is the short-term fading margin for q percent reliability.

Tabulations of the various losses and system parameters are given for 400 mc in Table II and for 2,000 mc in Table III. The results are plotted in Fig. 7 for the 90 and 99.9-percent reliabilities desired. While the tables show powers in excess of 60 dbw (1 megawatt) for completeness, the curves in Fig. 7 are carried only up to this level.

Table IV—Additional Distance With Diversity at 400 Mc

Reliability	Order of Diversity	1 kw	10 kw	100 kw	1,000 kw
90%	1	308 mi	366 mi	420 mi	472 mi
90%	2	336	384	448	500
	Additional Distance:	28	28	28	28
99.9%	1	98	200	275	340
99.9%	2	217	300	360	420
	Additional Distance:	119	100	85	80

Interpretation

Added gain provided by the 20-foot paraboloid at the higher frequency is hardly sufficient at the longer distances to overcome the additional free-space loss. This is the result of the increasing effect of L_c, the aperture-to-medium coupling loss for the narrowed beam.

Curves in Fig. 7 are plotted for distances from 100 to 600 miles. Some reservations should be attached to extension of the curves for distances of less than 100 miles. In that range, depending upon the height of the terminal antennas, there may be an appreciable diffracted surface wave present that would serve to widen the fading range and in any case, would provide substantially different short-term fading characteristics[1] than are indicated by Fig. 6.

The curves do not include any gains or losses incurred by the presence of obstacles in the path. It is assumed that along the path to the horizon the clearance between the path and any obstacle exceeds the radius of a first Fresnel zone. If obstacles are present, the computation must be altered as recommended[1, 16] in the literature.

The advantage to be gained by employing dual diversity of the switching type at one terminal is illustrated in Fig. 8 for 400-mc transmission. While diversity can be regarded as a means of saving transmitted power, if it is done by spacing the receiving antennas, or as an increase in reliability, it is instructive to evaluate its advantage in extending the working distance possible with a given transmitted power.

Table IV presents the additional distances obtainable by including the diversity fading margins as scaled from Fig. 8. With higher orders of diversity and with systems that combine[17] the outputs of spaced antennas, greater gains in distance or savings in power are possible.

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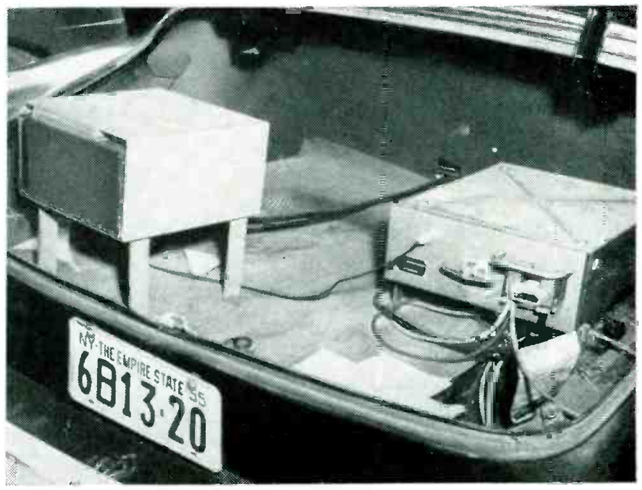

Meter on police-car dashboard records speed of passing car. Radar transmitter and receiver are mounted in trunk

How Accurate Are

SUMMARY —— Erroneous readings of radar units used by police departments to enforce speed laws arise from carrier frequency shift of transmitter, parallax when radar car is parked off highway, and multiple reflections from other passing cars or nearby objects. However, these errors usually give the speeder a break

MOST SPEED radars commercially available have the basic form shown in Fig. 1 and depend upon precise measurement of the Doppler shift in signal frequency. Energy radiated by the transmitter at a frequency f_o is reflected by the moving target and gives rise to a detected signal having a frequency $f_o + f_d$.

The relative speed V of the automobile is related to the Doppler frequency f_d and to f_o by

$$V = C f_d / 2 f_o$$

where C is velocity of propagation of the radar waves. Therefore, if f_o is known, f_d provides a direct and precise measure of V.

In the system shown the received signal is mixed with feedthrough power from the transmitter and the difference frequency f_d is filtered out and amplified. The signal is then limited and a frequency counter and meter or pen recorder provide a direct speed reading. Photographs show a typical radar installation in a police car.

The principal sources of error in the radar used resulted from shifts in carrier frequency, counter and/or meter inaccuracies and errors in reading due either to parallax or human error. Other errors resulted from the fact that the quantity measured is the relative speed and not the linear speed of the vehicle

Table I—Speed-Counter Errors

Input Frequency in cps	Calculated Speed in mph	Indicated Speed in mph	Radar Error in mph	Percent Error
60	8.2	7.0	—1.2	14.6
120	16.4	15.0	—1.4	8.5
180	24.6	23.5	—1.1	4.5
240	32.9	33.0	+0.1	0.3
300	41.1	41.0	—0.1	0.2
360	49.3	49.0	—0.3	0.6
420	57.6	57.5	—0.1	0.2
480	65.8	65.5	—0.3	0.5
540	73.9	73.5	—0.4	0.5

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ENGINEERS AS EXPERT WITNESSES

Nationwide, law-enforcement agencies are readying a crackdown on careless driving. The coming year may see vastly expanded use of radar for speed control.

However, in several instances the validity of radar speed readings have been challenged in court. Such cases may become more numerous.

The arresting agency must then call upon a qualified expert to testify to the accuracy of the radar. Thus, it behooves the electronics engineer, who may be called upon, to know something of the accuracies attainable with a typical unit.

The author describes results of independent accuracy tests made by him for the City of Buffalo traffic department. The results were observed on a single unit and cannot be applied in general. However, they indicate the precision that can be achieved and point out certain situations in which operation is unreliable

Radar Speed Meters?

relative to the ground. Reference to Fig. 2A shows that the speed of the car relative to point P is equal to $V_o \cos \theta$. The error in the radar observation comes from the cosine factor and is negligible for small values of θ. It always yields a reading which underestimates the actual speed of the target vehicle.

The first method used to measure radar performance involved measurements of f_o followed by meter calibrations taken with known frequency inputs to the counter. The second method employed a precision odometer attached to a test vehicle. Radar readings were compared with readings obtained on the odometer and related to time. The first set yields information about the inherent accuracy of the radar and the odometer readings shed light on the overall performance under actual operating conditions.

Precision Measurements

Precise error measurements were made by injecting signals of known frequency into the speed counter. Integral multiples of power-line frequency were used. The corresponding speed represented by each of these frequencies was computed from the Doppler equation using the measured carrier frequency of 2,447 mc. Line frequencies were accurate to within 0.08 cycle. The results are shown in Table I.

In actual operation, the carrier frequency will drift varying amounts depending upon external factors such as temperature and line voltage. It was not possible to make long-term frequency checks on the unit tested but it was assumed frequent adjustments would keep f_o within $\pm$ 10 mc. Based upon this assumption the maximum variation in speed readings will be approximately $\pm$ 1.4 mph at 35 mph.

It was noted during these tests that the readings were sensitive to voltage variations in the radar-car power supply. Subsequent tests showed that the errors in Table I which were taken with car generator off, were increased by from 5 to 6 percent with the engine idling.

Numerous tests were made in the

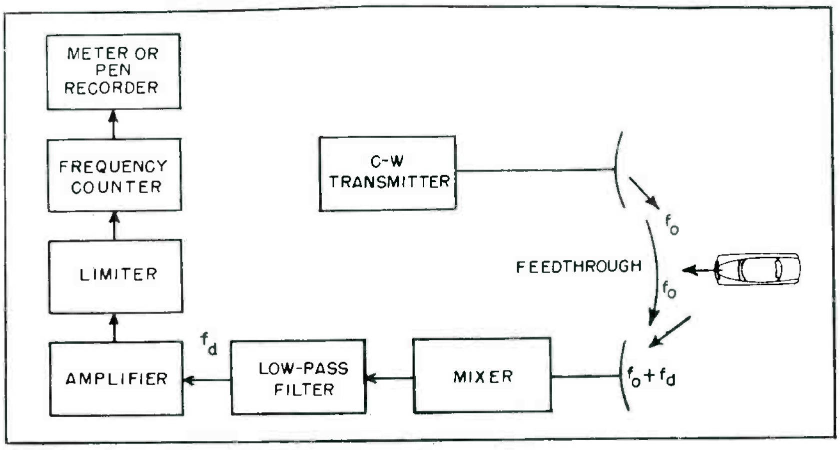


FIG. 1—Speed radar depends for its operation on Doppler frequency shift

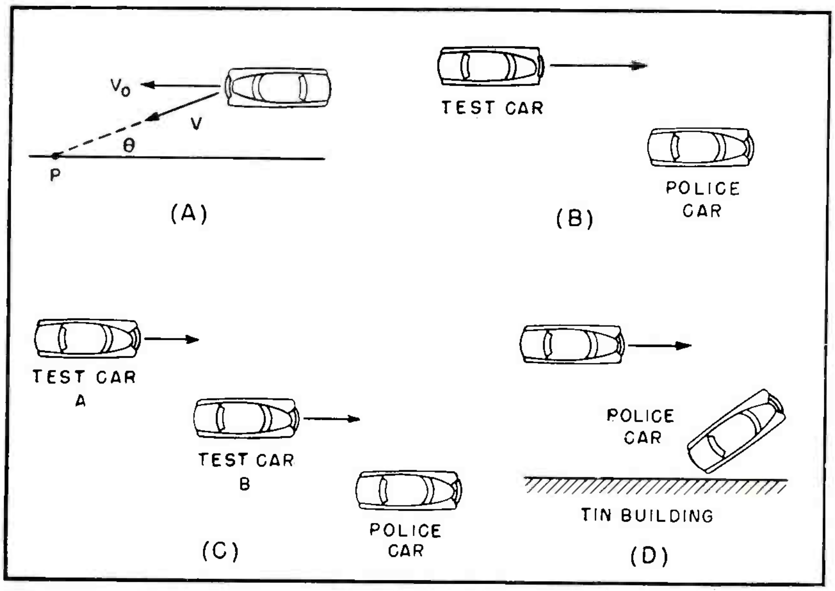


FIG. 2—The parallax problem (A), typical installation (B), condition where echoes from two passing cars may cause inaccuracy (C) and test setup for studying effect of reflection from nearby object (D)

manner illustrated in Fig. 2B. Radar readings made by police officers were compared with those made by an observer riding in the test vehicle and reading the odometer. The test car was driven close to the radar car to minimize cosine errors. Table II shows the results of these runs.

The total errors include contributions from the radar itself, external factors such as reflections and reading errors, the cosine term and the odometer. Because of the high degree of inherent radar accuracy it may be assumed that it is more accurate than the odometer. However, comparison of the radar readings with those of the odometer makes it possible to estimate the influence of factors not associated with the internal operations of the radar, such as the effect of the cosine factor and secondary radar reflections.

While the spreads were relatively large the average errors were small in all speed ranges. Readings which overestimated the target's speed were rare and on the average the errors favored the driver.

To confirm expected cosine errors, some runs were made which were similar to those of Fig. 2B, but with a wider passing margin. Passes were made at distances from 6 to 15 feet with increasing errors. Readings generally took place at ranges between 50 and 65 feet from the radar. When cosine errors were estimated for the individual cases and compensated for, the residual errors were comparable to those of Table II.

To assess the radar's performance in situations where two cars pass it simultaneously several runs of the type shown in Fig. 2C were made. Several speed differentials between *A* and *B* were tried and runs were made at various values of individual speeds. The readings varied over such a wide range that they were considered unusable for determining the speed of either *A* or *B*. In one case *A*'s speed was 35.5 mph, *B*'s was 21 mph and the radar gave a single reading of 24 mph.

Tests were also run in the manner illustrated in Fig. 2D. These were intended to determine the effects of nearby reflecting objects. The readings obtained gave speeds which were consistently lower than would normally be the case. The indications were similar to those observed with two cars because the radar sees not only the car itself but its image in the reflector as well.

Maximum parallax errors were measured by setting the meter precisely at given speeds and then reading values observed from either side. The results are tabulated in Table III. By observing the manner in which police officers made this reading, it was estimated that errors due to this effect were practically always less than 0.2 mph.

Conclusion

Speed errors made by the radar were almost always in a direction which favored the passing vehicle. The one exception occurred when observations were made with the engine in the radar car idling. The radar then consistently overestimated actual speeds.

Principal errors arose from differences between actual and relative speeds, speed-counter inaccuracies especially those due to shifts in line voltage, meter inaccuracies and parallax. Additional errors can be expected as a result of carrier-frequency shifts. While these were not measured over a long period it is assumed that they are periodically checked and kept within ±10 mc. Periodic calibration of the counter and speed meter are necessary but the reported measurements were made without prior calibration.

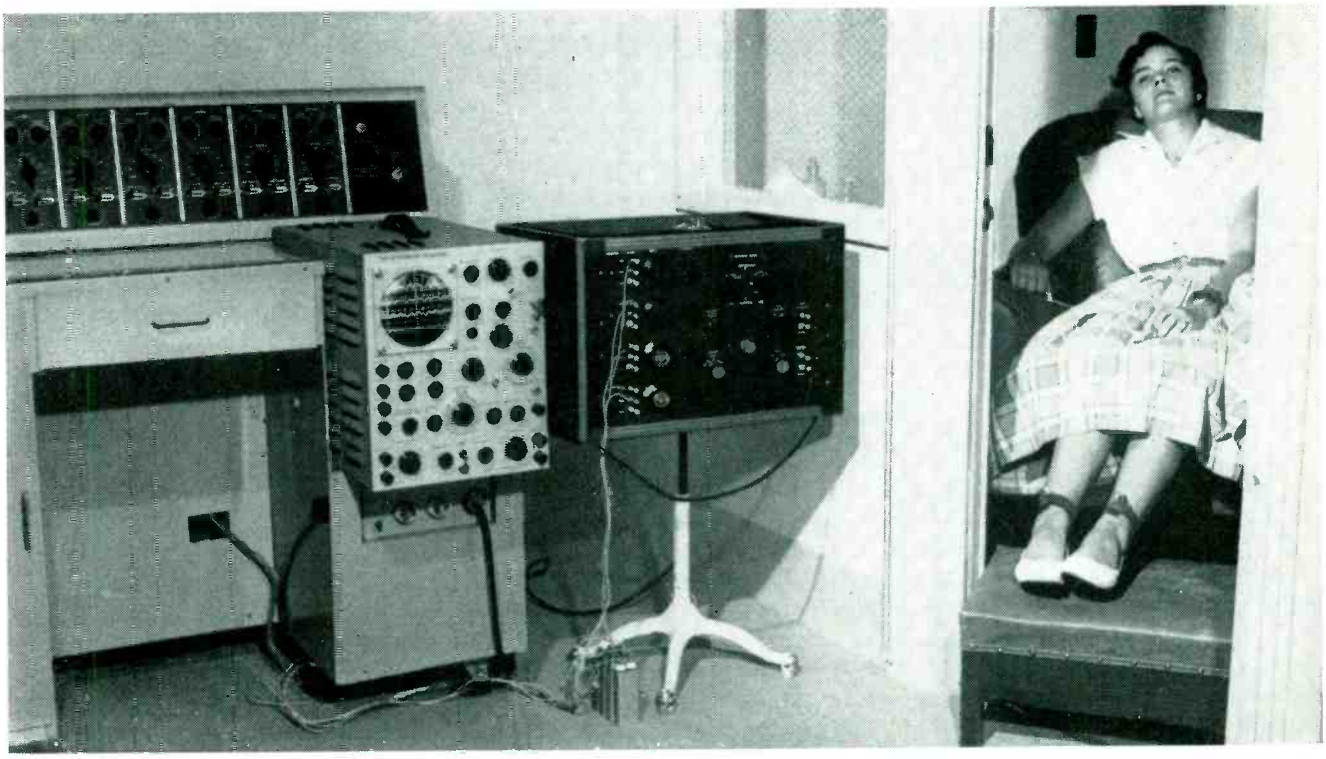
The author acknowledges the assistance of Walter A. Flood and John J. Earshen in conducting these tests.

Table II—Speed Meter vs Odometer

Speed Ranges (mph)	20-30	30-40	40-50
Spread in errors (mph)	6.3	4.0	1.5
Maximum error (mph)	—5.3	—3.0	—2.0
Minimum error (mph)	+1.0	+1.0	+0.5
Average total error (mph)	—1.7	—0.9	—1.1
Average radar error (mph) (See Table I)	—0.9	—0.03	—0.2

Table III—Parallax Errors

Speed	Maximum Error
60	±2.0
40	±1.5
30	±1.0
20	±1.0



Electronic switch at center measures heart-muscle potentials of patient at right. High-gain preamplifiers of electroencephalograph at left bring signal levels up to that required by switch. Switch effectively converts oscilloscope into four-beam instrument

Multichannel Switch For Biological Observations

SUMMARY —— Simultaneous observation of four signals is provided by oscilloscope accessory. Each channel is a d-c amplifier with a gain of five. Frequency of switching between channels is variable between 1 and 30,000 cps. Unlimited number of channels can be added if necessary

By ROBERT W. WOODS

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DESIGNED as an oscilloscope accessory, the electron switch to be described permits simultaneous observation of related biological phenomena such as electrical potentials occurring across membranes in the body of an animal or man.

The instrument as constructed provides a maximum of four channels; the principle of operation, however, makes it possible to have any number of channels desired by the addition of five triodes for each additional channel. A channel switch sets the number of channels in use and a channel-stop switch confines the operation to continuous observation of any single channel desired. Switching transients are of extremely short duration, essentially limited by stray capacitance. Frequency of switching is continuously variable from 1 to 30,000 cps, the repetition rate being 1 to 30,000 divided by the number of channels in use.

In addition to the signal output, a pulse output with either positive or negative polarity is available. If the internal multivibrator is made inoperative, the same terminals may be used as an external-pulse input to actuate the switching circuits. This external pulse may be regularly produced at low frequencies or irregularly, as desired.

In the diagram of Fig. 1, the

output of multivibrator V_1 is made asymmetrical so the fine frequency control may be affected by R_1 in the left-hand grid circuit, which lengthens the time constant of discharge for that grid. The right-hand grid circuit, from which the output pulse is taken, has a relatively short time constant of charge and discharge and since the transient time of switchover in this grid is independent of the setting of the fine frequency control, there is a more consistent pulse shape. Switch S_1 inactivates the multivibrator. This permits pulsing from an external source through C_1 and S_2.

In the pulse-forming circuit, triode V_{2A} is biased positively so an additional positive pulse is ineffective, but it is responsive to a negative pulse. From the plate of V_{2A} the resultant positive pulse is fed through differentiator C_2R_2 to the grid of V_{2B} which is biased to cutoff. The negative pulse output of V_{2B} is available for control of the switching circuit.

Dual-triodes V_3, V_4, V_5 and V_6 are flip-flop or trigger-circuit stages. The negative pulse formed in V_2 is fed to the left-hand grid of each of these flip-flops in parallel. This negative pulse would be without effect if the left-hand triodes of the flip-flops are nonconducting; but if one of them, say flip-flop V_3, is conducting the negative impulse would cut it off and the corresponding right-hand triode would begin conduction producing a negative pulse on its plate. This pulse, fed to the right-hand grid of flip-flop V_4, would cut off its right-hand triode, cause its left-hand triode to conduct and thus prepare it for reception of the next pulse from V_2. Successive pulses from V_2 would step the left-hand conduction from flip-flop V_3 to V_4 to V_5 to V_6.

Ring Operation

If the last in line is connected back to the first making a ring, a cyclic rotation of this left-hand conduction is obtained which can be used to switch the channels. The number of flip-flops in this ring determines the number of channels in use. Switch S_3 makes it possible to feed flip-flop V_3 from the output of V_4 or V_5, etc., thus controlling the number of flip-flops in the ring and the number of channels in use.

When the number of channels is three or more, it is necessary to establish the condition that only one flip-flop shall have left-hand conduction. When the instrument is first turned on, for example, more than one flip-flop may show left-hand conduction and a form of multiple wave will travel around the ring. The single condition may be established, however, by returning one of the right-hand grids, for a time as long as one cycle of operation, directly to the common cathode return at −255 volts.

The various conducting cycles travel around the ring and stop at the flip-flop with the shorted grid, leaving that flip-flop the only one with left-hand conduction. Switch S_4 performs this function, but since shorting the grid stops the switching S_4 has been designed to stop the switching on any desired channel at the will of the operator and

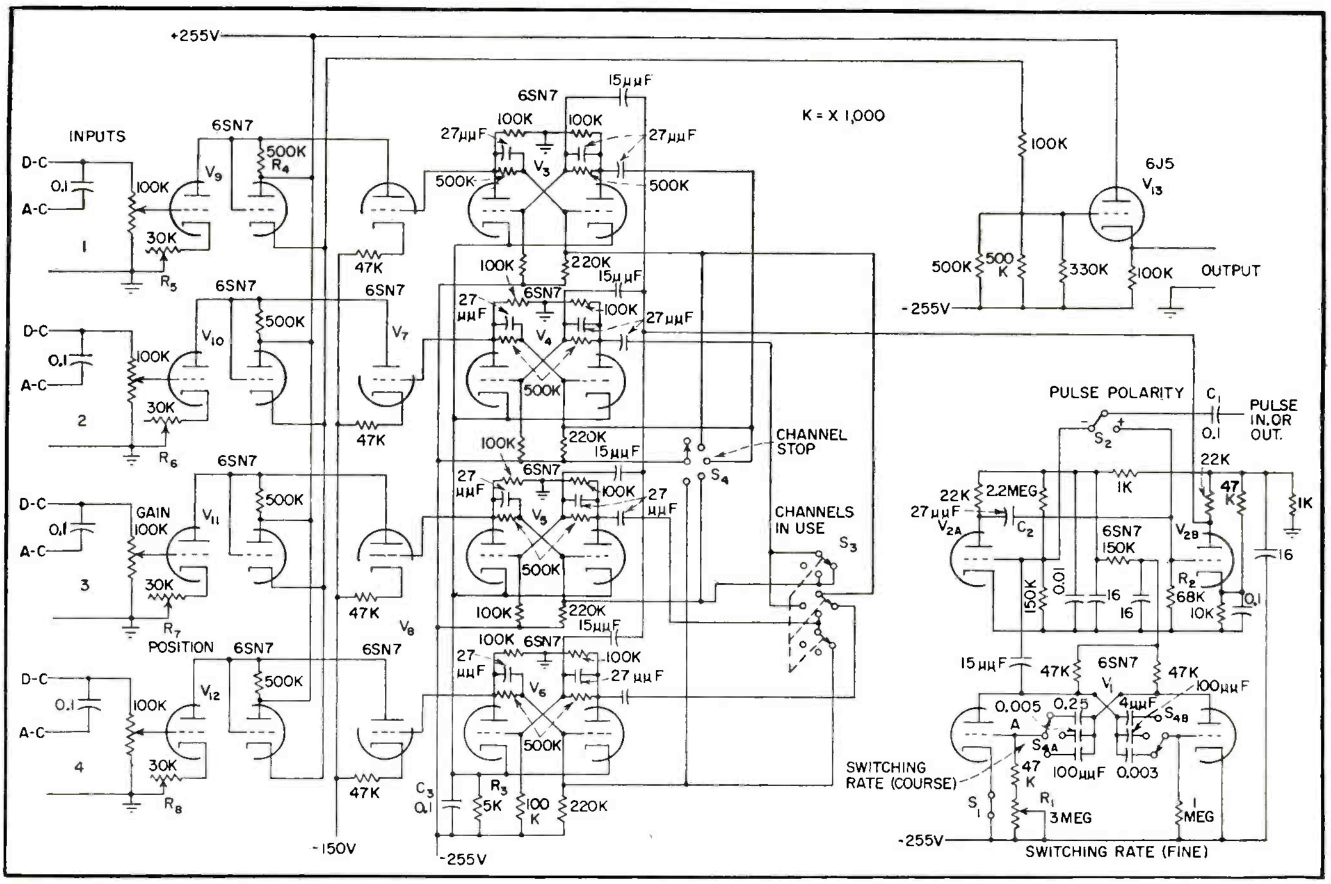

FIG. 1—Electronic switch requires five triode stages for each input channel. Voltages indicated are from regulated supplies

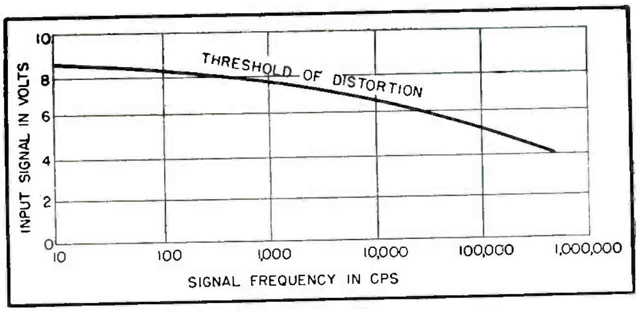

FIG. 2—Threshold of distortion vs input signal and frequency

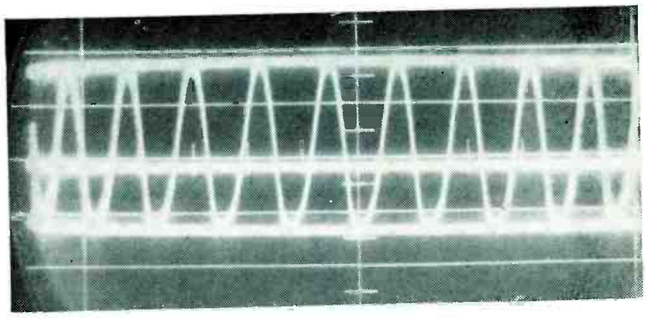

FIG. 3—Using spare channels as markers

serves as a channel stop switch as well as to establish the one-channel-at-a-time condition.

The C_3-R_3 bias combination for the flip-flops maintains a constant bias voltage since the number of conducting triodes is invariable. Capacitor C_3 is necessary to smooth switching transients.

Sections of V_7 and V_8 are direct coupled to the plates of corresponding left-hand triodes of the flip-flops. If the flip-flop is not conducting the plate voltage is high and the corresponding V_7 or V_8 triode is conducting, but if the flip-flop is conducting, the V_7 or V_8 triode is cut off and is not conducting. All of the V_7 or V_8 triodes except one are conducting at any one instant.

Signal Inputs

Dual-triodes V_9, V_{10}, V_{11} and V_{12} are the input stages. The first triode sections are essentially triode amplifiers with gain controls in the grid circuits and variable bias or positioning controls in the cathode circuits. These amplifiers are direct coupled to the second triode sections, which operate as cathode followers. Gating is accomplished, in the first channel for example, by drawing the plate current of the first triode section of V_9 and the associated triode of V_7 through the same plate-load resistor, R_4. If the V_7 triode is conducting, the drop through R_4 reduces the grid voltage of the cathode follower to a point beyond cutoff and the plate voltage of the first triode of V_9 to a point near ground potential. Thus only one channel at a time is operative.

The output of the several cathode followers is connected in parallel and fed to the grid of V_{13}, the output cathode follower. The voltage divider in the grid circuit of V_{13} is adjusted so with positioning controls R_5, R_6, R_7 and R_8 set at the midpoint of their range, the voltage at the cathode of V_{13} is zero with respect to ground. The values given accomplished this result with the tubes used; other tubes may require a different ratio.

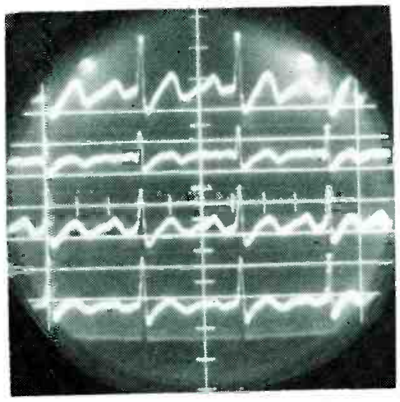

FIG. 4—Simultaneous four-lead electrocardiograph traces

Modifications

To keep the frequency of the multivibrator independent of external capacitance effects at the synchronizing input connections, an isolating triode amplifier capacitance coupling a positive pulse to one of the grids of V_1 at point A would be a valuable addition to the circuit.

As it stands, the unit is a high-level switching device because of a 60-cycle hum pickup of approximately 0.001 volt. By using d-c on the filament of V_{13} this hum is greatly reduced, but not entirely eliminated. Direct-current filament power for all amplifier filaments would probably increase the utility of the instrument for low-level switching. Better shielding and placement of parts for shorter leads would also decrease the hum-pickup problem.

The amplifier section of the switch, consisting of V_9 to V_{12} and V_{13}, was tested for fidelity by applying a sine wave to one of the inputs, with gain wide open, and varying the amplitude until the output wave showed visible evidence of distortion on the oscilloscope. This was repeated at spot frequencies from 10 to 100,000 cps and the threshold of distortion, the amplitude of the input signal at which distortion just becomes evident, was plotted against frequency as shown in Fig. 2.

The channels may be used for measurement. For example, if channel 1 is to carry the signal, channel 2 can be superimposed on the zero-signal trace of channel 1 to mark the zero line. With the signal applied to channel 1, channels 3 and 4 can be moved to mark the positive and negative peaks as shown in Fig. 3. Subsequently a calibrated voltage applied to channel 1 could be adjusted to make channel 1 coincide with the peak marker. A time comb could also be applied to channel 2.

To date, the instrument has been used for measurement of peak potentials and for simultaneous observation of the four standard leads in electrocardiography as shown in the photograph and Fig. 4.

In Fig. 4, channels 1 to 4 are positioned top to bottom. Channel 1 carried the standard first lead (right arm against left arm), channel 2 the second lead (left arm against left ankle), channel 3 the third lead (right arm against left ankle) and channel 4 the fourth lead (chest against left ankle). This setup is shown in the photograph.

A word of appreciation is in order to Gordon Simkin, technical assistant, for his work on this project.

Automatic Colorimeter

SUMMARY —— Three-phototube measuring head with associated electronic equipment give readings of percent saturation on three meters marked red, blue and green. Can be used for quality control of color television picture tube production

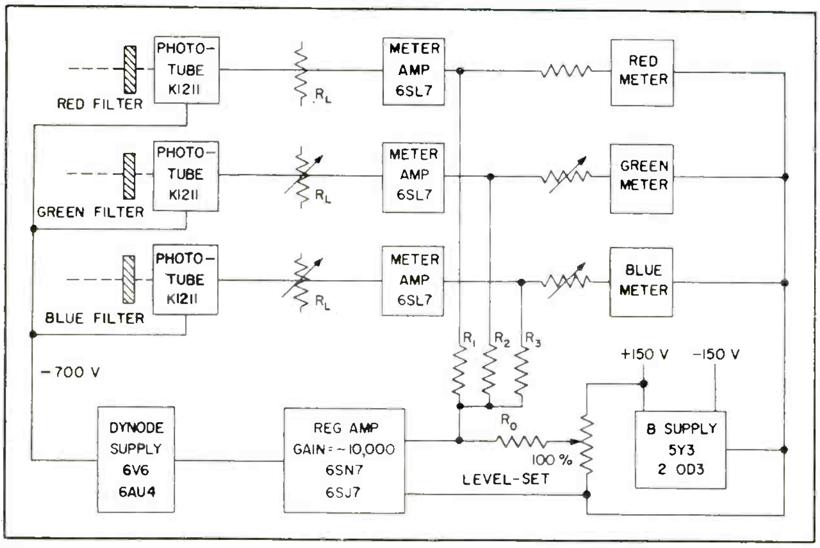

FIG. 1—Negative feedback is used to stabilize colorimeter against source brightness variations. Meters indicate primary color proportions

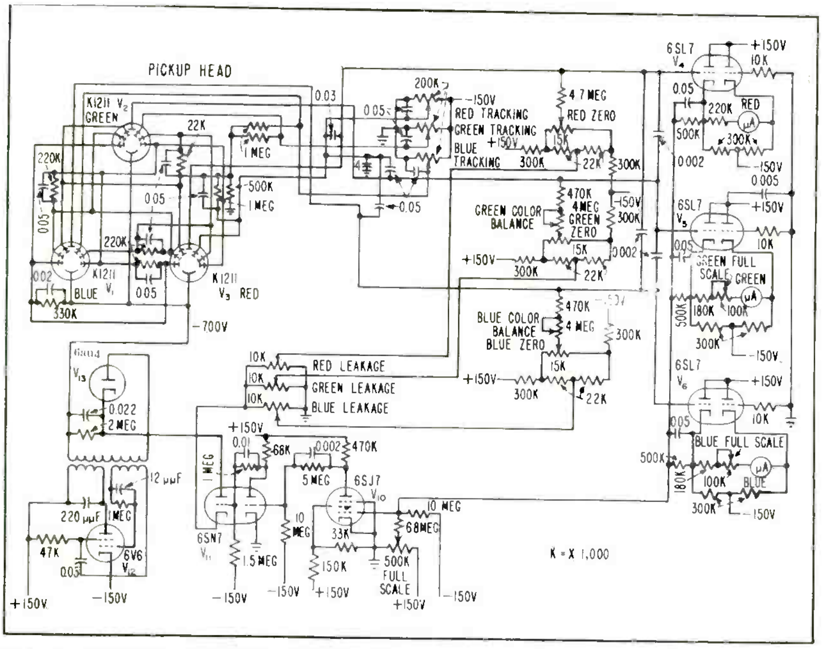

FIG. 2—Complete schematic diagram illustrates controls used to calibrate instrument with white light source

DEVELOPED primarily for checking tricolor television tubes by production personnel the colorimeter to be described imitates the color vision properties of the human eye. When the color pickup head is aimed at a luminous surface, its color content is analyzed and three meter indications are obtained within a second or so provided the surface brightness is sufficient.

Selectively energized through red, green and blue filters, the meter indications are a direct measure of the primary color proportions and numerically define the hue and saturation of the luminous source. Color comparison accuracy is good as time lapse between successive measurements can be only a few seconds. Source brightness within limits has a negligible effect on the indicated color proportions.

The pickup head is housed in an aluminum shell 6 inches long and 2 ¾ inches in diameter. The circular red, green and blue color transmitting filters are arranged in an equilateral triangle. The filters are of gelatin film cemented between 22-mm glass disks. They are fitted into blackened, undercut rims cut on end-capped aluminum shells enclosing three multiplier phototubes.

The K1211 miniature phototubes are six-stage dynode multiplier types having end-on cathodes of ½-inch diameter and S-11 photometric response. Cathode sensitivity is rated at 50 μa per lumen average response to a 2,870 K incandescent lamp. The amplified anode current

Checks TV Color Tubes

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Color measurements are made by placing pickup head of colorimeter on face of operating tricolor tube and noting three meter readings

is an exponential function of the applied dynode voltages.

Since multiplier phototubes, with their built-in electrostatically focusing dynodes, are operationally disturbed by magnetic fields, the pickup head has a layer of Mumetal wrapped around the aluminum enclosures of the phototubes.

Operation

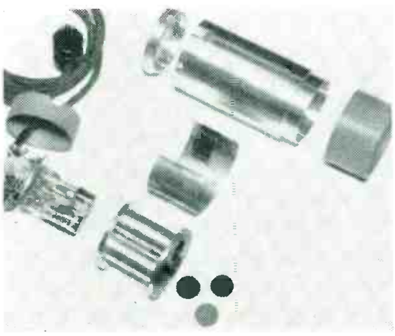
The operation of the instrument is explained by the block diagram, Fig. 1. Light striking the cathodes of the multiplier phototubes, through the respective color filters, causes current flow in each anode load resistor. The resultant voltages are a measure of the color composition of the light source and its brightness.

However a high-gain regulating amplifier and a fixed-voltage dynode power supply control the operating voltage applied to the parallel-connected phototube dynodes. The phototubes are gain controlled by a common signal. This signal is developed from the light-source intensity and automatically suppresses the brightness variations. The instrument thus responds only to the color composition of the light source.

The phototube anode voltages are transferred to the indicating meters through cathode-follower meter amplifiers. From each point a sampling current is developed in R_1, R_2, R_3 whose sum is balanced against the adjustable current through R_o of opposite polarity. The voltage at the junction of these four resistors is the input signal to the regulating amplifier. The amplifier has a reversed-polarity output to the dynode voltage divider and forms a negative feedback loop.

The meter voltage sum is thus constrained to a fixed value which is adjusted to exactly the full-scale value of one meter by the level-set control. Since the meters and phototubes are linear, each meter deflects to the relative excitation of its respective photocathode regardless of the common light intensity. The light level must be greater than a minimum threshold value or the full-scale sum cannot be maintained.

Whenever the input light level to the pickup head is insufficient to develop the total meter voltages to a level needed to equalize through R_1, R_2, R_3, the reference current in R_o, the amplifier stays saturated. The applied dynode voltages are maximum and the phototubes operate at maximum gain. An increase of the source brightness that would develop too much signal output is counteracted by the amplified difference voltage. The stabilizing ability when one or all phototubes are variably illuminated above the threshold value is: $\Delta E_m = \Delta E_d / A_c \approx 300/3{,}000 = 1/10$ v, where ΔE_m = indicating meter voltage variation for brightness changes, ΔE_d = dynode voltage swing with regulation against brightness changes $\approx$ 300 volts and A_c = effective loop gain $>$ 3,000.



Internal construction of pickup head showing filters, phototubes and circuitry

The meters contain 50-μa movements and with 220,000-ohm series resistors have a full-scale reading of 11 volts. Therefore, $\Delta E_m / E_m <$ 1/110 unit of full-scale error.

This is distributed among the three meter readings according to the chromaticity of the luminous source. Raising E_m would decrease the error and raise the threshold but caution is to be observed in operating too closely to the knee of the phototube anode characteristic.

Circuit Details

The schematic diagram is shown in Fig. 2. The grid-cathode elements at the input of regulating d-c amplifier V_{10}-V_{11} develop a contact potential that cannot be distinguished from the control signal. A variation of 0.1 volt will cause a full-scale meter error of 3 percent. The 100-percent level-set control (labeled FULL-SCALE in Fig. 2) compensates for this effect.

The phototube anode load resistors are adjustable in the green and blue channels for setting gain relative to the red channel. Each anode load resistor returns through the meter zero-set controls. The three leakage compensating controls effectively complete the zeroing circuits. The leakage controls permit application of a canceling potential that maintains zero meter readings in the absence of light input to the photocathode despite dynode voltage variations.

Feedback Loop

The indicating meters are cathode-coupled to balance dual triodes V_4, V_5 and V_6. The green and blue meter series resistors are full scale adjusted to equal the full-scale red meter reading. The three 500,000-ohm summing resistors are tapped from each meter drive point to include the indicators in the feedback loop.

Even though the three K1211's, V_1, V_2 and V_3 are paralleled, a differential gain control condition is encountered. In practice, this would be interpreted as a color variation when only the incident brightness changed. At least two-point compensation is possible by the adjustment of the three tracking controls. These fix the voltage on the last dynode in each phototube.

Therefore, as the parallel connected forward dynodes approach the voltage levels of the last dynodes, the phototube with the highest fixed dynode voltage has the most gain reduction. The tracking adjustments are usually made to bracket the normal range of operating brightness levels. A white cathode-ray tube (P4 screen) with variable grid drive for changing brightness permits a simple checking procedure.

The dynode power supply V_{12} and V_{13} uses a relaxation oscillator to generate, in a stepup isolation transformer, a voltage which is then rectified and filtered. The 6AU4 is used for its heater to cathode insulation. Since the oscillator plate voltage is obtained from the stabilized ±150-volt supplies in the chassis, it is free from line-voltage fluctuation. It is limited to 700 volts to keep leakages in the multiplier phototubes at low levels.

Calibration

The zero-settings of the color indicating meters are made when the pickup head is placed face down on any nonluminous surface. The effective dynode voltages are at a maximum and the regulating feedback loop is broken during this interval. An unstable dynode supply can be the cause of zero shifts at this time which result in color reading errors.

The initial adjustments of this colorimeter were made with a white television picture tube. The final white color calibration can be made and maintained with a reference white working standard such as an incandescent lamp combined with a daylight glass filter. A crt was selected having a close match to illuminant C as measured on a Barnes XYZ colorimeter. For brightness data the Weston 931 foot-lambert meter was used. This meter has a circular opening only slightly smaller than the pickup head. The adjustments require the use of a calibrating plug. This is a shallow piston-and-rod unit that closely fits the open end of the pickup head and inserts to the bottom. A circular cutout permits, by rotation, the exposure of any one of the three filter-photocathode areas.

The picture tube is operated with a square raster and 100 foot-lamberts of luminous intensity. The pickup head is centered on the raster and the calibrating plug is sequentially positioned to expose the red, green and blue filters. For each position the 100-percent level-set, green full scale and blue full scale adjustments are made. In addition, the respective leakage adjustments are completed with an opaque sheet placed on the opening of the pickup head. The results should be full-scale on one and zero readings on two meters in turn.

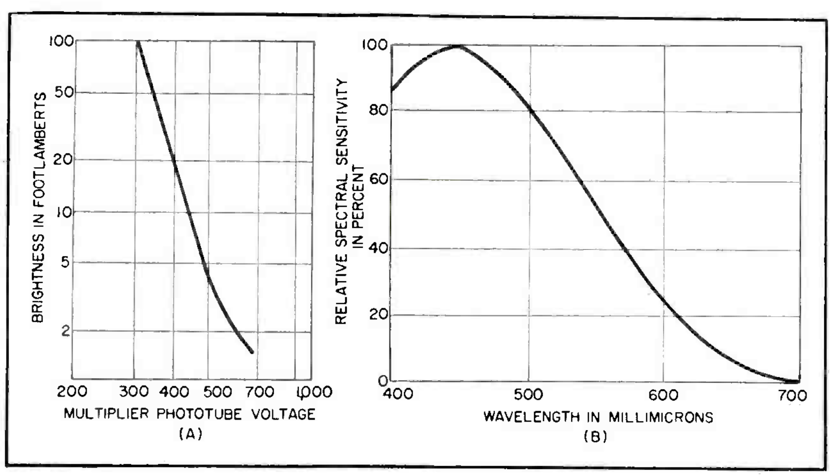


FIG. 3—Regulation of colorimeter shown by straight line above 5 foot-lamberts (A) and spectral response of K1211 phototube (B)

Color Balance

The color balance controls are set to fix the relative meter readings to the white color standard. For illuminant C, R = 29, G = 33 and B = 38 as the comparative offset to equal energy excitation, which is defined by R = G = B = $33\frac{1}{3}$.

The three tracking controls are successively adjusted to maintain steady meter readings as the reference picture tube brightness is varied between 10 and 100 foot-lamberts. By reducing the brightness level to the point where the meter reading sum suddenly slumps, a check is made for the threshold value of response.

The colorimeter's amplitude-regulating circuit attempts to maintain a constant value of meter readings. This is illustrated by the straight line to 5 foot-lamberts on the log-log plot of dynode feedback voltage versus source brightness, Fig. 3A. The color threshold is 1.5 foot-lamberts, which is low enough for ambient lighting to contaminate color indications. Below this level the meter indications are about proportional to the brightness and do not contain usable color information.

Theoretically the instrument could read color for all increasing brightness levels. But a limit is imposed by the K1211 photocathode at 10 microamperes peak emission. This is about the point where the current ceases to be a linear function of the incident light.

From the spectral sensitivity of the cathode, in Fig. 3B, the blue filtered phototube has the largest probability of limiting. A light source emitting energy equally throughout the spectrum would reach this limit with a brightness of about 1,000 foot-lamberts.

Filters

The photometric filters used are red = one red cellophane sample and one Wratten No. 86, green = two Wratten No. 102 and blue = one Wratten No. 48.

A Wratten No. 25 is also usable for the red filter even though its sharp cutoff for orange and yellow is not precisely suitable.

These filters provide high transmittance coincident with the desired spectral response when combined with the spectral sensitivity of the K1211 phototube. The resultant spectral discrimination of this colorimeter is shown by Fig. 4. The curves are established largely by the spectral characteristics of the phototubes, the availability of filter material, and the desire for high optical efficiency. The area under the red response curve represents about 5 percent of the K1211 unfiltered sensitivity to equal radiant energy.

The curves are based upon ICI mixture data for real spectral primaries and the condition for equal radiant energy response. They provide meter indications that read the percentage of red, green and blue colors in the luminous sample. These are directly transferable to an R-G-B diagram as shown in Fig. 5. Equal curve areas result in equal indications for an equal energy spectrum. The approximate spectral wavelengths are indicated around the edge of the triangle.

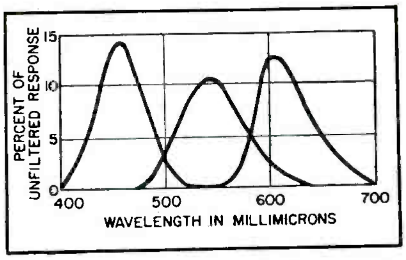


FIG. 4—Response of red, blue and green phototubes when balanced for equal meter readings and with an equal-energy spectral source

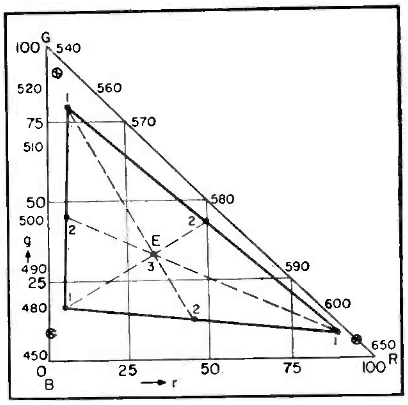


FIG. 5—Colorimeter indications recorded in R-B-G diagram for single-screen primary color phosphors (crosses) and same phosphors on a tricolor shadow-mask tube (line-connected dots)

The colorimeter responds to luminous excitation so that R + G + B = 100 percent where R, G and B each may be between 0 and 100 percent. White color is indicated by similar percentages on each meter. Equal energy white, the center of the triangle, is defined as color of zero saturation. The edges of the triangle define colors of maximum saturation with the corners identifying the pure primary colors. These are indicated, respectively, by two meters summing to 100 percent, one meter at zero, and by one meter totaling 100 percent, two meters at zero. The blue indicating meter is operationally unnecessary. It is retained for its convenience in operation and the monitoring of the 100-percent level.

The spectral acceptance of a similar instrument may be modified to the ICI distribution coefficients that permit color interpretation in the familiar XYZ form. This compresses the color information into a fraction of the R-G-B scale lengths. The reading accuracy is reduced for only real colors are available in any case. However, the double peaked x tristimulus function can be simulated by tying a resistor from the Z blue meter drive point to the X red phototube anode load resistor. This is effectively a unilateral signal so that no red peak is introduced into the z function.

The primary target of this colorimeter is a cathode-ray tube. The usual display is a tv raster of large area and medium brightness generated by a small moving spot of high intrinsic brightness. To the pickup head, this is an intermittent light with a low duty cycle. The resultant peak phototube currents greatly exceed the average currents to which the indicating meters respond. The short persistence of most phosphors does little to modify the peak to average brightness.

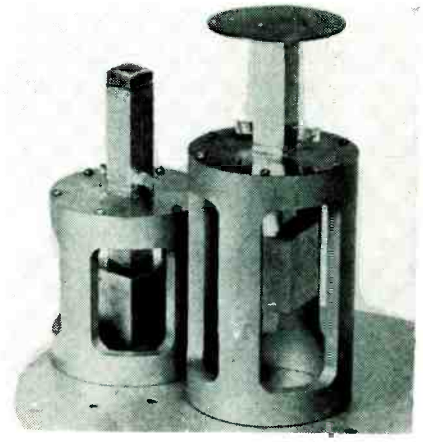
CRT Indicator

It is possible to use a cathode-ray tube as the color indicator. The deflection plates are cross-connected to develop 120-degree radial scan separation for primary color excitation. The display is in polar coordinate form on a circular grid with the radial and angular spot displacement identifying the quantities saturation and chromaticity, respectively.

In Fig. 5 the crosses record the hue and saturation of color tube phosphors as measured on single screen experimental cathode-ray tubes. The same phosphors, applied to a typical 19TP22 tricolor tube, have the measured hue and saturation as shown by the line-connected dots. Some tolerable desaturation of the display colors must be established. To fix these limits realistically, a measuring instrument of this kind is needed if every manufactured tube is to be checked.

The author acknowledges the work of Frank Kliminski in the construction of this instrument.

Indicating unit has provision for calibrating meter for three separate sensing units. Relay built into meter sets off alarm at preset ice-load level



Piezoelectric sensing unit shown in cross-section in Fig. 1

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Ice Detector for

ACCURATE determination of ice accretion on lighter-than-air craft is especially acute as the ice cannot be removed by any practical, self-contained means. The quantity of heat required to melt even a thin ice coating by heating and circulating the helium would be astronomical.

The system described here is designed to measure quantitatively the actual deposited mass per unit area as a primary variable. This is done by causing the accumulated ice mass to change the equivalent mass of a vibrating system and thus to alter its frequency of vibration. The change in the system resonant frequency is measured and a quantitative measure of the amount of deposited mass per unit area is thus obtained.

The system consists of three basic parts: the piezoelectric vibrating elements, the oscillator circuits whose frequencies are controlled by the piezoelectric elements and a frequency detector and indicating circuit.

This piezoelectric unit consists of two elements. One is cemented to the inside surface of the fabric which covers the top of the container of the unit so that the formation of ice actually adds to its equivalent mass. The other element is not in contact with the surface and is not affected by the formation of ice. This latter element acts as a frequency control unit against which the frequency of the sensing element can be compared.

Crystal Stacks

Figure 1 shows the construction used in the final model. The sensing element consists of four parts. The first is a tapered beryllium disk driven by an adp crystal stack. This driving stack is separated from the beryllium plate by a small quartz plate. Another quartz plate is affixed to the opposite end of the stack and to this is cemented a terminating equivalent quarter-wave aluminum bar.

The adp stack is made of four crystal slabs each $1\frac{1}{2}$ in. by $\frac{1}{2}$ in. by $\frac{1}{8}$ in. giving a total stack $1\frac{1}{2}$ in. by $\frac{1}{2}$ in. by $\frac{1}{2}$ in. The adp was chosen because it combines a good coupling factor with frequency stability. The use of the two quartz elements on each end of the stack provides two desirable effects. First, they dielectrically insulate the adp from the beryllium disk and terminating aluminum bar. Second, by splitting the quartz plate, the compliance in a plane perpendicular to the direction of motion of the crystal stack is increased. This reduces the tendency to clamp the end of the bar which would reduce the effective coupling coefficient and thus reduce the system sensitivity.

The vibrating element which is used as a reference is identical to the sensing element except for the beryllium plate which is replaced by a small piece of lead with a roughly equivalent mass. This element is then mounted in a similar fashion to that used for the sensing element but no portion of it is in contact with the cover on which the ice forms. The frequency difference between the sensing element and the reference element is therefore a measure of the deposition of ice on

*Work done while with Clevite-Brush Development Co.

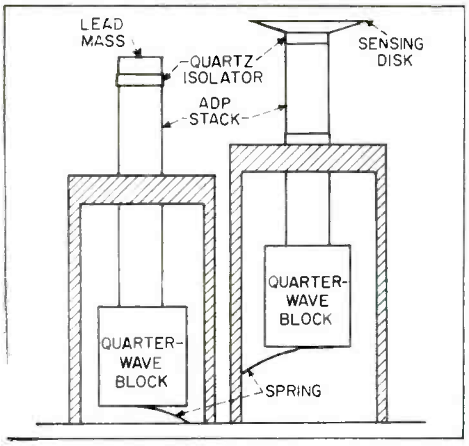
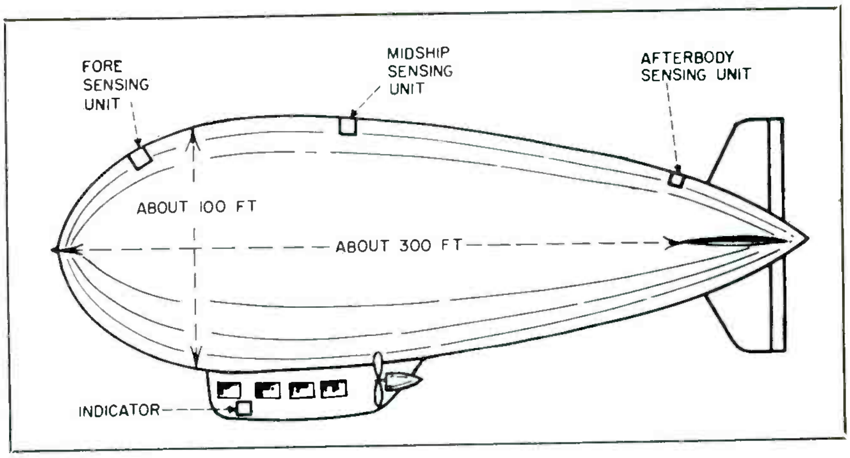


FIG. 1—Cross-section of piezoelectric stacks. Lead on top of reference stack approximates mass of sensing disk



Locations of indicator and sensing units on blimp. On preliminary test flights remote-control tv and motion-picture cameras were mounted on top of gas bag to monitor ice formation as a check on detector accuracy

Lighter-Than-Air Craft

SUMMARY —— Piezoelectric Meacham-bridge oscillator system determines ice accretion on surface of blimps. System also has applications in remote monitoring of ice formation on radomes and in automatic measurement of deposited coatings such as oil, grease or water

the former. Cold chamber measurements have shown that such a system effectively eliminates second order variables such as temperature and pressure.

A photograph shows the sensing and comparator elements as constructed in the first model.

Oscillator Circuits

The schematic diagram of the oscillator circuits is shown in Fig. 2. This circuit consists essentially of a Meacham-bridge oscillator wherein the nonlinear bridge element which is usually an electric light bulb has been replaced by a vacuum-tube agc circuit. The most severe problem that was encountered in the development of this circuit was that of obtaining satisfactory operation under conditions of low Q in the vibrating crystal system and over a large range of

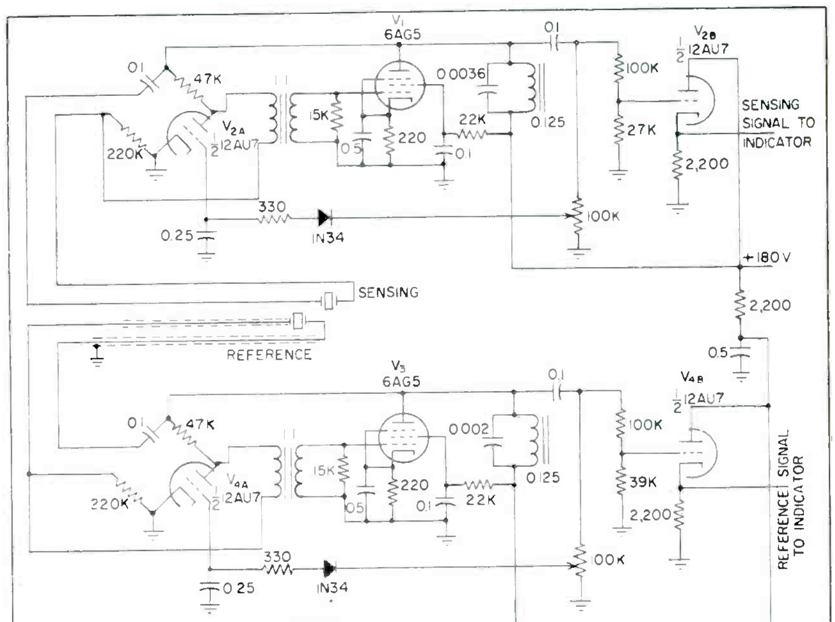


FIG. 2—Duplicate Meacham bridge circuits are used for sensing and reference. Triode in one leg of bridge functions as automatic gain control

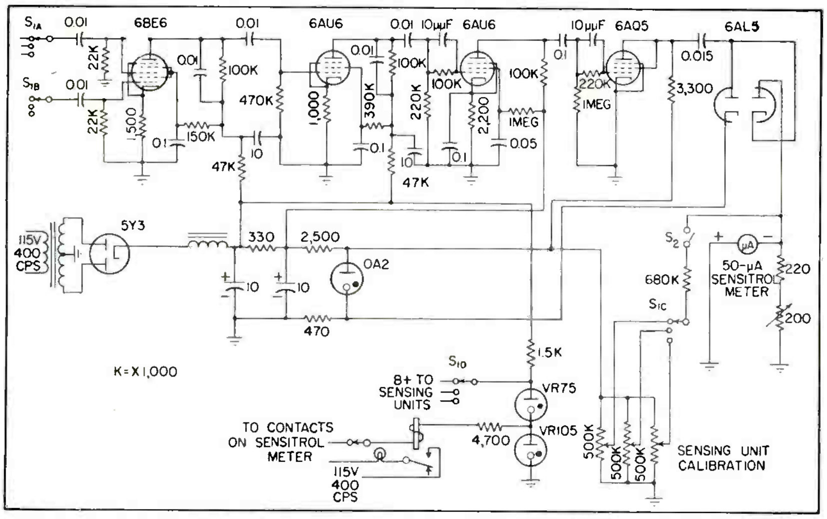


FIG. 3—Indicating unit is connected to either of three sensing units by switch S_1. Separate meter calibration is provided for each sensing unit

equivalent resistances. These two effects are, of course, intimately related and require the same circuit modifications for their accommodation.

In the normal Meacham-bridge circuit, the equivalent resistive impedance of the crystal element, when operating at its resonant frequency, is low, and therefore low-impedance elements can be used in the other arms of the bridge. In this application, however, the equivalent resistive impedance of the crystal was high and varied over a considerable range between unloaded and fully ice-loaded conditions.

The equivalent resistive impedance of the crystal without any ice load is approximately 20,000 ohms, and this value increases to between 80,000 to 90,000 ohms with full ice loading of 0.050 in.

Operation at spurious resonant frequencies of the vibratory system was avoided by the use of tuned circuits having a bandwidth wide enough to accommodate the range of frequencies occurring between unloaded and fully loaded conditions and yet narrow enough to exclude operation at any other system resonance.

The oscillator circuit consists of a 6AG5 vacuum tube with tuned grid and plate and grid excitation fed back through the frequency-controlling bridge circuit which embodies the vibrating crystal as one arm.

A portion of the output of the 6AG5 is rectified through a 1N34 diode and then applied to the control grid of one half of a 12AU7 which is inserted as a level control in the Meacham bridge.

The output is also fed to the grid of the other half of the 12AU7 which acts as a cathode follower providing a low output impedance to the long length of cable running over the surface of the airship from the sensing units on top to the indicating unit in the gondola. An identical oscillator circuit is provided for the reference crystal.

Although this circuit is basically simple and straightforward in design, extreme care had to be taken in the determination of the proper circuit values so that successful operation could be achieved with the low Q in the crystal vibrator. These modifications to the usual Meacham circuit should have other applications where similar problems are encountered.

Detection and Indicator Circuit

The sensing system produces two outputs, one from each cathode follower. It is necessary, therefore, to provide a circuit which will detect the frequency differences and display the resulting output in a manner which can be correlated with the amount of deposited ice.

The operation of this part of the system can be seen by reference to Fig. 3. The signals from the two cathode followers are fed into a 6BE6 multiple-grid mixer. The output of the mixer tube is passed through one stage of amplification provided by a 6AU6. The associated circuits of this tube are designed to pass only the difference frequency, as are subsequent stages. The signal is passed to another 6AU6 which provides additional amplification and effects a partial transition from sine-wave operation to square-wave operation. The 6AQ5 stage completes the transition to square-wave operation.

The final stage uses a 6AL5 as a counter-type discriminator. The output of this stage is fed to a microammeter having a sensitive relay which can be adjusted to flash a warning signal for any predetermined accumulation of ice up to 0.25 lb per sq ft.

Performance Characteristics

Operation from no ice loading to an ice loading of 0.25 lbs per sq ft has been achieved. The indicating meter has been calibrated to read directly in lbs per sq ft of deposited ice and experiments to date have shown that this calibration holds equally well for water films.

To date it has been possible to achieve reproducible indications of deposited ice within the basic accuracy originally desired (minimum measurable and reproducible increments of 0.010 in. of ice). The system is now undergoing flight tests at the Naval Air Development Station, South Weymouth, Massachusetts.

Further development will permit considerable extension of the dynamic range of the instrument and provide a safety device applicable to heavier-than-air as well as lighter-than-air craft.

Applications other than those involving use with aircraft include the remote detection and control of ice formation on radomes or other structures, recording of ice or frost for meteorlogical purposes and the automatic measurement and recording of any deposited coating, such as oil, grease, soft mud or water, which has reasonable adherence and which does not introduce damping beyond the present operating range of the instrument.

The work described in this article was sponsored by the Office of Naval Research under contract No. Nonr-1494 (00).

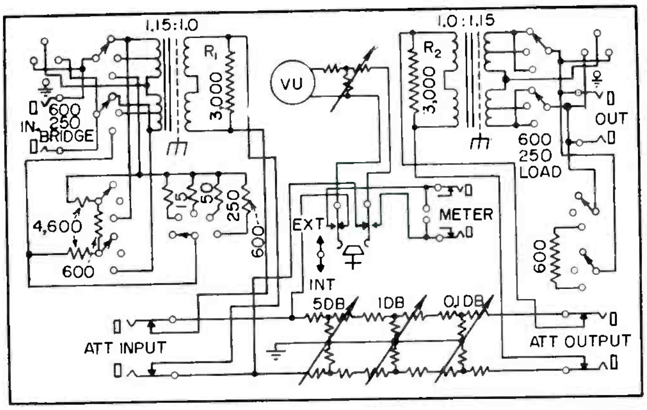
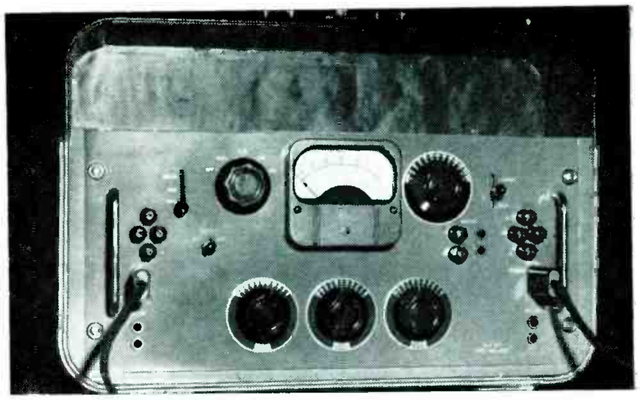


FIG. 1—Complete gain set has frequency response of 20 to 20,000 cps. ± 0.7 db when loading and ± 1.5 db when bridging



Gain set is housed in luggage case with breakdown hinges for removing cover. Case provides room for leads and accessories

Transmission Gain Set

SUMMARY —— Precision attenuator aids testing of a-m and f-m broadcast stations' audio facilities. Unit has total maximum attenuation of 63.5 db in steps of 5, 1 and 0.1 db. Minimum insertion loss is 2.5 db over frequency range of 20 to 20,000 cycles per second

By GERALD R. CHINSKI
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Radio Station KXYZ
Houston, Texas

As an aid to meeting increased need for better and faster measurement and servicing techniques for a-m and f-m broadcast stations, an audio-transmission gain set has been constructed.

The equipment is shown in the photograph and in the schematic diagram, Fig. 1. It is housed in a heavy-duty luggage case that has extra space for packing accessory cables and patch cords.

Circuit

The heart of the instrument is a precision variable balanced H-type attenuator having zero insertion loss and a maximum selective loss of 61 decibels. The individual elements, cascaded to form the attenuator, are three 600-ohm, 0.5-precent accuracy controls. These controls have, from left to right in Fig. 1, ten steps of 5 db per step, ten steps of 1 db per step and ten steps of 0.1 db per step.

The attenuator is capable of handling a maximum power level of about +55 dbm and the overall power level is +30 dbm. There is no frequency discrimination in the attenuator, even at maximum loss, out to 80 kc. The balanced attenuator is made directly available through break-in jacks.

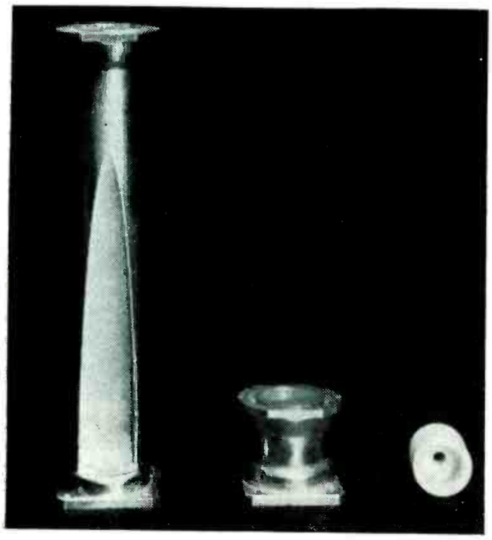
Overall input and output is provided by both jacks and instrument binding posts. Switching provision is made for input and output impendance matching at 600 and 250 ohms. A third position on the input selector key makes the input bridging at 9,500 ohms. This produces a fixed 30-db loss when fed from a loaded 600-ohm source.

In the bridging position power-loading resistors of values shown can be switched across the input terminals. This provides a handy arrangement for measuring amplifiers while being driven at high output. The output impedance selector key also terminates the gain set unit in 600 ohms when in the up position.

The end matching coils are excellent at low level and have no tendency to saturate at higher levels of the order of +30 dbm. They are well balanced and have 90-db magnetic shielding. Windings are arranged to cancel out externally induced electromagnetic fields and are provided with electrostatic shields between primary and secondary.

Resistors R_1 and R_2 build out the attenuator loading, so that the transformed impedance, at the input and output terminals, is close to the value selected and almost purely resistive.

The gain set is equipped with a standard vu meter, having a 1 mw in 600 ohms reference and a multiplier range of 24 db.



By IRWIN D. OLIN
Naval Research Laboratory
Washington, D. C.

The conventional tapered transducer at left and the new stepped transducer, center, showing reduced size. Transformer dielectric insert is at right

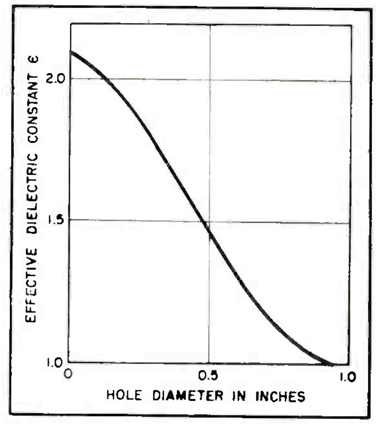


FIG. 1—Dielectric constant vs bore for a Teflon tube, 15/16 in. i/d, in a circular waveguide

Dielectric Transformers

SUMMARY — Dielectric sections provide reflectionless match between differing waveguide impedance levels and maintain match over a broad frequency range. Dielectric version of conventional rectangular-to-circular waveguide transducer is 80 percent shorter and has improved performance

MANY PROBLEMS encountered in microwave transmission require impedance transformers to optimize system performance. This paper describes the application of dielectrics to dominant-mode circular-waveguide transformers. Two designs are presented both operating within the X-band from 8,500-9,600 mc and using 15/16 in. i-d circular waveguide.

The first design is a rectangular-to-circular waveguide transducer, a dielectric transformer which, when inserted in a circular waveguide, permits the rectangular guide to join it directly.

The second design is a pressure seal for circular waveguide. Seals of this type may be used to provide weather-proof protection of a waveguiding system or enable a section of guide to operate under pressure.

These designs use a transformer composed of dielectric sections to provide a reflectionless match between differing impedance levels and maintain this match over a broad frequency band.

The configuration of the matching transformer is arbitrary. It could be a section of smoothly tapered dielectric or it could be composed of dielectric steps. The problem of converting from one impedance level to another is approached through the use of intermediate dielectric sections of varying impedance levels.

The change in the amount of reflection introduced as a wave travels from one section to another describes this variation. This may be termed the reflection taper. The number of these sections is arbitrary, being finite for a stepped section (each section made one-quarter guide wavelength long at the design frequency) and tending toward infinity in the case of the smooth taper.

The solution which results in the most compact design is the stepped matching transformer. The number of steps employed and the reflection taper govern the bandwidth over which the match between the two impedance levels is maintained.

Binomial Taper

Assume n steps will be used (n-1 quarter-wavelength sections) in going from one impedance level to another. The reflection taper depends upon the reflection coefficient of each step in relation to an adjacent step. The reflection taper is given by 1, k_2, k_3, . . ., k_n.

One of the most satisfactory tapers which provides a broadband design is the binomial taper. The reflection taper corresponds with the coefficients in the binomial expansion. Thus for a three-step design (n=3) the reflection taper would be given by 1, k_2, k_3 = 1, 2, 1.

Several 15/16-inch o-d Teflon tubes about 5 inches long were

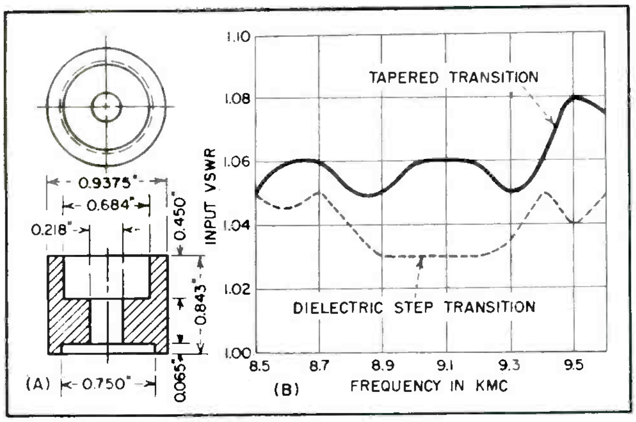


FIG. 2—Stepped transformer for the rectangular-to-circular waveguide transducer (A) and performance characteristics of new stepped transducer and conventional tapered transducer (B)

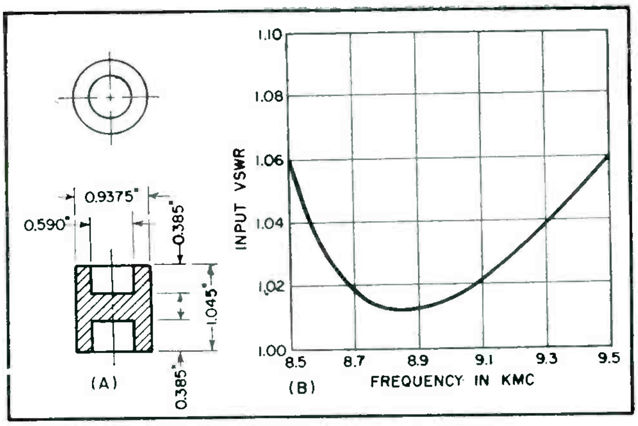


FIG. 3—Teflon pressure seal design for circular waveguide (A) and performance characteristic of the pressure seal (B) which provides weather-proof protection

for X-Band Waveguide

bored with varying inside diameters and a small longitudinal slot milled into the surface. The tubes were successively placed in a precision circular slotted line and the guide wavelength measured.

Using these figures and assuming only dominant mode transmission, a value of effective dielectric constant was computed for each tube. This value represents the dielectric constant of a material completely filling the guide and resulting in the same guide wavelength.

For a given tube several values were determined, one for each frequency at which measurements were taken. These values showed no appreciable variance, within the limit of experimental error. A curve of the effective dielectric constant versus the bore diameter of the tube was thus obtained, shown in Fig. 1. This curve gives all the information necessary to design Teflon dielectric matching sections in this size circular guide.

The transformer is circularly symmetrical, being composed of dielectric tubes. Hence it satisfies conditions for exciting the TE_{11} mode at any angle in the circular waveguide from the TE_{10} mode in the rectangular waveguide.

The problem reduces to providing an impedance match between the two waveguide sections. Since two different cross-sectional geometries are involved, the definition of waveguide characteristic impedance becomes ambiguous. However, by constructing transformers designed according to the different definitions, it was found that the definition based on power-voltage considerations gave the best results.

Stepped Design

A binomial stepped design was employed using three impedance steps between the impedance level of the two guides. All the calculations were referred to 9,100 mc. Due to the step-like nature of the design, a discontinuity susceptance is effectively placed at each abrupt change in dimension. If this change is small, compared to the waveguide dimensions, the overall performance will not be greatly different from that predicted.

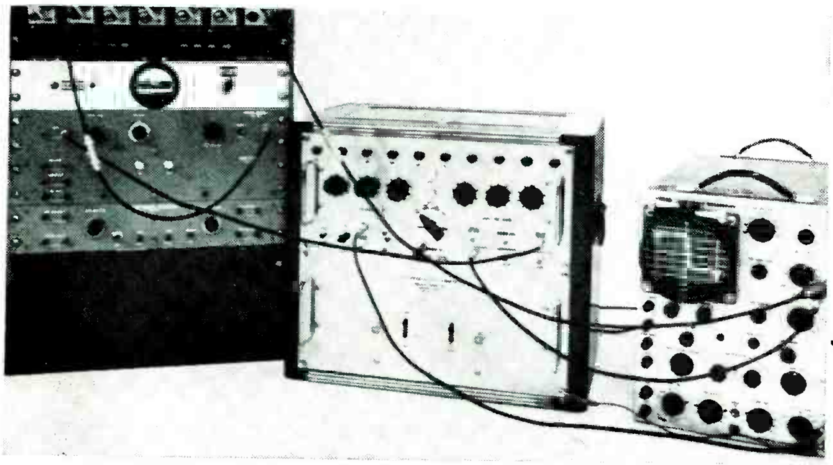
In this design the following adjustments were made: the transformer was positioned 0.065 inch away from the circular-rectangular junction; the low-impedance section was lengthened; and its impedance slightly increased.

Note that since the junction is the place at which the change in cross section takes place, the coupling flanges used here contributed to the performance of the overall transducer. The rectangular wave guide was equipped with a UG 40A/U choke flange and the circular waveguide with a flat flange.

The completed design is shown in Fig. 2A and its performance illustrated in Fig. 2B. The same figure shows the performance of a typical tapered transducer designed to perform the same function.

The pressure-seal design is composed of a section of waveguide completely filled with a dielectric and some means for providing a broadband match to the adjacent unfilled waveguide. In this type of design, or in any design where only one waveguide cross section is involved, any choice of characteristic impedance definition will result in the same dimensions for the matching section. The design chosen for the matching section was a single binomial step. After slight modification the performance shown in Fig. 3B resulted. The dimensions for the design are shown in Fig. 3A.

The author wishes to acknowledge the contributions of P. J. Allen and R. D. Tompkins in the work described.



To make delay measurement, delay trigger 2 is fed to external sync input of crt. Initiating trigger goes through target simulator (left) to crt vertical input. One-microsecond markers are fed directly to crt vertical input

Precision

By WILLIAM PERZLEY
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APPLICATION of digital-computer techniques to time-interval generation and measurement can provide a highly accurate generated delay and exact time discrimination.

The precision digital delay generator to be described gives as its output a reference pulse followed by pulses precisely delayed in time with respect to the reference pulse. It can supply these pulses under one-shot or variable frequency steady-state conditions. Its accuracy is determined by the frequency stability of a 1-mc crystal-controlled master oscillator, which is thermostatically controlled and accurate to one part in one million. Performance characteristics are given in Table I.

Figure 1 illustrates the output pulses available under steady-state conditions. In this mode, both t_1 and t_2 are independently controlled by their respective input dial settings. Figure 1B gives the output pulses available under one-shot conditions.

The ability to supply pulses accurately positioned, as shown in Fig. 1, makes the digital delay generator useful in radar and sonar range calibration and target simultation. In this application, the intiating trigger is used as the system trigger and delay trigger 1 at preset delay settings is injected as the simulated target. The process of calibration involves adjusting the range-measuring circuitry of the system to agree with the known target delay.

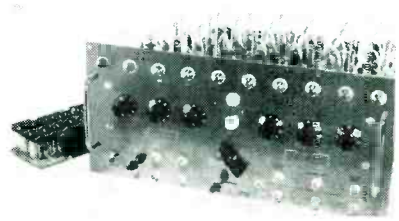
The technique used in delay measurement is to compare the delayed signal with signals of known delay generated by the delay generator, making a vernier measurement or interpolation with a synchroscope. The equipment setup is shown in the photograph.

Logic of System

The block diagram (Fig. 2), shows the 1-mc crystal-controlled oscillator followed by two cascaded divide-by-ten counters to provide three separate ranges of operation. Range 1 utilizes the 1-mc crystal output directly, range 2 uses the 100-kc output from the first divider circuit. Range 3 uses the 10-kc output of the divider. The unit provides an external input jack which will accept other standard frequency inputs.

The crystal-controlled master pulses of ranges 1, 2 or 3 are fed to a 10-stage binary counter. The stored count provides the time-measurement information which is used in the selection of a specfic input pulse. This is accomplished by diode gating circuits which are connected to the outputs of the binary counters through a manually controllable decimal-to-binary encoder. The arrangement makes it possible to set manually any count up to the maximum capacity of the binary counter 2^n where n represents the number of counter stages—and extract an output pulse, delay trigger 1, at that particular count for each cycle of the count chain. Any number of encoder-gate combinations can be used with a single count chain depending upon the number of controllable delay periods desired.

The unit has two selection gates. The first gate output provides a pulse, delay trigger 1, delayed with respect to the start of the cycle, while the second selection gate determines the period for cyclic operation. This arrangement allows maximum flexibility for a count chain of fixed length. The settings of both the first and second encoder-gating systems can be varied throughout the full count range if the second selection gate is set equal



Chassis of precision digital delay generator illustrating modular design

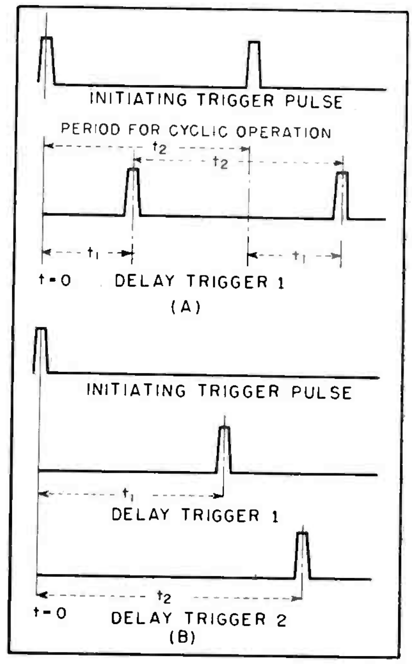


FIG. 1—Pulse outputs for cyclic operation (A) and one-shot operation (B)

Digital Delay Generator

SUMMARY —— Pulses for calibrating radar equipment and for target simulation are made available by instrument using 1-mc crystal oscillator and flip-flop frequency dividers. Precision of pulse timing is independent of flip-flop transition time

to or greater than the first.

The accuracy of the generated delay is not dependent on flip-flop transition time or length of flip-flop counter chain and consequently represents an improvement over conventional digital and analog methods of generating precise time intervals. The pulses from the crystal continuously sample the selection gates as well as pulse the count chain. There is sufficient inertia in the count chain so that the *M*th pulse which sets the counter to *M* will not pass through the selection gate assuming that the output of the decimal to binary encoder is *M*. However, the $(M+1)$th pulse will pass directly through the selection gate and be available without accumulative delay. This arrangement is one count off and is readily corrected by a one-unit compensation in the decimal to binary encoder. Its advantage is zero phase lag regardless of time delay setting.

Operation

Under steady-state conditions, the start button triggers the one-shot generator which in turn sets control flip flop 1. Control flip flop 1 gates the succeeding master clock pulse through gate 3. This gated pulse marks the start of the time cycle and is called the initiating trigger pulse. The initiating trigger pulse resets control flip flop 1 and sets control flip flop 2. Control flip flop 2 opens gate 4 which allows the succeeding clock pulses to flow into the count chain and sample the selection gates.

A recycling scheme enables the pulse selected by the second selection gate to reset the binary counters and cut off the input flow of

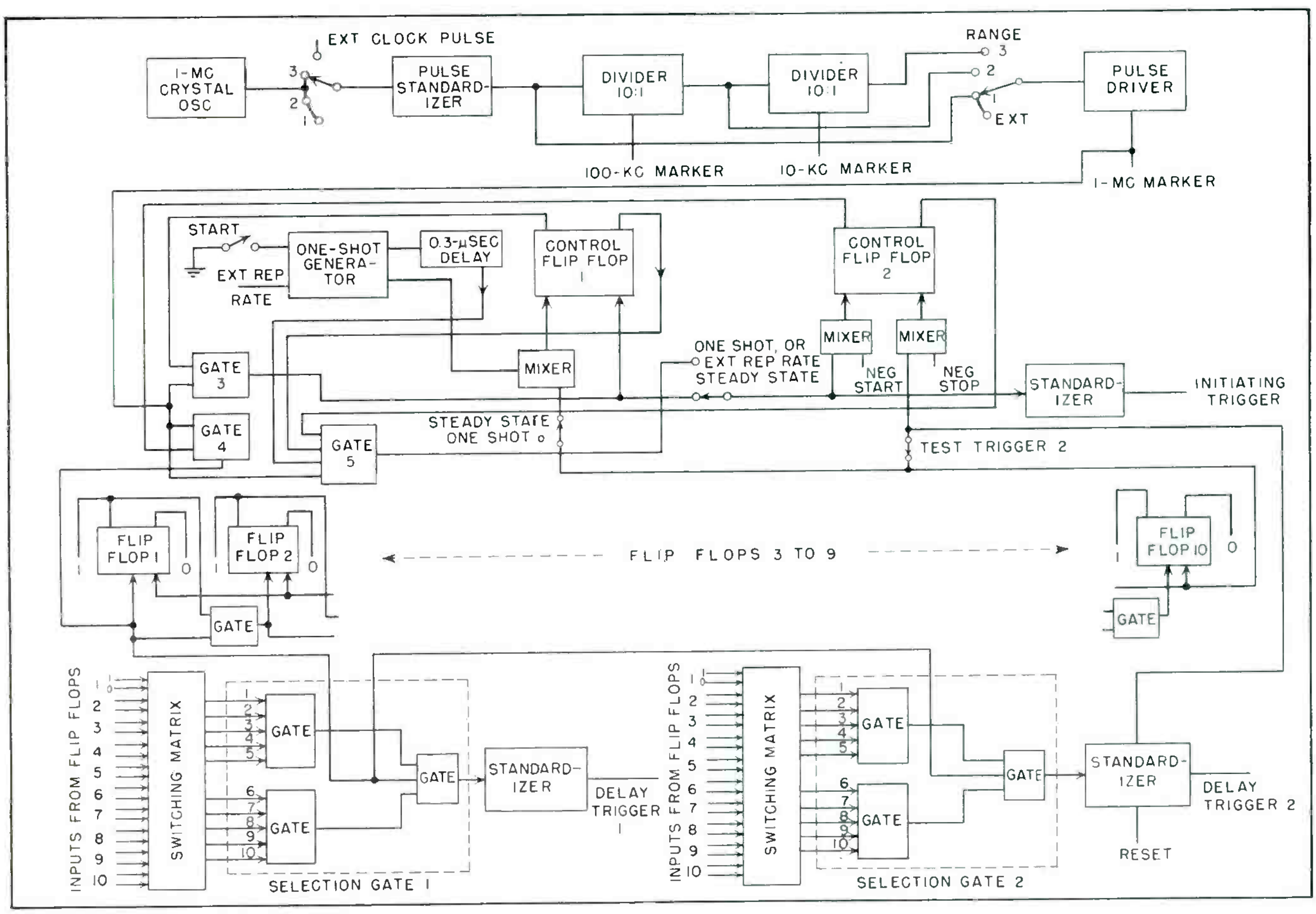


FIG. 2—Logical design of the precision delay generator and its detailed operation may be traced from this functional block diagram. Crystal oscillator and counter chain provide three operating ranges

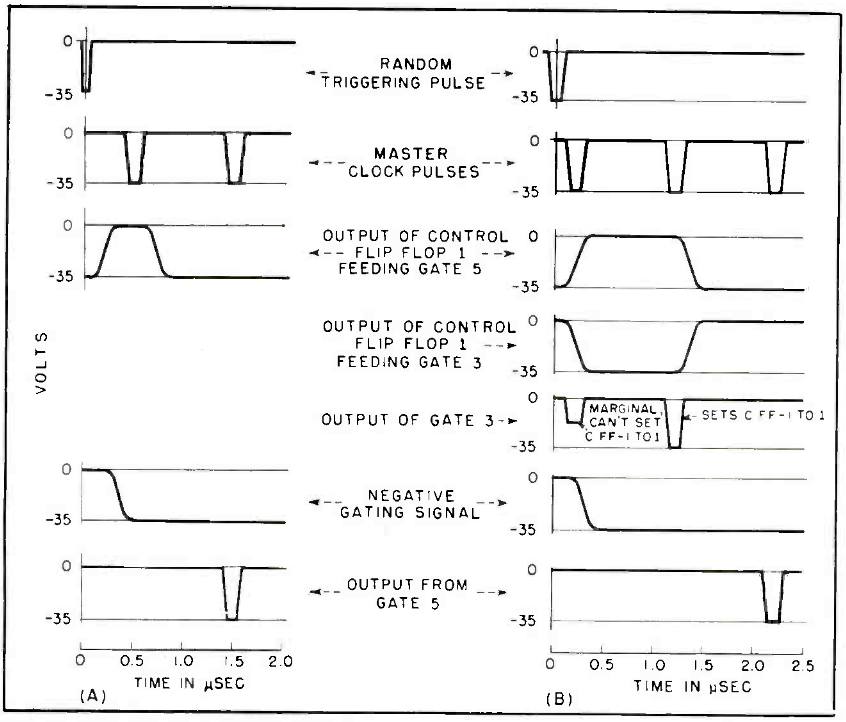


FIG. 3—Waveforms in buffer circuit when clock pulse occurs more than 0.3 μsec after trigger (A) and when clock pulse occurs less than 0.3 μsec after trigger (B)

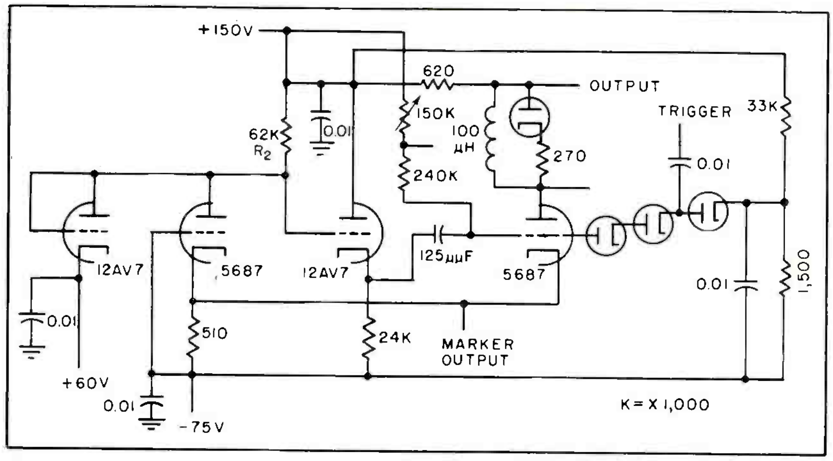


FIG. 4—One-megacycle to 100-kc count-down circuit is monostable multivibrator with common-cathode coupling

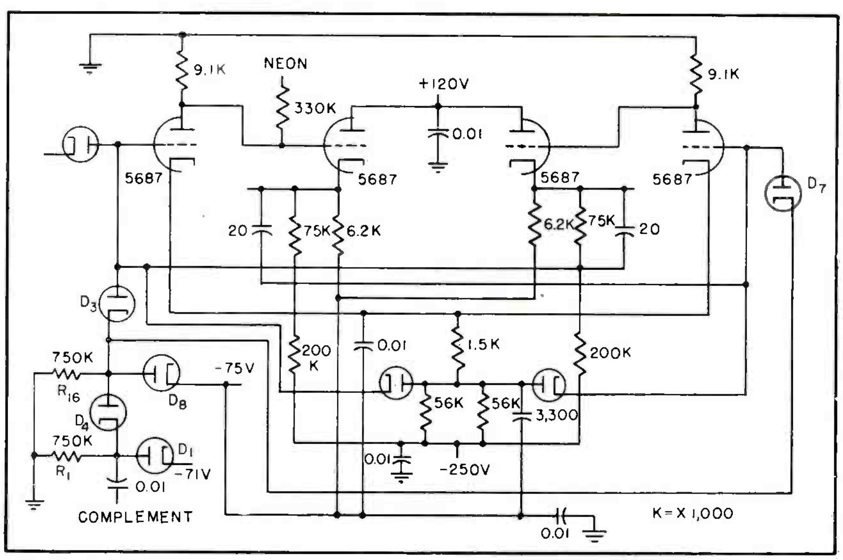


FIG. 5—One-megacycle binary counter is modified Eccles-Jordan flip-flop circuit

pulses by resetting control flip flop 2. This shuts gate 4. The pulse selected by the second selection gate sets control flip flop 1 to allow the succeeding pulse from the master clock to pass through gate 3 and set control flip flop 2. Control flip flop 2 then opens gate 4 and the cycle repeats.

Marker pulses are supplied for each of the three ranges. They are in time synchronization with the selected pulses from selection gates 1 and 2. The marker pulses are useful when making delay measurements with an oscilloscope.

Should the total count available in the chain be insufficient to yield a low enough repetition rate for a specific test, an external repetition rate source can be used to provide increased delay time.

One-Shot Operation

When operating asynchronously, one-shot or with external repetition rate control, the two selection gates are so set that selection gate 2 is higher than selection gate 1. The external trigger pulse hits the one-shot generator, resulting in a trigger pulse applied to control flip flop 1. This pulse sets control flip flop 1.

Control flip flop 1 gates the succeeding master clock pulse through gate 3 to reset itself. The one-shot generator also generates a negative gating signal which is first delayed by 0.3 microsecond, time for the flip flop to change state, and then applied to gate 5. The negative gating signal is delayed to insure that control flip flop 1 has had sufficient time to reach the 1 state to insure keeping gate 5 closed to the first clock pulse succeeding the initiating external repetition trigger pulse. This could occur within 0.3 microsecond after application of the random external trigger. The gate is unprimed during this 0.3-microsecond interval, this, plus the fact that control flip flop 1 will hold it closed until the next master clock pulse arrives, insure that the master clock pulse gated by gate 5, whether it be the second or third pulse succeeding the random external trigger, will be full amplitude. This technique eliminates marginal operation. The first master clock pulse after $t = 0$ may or may not pass through gate 3 and reset control flip flop 1 but the second master clock pulse will most certainly do so. Should the first clock pulse reset control flip flop 1 the second clock pulse will pass through gate 5, setting control flip flop 2 and mark the start of a new count cycle. The arrangement described functions as a buffer between the two random control frequencies insuring error-free operation. The instantaneous repetition interval resulting can vary as much as one cycle of the master clock rate per count cycle. This represents a repetition frequency variation of less than 1 part in 1,000. Figure 3 indicates two possible timing diagrams for the buffer.

Self-Checking Feature

The unit is capable of checking essentially all its own circuits.

The unit is placed into operation in the one-shot mode. The output from delay trigger 1 is fed back into the negative stop terminal of control flip flop 2. The start button sets the unit into operaton and master clock pulses flow into the count chain as well as sample the selection gates. When the count reaches a value equal to one less than that set on the delay trigger 1 input dials, selection gate 1 is primed and the succeeding master clock pulse is gated out of delay trigger 1. Feeding this pulse back into control flip flop 2 immediately resets control flip flop 2, which in turn shuts gate 4. The count chain now stores the number which had previously been set on the input dial. The stored count can be read at front panel from neon indicators. Any disagreement indicates that there has been a system malfunction. The same procedure can be used to check the delay of delay trigger 2. For this test, the system functions as it normally would in the one-shot mode, except that the front-panel switch test trigger 2 is thrown, which opens the reset line to the count chain thereby retaining the accumulated count. Testing the system under one-shot conditions is generally more severe than under similar steady-state conditions.

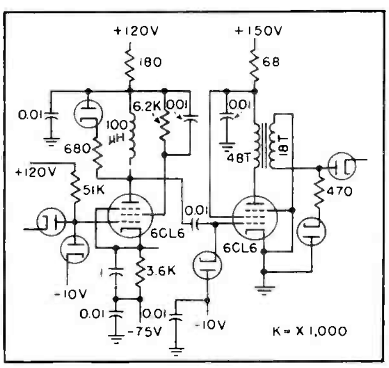


FIG. 6—Pulse standardizer

Circuits

The internal circuitry operates in straight binary using negative pulses throughout. The signal amplitude required for triggering all regenerative circuits is -10 volts. A combination of d-c and capacitive coupling incorporating d-c restoration is used throughout.

The 10-to-1 divider circuit given in Fig. 4 is a modified monostable multivibrator incorporating common-cathode coupling. Clamping of the plate swing of the normally cutoff tube and the grid swing of the normally conducting tube provides for stability of operation. The circut utilizes a cathode follower within the plate-to-grid feedback loop which isolates plate load R_2 from the interstage capacitive loading. This provides rapid recovery as well as large output swing resulting in a stable count down from 1-mc to 100-kc. A similar circuit is used for the 100-kc to 10-kc count.

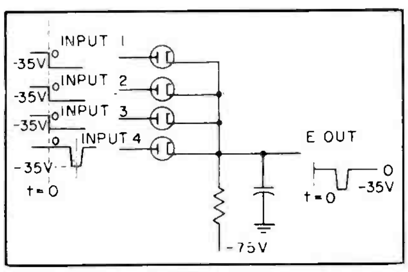


FIG. 7—Diode coincidence circuit

The 1-mc binary counter given in Fig. 5 is a modified Eccles-Jordan flip flop so designed as to provide a high degree of reliability. The circuit employs cathode followers within the plate-to-grid feedback paths providing a high output voltage swing at high switching speeds since the capacitive load is driven by the cathode followers. The flip flop employs cathode stabilization insuring satisfactory operation with half-emission tubes. The grid swing is clamped at both ends, removing all grid recovery problems. Complementing is accomplished by driving both flip-flop grids negative simultaneously through isolation diodes D_3 and D_7. The negative input the complement pulse passes through the d-c restoration clipping circuit composed of R_1, D_1, D_4, R_{16} and D_8 where the most positive 4 volts of signal is clipped. This provides immunity to spurious signals under 4 volts in amplitude.

Table I—Performance of Delay Generator

Accuracy of Generated Time Intervals	
Range	Accuracy
0–1,000 μsec	better than ±0.002 μsec
0–10,000 μsec	better than ±0.01 μsec
0–100,000 μsec	better than ±0.1 μsec
Accuracy of Delay Measurement*	
Range	Accuracy
0–1,000 μsec	±0.03 μsec
0–10,000 μsec	±0.3 μsec
0–100,000 μsec	±3.0 μsec
Secondary Standard Pulse Rates	
Range	Formula for Freq in cps
0–1,000 μsec	$\sum_{n=1}^{1,000} 1/n \times 10^{-6}$
0–10,000 μsec	$\sum_{n=1}^{1,000} 1/10n \times 10^{-6}$
0–100,000 μsec	$\sum_{n=1}^{1,000} 1/100n \times 10^{-6}$

* Using Tektronix 514AD or equivalent cro

The pulse-standardizer circuit given in Fig. 6 is composed of two cascaded 6CL6's. The first stage consists of a conventional cathode-stabilized amplifier with plate ringing circuit wherein a positive standardized output pulse is generated for each negative input trigger. The output pulse is further amplified and shaped by the normally cut-off output tube. The output circuit is transformer coupled to the load and operates in the bottom portion of its plate characteristic thereby effectively clamping the output pulse amplitude.

Gating is accomplished with diode coincidence circuits of the type shown in Fig. 7. Proper design can insure zero delay in gate output when coincidence is detected.

High-Quality Receiver

SUMMARY —— Off-the-air pickup of television signals for commercial rebroadcast requires features often lacking in modified home receivers. Article describes how a set especially designed for rebroadcasting attains operational reliability, immunity to interference and proper video i-f response

By RAYMOND S. ROSENBERG

Nems-Clarke, Inc.
Silver Spring, Maryland

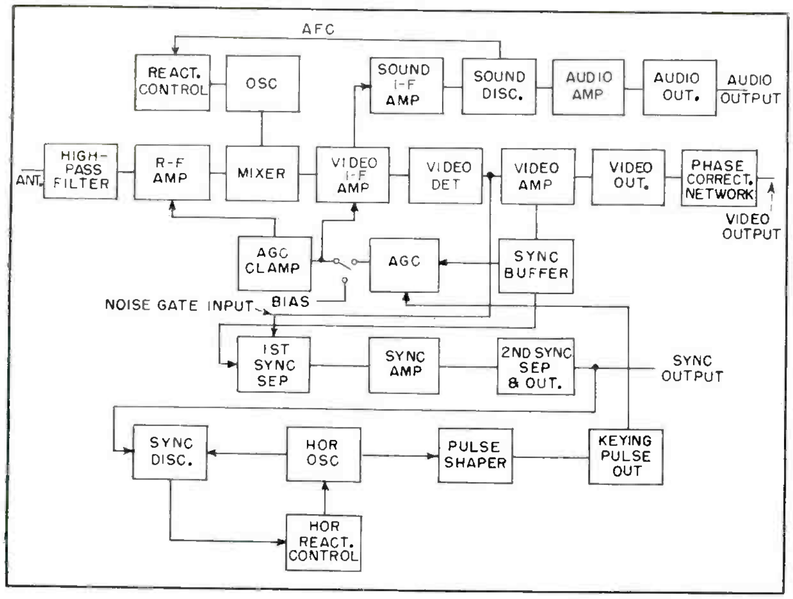
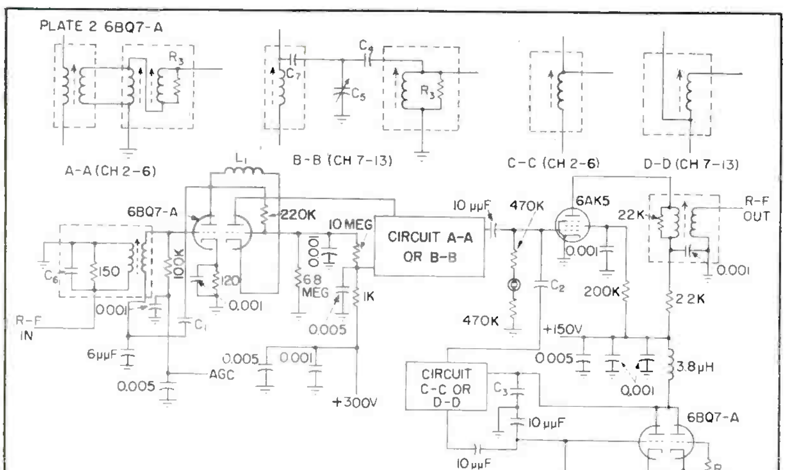


FIG. 1—Receiver incorporates automatic frequency control of local oscillator for greater frequency stability



CH	C_1	C_2	C_3	C_4	C_5	C_6	C_7	R_1	R_2	R_3	L_1
2-4	25*	20	100	NOT USED	NOT USED	NOT USED	NOT USED	22K	150	15K	NOT USED
5-6	2.5	1.5	100	NOT USED	NOT USED	NOT USED	NOT USED	22K	150	1.6K	NOT USED
7-9	25	1.0	10.0	2.0	05-3	6.8	15	27K	39	16K	0.13μH
10-13	2.0	10	82	25	05-3	68	10	27K	27	16K	0.13μH

*ALL C IN μμF

FIG. 2—Plug-in front ends are designed for optimum performance at frequency of desired channel

SEVERAL STATIONS engaged in direct pickup and rebroadcast of television signals have modified home tv receivers to meet their needs.

Some requirements of a tv receiver for commercial rebroadcast operation have been found lacking in modified home-type receivers. These requirements include: reliability in terms of uninterrupted service, accessibility of all components, interference immunity to high-level signals at the antenna and to strong radiated signals at the intermediate frequency, correct video i-f response, stabilized local oscillator and low audio harmonic distortion with proper receiver frequency response.

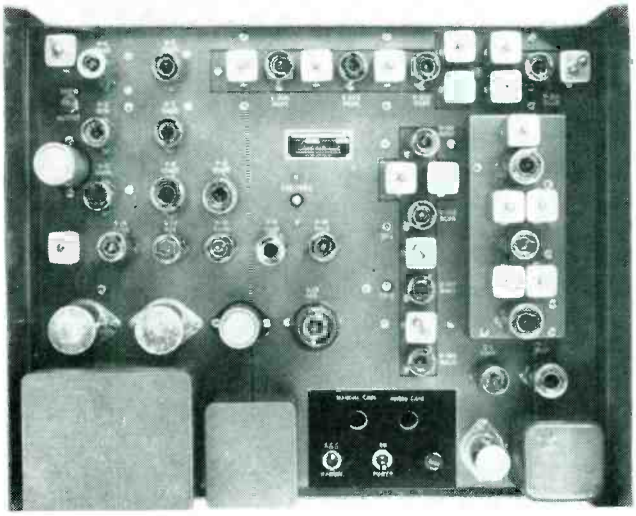
Front and rear views of a television receiver designed for commercial rebroadcast sevice are shown in the photographs. Figure 1 is a block diagram.

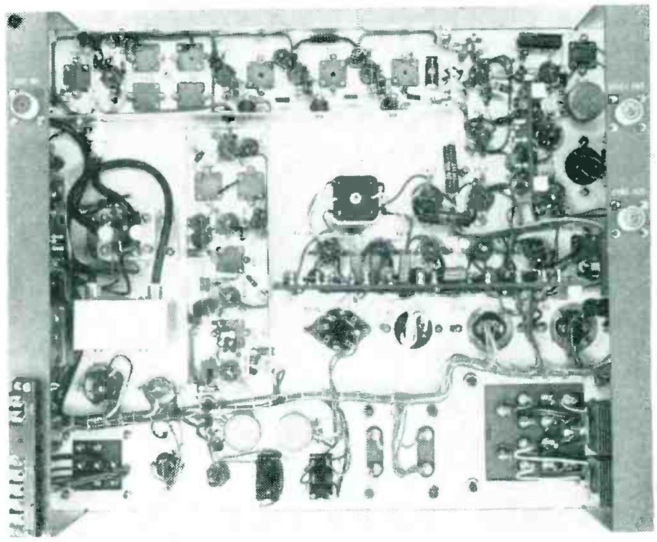
Front End

Each front end (Fig. 2) is a complete subassembly which plugs into the main chassis. This construction eliminates moving contacts and optimizes circuit constants for each channel.

One-half of a 6BQ7A serves as a modified Colpitts oscillator, the other half as the control tube for afc. The reactance tube utilizes the internal capacitances of the tube and resistor, R_2, as the grid phase-shifting network. The value of

for TV Rebroadcasting





Front and rear views of television receiver for off-the-air pickup. Set is designed for rack mounting

R_2 used is a function of the operating frequency and is selected for maximum frequency control. Resistor R_9 loads the oscillator tuned circuit and its maximum value is limited by the plate dissipation of the local oscllator.

Included as an integral part of the receiver is a high-pass filter. The filter has greater than 50-db rejection at 21 mc and eliminates interference due to strong signals received at the intermediate frequency and prevents overload of the first r-f stage by high-power a-m broadcast and other low-frequency emissions. The response of the filter is shown in Fig. 3A.

Accessory Filters

To eliminate cross-modulation interference in high-signal areas, accessory high- and low-pass filters were developed. Both have appreciable attenuation in the f-m band. The response curves are shown in Fig. 3B.

Figure 4 is a schematic of the rest of the receiver.

Particular attention was devoted to producing an overall response that did not appreciably change with agc level and to producing the proper low-frequency slope with a minimum number of tuned circuits.

The mixer plate circuit on the tuner chassis is link coupled to a tuned circuit in the grid of the first i-f amplifier forming a double-tuned transformer. The secondary of this transformer is inductively coupled to the first sound trap (21.25 mc), which also provides the signal source for the 21.25-mc sound i-f amplifier.

An M-derived filter network is used between the plate of the first and the grid of the second i-f amplifier. This network contains two traps, one tuned to 21.25 mc for additional sound rejection, the other tuned to 27.25 mc, the adjacent picture carrier frequency.

The first and second i-f stages are gain controlled. Cathode compensation of input capacitance variations with bias is used.

The last three i-f stages form a flat staggered triple with a flat-top bandwidth of 3.75 mc.

The first stage, due to the M-derived filter structure in its plate, will not respond to screen neutralization, and for this stage a 6AU6 with its low grid-plate capacitance was selected.

The desired video i-f response, in particular the critical low-frequency slope, has been produced in only two stages of the receiver. The wide bandwidth of the r-f circuits

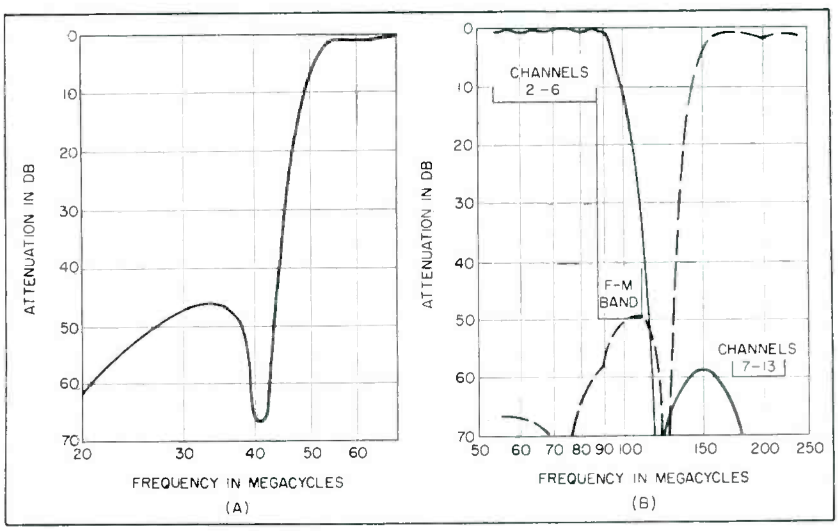


FIG. 3—Response of antenna filter (A) and high-band and low band filters (B)

and of the flat staggered triple prevents these stages from materially affecting the overall response.

Figure 5 shows the overall video i-f response from antenna to video detector. The response is flat to 3.75 mc with usable response to 4.0 mc. Markers occur at 22, 25, 25.75 and 26.5 mc.

Other Circuits

The sound i-f consists of a high-gain voltage amplifier with 300-kc 3-db bandwidth driving wide-band cascade limiters followed by a phase-shift discriminator with 0.75-mc peak separation for low distortion.

The aural signal is available at output impedances of 600 or 150 ohms, balanced or unbalanced.

For optimum performance the combined television transmitter and receiver characteristic must produce a linear phase system.

The low-frequency cutoff amplitude slope of an ideal receiver as shown in Fig. 6 affects the carrier and the upper and lower sidebands for ±0.75 mc from center, introducing a serious source of time delay. This delay is maximum at 0.1 mc and decreases to zero at approximately 2.5 mc.

Attenuation in the region of 4.0 to 4.5 mc gives rise to serious time delay beginning at 2.5 mc and increasing with frequency. An all-pass phase-correcting network suitable for compensation of this delay is so complex as to make its inclusion in home tv receivers impractical. Attenuation of the sound carrier must occur ahead of the second detector to prevent mixing of the sound and video information and, in the case of color, the sound and color subcarrier, which would produce a 920-kc beat. Beat interference produced at the second detector cannot be trapped in the video amplifier.

Phase Compensation

Figure 7A is a horizontal sync pulse taken from the coaxial cable feeding a television transmitter.

Figure 7B is the same pulse viewed with a diode double sideband detector sampling the transmitter final r-f output before it is fed to the sideband filter. No phase compensation of any type was employed at the transmitter, and therefore for these tests the transmitter did not conform to the NTSC standards.

The pulse of Fig. 7A has acquired a spike on the leading edge in passing through the transmitter. The pulse shown in Fig. 7C was taken from the output of the rebroadcast receiver with its phase-correcting network removed. The r-f input was double sideband and was taken from the transmitter coaxial line ahead of the sideband filter. The transient distortion of this pulse is serious and is entirely due to uncompensated delay produced by the low-frequency cutoff characteristic of the receiver.

Figure 7D was made under the same conditions as Fig. 7C with the

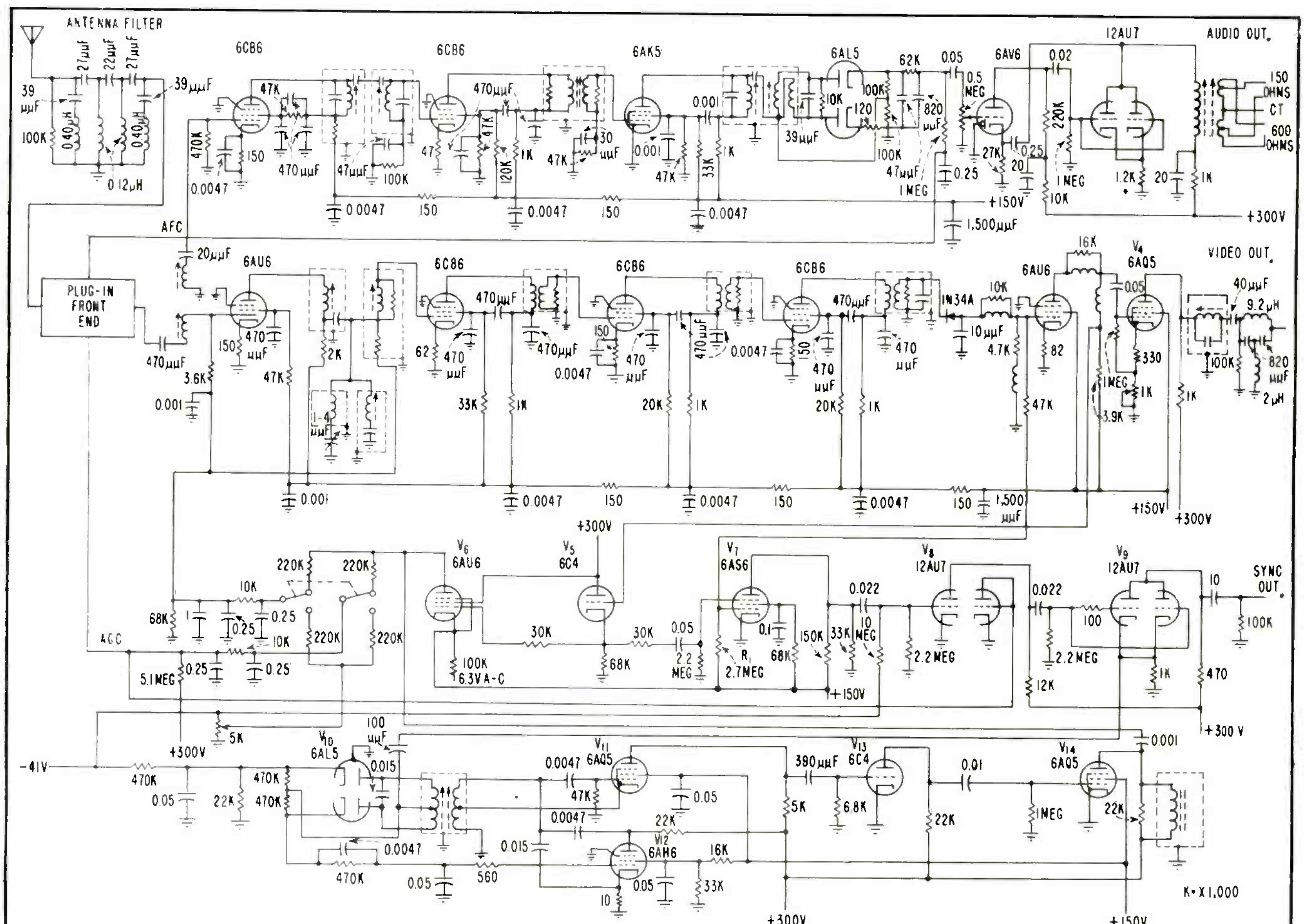


FIG. 4—Main receiver chassis includes aural, video, sync and 700-v horizontal sync pulse channels

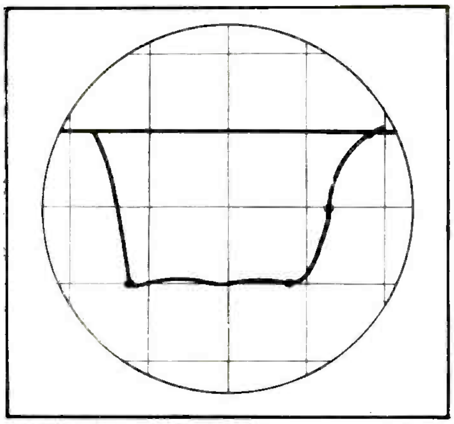


FIG. 5—Overall video i-f response

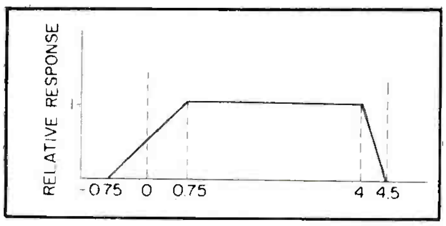


FIG. 6—Ideal receiver response

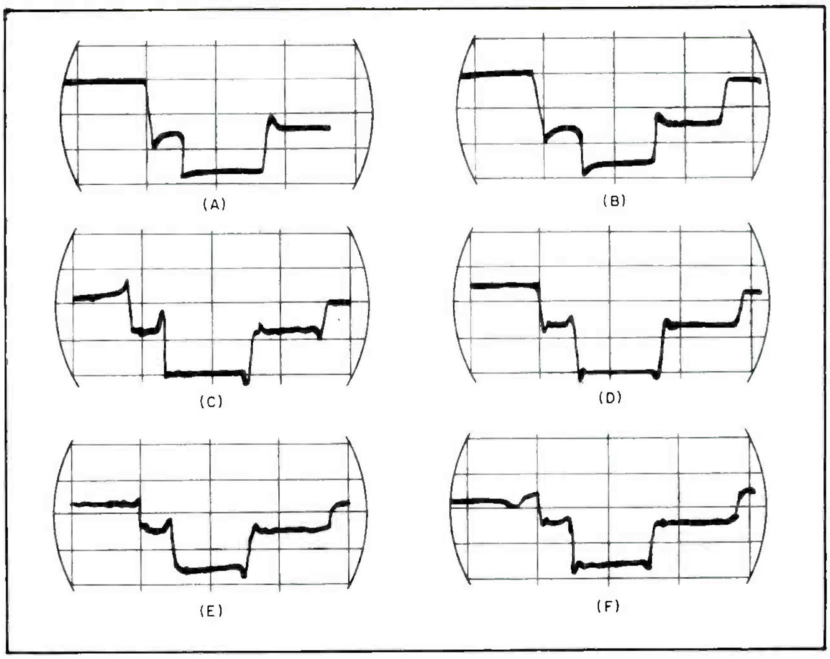


FIG. 7—Horizontal sync pulse into transmitter (A) and same pulse at double sideband detector (B). Pulse at output of receiver with phase-correcting network removed and double sidebank input (C)—same pulse with network in place (D). Single sideband pulse without (E) and with (F) phase-correcting network

addition of the all-pass phase-correcting network in the receiver. Compared with Fig. 7B it shows that almost perfect compensation has been achieved.

Figure 7E is the response of the receiver without phase compensation to a single sideband transmission. Comparison of Fig. 7E with Fig. 7C shows no increase in transient distortion due to uncompensated delay caused by the transmitter vestigial sideband filter. It appears that the most serious source of transient distortion in the television system is uncompensated delay introduced by the low-frequency cutoff characteristic of the video i-f amplifier.

Figure 7F is the response of the receiver with normal phase compensation to a single-sideband transmission. Compared with Fig. 7D, the same receiver with double-sideband input, the effect of the transmitter sideband filter is negligible.

Sync Amplifier

Tube V_7 is a 6AS6 dual-grid sync separator with the composite input signal applied to the suppressor grid. The control grid is connected to the video detector output. On large amplitude noise bursts there is sufficient voltage of negative polarity at the detector to cut off V_7 and prevent the suppressor grid from drawing current and setting up a bias. Under normal operating conditions, however, there is insufficient voltage available at the detector to overcome the clamping action produced by the current through R_1 and the control grid to cathode. Voltage amplifier V_8 operates at fixed bias derived from the −41-volt supply. Tube V_9 consists of both halves of a 12AU7 connected in parallel and plate coupled to the sync output connector. Sync positive pulses are obtained at the cathode to drive the horizontal sync discriminator.

To obtain a high-voltage pulse to operate an agc system, it is necessary to build a horizontal oscillator with synchronizing circuits, a waveform shaper and a pulse power amplifier. Tubes V_{10}, V_{11} and V_{12} form a horizontal sync circuit. Tube V_{11} is an electron-coupled oscillator operating at 15,750 cps. criminator, V_{10}. The output of the tube connected across the oscillator tuned circuit and controlling its frequency in response to a control voltage obtained from the sync discriminator, V_{10}. The output of the oscillator is differentiated and amplified in V_{13}. The signal voltage on the grid of V_{13} drives it beyond cutoff and produces a sharpened pulse. Power amplification takes place in V_{14}. An output pulse of greater than 700 volts is obtained in synchronism with the horizontal sync pulse in the video amplifier.

Keyed AGC

Tube V_6 provides a keyed agc voltage. Composite video is applied to the control grid and a high-voltage pulse is applied to the plate. These two voltages appear simultaneously and an output is produced proportional to the grid voltage.

The agc voltage is connected through a divider circuit to the first and second video i-f grids. A delay circuit is connected in the agc line to the front end to prevent application of agc voltage to the r-f stage until the signal has built up to such an extent that noise is negligible. The keyed agc circuit minimizes picture degradation due to impulse noise and is effective in reducing flutter and rapid fading produced by reflections from aircraft. The highest flutter frequency the receiver will handle is 90 cps.

The author acknowledges the contributions of Ralph E. Grimm, chief engineer of Nems-Clarke, Inc.

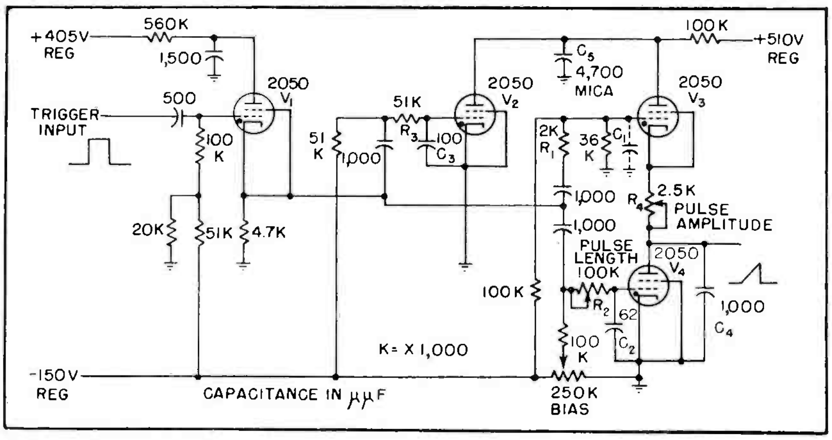


FIG. 1—Sawtooth pulser circuit may be triggered at rates from 50 to 5,000 cps

Sawtooth Pulser Gives

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VOLTAGE-CURRENT characteristics of circuit elements may often be obtained by d-c methods involving the measurement of the voltages across the element and across a standard resistance in series with it. Drawbacks of this, however, are polarization effects, heating effects and the need to make point-by-point plots.

The polarization effects can be avoided by using pulses or a-c with periods shorter than the polarization time. By using a-c and employing the well-known technique whereby the V and I outputs are used to deflect the beam of an oscilloscope along perpendicular directions, the characteristic curve may be obtained as an oscilloscope trace.

Unfortunately, however, in many cases the characteristic obtained is sensitive to the local temperature of the element and this may depend on the Joule heat dissipated in the specimen. In these cases it is imperative to use pulse techniques, the Joule heating being reduced in proportion to the smaller time that the voltage is impressed on the specimen.

Circuit Requirements

To retain the convenience of obtaining the characteristic as a trace on a scope, it seemed desirable to carry over to pulse measurements the techniques customarily used with a-c. This can be achieved by using a pulse whose amplitude is a well-defined function of time over the desired voltage range. The exact waveform of the voltage variation supplied to the specimen is unimportant as long as the pulse voltage and current outputs from the test circuit are synchronized.

To obtain traces of uniform brightness and to cover the voltage range in a monotonically increasing fashion, a sawtooth pulse voltage is used. To minimize Joule heating it is desirable to use both as short a pulse and as low a repetition rate as possible. As a check on the possibility of thermal effect, it is useful to be able to change the repetition rate easily, since thermal effects can be identified by their dependence on the repetition rate.

These conditions are satisfied in the equipment to be described. It provides a sawtooth-shaped pulse output whose repetition rate is determined by the frequency of the external trigger generator. The trigger frequency may be varied from 50 to about 5,000 cycles per second. This is conveniently accomplished with a Hewlett-Packard model 212A pulse generator.

The length of the output pulse is variable from about 0.2 to 5 microseconds while the pulse amplitude extends over a range of voltage from 0 to about 300 v. Additional d-c bias may also be applied in series with the pulses to extend the voltage range.

Circuit Operation

The circuit is made up of four tetrode thyratron tubes whose operation may be understood by referring to Fig. 1. Tube V_1, triggered externally, produces a standard pulse with a fast rise time and several hundred volts amplitude.

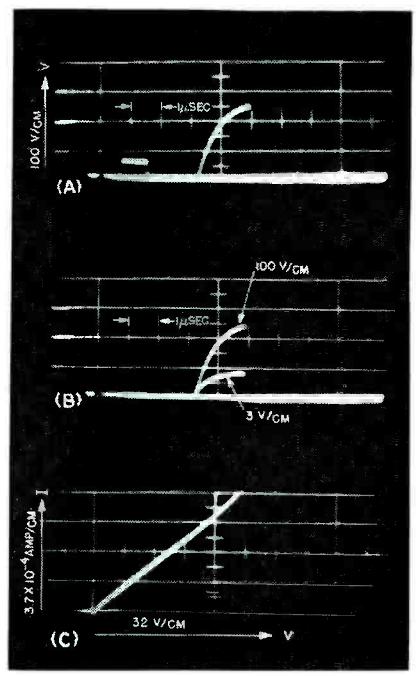

FIG. 2—Example of curves obtained for 100,000-ohm component, with 1,000-ohm resistor in series to give measure of current for vertical plates of scope

SUMMARY — Four-thyratron circuit triggered by external variable-rate pulse generator makes it possible to display complete voltage-current characteristics of a wide range of circuit elements on an oscilloscope screen. Reverse characteristics of germanium diffused junction rectifier are shown as one example of use

Voltage-Current Curves

This standard pulse is fed by parallel paths to the control grids of V_2, V_3 and V_4.

The arrival of the pulse at the control grid of each tube is determined by the delay introduced by an integrating network consisting of a resistance and capacitance in the grid circuit of each tube. The standard pulse, after being delayed by $R_1 - C_1$ where C_1 is the stray circuit capacitance to ground, causes tube V_3 to fire. The cathode of V_3 is thus raised to approximately the plate potential of 510 volts as stored on C_5. This action produces a constant-amplitude pulse on the cathode of V_3 which is fed through the integrating network $R_4 - C_4$ to produce on C_4 a single sawtooth wave which is the output pulse.

The zero time of the output signal is determined by $R_1 - C_1$. After a delay determined by $R_2 - C_2$, V_4 fires, lowering its plate potential, and discharges C_4 to approximately ground potential, thus terminating the output pulse. Variation of R_2 adjusts the lengths of the output pulse.

The standard pulse, also having been fed through integrating network $R_3 - C_3$, then fires V_2 to completely discharges C_5, and resets the thyratron tubes by lowering their plate potentials below the extinction point.

The time delay introduced by $R_3 - C_3$ is approximately 5 microseconds, which limits the maximum length of the output pulse. The amplitude of the output pulse is determined by the value of R_4 which adjusts the time constant of $R_4 - C_4$ and thus controls the voltage rise on C_4.

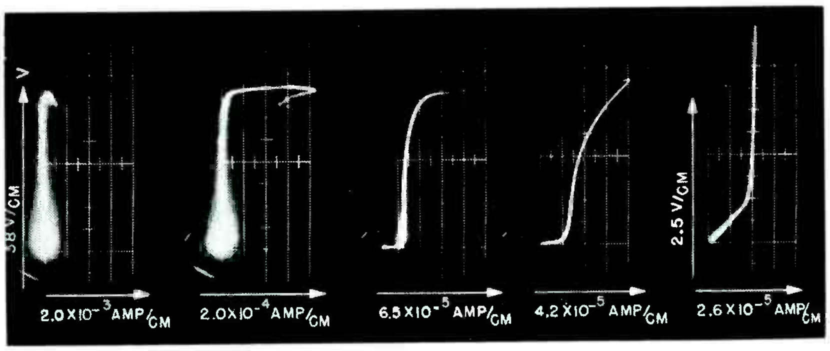

FIG. 3—Example of curves obtained for type 1N92 germanium rectifier when tested with five different values of resistance in series

In the load circuit, if the series resistance is made small compared to the element resistance, then the total voltage across the combination is approximately the voltage on the specimen while the voltage across the series resistance is the measure of the current.

Resistor Curves

When using the sawtooth pulser on a 100,000-ohm test element in series with a resistance of 1,000 ohms, the triggering rectangular input pulse and the resultant approximate sawtooth output are as shown in Fig. 2A. The voltage outputs obtained from the total combination and from the series resistance are shown in Fig. 2B. Figure 2C shows the resultant traces when the voltage and current outputs are applied to the horizontal and vertical axes of the oscilloscope.

Crystal Diode Curves

In Fig. 3 the apparatus was used to obtain the reverse characteristic of a GE 1N92 germanium diffused junction rectifier. By changing the value of the series resistance, it was possible to look at different regions of the curve in detail.

The equipment described here dissipates less power in the test specimen than that previously described by Pankove; series resistance and repetition rate are readily varied, and time or hysteresis effects are essentially eliminated.

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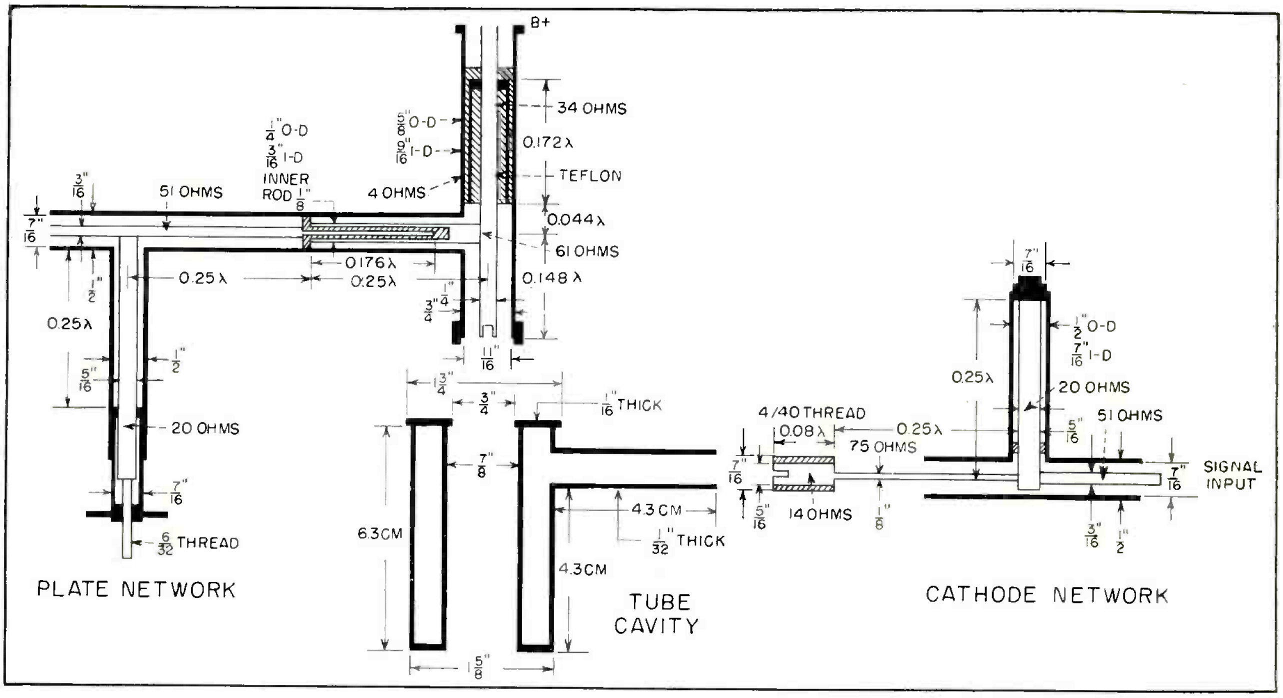

FIG. 1—Details of wide-band amplifier showing plate network, left, tube cavity, center, and cathode network, right

Wide-Band Amplifier

SUMMARY —— Low-noise r-f amplifier for uhf receiving equipment provides a 5 to 10-db gain in the 1,000-mc region, a bandwidth better than 200 mc and 51-ohm input and output impedances. Amplifier uses a 416B planar triode. Detailed design procedure is given

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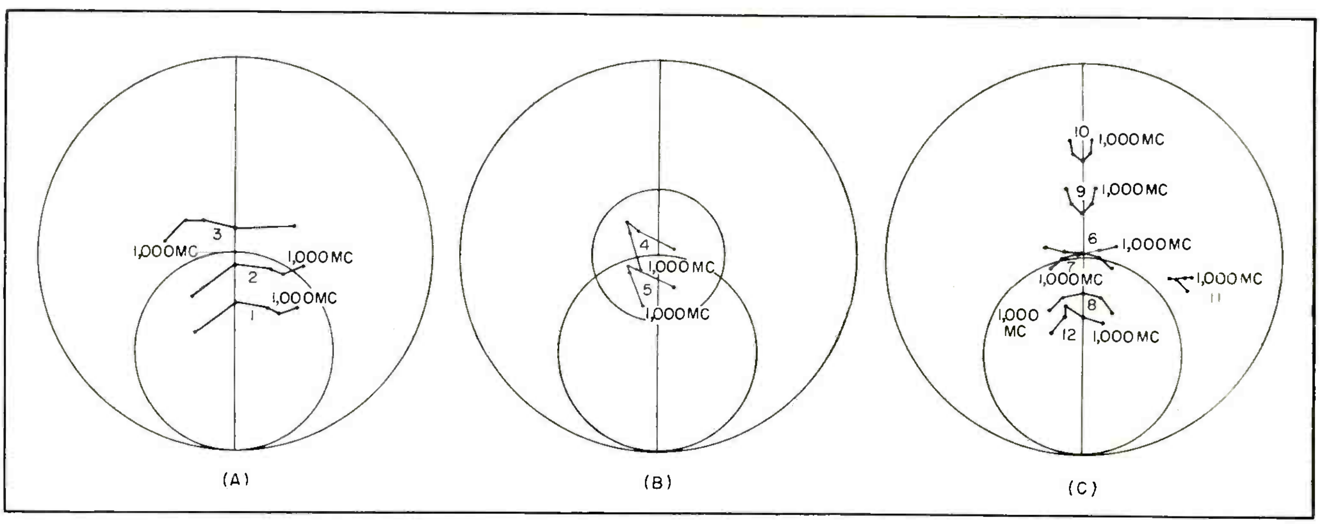
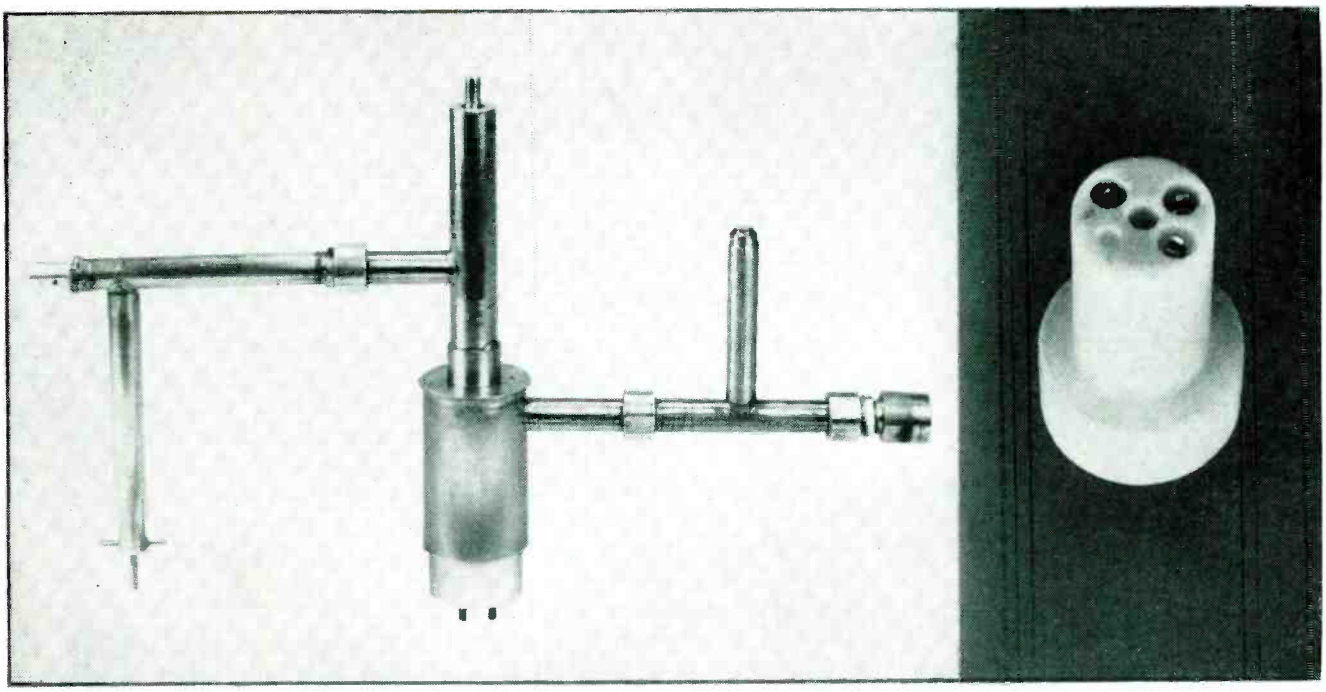


FIG. 2—Smith chart curves showing values of impedance at various points in cathode network (A and B) and in the plate network (C.) Plotting points on curves designate 50-mc steps from 1,000 to 1,200 mc



Wide-band uhf amplifier. Special Teflon tube socket for 416B planar triode is shown at right

for UHF Receivers

In UHF receiving equipment it is often desirable to have a low-noise, wide-band r-f amplifier.

For one particular application it was necessary to have such an amplifier operate in the 1,100-mc region with a bandwidth of 200 mc, a gain of 5 to 10 db and an input and output impedance of 51 ohms.

Several types of tubes were investigated and it was decided that the 416B planar triode would be most suitable.

Perhaps the most outstanding feature of the 416B is its transconductance, 50,000 μmhos for a plate current of 30 milliamperes. This high value of g_m is obtained by using close grid and interelectrode spacing and tight tolerances.

Other characteristics of the 416B are: amplification factor 200, plate resistance 4,000 ohms and plate current 30 ma at 200 volts. One objectionable feature is the heat generated by the tube: about 7 watts from the filament and 6 watts from the plate.

Since it was desired to match the input of the 416B to a 51-ohm signal source, the cathode impedance of the tube under grounded-grid conditions had to be determined. The tube cavity, which provided for measuring the cathode impedance, is shown in Fig. 1, center.

From previous measurements it was known that the cathode had an inductive reactance component. A shunt capacitor with a 14-ohm impedance was inserted in the input line immediately at the cathode shell of the tube. This capacitor served not only to add a capacitive reactance component but also offered a point from which the input network could be designed.

Measurements

Values of cathode impedance were measured with a slotted line between 1,000 and 1,200 mc and are shown by curve 1 of the Smith chart, Fig. 2A. This plot is at 51 ohms since that is the characteristic impedance of the slotted line.

A satisfactory match between the cathode of the 416B and a 51-ohm signal source was obtained using a quarter-wave transformer and a quarter-wave shorted stub in the input network, also shown in Fig. 1 (right).

The quarter-wave transformer was made by transforming the impedance at the input side of the shunt capacitor from 51 ohms to 75 ohms (curve 2, Fig. 2A) and moving one quarter wavelength toward the generator, curve 3. At this point, a quarter-wave shorted stub was shunted across the line causing the arms of the curve to fold inward, curve 4. This result is then transformed back to 51 ohms, curve 5. Moving away from this point along a 51-ohm line revolves the points on the curve about the center of the chart.

From curve 5 it can be seen that the effective load resistance presented by this network varies from 56 ohms to 89 ohms. However there is actually only about an 8-percent change in the power developed across the load resistance.

The circle shown in Fig. 2B represents a voltage standing wave ratio of two. Curve 5 lies within this circle showing that the voltage

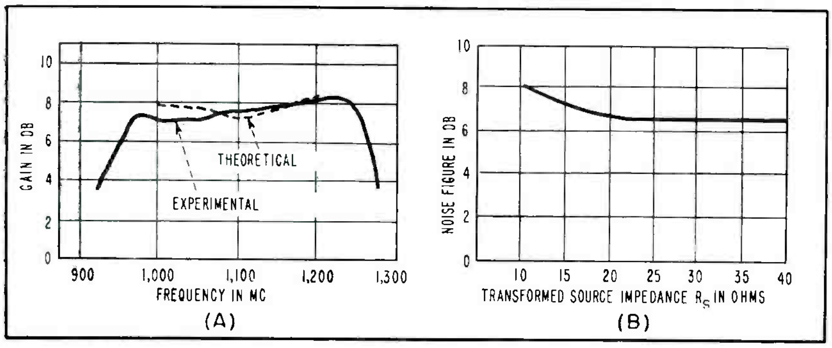


FIG. 3—Gain in db versus frequency (A) and noise figure versus transformed source impedance ($R_s = 1/G_s$)

standing wave ratio of the input network is less than two over the band from 1,000 to 1,200 mc which is adequate.

Output Network

Before the design of the plate network could be started, it was necessary to determine the impedance of the plate of the 416B under operating conditions by using the slotted line for frequencies from 1,000 to 1,200 mc. These values of impedance were found to range from 7.3 $-$ j 104 ohms for 1,000 mc to 0.9 $-$ j 79 ohms for 1,200 mc.

After the values of plate impedance had been determined, a network was designed which would match the tube to a 51-ohm load and keep the value of equivalent series resistance presented to the plate of the 416B reasonably constant. This network consisted of a quarter-wave shunt stub, a quarter-wave series capacitor, and a quarter-wave choke as shown at the left in Fig. 1.

The graphical representation of the operation of the network can be seen on the Smith chart, Fig. 2C. Starting from the 51-ohm load and moving any distance along a 51-ohm line has no effect on the impedance at any frequency. Therefore, the impedance at the shunt stub is a pure resistance of 51 ohms. This can be represented by a point at the center of the chart $1 + j0$.

At the point where the shorted stub joins the line, a shunt reactance is injected which spreads the points out from the center of the chart, curve 6. Moving from this point toward the generator along the 51-ohm line a distance equal to one quarter wavelength at 1,100 mc rotates the curve half way around the chart and tends to fold the arms of the curve in slightly, curve 7. Also at this point there is a series capacitor. The impedance of this capacitor has little effect upon the overall impedance and can therefore be neglected.

The values of impedance are next transformed from 51 ohms to 33.5 ohms, curve 8, which is the impedance of the outside shell of the series capacitor. Moving along the 33.5-ohm line one quarter wavelength rotates the curve another 180 deg around the chart causing the arms to fold in somewhat more, curve 9.

Connection to Tube

At this point the 33.5-ohm line joins the 61-ohm section of line which attaches to the tube. There is also a quarter-wave choke on this line which is placed such that it reflects an open circuit at the point where the 33.5-ohm and the 61-ohm lines join. This makes it possible to apply B+ to the 416B plate without allowing any signal to travel into the power supply.

Moving from the junction of the 33.5-ohm and 61-ohm line, curve 10, down to the tube a distance of 4.04 cm, moves the points on the chart about 0.150 λ toward the generator, curve 11. These values of impedance are then added in parallel with the impedances presented by the plate of the 416B to obtain the total impedance, curve 12.

In curve 12 (Fig. 2) the values of equivalent series resistance presented to the plate vary between 104 and 131 ohms. The average value for the five frequencies is about 120 ohms. The variation from 120 ohms is about ± 10 percent and satisfactory.

To supply filament voltage and cathode bias to the 416B, it was necessary to construct the special tube socket shown in the photograph. Since there is a considerable amount of heat dissipated by the filament, Teflon was chosen as the socket material.

To block any r-f on the filament or cathode leads, quarter-wave chokes were constructed using polystyrene and pressed into holes drilled in the Teflon plug. These chokes have spring clips attached to one end which will engage the pins on the base of the tube when the Teflon plug is inserted into the base of the tube cavity.

Experimental Results

The response of the amplifier was determined experimentally using an input signal between 925 and 1,275 mc from a 51-ohm signal generator and a 51-ohm bolometer load on the output.

For an input of 1 mw, the output averaged about 5.7 mw over the band between 1,000 and 1,200 mc. This average is in close agreement with the calculated average of 6 mw.

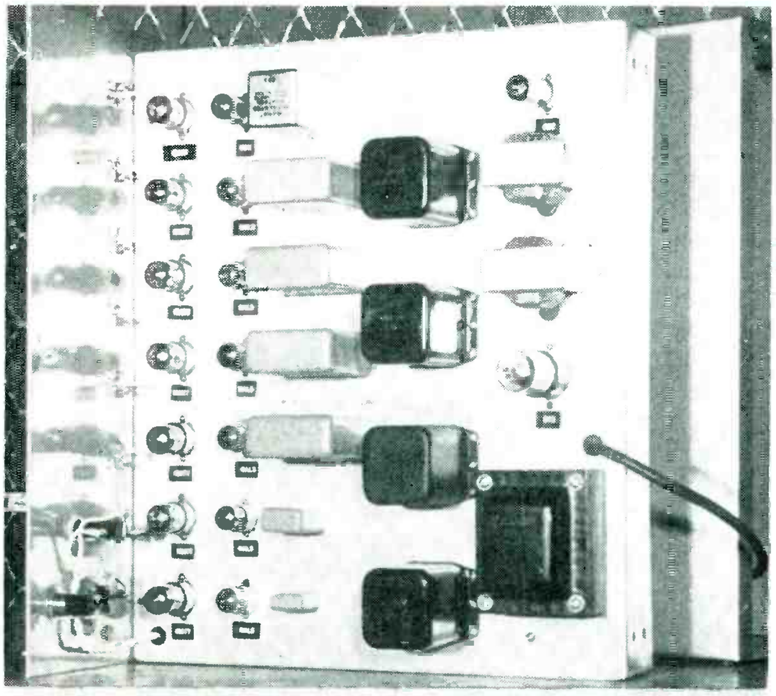
The overall response was flat within ± 0.6 db as compared with the theoretical value of ± 0.5 db. It can be seen from the graphical representation shown in Fig. 3A that the 3-db bandwidth is over 300 mc.

The noise figure of the first model wide-band amplifier, constructed from brass rod and tubing, was measured using a fluorescent tube noise source which had an output of 16.4 db above KTB. The resulting value of noise figure was 11.9 db.

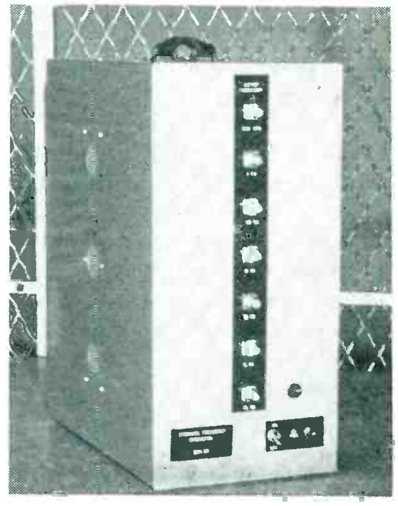
A second model was constructed which was a duplicate of the first except that all of the brass parts were plated with 0.001 inch of silver. The noise figure of this unit was 10.0 db, or an improvement of about 2 db over the brass model.

Although the noise figure of the silver-plated model is 2 to 3 db above theoretical, it is still satisfactory since the theoretical noise figure is difficult to realize at this frequency.

A view of the completed amplifier is shown in the photograph.



Top view of chassis showing physical layout of components



Complete generator showing outputs

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Audio-Standard Generator

SUMMARY — Simultaneous output voltages are available at frequencies of 500 cps, 1, 1.5, 2, 3, 5 and 10 kc from unit employing tuning-fork standard. Technique involves full-wave rectifiers as doublers to achieve desired frequencies

CALIBRATION of sensitive test equipment often requires an accurate source of audio frequencies.

For example, the pulse-repetition frequency of pulsed-magnetron test sets must frequently be calibrated by means of a high-quality audio generator.

When a wide range of harmonically related frequencies is desired, a crystal-controlled oscillator utilizing multivibrator-type dividers is often used to furnish an output at submultiples of the crystal frequency.

This article describes a less complex and less expensive experimental unit which features tuning-fork frequency control, relatively simple circuitry, reliability and elimination of the need for adjustments. Seven triode sections are used as cathode-follower output stages and all frequency multiplication is accomplished by diode doublers.

Frequency Control

The tuning fork is a frequency standard comparable in stability and accuracy to the quartz crystal.[1, 2] Mechanically resonant reeds may also be used for frequency control with a slight sacrifice in accuracy. These mechanically vibrating elements are useful as the frequency-determining portion of an electron-tube oscillator such as that used in the standard audio-frequency generator described in this paper.

Oscillator-frequency control elements of the resonant-reed and tuning-fork types are readily available for any frequency in the lower audio range. The accuracy of commercial units ranges from 0.1 to

0.001 percent; higher values of accuracy are available on special units, depending on the characteristics desired.

The tuning-fork or resonant-reed controlled oscillators are electrically equivalent to the Meissner r-f oscillator.[3] This is shown in Fig. 1. The frequency of the r-f oscillator is determined primarily by the circuit within the dotted lines, which is composed of L_1, L_2, L_3 and C_1.

This circuit may be considered as a transformer whose primary and secondary, L_1 and L_2, are coupled through a high-Q resonant circuit composed of C_1 and L_3. If there is little coupling from L_3 to L_1 and L_2, the frequency of oscillation is approximately equal to $1/2\pi\sqrt{L_3C_1}$ and is substantially independent of external circuit parameters. Examples of these are tube capacitance or plate voltage.

Operation

In the tuning-fork oscillator, however, the transformer is physically quite different, although electrically equivalent. The primary and secondary are separated and not mutually coupled. One leg of a tuning fork made of magnetic material forms the core material of each coil.

Plate-current disturbances of any kind, such as those which occur when voltage is applied, have two simultaneous effects: the tuning fork is set in motion; and a magnetic flux is induced in it by the coil whose core it forms. Because a well-made tuning fork is mechanically equivalent to a high-Q resonant circuit, it vibrates only at its resonant frequency when shock excited. The loaded Q of a tuning fork can easily be made greater than 10,000.

When the tuning fork is excited, both legs exhibit some movement. The motion of the leg used as the core of the grid winding induces a voltage in the coil L_2. The circuit will then oscillate, provided the polarity of the grid voltage is such that it reinforces the plate signal and the tube supplies enough gain to offset circuit and mechanical losses.

Because feedback can occur only when the tuning fork is vibrating, the accuracy and stability of the oscillator depend directly upon the mechanical properties of the vibrating element.

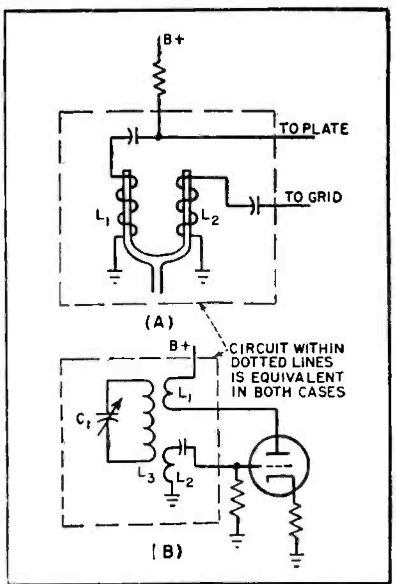

FIG. 1—Schematic diagram of tuning-fork-controlled oscillator (A) and Meissner r-f oscillator (B)

Circuit

A complete schematic of the standard-frequency generator is shown in Fig. 2. Triode V_1 is the tuning-fork-controlled master oscillator from which all output frequencies are derived. A small amount of negative feedback, provided by resistor R_1, limits the gain of the oscillator tube. Thereby the tuning fork is prevented from being overdriven and the purity of the waveform is improved to an appreciable extent.

The oscillator operates at a frequency of 500 cycles per second. This frequency was arbitrarily chosen because lower frequencies can be calibrated against the power-line frequency by Lissajous figures[4] observed on an oscilloscope. This technique may also be used to extend the usefulness of the standard-frequency generator down to 100 cycles or up to a frequency of 100 kilocycles.

Multiples of the base frequency are obtained by principles which are commonly known but not often applied to this particular application. The first four terms of the Fourier expansion of the full-wave rectification of a sine wave will result in the following expression

$$e = \frac{2E_m}{\pi} - \frac{4E_m}{3\pi}\cos 2\omega t - \frac{4E_m}{15\pi}\cos 4\omega t - \frac{4E_m}{35\pi}\cos 6\omega t$$

This expansion includes a second harmonic equal to $4/3\pi$ times the peak voltage applied. The presence of this second harmonic may be used to provide multiples of the oscillator frequency.

One half of twin triode V_2 is a cathode follower providing a low-impedance output at the fundamental frequency; the other half is an amplifier. The plate load of the amplifier consists of a transformer in which a center-tapped secondary provides a phase difference of 180 degrees between the voltages at the two ends with respect to ground.

Rectification

Diode V_3 is a full-wave rectifier. The original sine wave is thus converted to the familiar output waveform of a full-wave rectifier having a resistive load which is rich in harmonic content. The high-Q parallel-tuned circuit included in the diode load eliminates all harmonics except the second. The unloaded Q of the inductors used in this circuit ranges from 120 to 200.

An isolating resistor in series with the tuned circuit maintains a high loaded Q by minimizing d-c through the inductor and equalizes the amplitude of all frequency generator outputs.

The filtered second-harmonic voltage is then fed into a second twin triode, V_4. One triode amplifies the second harmonic in preparation for the next diode frequency doubler; the other triode provides another low-impedance cathode-follower output stage.

Frequency doubling provides only frequencies which are $(2)^n$ times the oscillator frequency, where n is an integer. Often, however, frequencies such as 3, 6 or 10 times the fundamental frequency are required. Two methods of achieving such frequencies were considered. The sine wave could be shaped to a form, such as a square wave, containing odd harmonics and then filtered.

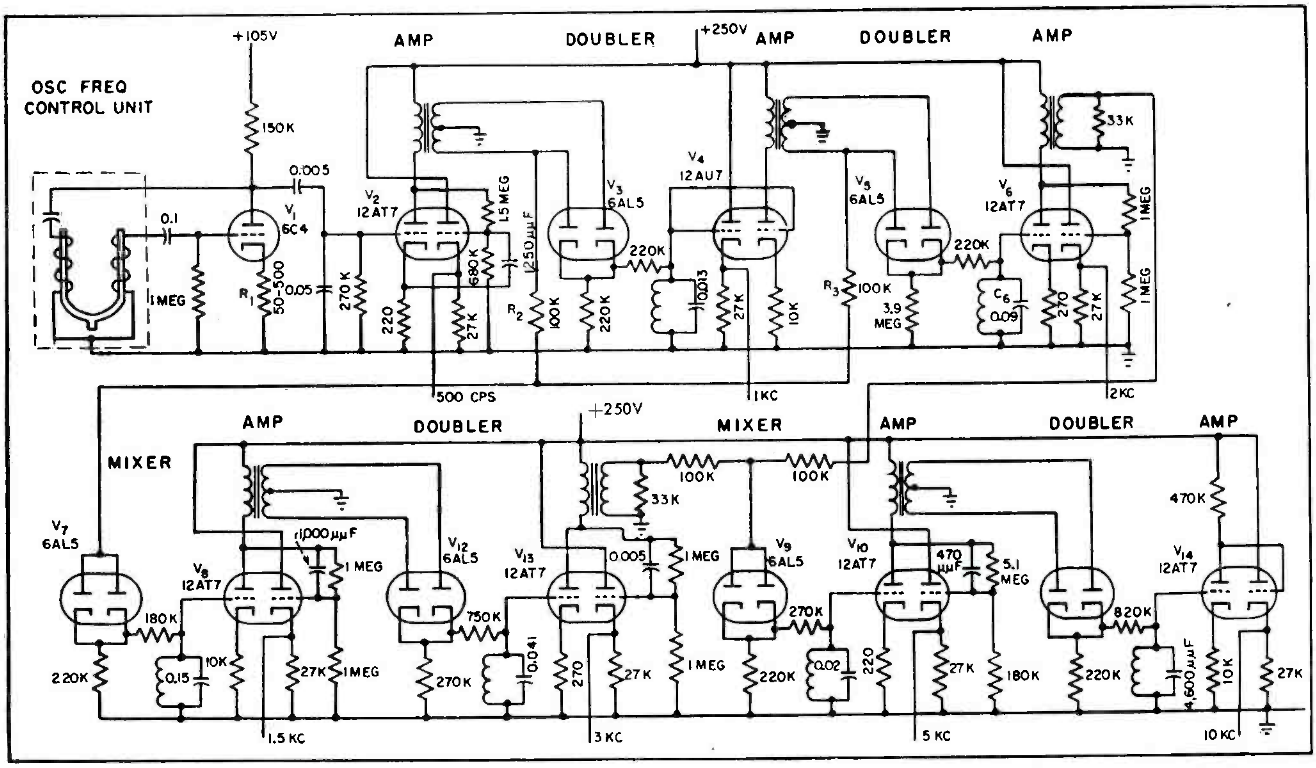

FIG. 2—Schematic of audio-frequency generator employing tuning-fork-controlled master oscillator. Diode frequency multipliers are used to obtain frequency doubling

Alternately, two of the available frequencies could be added and then rectified to provide either their difference or sum and associated harmonics.

Diode Doubler

The second method was used because it required only a single tube, a diode. Two mixing stages are incorporated which furnish output at 1,500 and 5,000 cycles. Each of these stages combines two frequencies whose sum or difference is desired and the resultant voltage is then rectified. If the two voltages are represented by $E_1 \sin \omega_1 t$ and $E_2 \sin \omega_2 t$, the Fourier expansion of the rectified output contains the two terms $k\, E_1\, E_2 \sin (\omega_1 + \omega_2) t$ and $k\, E_1\, E_2 \sin (\omega_1 - \omega_2)\, t$ where k is a mathematical constant of proportionality.

The rectifier output will contain voltage components whose frequencies are equal to the sum and the difference of the two original frequencies. The particular component desired may then be selected by a suitable tuned circuit similar to that previously described in this article.

The 500-cycle and 1,000-cycle voltages, obtained from V_2 and V_4, respectively, are combined through resistors R_2 and R_3 and applied to the diode mixer V_7. The 1,500-cycle component is selected from the mixer output by a tuned circuit and amplified by V_8, fed through diode doubler, V_{12} to furnish a 3,000-cycle output.

A second diode mixer, V_9, provides a 5,000-cycle output by combining the 3,000-cycle and 2,000-cycle voltages. The 5,000-cycle voltage is then amplified by one half of V_{10} and rectified by the final diode frequency multiplier to provide an output frequency of 10 kilocycles. The number and choice of output frequencies is determined by the particular requirements of the application and not limited to those shown here.

Advantages

Reliability is inherent in this experimental standard-frequency generator because all tubes are operated conservatively and use of capacitors has been held to a minimum. Because there are no multivibrators nor oscillating circuits other than the master oscillator, output is limited to the frequencies designed into this piece of equipment.

Power-supply requirements are simplified because variations in supply voltage affect only the oscillator circuit. An OB2 voltage-regulator tube of the glow-discharge type provides adequate regulation of oscillator plate voltage for practically all purposes. Total power-supply drain is approximately 60 milliamperes.

All output voltages are available simultaneously at 500 cycles, 1, 1.5, 2, 3, 5 and 10 kilocycles. Peak-to-peak amplitude of all outputs is 20 volts. No perceptible drift has been observed at any time during long periods of continuous operation of this equipment.

The author expresses his appreciation to D. Mawhinney who constructed the unit and simplified many of the difficulties prior to the completed design.

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Expanded-Scale Voltmeter

SUMMARY — Instrument shows rms voltage with 0.25-percent accuracy over range of 100 to 500 volts. Hot-wire thermal bridge provides highly stable voltage standard, which is relatively independent of frequency from 50 to 2,000 cycles per second

MANY applications in electronic engineering require an indicating instrument that will accurately measure high voltages.

To meet this need, an expanded-scale voltmeter has been developed which permits the indication of a narrow voltage range over the complete indicating-meter scale.

In the laboratory-model instrument, a tapped input transformer permits this voltage range to be placed conveniently, so that in actual use the applied voltage is equal to the sum of the readings of two knobs plus the reading of the meter. In the panel-mounted voltmeters, this adjustable feature is eliminated and the scale is expanded about the nominal voltage.

Accuracies of 0.25 percent over a frequency range of 50 to 2,000 cycles are achieved in the laboratory-model voltmeter and accuracies of 0.5 percent over the same frequency range are achieved in the panel meter. Sensitivities as high as 0.3 inch per volt are obtainable.

Principle of Operation

A thermal bridge is used as the voltage standard in both models of the expanded-scale voltmeters. By exploiting the nonlinear properties of a hot wire, a highly stable voltage standard has been developed. This element is used in a bridge circuit with wire-wound resistors to give a system whose output is shown in Fig. 1. The output voltage goes through a null at an input of E_s. For small deviations from E_s, the output voltage is proportional to $(E_m - E_s)$. Since the nonlinearity is produced by heating of the wire, the indication is rms and relatively independent of the frequency.

High-frequency limitations imposed are those of wire-wound resistors and low-frequency limitations result from distortions caused by nonlinearity during a cycle of the input frequency. These impose limits of about 20 to 100,000 cps on the voltage standard. Accuracy of 0.1 percent can be obtained.

The temperature coefficient of the bridge is very small because of the high operating temperature of the wire in the nonlinear element, since a change in ambient produces only a small percentage in the wire's temperature rise. This small coefficient is compensated for by using a temperature-sensitive resistor in one branch of the bridge. The high operating temperature of the nonlinear element also produces rapid response to voltage changes.

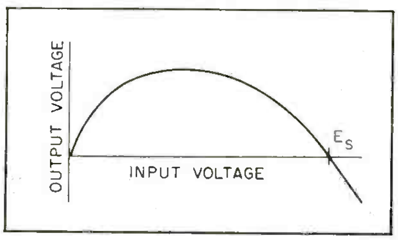


FIG. 1—Characteristic of hot-wire thermal bridge used as voltage standard

Laboratory Model

The circuit of the laboratory model of the expanded-scale voltmeter is shown in Fig. 2. The nonlinear voltage standard is driven from a precision tapped transformer which permits measuring a wide range of input voltages. The taps are arranged in decades with 10-volt steps from 100 to 390 volts on the input, providing exact input ratios to the voltage standard. An accurately center-tapped secondary

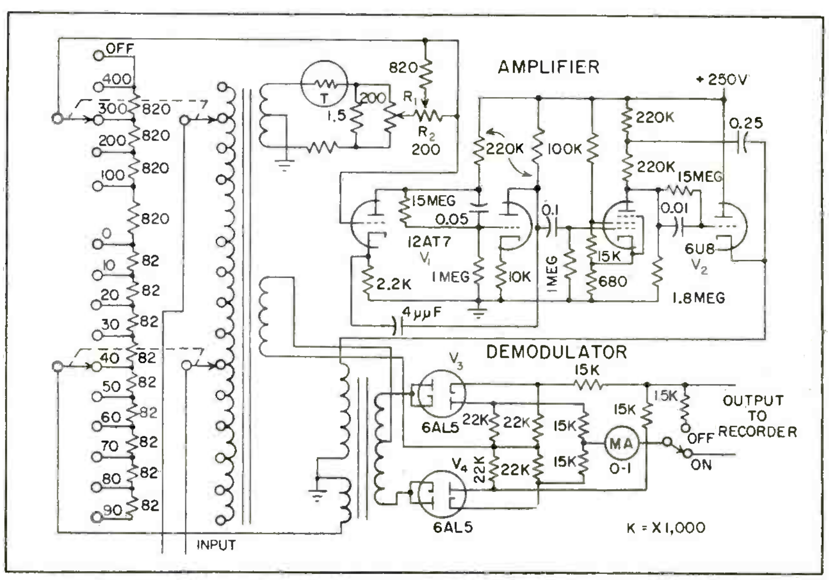
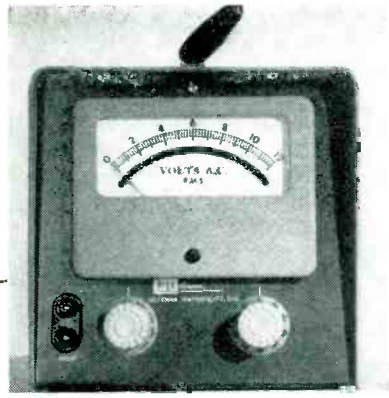


FIG. 2—Laboratory-model expanded-scale voltmeter has provision for operating 1-milliampere external recorder

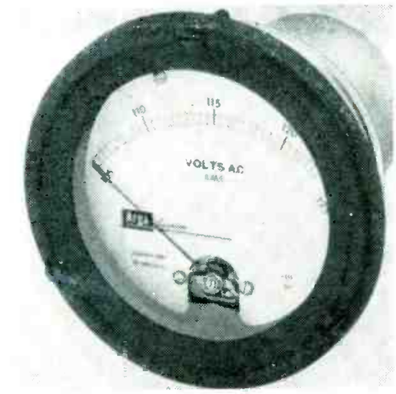
for A-C Measurements

By HERBERT GALMAN

Chief Development Engineer
Arga Division, Beckman Instruments, Inc.
South Pasadena, California



Expanded-scale voltmeter is read by adding dial settings to meter reading



Panel-model meter has circuitry in can attached to meter housing

on the transformer permits eliminating two resistors in the bridge to give a half-bridge voltage standard. The transformer has 0.1-percent accuracy from 50 to 5,000 cps.

The transformer-voltage standard combination produces an output proportional to $(N_s/N_p)(E_m - E_s)$ where N_s/N_p is the ratio of the transformer's secondary voltage to its primary. By multiplying this output by N_p/N_s, a voltage proportional to $[E_m - (N_p/N_s)\,E_s]$ is obtained. Since N_p/N_s was chosen to be decade voltages from 100 to 490 volts in 10-volt steps, a method of accurately subtracting these voltages from the input voltage is obtained. This subtraction is rms.

The amplifier, consisting of V_1 and V_2, multiplies the voltage standard's output by N_s/N_p through changing the feedback resistors with changes in the transformer taps. Negative feedback makes the gain very accurately proportional to the feedback resistors. The feedback reduces the gain by more than 100, giving almost complete freedom from change of gain due to variations in tubes and associated components.

The amplifier's output transformer drives V_3 and V_4— a balanced, full-wave, phase-sensitive demodulator. This demodulator produces an output of one milliampere to drive a panel meter. In addition, terminals permit operation of a 1-milliampere recorder. The high output resistance of 30,000 ohms produces optimum response from the recorder.

Because of the balanced operation and the high output voltage of the demodulator, negligible zero drift is encountered in this stage making a zero adjustment unnecessary.

Potentiometer R_1 adjusts E_s and is set by applying an input of 100 volts to the instrument from an accurate standard and setting the decade knobs to 100. The potentiometer is then adjusted to bring the panel meter to zero. Potentiometer R_2 sets the full-scale reading of the panel meter and is adjusted by applying 110 volts and making the panel meter read 10.

Table I—Typical Voltage Errors

Harmonic Content	RMS Voltmeter Reading					
	100	104	108	400	404	408
10% 2nd	0	0	0	0	0	0
10% 3rd	0	0.15	0.30	0	0.15	0.30
10% 4th	0	0	0	0	0	0
10% 5th	0	0.10	0.20	0	0.10	0.20
10% 7th	0	0.06	0.12	0	0.06	0.12

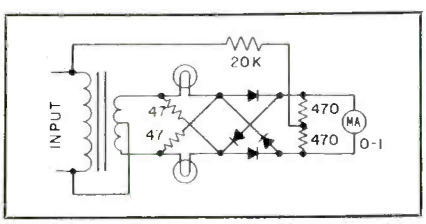


FIG. 3—Panel-type expanded-scale voltmeter for specific voltage ranges

Waveform Correction

The demodulator reads the average value of the voltage applied to it. This results in a waveform error. Since this error is only in the difference output of the voltage standard, the resulting error is usually negligible.

Typical errors are given in Table I, which gives the error in volts. This table shows that no waveform error exists at the 0-volt end of the panel-meter scale. Maximum error occurs at the 10-volt end of the scale. For a given harmonic content, the maximum error in volts is independent of the voltage range used. For normally encountered waveforms, with less than 10-percent distortion, only small errors will result.

To operate the voltmeter the hundreds and tens knobs are turned to bring the meter needle on scale and the setting of the knobs are added to the meter reading. For example, 200 + 30 + 3.7 = 233.7 volts. The meter has a full scale reading of 12 volts, giving a 2-volt overlap and eliminating the necessity of switching back and forth when the voltage is close to the end of the scale.

Panel-Mounting Meter

The panel-model of the expanded-scale voltmeter, Fig. 3, has one range. The network containing the voltage standard and demodulator are packaged in a hermetically sealed can attached directly to the meter itself.

In this version of the voltmeter the thermal bridge is operated at a voltage of 6 or 12 volts. A transformer is used to step down the input voltage to the proper voltage for bridge operation.

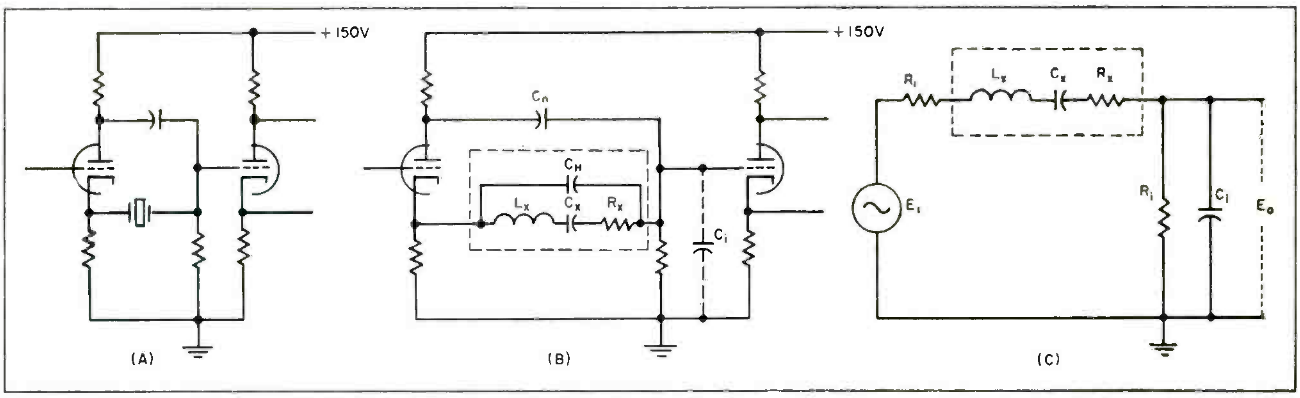


FIG. 1—Crystal filter circuits showing basic staggered element (A), with its equivalent circuit (B) and a further simplification (C)

Staggered Triple

SUMMARY —— Narrow-band filter with extremely sharp skirts is provided by piezoelectric crystals in stagger-tuned system. Circuit functions from 400 kc to 5 mc by suitable choice of crystals

By D. E. HILDRETH

Electronic Products Corporation
Santa Barbara, California

RECENT DEVELOPMENTS found in mechanical filters and the more familiar lattice systems seem to cover sharp filter applications quite well. However, the need occasionally arises for a filter outside of the frequency range of the mechanical filters or more simple in terms of component requirements and adjustments than lattice systems. Results with the staggered crystal filter shown here have been promising.

Unit Function

Basically, a staggered element in this system contains a phase inverter, to facilitate neutralization of crystal holder capacitance, a crystal and an isolation stage which may be a cathode follower or an amplifier. Maximum energy is transferred to the isolation stage at the series-resonant mode of the crystal. Circuit Q can be altered by the addition of resistance in series with the crystal-neutralizing circuit and the input of the isolation stage of this system.

Design criteria for the use of staggered elements is well covered in the literature.[1] Design criteria usually given is to enable the design of a system with maximal flatness. Higher Q's than those dictated by design criteria can be used where peak-to-valley ratios on the order of 3 to 6 db can be tolerated. The allowance of a peak-to-valley ratio is usually more than compensated for in terms of a superior skirt-shape factor.

A basic element is shown in Fig. 1A and its equivalent circuit is shown in Fig. 1B. It is further simplified in Fig. 1C.

If Fig. 1C is used to evaluate an indication of stage gain at resonance and R_i is made much larger than X_{ci}, the approximate equation for stage gain is the following

$$\text{Gain} = \frac{E_o}{E_1} = \frac{IX_{ci}}{E_1} = \frac{X_{ci}}{R_1 + R_x}$$

A typical apparent voltage gain for a crystal circuit at 400 kc assuming C_i to be 5 $\mu\mu$f and total R to be 5,000 ohms would be 80,000/5,000 = 16.

System Results

The circuit shown in Fig. 2 is the prototype which was built to be used with 400-kc crystals. The curve shown in Fig. 3 indicates frequency response which was present with a voltage gain of 20.

Figure 4 indicates results when crystals at 1.599, 1.600 and 1.601 mc were used. Inherently, this system is most practical where overall system Q's are on the order of 2,000 to 20,000. Where lower system Q's are required, staggered systems employing Q multipliers or normal

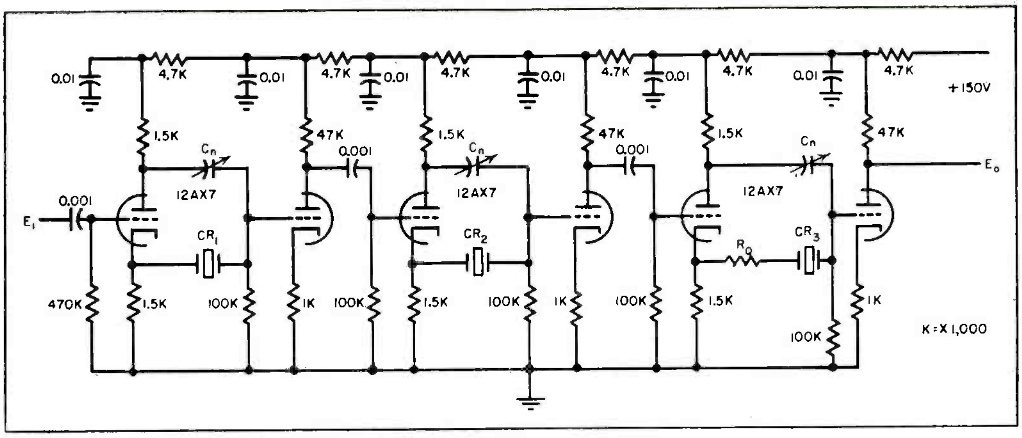


FIG. 2—Circuit diagram of prototype model of staggered triple crystal filter using 400-kc crystals

Crystal Filter

resonant circuits may be used to advantage.

Since resistance (R_Q in Fig. 2) must be added in series with a series resonant circuit to reduce Q, the circuits shown would result in signal attenuation rather than gain if crystals were to be used for low-Q elements. This may easily be determined by referring to the gain equation where the Q-reducing resistance would appear in the denominator of this expression.

Where skirt-rejection requirements are not too severe, a single staggered pair may be used or a single crystal circuit where a sharp peak is desired.

Applications of this type of filter system seem to be large. It may readily be adaptable in the elimination of the double-heterodyne process in some high-frequency receiver applications where a high degree of both image rejection and selectivity are required. The size of such equipment could immediately be reduced and less shielding would be required to reduce the multiple beats present when more than one local oscillator is used in a receiver system.

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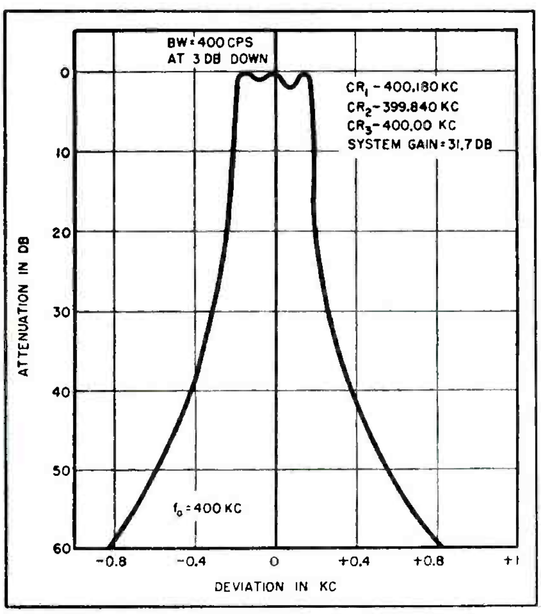


FIG. 3—Frequency response of filter circuit using 400-kc crystals with a voltage gain of 20

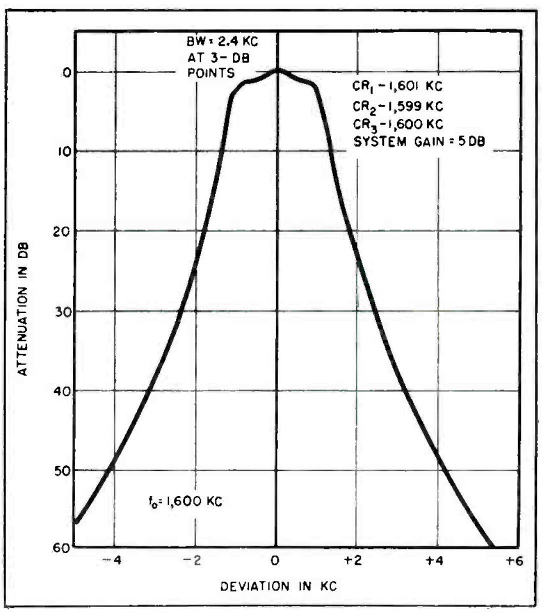


FIG. 4—Curve shows frequency response with a center frequency of 1,600 kc

VHF Transmission Line Calculator

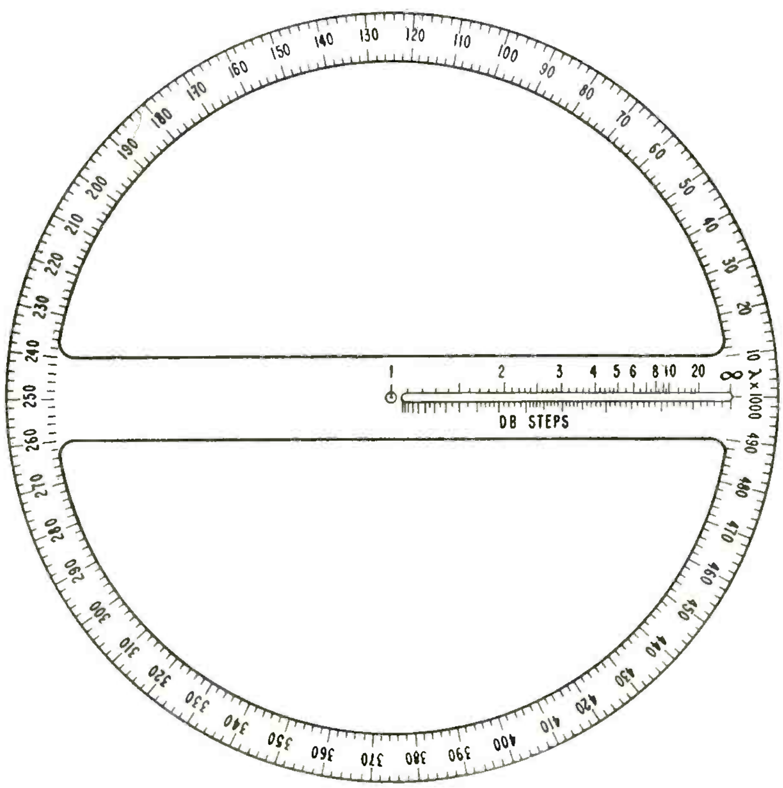
By A. E. SANDERSON *Aircraft Radio Corporation Boonton, New Jersey*

SUMMARY — Phase shift and attenuation introduced by transmission line connecting unknown impedance and measuring equipment can be quickly corrected by use of simplified calculator dial together with Smith or Z-Θ chart. Dial is also useful in design of filters, antennas and matching networks

CORRECTION of vhf impedance measurements for phase shift and attenuation introduced by the transmisson line connecting an unknown impedance with measuring apparatus can be made with the calculator shown here.

It is used in conjunction with either a Smith chart or Z-θ chart. With this device corrected measurements may be plotted directly on the Smith chart without the necessity of reading values from a separate calculator and transcribing them. Scales not necessary for transmission line corrections are omitted for simplicity on the chart below.

An impedance curve plotted on these charts is valuable in the design of vhf filters, matching networks and antennas. Such a curve will tell not only how good the network may be in terms of vswr, but with proper interpretation, will tell exactly what steps should be taken to perfect the design of the network.



Calculator Design

The transmission line calculator consists of a clear plastic disk about 8 inches in diameter with printed scales. Two D-shaped sections and a radial slot are cut out of the disk to allow marks to be made directly on the graph paper as the measurements are taken. A small hole is located at the center for a thumbtack pivot.

A scale around the outer perimeter of the calculator is marked off in units of 1/1,000 wavelength. The scale goes from 0 to 500, since 1 revolution of the calculator corresponds to the phase-shift correction for a section of line $\frac{1}{2}\lambda$ in length. A scale along the upper edge of the radial slot from the center to the outer edge of the calculator is marked off in vswr from 1 at the center to ∞ at the outer edge. This scale is nonlinear, but may easily be calculated from the re-

(Continued on page 170)

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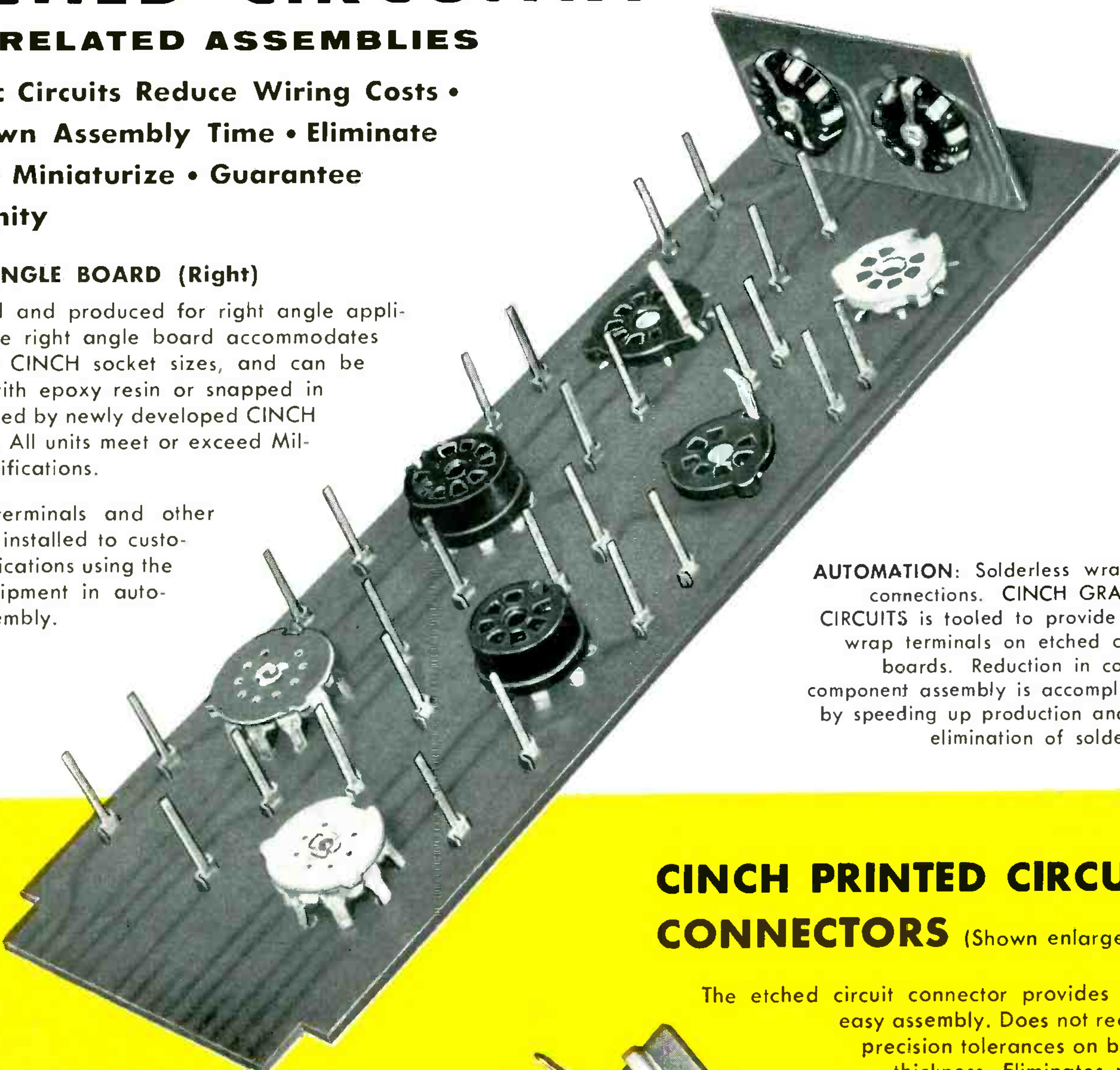

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(Continued from page 168)

lation vswr = $(1 + \Gamma)/(1 - \Gamma)$ where Γ is a linear function, being 0 at the center and 1 at the outer edge. This scale allows impedance points to be interpreted directly in terms of vswr.

A third scale extends along the lower side of the radial slot from the center to the outer edge of the calculator. This scale is marked off in db steps, starting from the outer edge as reference. Each db step represents the radial movement of a point by a given percentage of its distance from the center. Since this motion can be either toward or away from the center, no numbers appear on the scale. Lines marking 1-db steps are longer than the intermediate lines. This scale allows corrections to be made for the effect of line attenuation.

To determine proper line corrections as a function of frequency for the length of line used between the measuring equipment and an unknown impedance, the line is first terminated in a known or calibrating impedance. This may conveniently be a short circuit. The input impedance of the line is then measured at one frequency and the point is plotted on the Smith chart. The calculator is placed over the Smith chart and rotated until the slot is aligned with the point. Assuming a short-circuit termination, the phase correction for the line is read on the outer scale of the calculator at zero ohms on the Smith chart. The attenuation correction is the number of db steps between the measured input impedance point and the outer end of the scale.

This process is repeated for each frequency at which measurements are to be made and the phase and attenuation corrections recorded. The line input impedance can then be transformed to corresponding terminating impedances and plotted directly on the Smith chart.

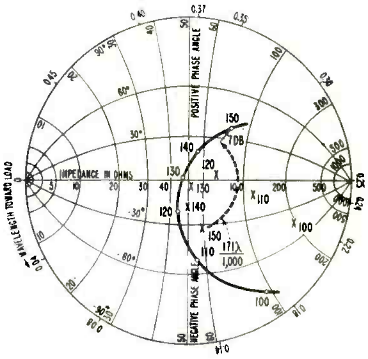

FIG. 1—Solution of transmission line problem. Input impedance of transmission line is indicated by crosses and impedance of antenna by circles

To do this, the short-circuit is replaced by the unknown impedance and the input impedance of the line is measured at one of the chosen frequencies. The slot of the calculator is then positioned over the point representing this measured impedance. Moving outward along the slot from this point by the tabulated db step correction gives the vswr of the unknown terminating impedance. The calculator is then rotated counterclockwise by the tabulated phase correction and the chart is marked through the slot opposite the vswr previously established. The impedance represented by this point is the terminating impedance.

With lines that are several wavelengths long, some precautions should be observed. Frequencies of measurement must be accurately determined, preferably with a crystal calibrator, because a small frequency error will result in a large error in the phase-shift correction.

Table I—Line Corrections for 133-mc Antenna

Frequency in Mc	Phase Correction $\frac{\lambda}{1,000}$	Attenuation Correction in Db Steps
100	455	0.7
110	398	0.7
120	341	0.7
130	285	0.7
140	228	0.7
150	171	0.7

Attenuation correction may become large and should therefore be determined quite accurately. For best accuracy, the calibrating impedance should have a vswr fairly close to that of the unknown impedance since the attenuation of the line is a function of vswr and will be greater for large vswr. If such a calibrating impedance is used, the line corrections must be determined by a method analogous to that described above for a short-circuit termination.

Example

As an example, consider the determination of the input impedance and resonant frequency as seen at the terminals of an experimental antenna unit mounted on a finite ground plane. The desired resonant frequency is 133 mc. The line used to feed this antenna has a characteristic impedance of 50 ohms.

Figure 1 illustrates measured data on such an antenna, plotted with the calculator. The antenna was replaced by a short-circuit and input impedance of the shorted line was measured at 100, 110, 120, 130, 140 and 150 mc. A table of line corrections was then made up (see Table I). The antenna was put back on the line, the new input impedances were measured, corrections applied and a corresponding series of five points were obtained. A smooth curve connecting these points intersects the axis of pure resistance at 46 ohms. The frequency at which this occurs is 129 mc. When the antenna was shortened to become a pure resistance at 133 mc, the vswr was 1.08.

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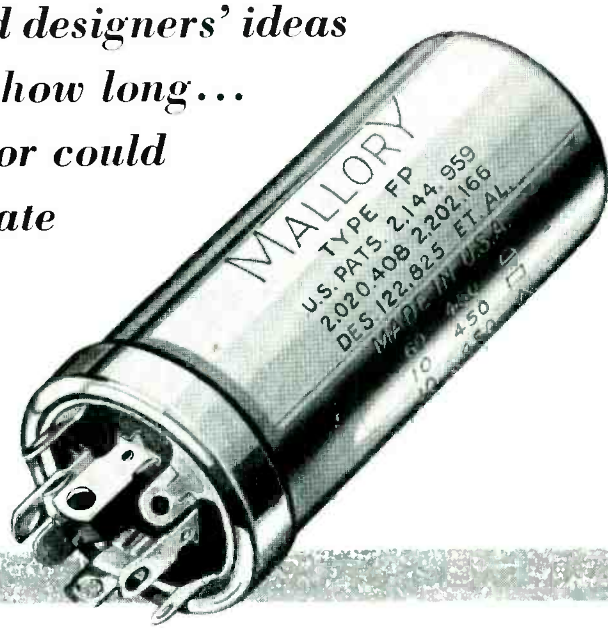

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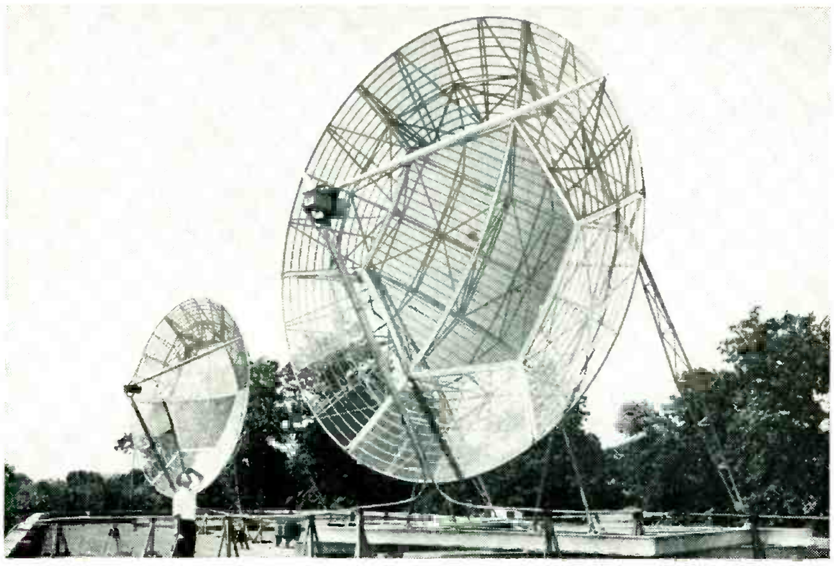
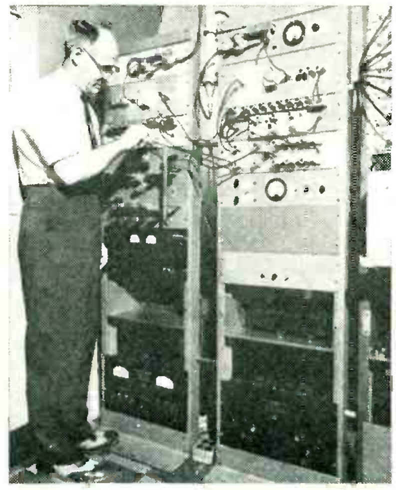
Electrons At Work

Edited by ALEXANDER A. McKENZIE

Over-Horizon Radio To Link Islands



Pair of 28-foot paraboloidal diversity antennas at Nutley, N. J.



Technician adjusts frequency division multiplex f-m receiver at Nutley terminal of tropospheric 91-mile 900-mc circuit to Southampton, N. Y.

PROPAGATION over distances in the order of 200 miles using uhf has recently proved feasible when appreciable transmitting power and diversity reception are suitably employed.

Tropospheric beyond-horizon circuits are to be installed between Florida and Cuba in a joint endeavor of American Telephone and Telegraph Co. and International Telephone and Telegraph Corp.

In addition, Radio Corp. of Porto Rico, IT&T subsidiary has recently filed application with FCC for the development of a radio link between San Juan, Puerto Rico and Ciudad Trujillo, Dominican Republic. The new link will be necessary to meet increasing traffic demands. Propagation tests will probably start in late 1955.

Experimental work in progress at Federal Telecommunication Labs (IT&T subsidiary) includes a 91-mile, 900-mc multiplex circuit between Nutley, N. J. and Southampton, L. I., N. Y. Loss over the path exceeds by some 30 db that predicted or encountered elsewhere. Some of the loss may be seasonal in character and some may result from the proximity of a ridge formed by the Palisades along the Hudson River. There appears to remain an additional loss factor that is suspected to arise from the overland nature of the path, perhaps from the over-city portion.

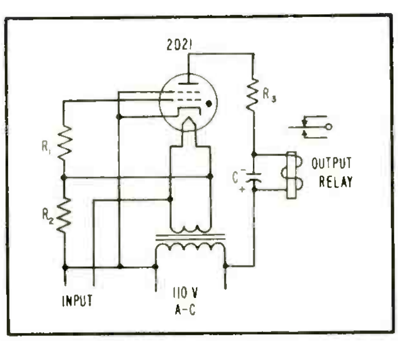
Sensitive Thyratron Relay Operates On Microampere

By JOHN N. HARRIS

Staff Member
Lincoln Laboratory
Massachusetts Institute of Technology
Lexington, Mass.

OFTEN there is need for a very sensitive relay that will operate from currents as low as a microampere. The circuit shown here has been successfully used in conjunction with a mercury thermoregulator for controlling temperature. It is suitable for many other applications.

When the input is open, the grid is returned through R_1 and R_2 to the cathode and the tube is ignited during the positive portion of the cycle. When the input circuit is closed, the filament voltage is in series with the grid return (since $R_2 >>$ resistance of the filament winding) and of such a phase as to prevent the tube from igniting.



Circuit of the sensitive thyratron relay

Resistance R_3 is chosen so that the rated current (usually 1 to 10 ma) passes through the relay. A resistance of 10,000 to 30,000 ohms has been satisfactory in most cases. The capacitance C is across the coil to prevent chattering and may be about 12 μf. Resistors R_1 and R_2 are chosen to satisfy the input impedance and current limitations. When it is desired to have very low current in the input circuit, values

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KR 8	0-150	Each supply	19"	10½"	13"	$330
KR 5	100-200	has two	19"	10½"	13"	$240
KR 6	195-325	10 Amp.	19"	10½"	13"	$240
KR 7	295-450	outputs	19"	10½"	13"	$250

300 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount W	H	D	Price
KR 12	0-150	Each supply	19"	7"	11"	$270
KR 3	100-200	has two	19"	7"	11"	$180
KR 4	195-325	5 Amp.	19"	7"	11"	$180
KR 10	295-450	outputs	19"	7"	11"	$190

125 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount W	H	D	Price
KR 11	0-150	Each supply	19"	7"	11"	$180
KR 1	100-200	has one	19"	7"	7½"	$ 90
KR 2	195-325	3 Amp	19"	7"	7½"	$ 90
KR 9	295-450	output	19"	7"	7½"	$ 97

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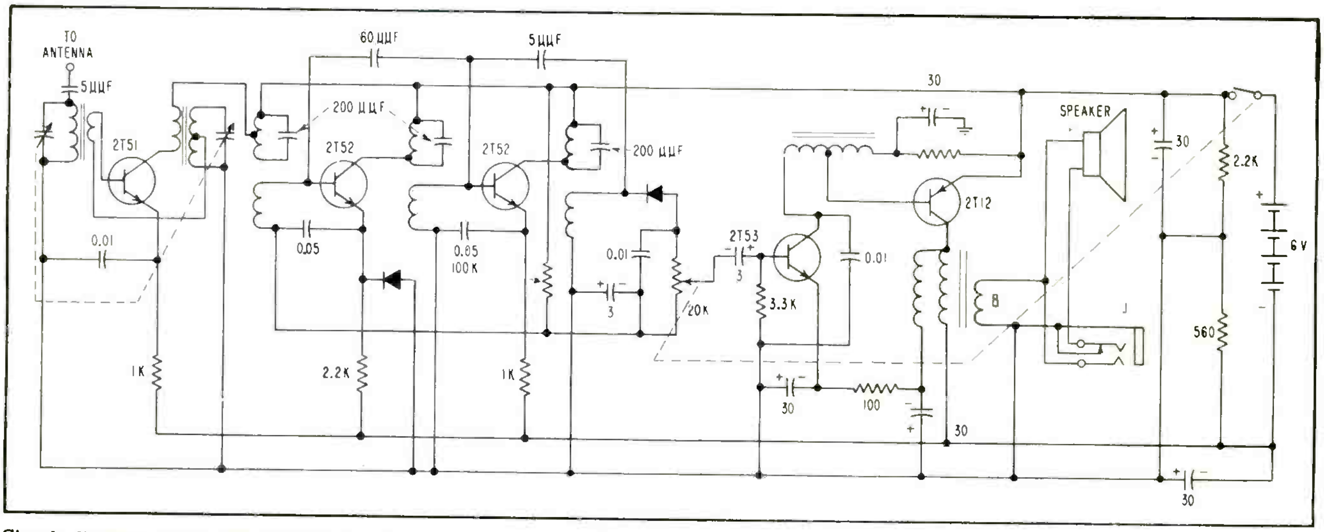
of $R_1 = 1$ megohm and $R_2 = 4$ megohms have been used. However, for many applications $R_1 = 250{,}000$ and $R_2 = 100{,}000$ have been found satisfactory.

For load requirements exceeding the rating of the output relay, a second power relay may be operated from it.

The research in this development was supported jointly by the Army, Navy, and Air Force under contract with the Massachusetts Institute of Technology, at Cambridge, Massachusetts.

Japanese Transistor Broadcast Receiver

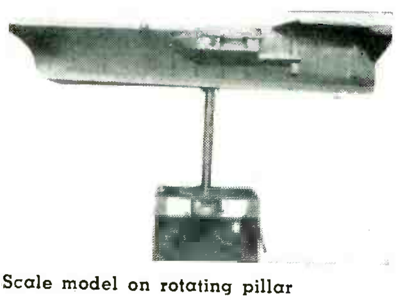


Circuit diagram of the Sony TR-55 transistor superheterodyne broadcast receiver

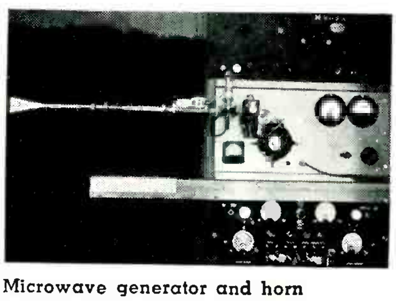
FIVE TRANSISTORS are used in a superheterodyne radio broadcast receiver built by Tokyo Tsushin Kogyo, Ltd. of Japan, licensees of Western Electric Co. Printed circuit wiring is employed. The output jack permits use of an earpiece instead of the self-contained 2½-inch loudspeaker. Four penlight cells furnish 6 volts on which the receiver operates for about 50 hours.

Power output of 10 milliwatts is possible with 10 percent distortion. Field strength required is between 1 and 2 millivolts per meter. The receiver tunes from 535 to 1,605 kc. Intermediate frequency is 455 kc. Selectivity is approximately 15 db at 10 kc off resonance. Photographs of the set were shown on page 12 of the October ELECTRONICS.

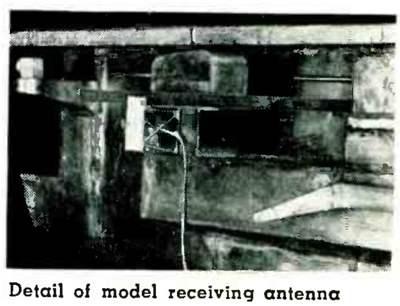
Antenna Arrays Insure Flat-Top Communications



Scale model on rotating pillar



Microwave generator and horn

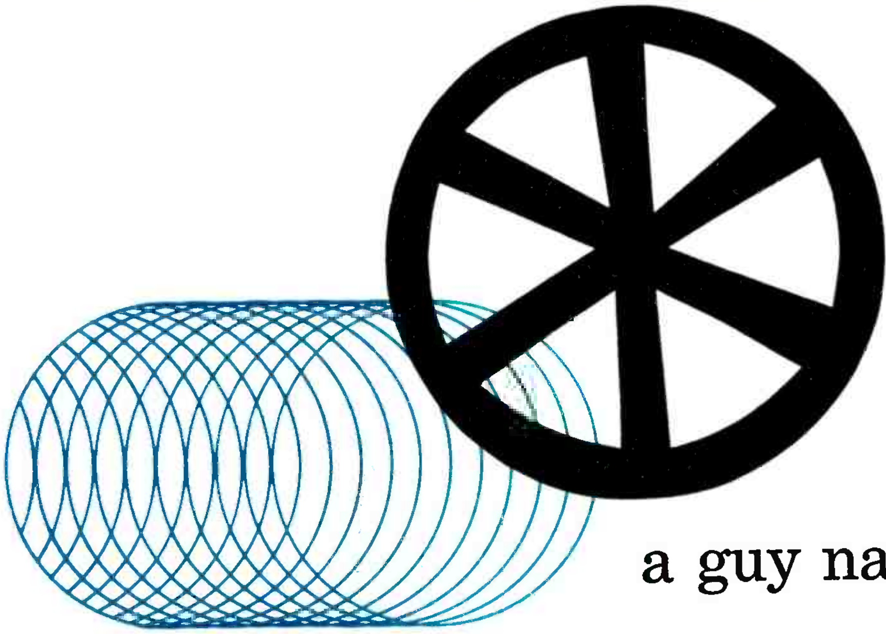


Detail of model receiving antenna

MODERN aircraft carriers like the *U. S. S. Forrestal* have a double problem installing effective antennas. The antennas must furnish reliable service over 360 degrees of direction. In addition, they must be effective over reasonable degrees of azimuth. But the antenna structures must not constitute a flight hazard and must be substantially unaffected by other structures.

The *Forrestal's* uhf radio gear, used to communicate with jet aircraft, is said to have an effective range of 1.5 times that of previous equipment. Eight diversity antennas are located on the gun tubs and corners of the flight deck. By virtue of their positions, the antennas are free from the interfering effects of other antennas, ship superstructure and reflections from the sea.

Even with antennas at half their former height the new uhf system



a guy named Og

Once your name was Og. You tired of shouldering mastodon steaks...of dragging your mate by her hair. You invented the wheel.

Later, your name was Watt. Steam made your kettle-lid dance...and the Industrial Revolution was on.

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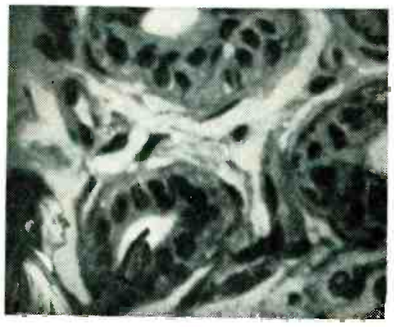
THE FRONT COVER

AN ELECTRONIC microscope designed by CBS Laboratories allows researchers in medicine and industry to view microscopic objects in color. Components of the system include a standard laboratory microscope, color camera, camera control console, color monitors and projectors.

Resultant images from the system are brighter than images using conventional optical methods. In addition, much less light is required at the specimen. Large bright color images using strictly optical microprojectors require such large amounts of light that many live specimens and some fixed slides are destroyed. Consequently, many specimens which up to this time have escaped practical enlargement can now be observed.



In this system, a color camera is mounted on a laboratory microscope. The optics are adjusted to focus the real field through the color drum segments onto the face of the single image-orthicon pickup tube.

The field-sequential system uses a 24 cps color-frame repetition rate. Horizontal scanning frequency is 29,160 cps and the vertical frequency is 144 cps interlaced 2 to 1. Aperture correction and crispening circuits are used.

The image from the compound microscope normally viewed by the eye is, in the color microscope, formed at the photocathode of the image orthicon. This image, with a diagonal of 1.6 in, is amplified electronically in brightness and then magnified in size to a diagonal of approximately 11.5 in. on a small monitor, 18.5 in. on a larger monitor and 83 in. on a large-screen projector. This results in image size magnification of 7, 12 and 52 respectively. Using a 2-mm objective and a 10× ocular, the overall magnification can be 46,800.

provides greater communications range than equipment used in World War II.

Characteristics of the antenna system were tested in advance by Federal Telecommunication Labs using a scale model of the carrier equipped with a scaled receiving antenna. The rotating model was illuminated by a microwave horn and recordings made of signal strength versus orientation.

Digital Voltage Divider Using Four Resistors

By L. J. KAMM

Chief Electrical Engineer
Schatzki Engineering Co.
Springfield Gardens
Long Island, N. Y.

DIGITAL voltage dividers are potentiometers consisting of a set of fixed resistors that are switched by a keyboard or other means to effect a voltage division. The simplest is the series type shown in Fig. 1A. When two or more decimal digits are used to set up a voltage division the number of resistors becomes large and since precision resistors must be used, the total cost is high. A parallel type of divider has been developed in which only four resistors are required per decimal digit regardless of the number of digits. Fig. 1B shows the basic circuit.

The output voltage is

$$v = \frac{G_2}{G_1 + G_2} V$$

where the resistors are expressed as conductances.

The value of v can be varied by transferring resistors from group G_1 to group G_2. Proper choice of values for g_1, g_2, make possible a large number of different values of v by different groupings of a small number of resistors. For example for a one digit divider, let $g_1 = 1$ mho, $g_2 = 2$ mho, $g_3 = 3$ mho and $g_4 = 4$ mho.

Then $G_1 + G_2 = 10$ mhos and the combinations that can be made are

Table I—Digital Combinations of G_1 and G_2 Using Four Resistors

$v/V = G_2/(G_1 + G_2)$	G_1	Value in mhos	G_2	Value in mhos
0	$g_1 + g_2 + g_3 + g_4$	10	0	0
0.1	$g_2 + g_3 + g_4$	9	g_1	1
0.2	$g_1 + g_3 + g_4$	8	g_2	2
0.3	$g_1 + g_2 + g_4$	7	g_3	3
0.4	$g_1 + g_2 + g_3$	6	g_4	4
0.5	$g_2 + g_3$	5	$g_1 + g_4$	5
0.6	$g_1 + g_3$	4	$g_2 + g_4$	6
0.7	$g_1 + g_2$	3	$g_3 + g_4$	7
0.8	g_2	2	$g_1 + g_3 + g_4$	8
0.9	g_1	1	$g_2 + g_3 + g_4$	9
1.0	0	0	$g_1 + g_2 + g_3 + g_4$	10

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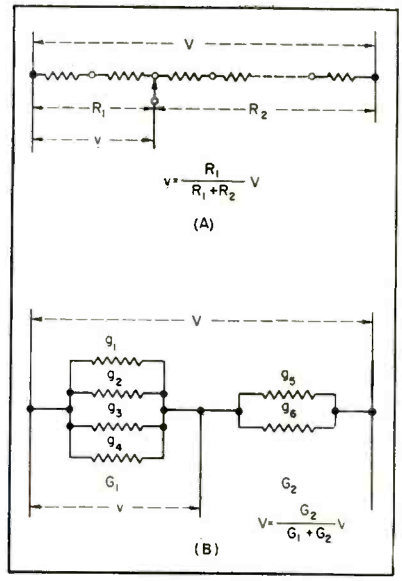


FIG. 1—Simple series voltage divider (A) requires a large number of precision resistors. Parallel type (B) can form a large number of digital values by varying combinations in G_1 and G_2

given in Table I.

Similarly for a two-digit divider, 8 resistors are used with values as follows

$g_1 = 10$	$g_5 = 1$
$g_2 = 20$	$g_6 = 2$
$g_3 = 30$	$g_7 = 3$
$g_4 = 30$	$g_8 = 4$

Resistors g_1 to g_4 are controlled by the hundredths digit switching while resistors g_5 to g_8 are controlled by the tenths digit switching.

For example, to obtain a value $v_1/V = 0.68$ let $G_1 = g_1 + g_2 + g_6$ or $10 + 20 + 2 = 32$ and let $G_2 = g_3 + g_4 + g_5 + g_7 + g_8$ or $30 + 30 + 1 + 3 + 4 = 68$. Then $G_1 + G_2 = 32 + 68 = 100$ and $G_2/(G_1 + G_2) = 68/100$.

With the proper choice of g values,

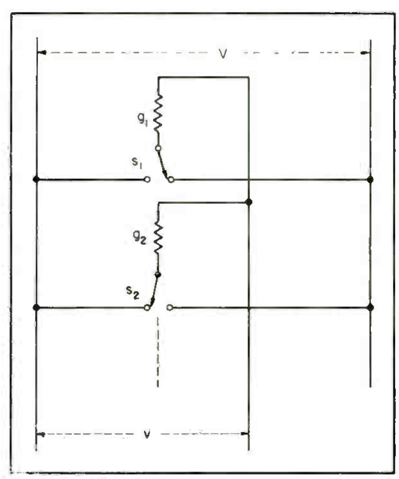
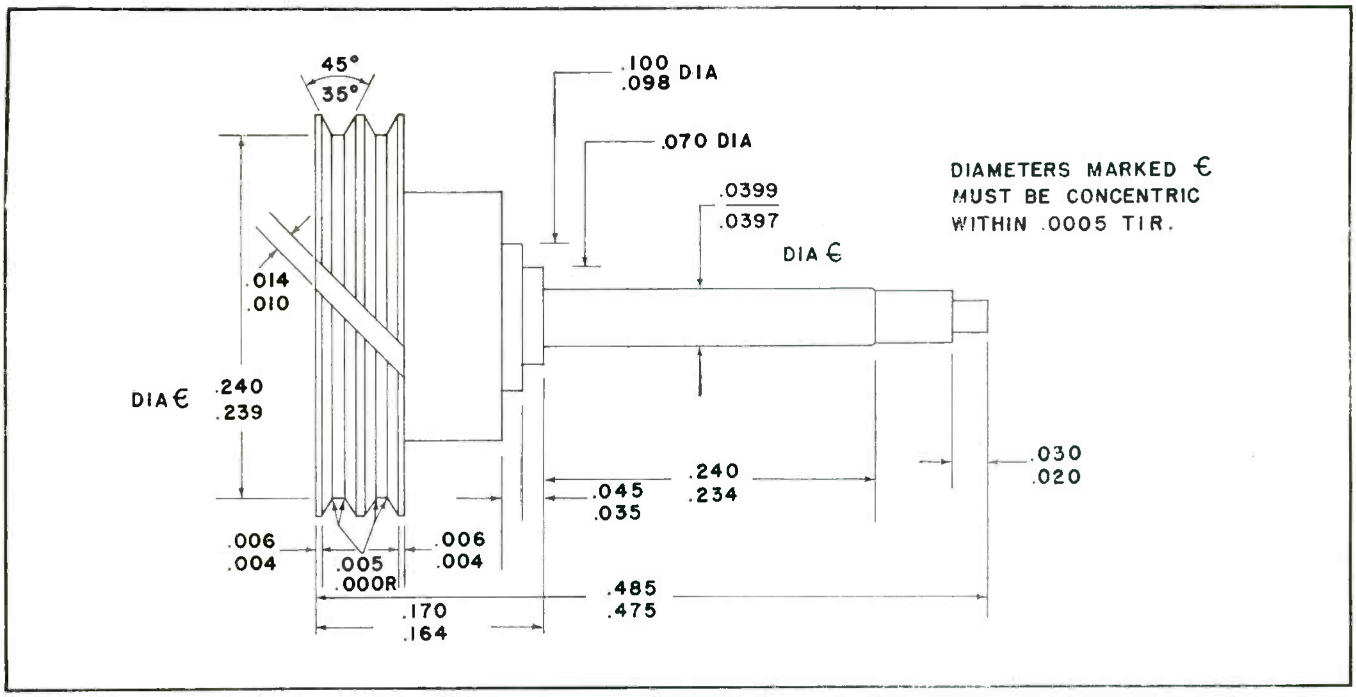


FIG. 2—Single-pole double-throw switching system for transferring resistors between groups G_1 and G_2



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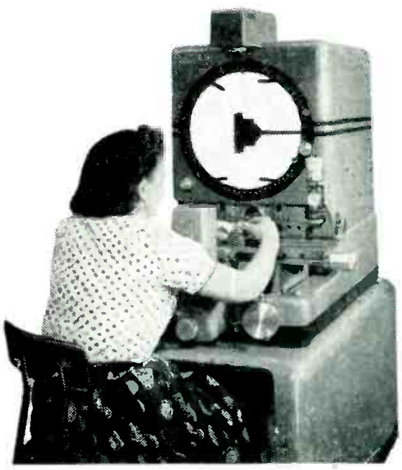

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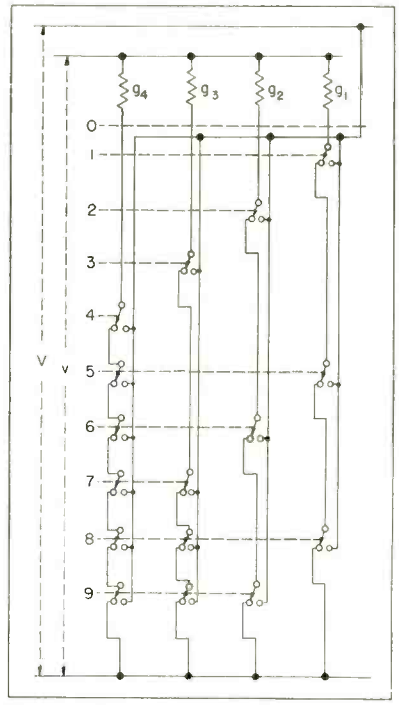

FIG. 3—Ten-position switch circuit for setting up digital voltage values with four resistors

switching for each digit is independent of the switching for the other.

For a three digit divider, 12 resistors are used with values as follows

$g_1 = 100$	$g_5 = 10$	$g_9 = 1$
$g_2 = 200$	$g_6 = 20$	$g_{10} = 2$
$g_3 = 300$	$g_7 = 30$	$g_{11} = 3$
$g_4 = 300$	$g_8 = 30$	$g_{12} = 4$

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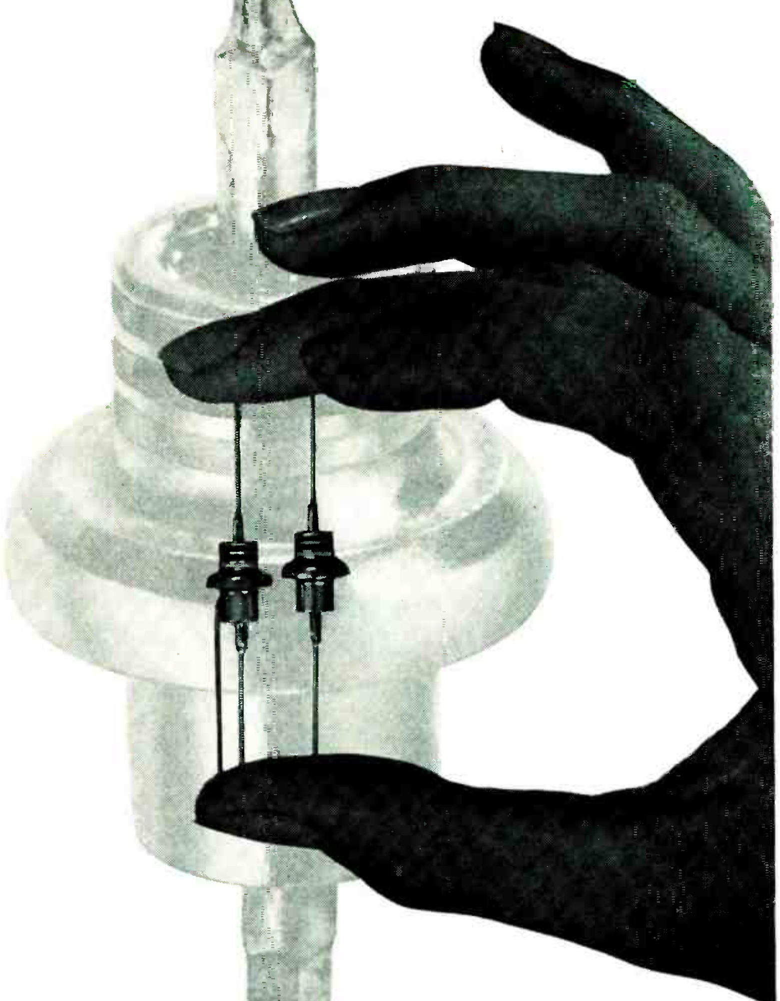

These devices offer excellent performance characteristics, even up to higher power ratings, together with high gain and low noise figures. The new package is designed to dissipate more heat. This makes it possible to maintain the high performance characteristics.

The low alpha-crowding effect makes the new Hughes transistors particularly adaptable to high current medium power amplifiers, in addition to: Computers...Switching ...Audio Amplifiers...I-F Amplifiers ...Oscillators. For all types, maximum collector current is 100 milliamperes, and collector dissipation is 500 milliwatts. Under certain conditions, or when used with clips or with suitable heat sinks, these ratings can be increased substantially. Detailed specifications for each type are available in pertinent data sheets.

ACTUAL SIZE (photo, transistors in hand).
New Hughes Fused Junction NPN Germanium Transistor, available in (A) Three leads, to fit conventional transistor socket mountings; (B) Clip-in style package.

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	Min.	Max.	
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HA5002	0.950	0.965	15V
HA5003	0.975	0.99	20V

Collector Cut-Off Current (I_{CO})	Alpha Cut-Off Freq. (α cogb)	Rise Time	Noise Figure
5μA	2.5	2.5 μsecs	....
12μA	1.0	....	15.0 db
10μA	1.5	....	15.0 db

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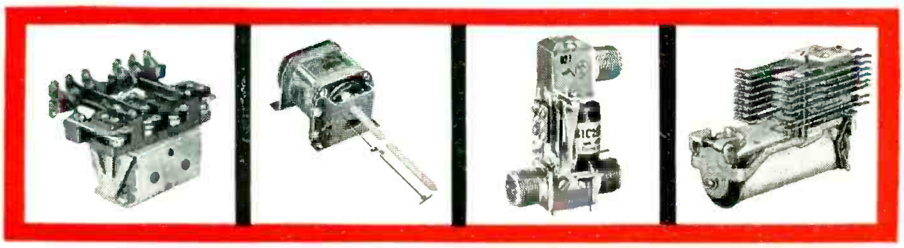

sistors from group G_1 to group G_2 is to connect one side of each resistor permanently to the output wire and connect the other side to one or the other of the end wires by a single-pole double-throw switch as in Fig. 2.

For manual setting by rotary switch, each resistor is switched by a 10-position switch with certain positions connected to one side of the line and the other positions connected to the other side. For manual setting by keyboard, each key must have 1, 2, 3 or 4 transfer contacts and each resistor wired as shown in Fig. 3 for the single digit case.

Other values of g may be chosen that are equally useful. Also, analgous circuits may be developed for binary and other number systems. This circuit has been used in digital servomechanisms using both 2 digits and 3 digits and has worked satisfactorily.

Zener-Voltage Breakdown Uses In Silicon Diodes

By Carl N. Wulfsberg
Air Force Cambridge Research Center
Cambridge, Mass.

General characteristics of the silicon junction diode shown in Fig. 1 indicate that it differs markedly from the point-contact germanium type in two ways.

Back resistances may exceed 10,000 megohms at moderate back voltages, and a sharp breakdown in back resistance occurs at a particular back voltage, the so-called Zener voltage. A third important difference is the ability of the silicon diode to operate at high temperatures without serious degradation

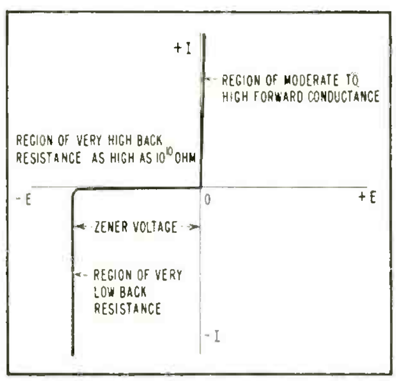

FIG. 1—Characteristics of silicon junction diodes

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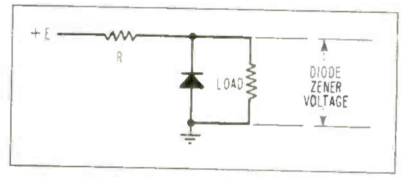

FIG. 2—Direct-current voltage regulator

of its characteristics.

Although back resistance decreases rapidly with increasing temperature, values in excess of a megohm may be expected at 150 C. Forward resistance also decreases, but more slowly, while the Zener voltage normally increases slowly with temperature. Being junction devices, the diodes may have rather

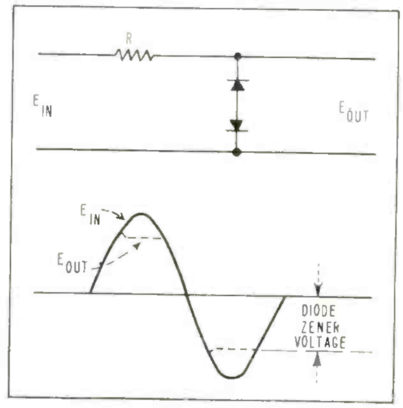

FIG. 3—Alternating-current peak voltage regulator

high shunt capacitances. From one manufacturer's data, very low Zener voltage diodes have capacitances in the order of 50 $\mu\mu$f; the capacitance decreases with increasing Zener voltage and drops to 2 or 3 $\mu\mu$f for diodes with high Zener voltages.

Numerous applications of silicon diodes in switching circuits suggest themselves, especially where high back resistances are desirable, such as diode gates and matrix switches. Matched pairs and quads are available, which should provide more stable operation than the comparable germanium types in discriminator and modulator circuits, especially under the condition of widely varying temperature. Silicon diodes are efficient rectifiers, with rectification ratios at one volt of 10^6 or higher. High-power types recently made available will undoubtedly find wide application as power rectifiers and in magnetic amplifiers.

Silicon diodes are suited for use in diode-capacitor memory devices;

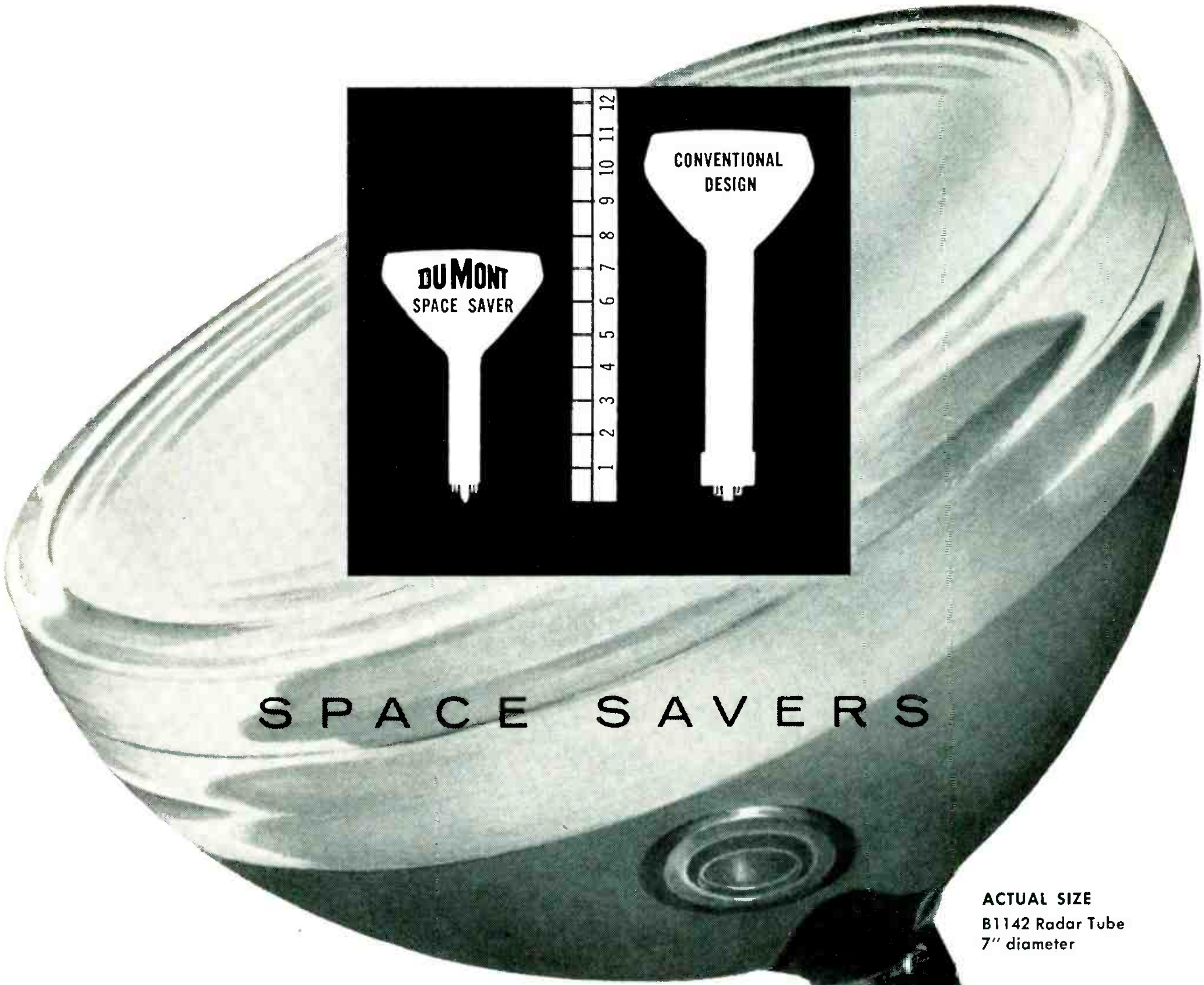

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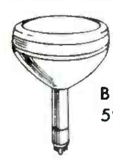
TABLE OF IMPORTANT SPECIFICATIONS

TYPE	DIAMETER	LENGTH	FOCUS	DEFLECTION	NECK DIAM.	VOLTAGE	DEFLECTION ANGLE
B1125	5"	7"	mag.	mag.	7/8"	8 kv	70°
B1144	5"	7"	mag.	mag.	7/8"	16 kv	70°
B1142	7"	8½"	mag.	mag.	7/8"	8 kv	70°
B1132	10"	12½"	elect.	mag.	1-7/16"	10 kv	90°

B1132
Radar Tube
10" diameter

B1125
Radar Tube
5" diameter



B1144 Radar Tube
5" diameter

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since the back current may be in the order of 10^{-10} ampere, relatively long storage times should be possible. Low back resistance of the diode at the Zener voltage may be utilized in a number of applications, such as limiting or clipping circuits in which no bias voltage is required and in devices protecting against voltage surges.

Since Zener voltage for a particular diode is constant over wide variations in reverse current, the diode is suited for use in d-c voltage-

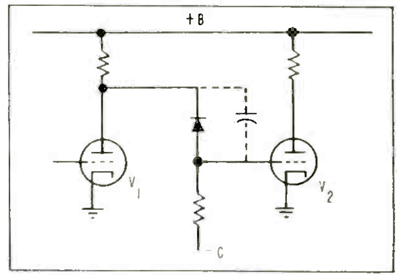

FIG. 4—Diode used as d-c coupling device

regulating or reference circuits, such as that shown in Fig. 2. Resistor R should be so chosen that the reverse current in the diode does not exceed a value given by the ratio of the maximum power dissipation of the diode to the Zener voltage.

Silicon diodes have several advantages over gas tubes as voltage regulators. Since any Zener voltage in the range of three volts to several hundred volts may be specified, the diode is a highly flexible device in this application.

No special provision need be made to insure a minimum starting potential, since this and the working potential are virtually the same in the silicon diode. A further advantage is that the diode may be shunted with a large filter capacitor without danger of oscillation.

A simple a-c peak voltage regulator may be constructed by connecting two silicon diodes back to back, as shown in Fig. 3. The peak output voltage is limited to the Zener voltage of the diodes, which may lie anywhere in the range from three to several hundred volts. This circuit could also be used as an effective speech clipper.

Figure 4 shows a diode used as a coupling device between the plate of one stage of an amplifier and the

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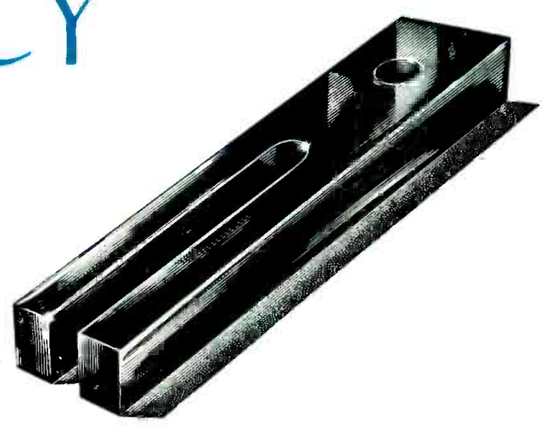

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PHILAMON LABORATORIES INC.
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grid of a following stage. While a resistor may be used in place of the diode to achieve the necessary change in level, there is a signal loss owing to the voltage-divider action of the resistors. By using a diode, the full signal amplitude is retained, the d-c level being reduced by a factor equal to the Zener voltage of the diode.

Good transient response is possible with a proper shunt capacitor. A 1-mc square wave with 0.1-μsec

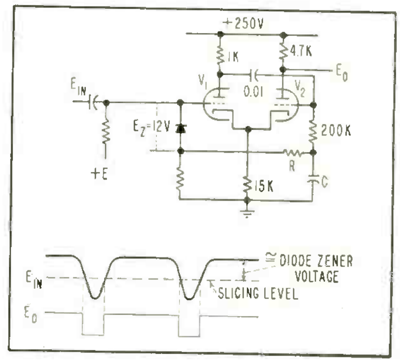


FIG. 5—Silicon diode slicing circuit

rise and fall times was generated at the plate of V_1 of Fig. 4 and, with the diode properly shunted, virtually no change in amplitude or waveform was observed at the grid of V_2. The d-c level, however, was reduced by 60 volts, the Zener voltage of the particular diode used.

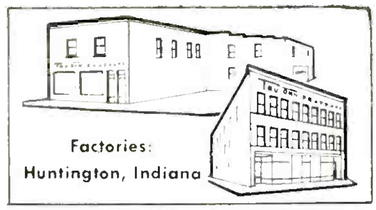
Figure 5 shows a fast slicing circuit; V_1 conducts until its grid potential falls below the slicing level, when the current is suddenly transfered to V_2, as indicated by the waveforms. Normally, the grid of V_2 is returned to a fixed direct voltage, which makes the slicing level dependent on the d-c level of the incoming signal.

By including a silicon diode as shown, with a suitable R-C smoothing network, the difference in the d-c levels of the two grids is fixed by the Zener voltage of the diode. With output amplitude dependent on the d-c level of the input signal, there is virtually no change in the slicing operation of the circuit with input levels ranging from 75 to 175 volts.

Silicon diodes facilitate design of a simple and accurate method of converting a binary number stored in a shift register into an analog direct voltage. The accuracy required of such a device is 1 part in

Factory: Huntington, Indiana

TRU-OHM NEWS



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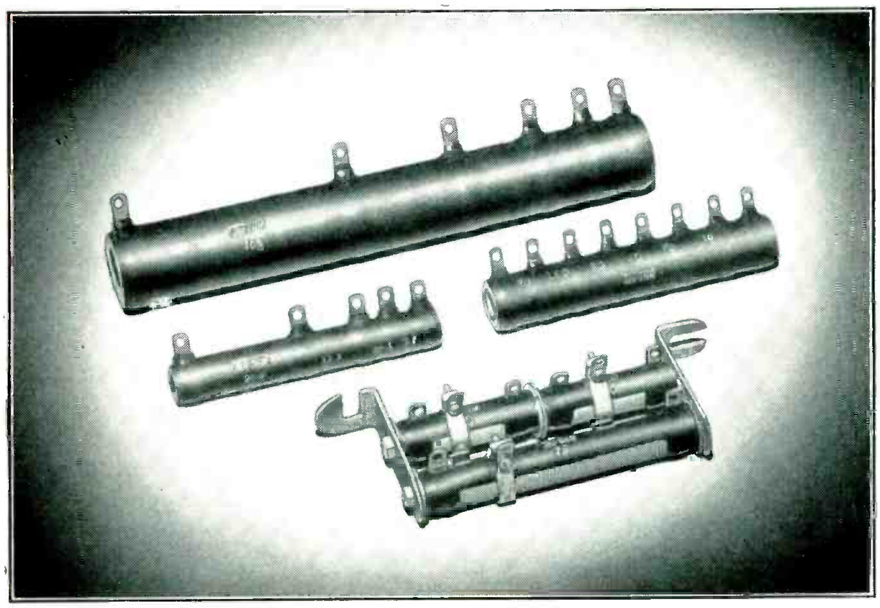

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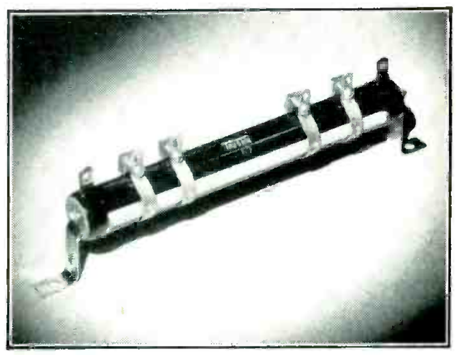

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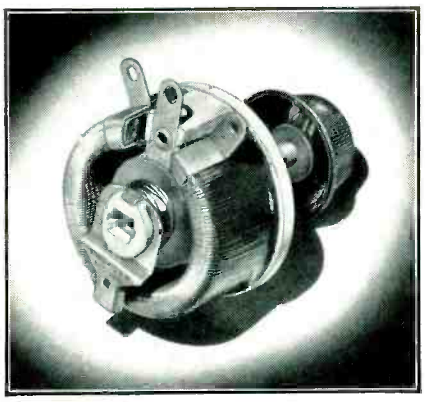

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2^n, where n is the number of binary digits. If n is greater than 4 or 5, it is usually necessary to provide the flip-flops in the register with buffer stages, which may work into a ladder-adding network or drive relays that control suitably weighted resistors.

The method shown in Fig. 6 requires no additional stages, and is relatively independent of tube characteristics and supply voltages. The shift register flip-flops are comprised of pentode pairs, with the

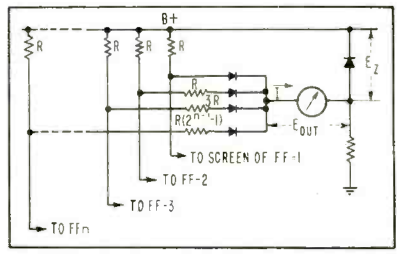

FIG. 6—Digital-to-analog voltage converter

screen of each pentode that is cut off when storing a one connected as shown. With ones stored in the flip-flops (screens cut off), the first flip-flop, which contains the most significant digit, contributes a current E_z/R, the second a current $E_z/2R$, and so on.

This binary weighting of the currents supplied by the various stages then results in a current (or voltage) proportional to the binary number stored. The only requirements placed on the tubes are that no screen current flow when a one is stored and that sufficient current be drawn when a zero is stored to cut off the associated collector diode, with resultant zero current contribution.

Use of silicon diodes as collectors reduces the back current of a cut-off diode to a negligible value, while offering a very small resistance in the forward direction. The accuracy of the circuit is chiefly dependent on the tolerances of the resistors and the ability of the regulating diode to maintain a constant voltage E_z. The most critical resistor is the one associated with the first flip-flop, which should have an accuracy of at least 1 part in 2^n.

Since highly precise resistors are available, the limiting factor will normally be the regulating diode, which must compensate for varia-

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tions in the supply voltage as well as a total variation $2E_z/R$ in the output current. By choosing the proper diode and operating it at a suitably high current, variations in E_z can be held sufficiently low that the circuit can be made good to 8 digits, which implies an accuracy of 1 part in 256.

Reflection-Type Asymmetrical Waveguide

By Koryu Ishii

Microwave Laboratory
Nihon University
Surugadai, Tokyo, Japan

One-way transmission waveguides using ferrite and resistive film attenuators depend on Faraday rotation of the electromagnetic wave. Waves in the forward direction may pass through the waveguide without high attenuation but waves in the opposite direction are absorbed by the resistive film and cannot pass.

A reflection-type asymmetrical waveguide described here uses a combination of H-plane tapered iris and matching screws. Figure 1 shows a diagram of the reflection-type asymmetrical waveguide.

The H-plane tapered iris made of thin metallic film is located in the rectangular waveguide. This iris determines direction of power transmission. The discontinuity of

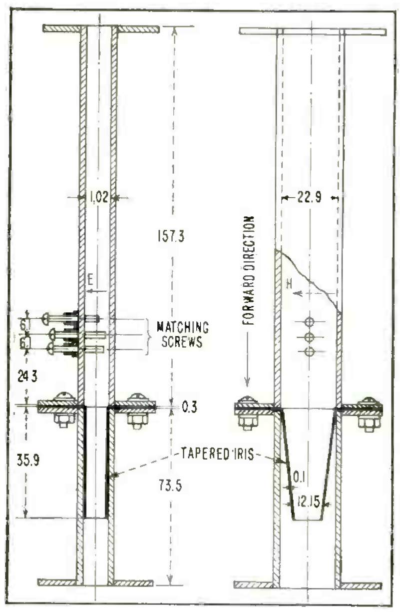

FIG. 1—Cross-section of asymmetrical waveguide in the E and H planes

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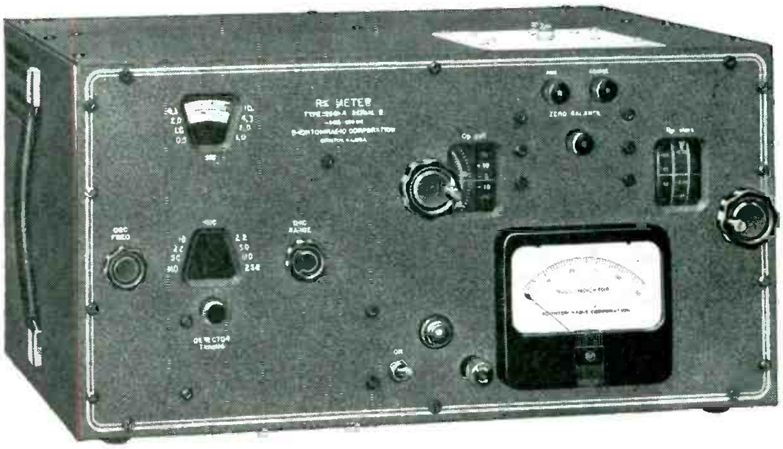

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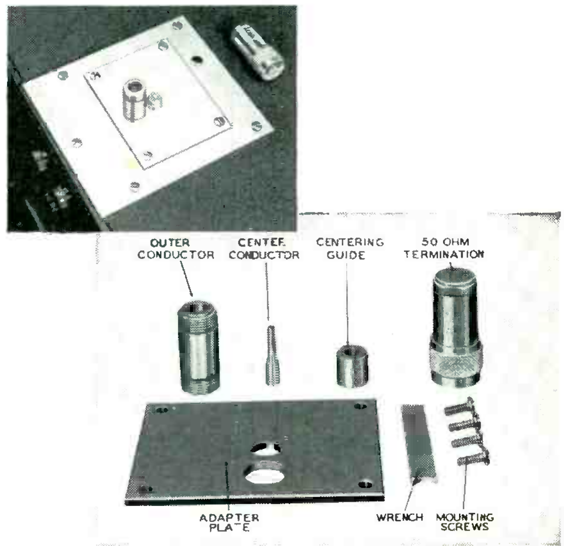
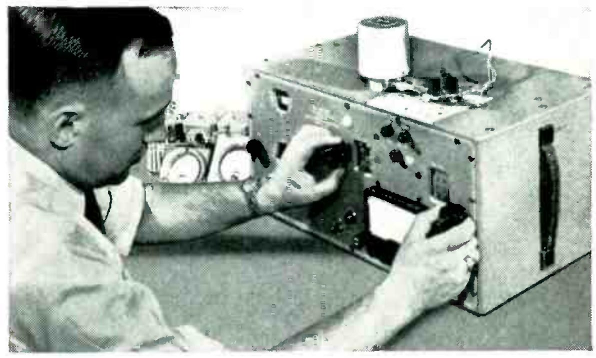
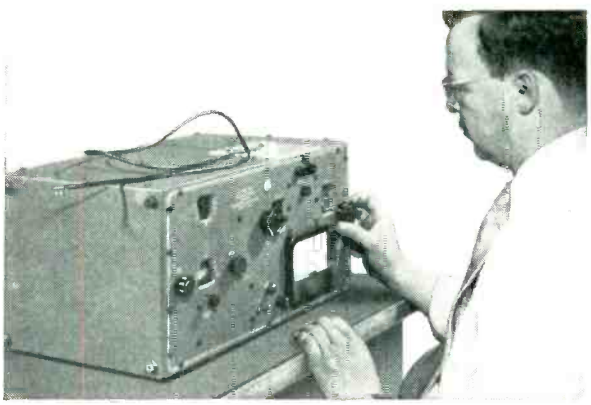


Co-ax Adapter Kit Type 515-A adapts RX Meter for coaxial connections.

The RX Meter Type 250-A is a completely engineered measuring instrument including a broad band RF oscillator, RF bridge and null detector. The parallel resistance and parallel capacitance or inductance of the unknown is indicated on precise, easily-read dials. Components such as resistors, capacitors or coils, are connected across two unbalanced binding post connections on top of the instrument. The Co-ax Adapter Type 515-A, shown above, replaces the binding posts in a few seconds with a Type N Connector for measurement of coaxially connected devices. No corrections are necessary over the entire frequency range for most measurements.



Dynamic measurement of a junction transistor under conditions of variable bias and applied RF. Similar procedures can be used with vacuum tubes.



The RX Meter measures the characteristic impedance, attenuation and propagation velocity of RG-58/U Cable.

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CAPACITANCE RANGE (Cp): —100 mmf to +20 mmf (may be extended).
INDUCTANCE RANGE (Lp): 0.001 uh to 100 mh.
TEST VOLTAGE: 0 volts D.C. (Up to 50 ma may be passed through unknown terminals). 0.1–0.5 volts R.F. (may be conveniently reduced to 20 mv).
POWER REQUIREMENTS: 105-125 volts, 50/60 cps, 60 watts (internally regulated).

The RX Meter provides a simple, accurate means of measuring, independently, the RF resistance and reactance of a wide variety of materials, components and circuits. It is also useful in making other types of measurement.

Dynamic measurements of the parameters of transistors and vacuum tubes can be made. D.C. current up to 50 ma can flow through the bridge terminals permitting simple direct biasing of the unknown element. By a simple procedure, the RF voltage across the unknown can also be varied, permitting measurement of input and output impedance under a wide variety of conditions.

Cable characteristics can be measured on the RX Meter using a very short cable sample. A simple measurement will yield the characteristic impedance, attenuation and propagation constant. By the use of a balun the same characteristics can be measured for balanced cables.

Type 250-A Price: $1250.00 F.O.B. Boonton, N. J.
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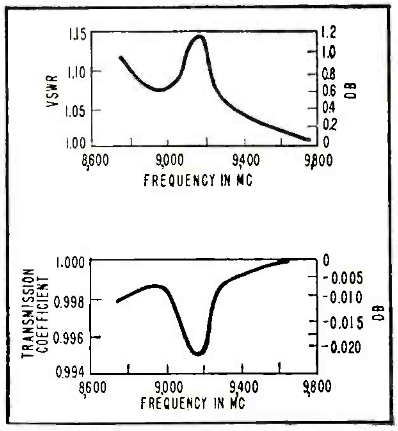

FIG. 2—Frequency characteristic of reflectionless termination

the iris for forward transmission is compensated by matching screws.

Operation in the forward direction is as follows. Transverse *H*-plane width of the narrow mouth of the iris is shorter than the half of the cutoff wavelength. Therefore, even if the iris is made of tapered waveguide and the impedance is gradually transformed, this section acts as a discontinuity. This discontinuity is, however, compensated with matching screws.

If the wave comes from the opposite direction, power cannot pass the narrow mouth of the iris. Because this size is below cutoff and since there is no matching device the discontinuity of the narrow mouth is not compensated. Matching screws at the right side do not act in the field free region this time.

Wave power transmission coeffi-

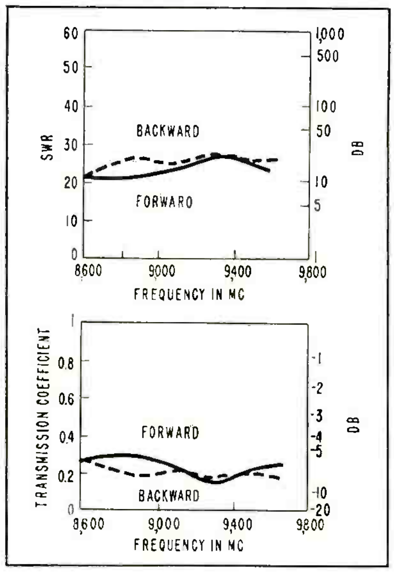

FIG. 3—Transmission characteristic of tapered iris in both directions

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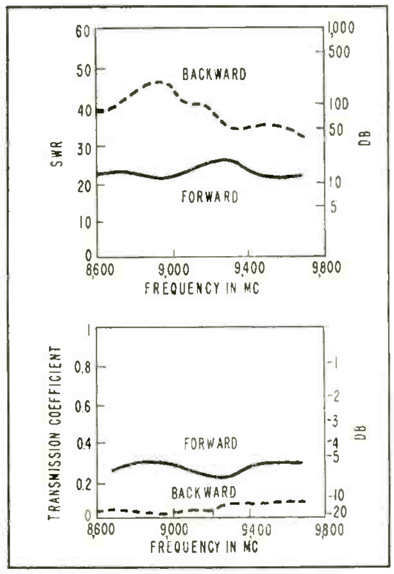

FIG. 4—Characteristics of matching transformer section of asymmetrical waveguide

cients of this asymmetrical waveguide were measured by conventional method using a standing wave detector and reflectionless termination.

Figure 2 shows the frequency characteristics of the reflectionless termination. The vswr is less than 1.15 and the power transmission coefficient is more than 99.5 percent over the range of 8,700 to 9,700 mc.

Transmission characteristics of a section of the tapered iris alone is shown in Fig. 3. The wave transmission is asymmetrical but the forward transmission coefficient is too small.

Figure 4 shows the transmission

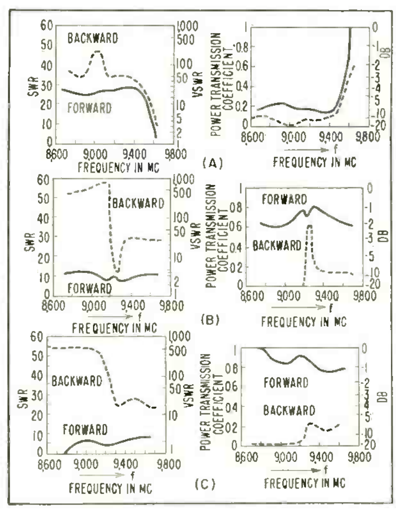

FIG. 5—Characteristics of complete waveguide adjusted for maximum forward transmission (A) and optimum transmission coefficients at 9,180 mc (B) and 8,785 mc (C)

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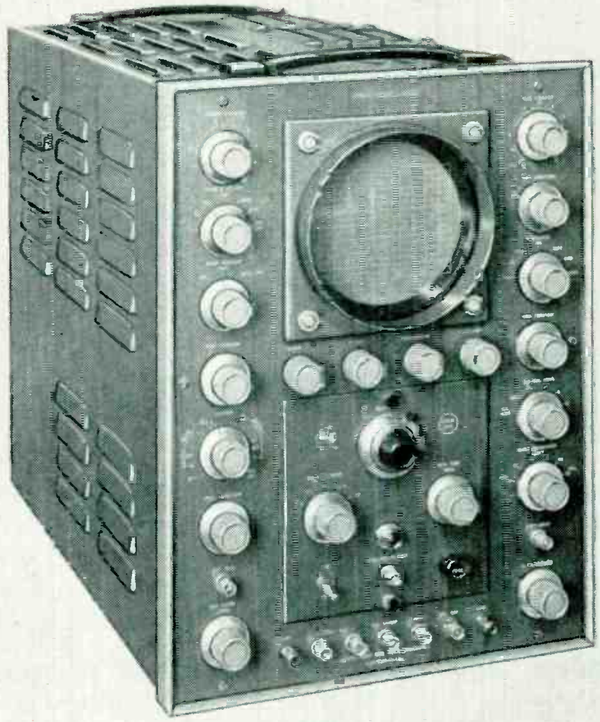

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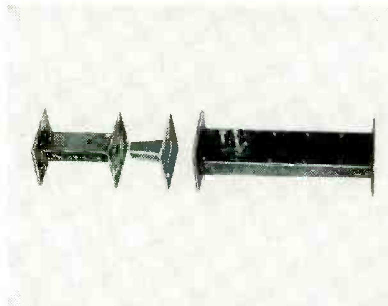


Three sections of asymmetrical waveguide before assembly. Tapered iris is at center

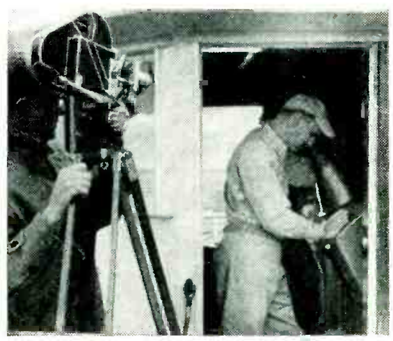
characteristics of the matching-screw section. This section is almost symmetrical.

With the iris section and the matching-screw section combined the power transmission characteristics is as shown in Fig. 5. In Fig. 5A, the matching screws were adjusted to obtain maximum forward power transmission coefficient at 9,615 mc. Fig. 5B and Fig. 5C show optimum transmission coefficient at frequencies of 9,180 mc and 8,785 mc, respectively.

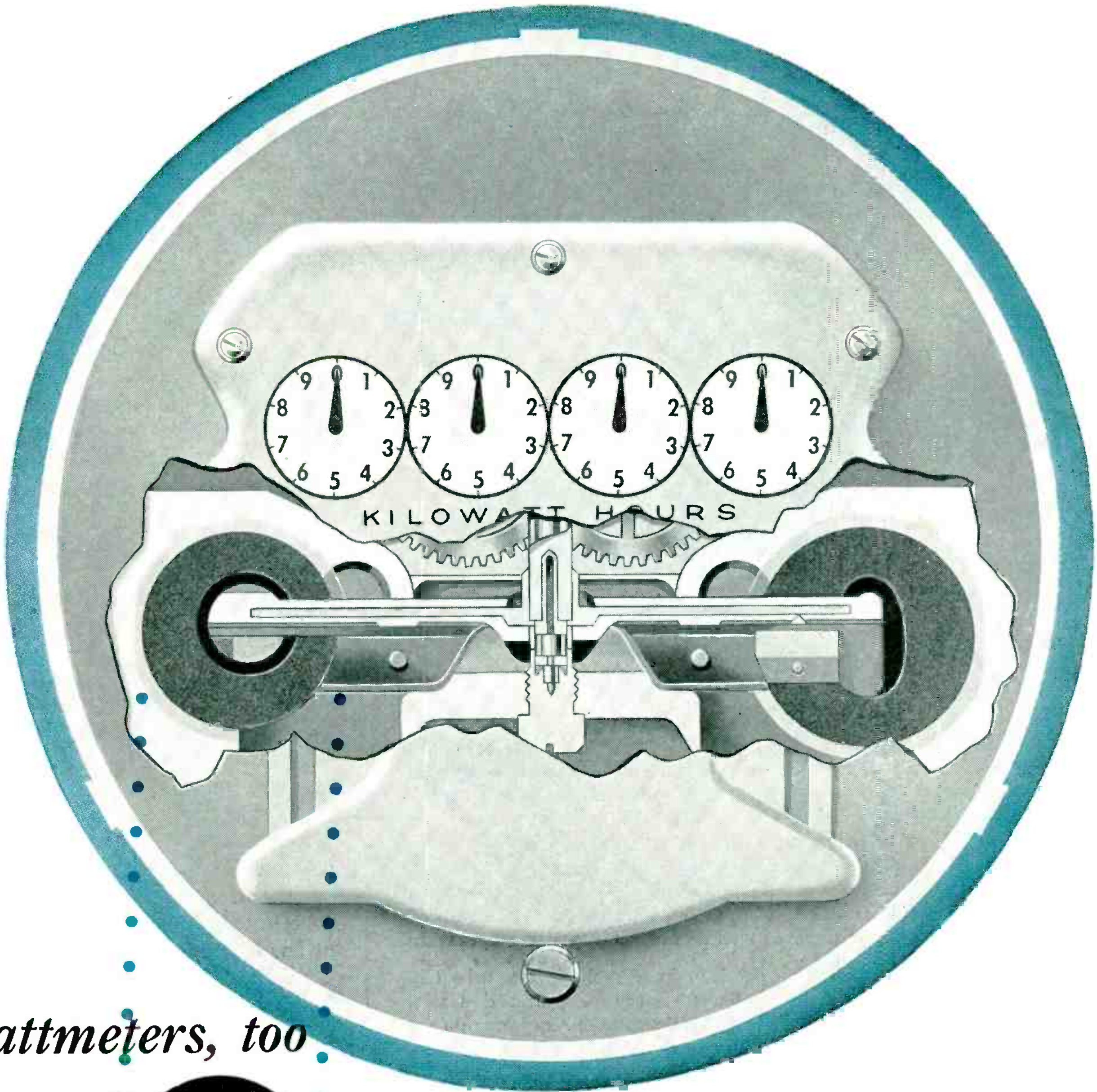
For Fig. 5A, the backward transmission coefficients were also improved by the matching screws but the asymmetrical nature of the waveguide is not so good.

In the case of Fig. 5B, the asymmetrical nature of the waveguide is very good over the range of 8,790 to 9,270 mc. Resonance due to both the tapered iris and the screw tuners are observed at 9,250 mc and forward attenuation is a bit

Radar Movie



A twenty-minute motion picture film called "Safe Passage" produced by Raytheon Mfg. Co., Waltham, Mass., shows some of the faulty techniques that have resulted in collisions between ships equipped with radar. Made with the assistance of the Coast Guard and others, the sound film is available on loan for education



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In Fig. 5C, the asymmetrical nature is best over the frequency band from 8,700 to 9,200 mc. In this range, the forward attenuation is less than 0.8 db.

At frequencies higher than 9,250 mc the cutoff effect of the tapered iris is not as effective for backward transmission and asymmetrical nature is weakened. In the useful range of the frequencies, high standing-wave ratio for backward transmission shows part of the incident wave power is reflected.

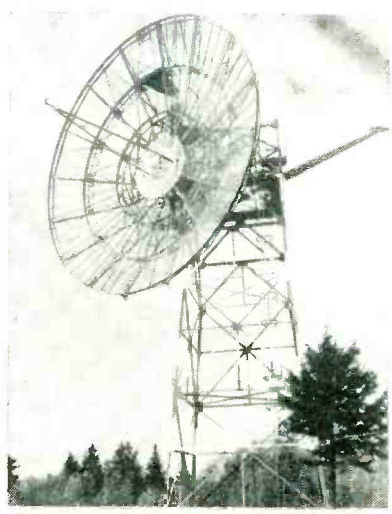
The author wishes to thank K. Owaki, S. Sonoda, I. Yokochi, Kenichi Fujinawa, Takeshi Hara and Nobuyoshi Watanabe.

Testing UHF DX

AN EXPERIMENTAL beyond-horizon circuit has been set up by Radio Corporation of America in co-operation with RCA Victor Ltd. of Canada, linking Covey Hill, Huntingdon County, Quebec, with Riverhead, L. I., N. Y.

Put into operation last August, the circuit spans 288 miles. Frequency of operation is 468 mc, so that propagation is necessarily by means of tropospheric scatter. The parabolic antenna used is a 40-foot dish mounted on a 50-foot tower. Covey Hill, most northerly peak of the Adirondacks, has an elevation of 1,100 feet.

Effected radiated power of the transmitting installation is 428 kw,



Forty-foot parabolic antenna beams RCA signals from Canada to Long Island in test of long distance uhf propagation

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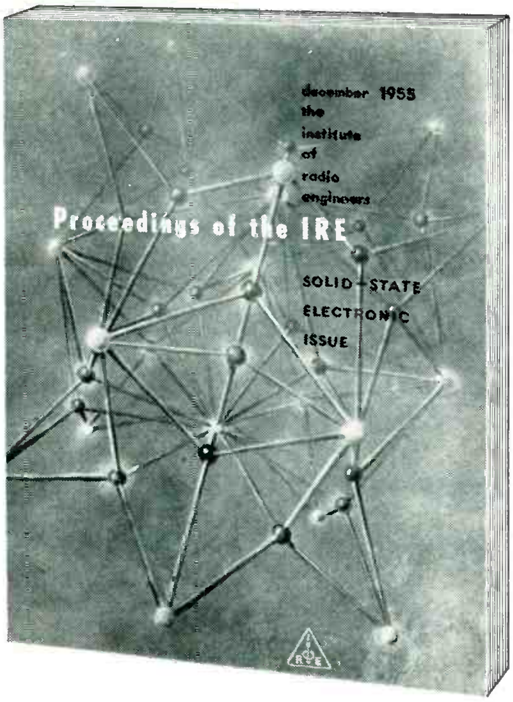

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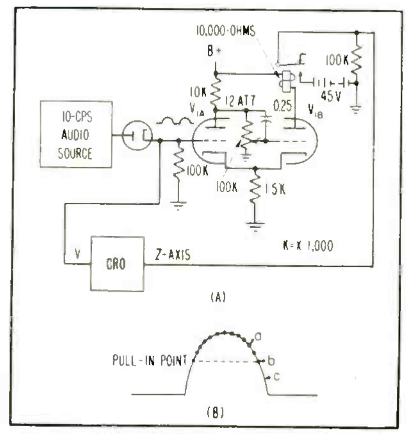
much of which results from a high antenna gain. RCA engineers stress the fact that this circuit is experimental, for data gathering and is not currently in use for communications.

The over-horizon technique is particularly applicable in remote regions where the cost of maintaining conventional microwave repeaters every 25 or 30 miles would be either prohibitive or physically impossible.

Zero Hysteresis Relays

By IRVING BARDITCH
Baltimore, Md.

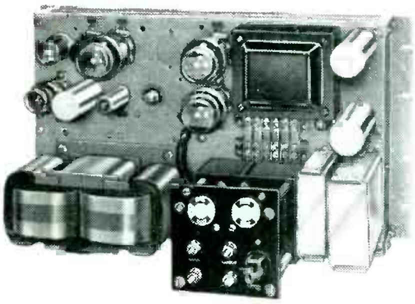
USE OF A RELAY that has identical values of pull-in and drop-out current is sometimes mandatory. Almost any relay can be made to do this in combination with the proper vacuum-tube drive circuit. A zero or even negative hysteresis can be obtained.



Circuit for comparing pull-in and drop-out voltage of relays (A). Oscilloscope waveform (B) shows position of closure point for early drop-out *(a)* equal pull-in and drop-out *(b)* and late drop-out *(c)*

The circuit diagram shows the trigger circuit with the relay in the plate of V_{1B}. Adjustment of the bias on V_{1B} allows the relay drop-out current to be made equal to, less than or greater than the pull-in current. A 100,000-ohm potentiometer permits this adjustment to be made without difficulty.

The set-up shown allows the relay action to be shown on the scope. The half-wave sinusoid pulses at a 10 to 20-cps rate drive the relay and present the pattern on the scope



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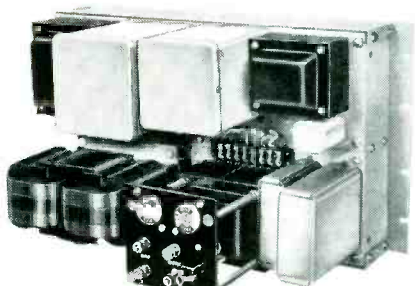

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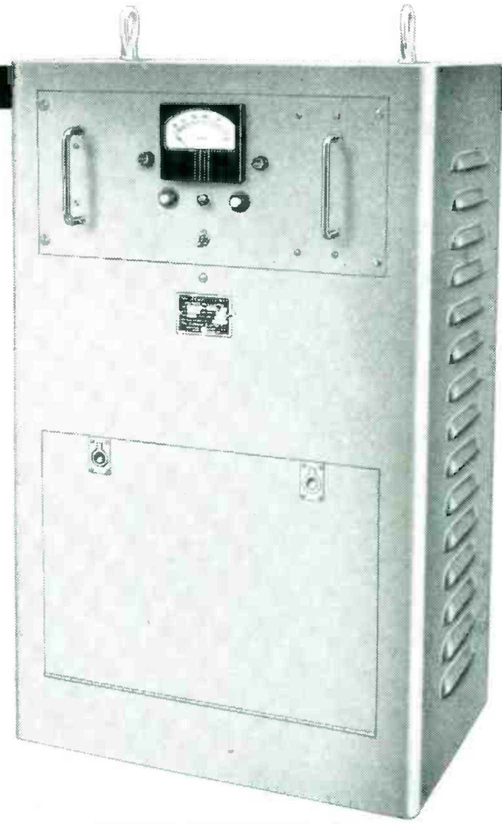

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that is blanked during relay closure. This shows the exact timing for opening and closing of contacts.

Light Beam Controls TV Receiver

CONTROL of a modern television receiver by a flashlight depends upon selection of an appropriate photosensitive target. Photocells located near the four corners of the television screen determine clockwise and

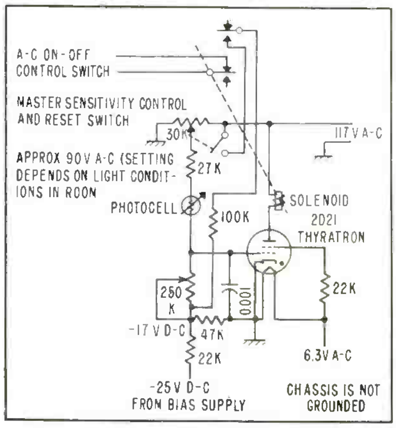

FIG. 1—Thyratron control circuit used for power switch and muting

counterclockwise channel selection, operation of the power switch and sound muting. Sensitivity, volume control and other adjustments must be manually preset.

Photoelectric devices used are cadmium-sulfide photocells. They change resistance with change in light. Resistance is an inverse function of light intensity, being extremely high in the absence of light. The range may be as great as 100 megohms to 25,000 ohms.

Two different types of controls are used. The motor drive unit is actuated through a pair of thermionic motor-control tubes (both in the same envelope) and relays. Loudspeaker muting and power switching is handled using a pair of thyratrons.

When the control grid of the 2D21 thyratron in Fig. 1 is near zero, conduction occurs. Since the plate voltage is alternating, the tube stops conducting every time the a-c swings negative. Alternating voltage applied to tube plate and control grid are in phase and tube conduction occurs during the positive

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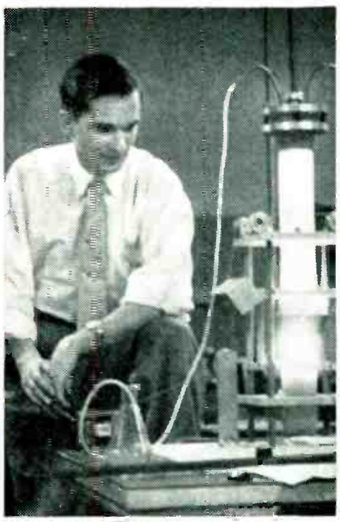
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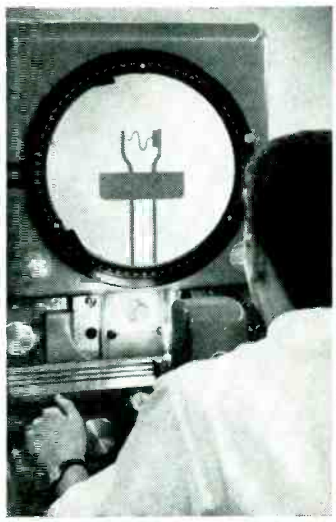
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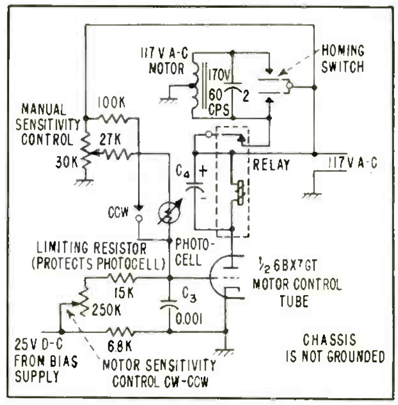


FIG. 2—Motor control circuit selects channels

swing. The plate-circuit solenoids are energized by pulsating direct current.

Since the photocell decreases resistance when illuminated, the thyratron will fire owing to rising potential on the control grid, energizing the solenoid that performs the appropriate switching function.

Action of the tuning motor control circuit is similar to the thyratron action. Because only momentary contact and release are required, plate-current relays are operated by conduction of either half of a dual-triode 6BX7 tube, as shown in Fig. 2.

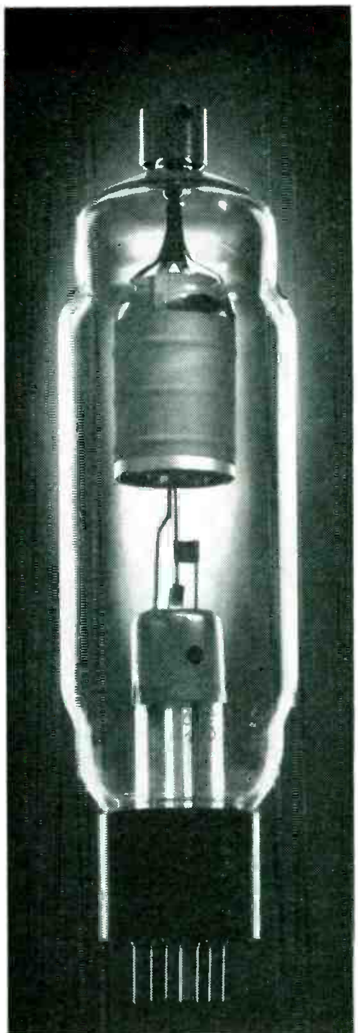
When the amplitude of a-c control voltage swings the grid of the tube sufficiently positive for an average 9-ma rectified direct-current flow through the coil the relay will operate. With no excitation voltage at the grid, no d-c plate current will flow since the tube is normally biased to cutoff.

Filter capacitors C_3 and C_4 smooth out the pulsating voltage and avoid relay chatter that would otherwise result during negative swing of the alternating current.

Information on the Zenith Flashmatic remote control has been abstracted from an operating guide furnished through the courtesy of Zenith Radio Corp.

Volscan Evaluation

AIR TRAFFIC control tests will be conducted for Air Research and Development Command by engineers of Air Force Cambridge Research Center. Evaluation of the Volscan (AN/GSN-3) system will be conducted at Clinton County Air



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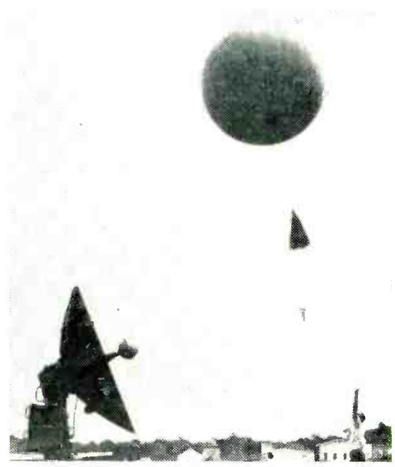
Dynamic Characteristics of Triode-Connected Pentodes

By ALEXANDER J. DESSLER and H. G. ROBINSON
Duke University
Durham, North Carolina

APPROXIMATION formulas accurate to within 20 percent are given in this article for the μ, g_m and r_p of triode-connected pentodes utilizing

Faster Radiosonode



Weather information can be collected quickly using radio sounding apparatus carried by a new type of balloon. Made of neoprene, the new balloons can be inflated with 300 cu ft of hydrogen and will rise at 1,800 ft a min until they burst at about 15 miles. Conventional types rise at 1,000 ft a min. Advantage of the newer technique is that pressure, temperature and humidity data can be received before the balloon, which also indicates wind direction and velocity at various levels, is blown beyond the range of reception.

only readily obtainable pentode-connected data. A formula is also given for the dynamic screen-grid resistance of a pentode.

The formulas, based on the approximations that the characteristic curves are linear in the vicinity of the quiescent operating point and that the shielding of the screen grid essentially prevents changes in the plate voltage from affecting the cathode current, give the dynamic characteristic values for triode-connected pentodes:

$$g_{m,T} \approx \left(1 + \frac{I_s}{I_b}\right) g_m$$

$$r_{p,T} \approx \frac{E_s}{(I_b - g_m E_c)\left(1 + \frac{I_s}{I_b}\right)}$$

$$\mu_T \approx \frac{g_m E_s}{I_b - g_m E_c}$$

$$\mu_T \approx (g_{m,T})(r_{p,T})$$

where

$g_{m,T}$ = triode-connected transconductance
μ_T = triode-connected amplification factor
$r_{p,T}$ = triode-connected dynamic plate resistance
g_m = pentode-connected transconductance
I_s = d-c pentode screen grid current
I_b = d-c pentode plate current
E_s = d-c pentode screen grid voltage
E_c = d-c control grid bias (negative) or $-R_k(I_b + I_s)$ when the cathode bias resistor, R_k is given.

The following is an example using the 6AK5 sharp-cutoff pentode. The pentode connected data for typical operation is obtained from the tube manual.

g_m = 5,000 μmhos
I_s = 2.5 ma
I_b = 7.5 ma
E_s = 120 v
$E_c = -R_k(I_s + I_b)$
$= -180(10 \times 10^{-3}) = -1.8$ v

$$g_{m,T} \approx \left(1 + \frac{2.5}{7.5}\right)5{,}000 = 6{,}700 \ \mu\text{mhos}$$

$$\mu_T \approx \frac{5{,}000 \times 10^{-6} \times 120}{7.5 \times 10^{-3} + 5{,}000 \times 10^{-6} \times 1.8} = 36$$

$$r_{p,T} \approx \frac{120}{(7.5 \times 10^{-3} + 5{,}000 \times 10^{-6} \times 1.8)\left(1 + \frac{2.5}{7.5}\right)} = 5{,}400$$

The plate voltage for triode operation should equal the pentode operated screen voltage; also the triode-connected control-grid bias should remain the same as that on the pentode.

Higher order correction terms added by more exact analysis were not included since for design pur-

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poses an accuracy of 20 percent is usually sufficient.

An approximation formula for the screen resistance, r_s, of the pentode is

$$r_s \approx \frac{E_s}{\frac{I_s}{I_b}\left(I_b - g_m E_c\right)}$$

As an example, using the above 6AK5 data

$$r_s \approx \frac{120}{\frac{2.5}{7.5}\left(7.5\times10^{-3}+5{,}000\times10^{-6}\times1.8\right)}$$

$= 22{,}000$

In normal pentode operation r_s, with regard to a-c, is effectively in parallel with the screen dropping resistor and the screen decoupling capacitor, C_{sg}. Therefore the minimum value of C_{sg} necessary to achieve a given low-frequency response can be calculated. Negative feedback produced by screen degeneration can also be found by using r_s.

Radio Opens Garage Door

REMOTE control of garage doors is effected by a selection of proper radio frequency and modulating frequency using a mobile transmitter and fixed receiver connected to a motor-actuated device.

Equipment manufactured by Robot Appliances, Inc. of Dearborn, Mich. operates on one of 50 differ-

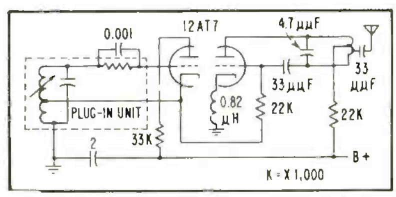

FIG. 1—Mobile transmitter

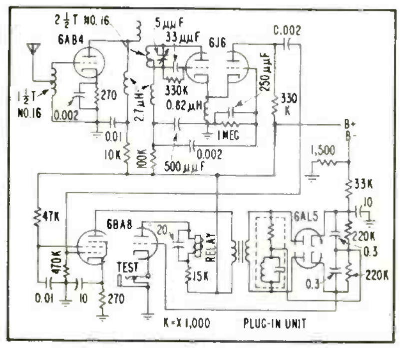

FIG. 2—Garage receiver operates motor

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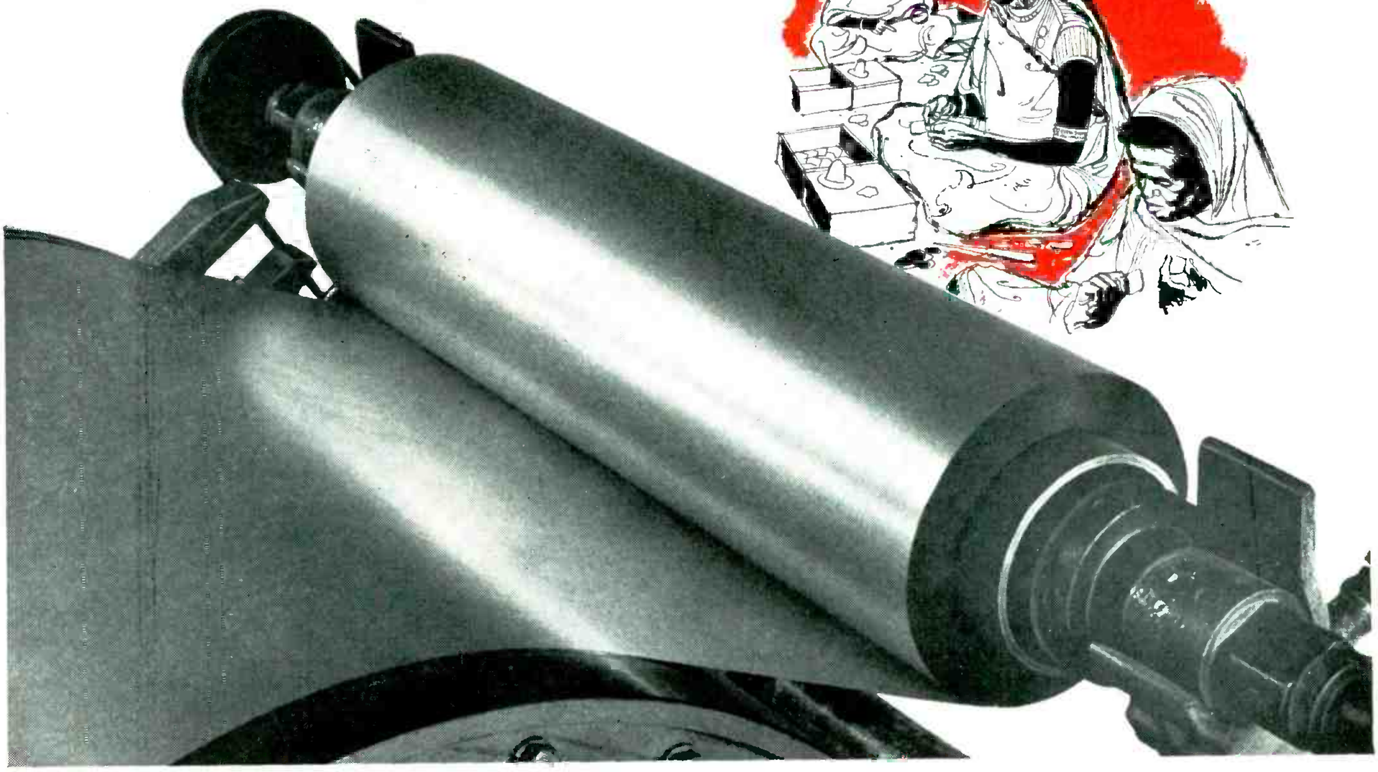

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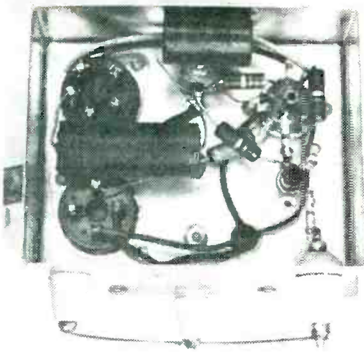
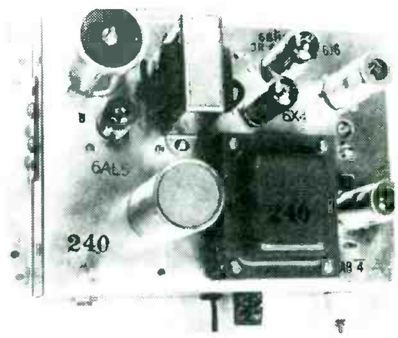


Loop is shown mounted on side of transmitter box (bottom of photograph)



Receiver that is actuated by 7-kc modulation. Equipment is mounted near door-operating motor under a dust cover

ent available radio signals. Frequencies in the same neighborhood can be staggered to avoid false operation of adjacent systems.

Besides a radio-frequency tuning control (not shown in detail) in Fig. 1, there is a plug-in audio oscillator circuit to match the discriminator in the receiver. Power is obtained from a vibrator power supply connected to the car battery.

The receiver, Fig. 2, depends both upon reception of a radio-frequency signal to which the receiver is tuned and output from an audio discriminator to operate a relay that actuates the door motor. The power supply (not shown) is conventional.

One-Man TV Camera Aligner

By W. L. Shepard
General Electric Co.
Electronics Park
Syracuse, N. Y.

ADJUSTMENT of either a black and white or color camera requires setting the alignment controls. This requires that the beam-focus voltage be rocked through focus setting. Normally this involves a manual adjustment at a point remote

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from the camera, requiring a second man at this remote point.

A simple circuit used in some equipment automatically eliminates the necessity for manual rocking of the beam focus. Thus the need for two men to perform the adjustment procedure is eliminated.

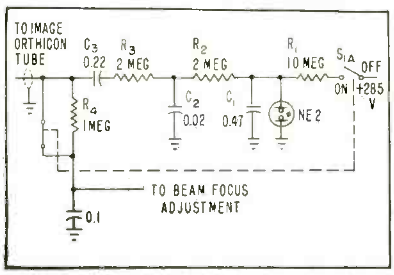
The circuit requires few parts. When switch S_{1A} is turned to the on position, voltage is applied to the circuit and the short across R_1 is removed. Capacitor C_1 charges through R_1 until a voltage high enough to fire the neon bulb is reached. Then C_1 is discharged through the bulb. The time constant of R_1 and C_1 determines the number of times per second that the beam focus is rocked through the focus position.

The resultant sawtooth is then applied to C_2 through R_2. This results in a partial integration of the sawtooth to produce a triangular waveform. This waveform is then applied through R_3 and C_3 to R_4. Resistor R_3 serves to isolate the circuit and divide the voltage to obtain the correct swing of the beam focus. The triangular waveform superimposed on the correct direct voltage causes the beam focus to go in and out of focus.

The values given will cause the beam focus to rock completely through focus approximately twice a second. This rate can be adjusted easily by changing the values of either C_1 or R_1.

It is necessary, when installing this device, to use shielded wire for any long leads going to the image orthicon tube. This prevents any tendency for feedback.

To use this device it is only necessary to adjust the beam focus voltage for best focus. Then switch S_1 is turned on. After the alignment procedure is completed, the switch is turned off and the camera then functions normally.



Circuit of the focus adjustment unit that can be mounted in the television camera

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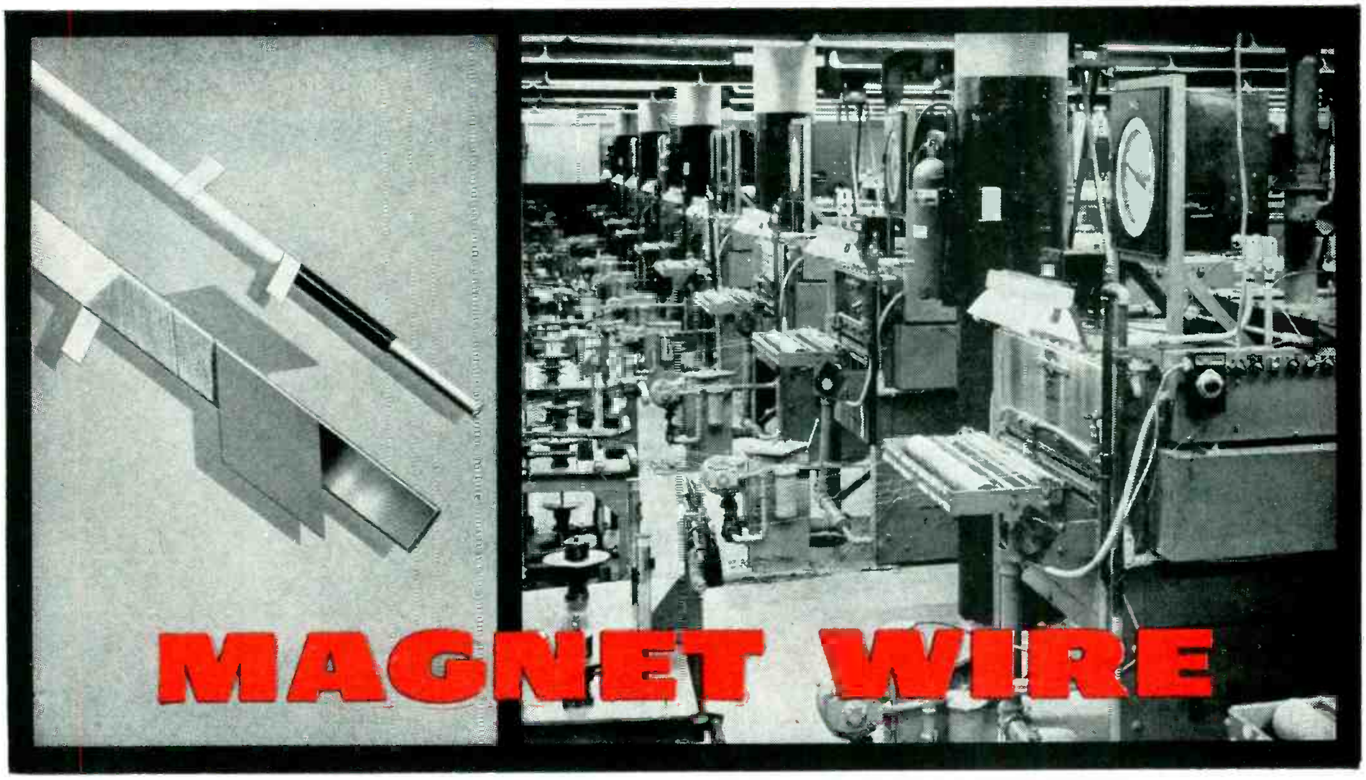

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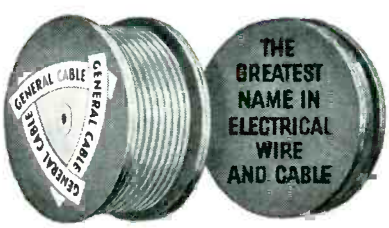

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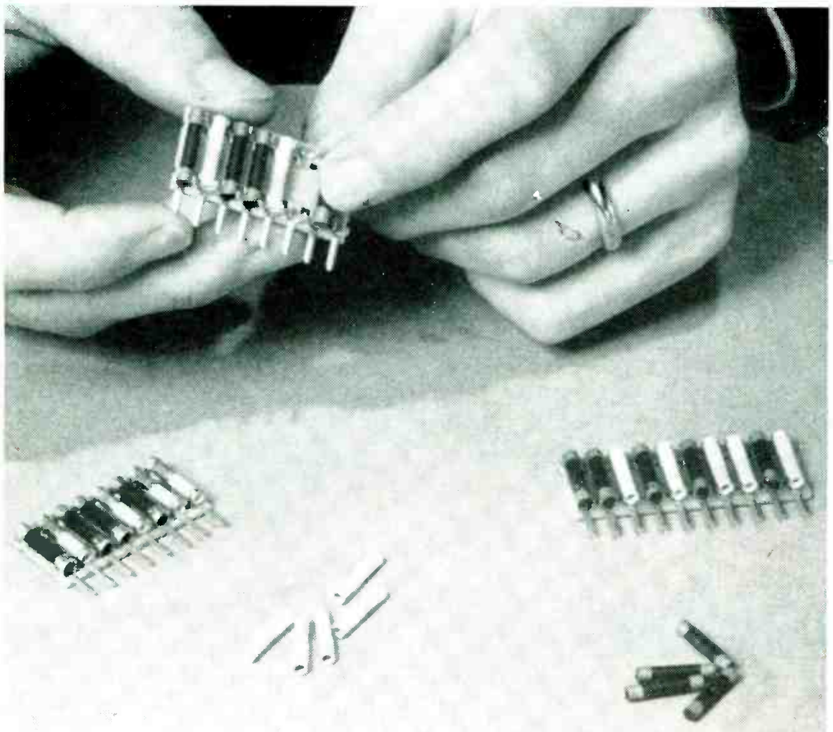
Edited by JOHN MARKUS

Plug-In Assemblies Use Standard Component Bodies



During development of a new design, engineer can make up own module by snapping components into clips, then soldering clips conventionally

Finished modules are easily inserted in punched holes of etched wiring board

PACKAGED SUBASSEMBLIES of standard composition resistors and tubular ceramic capacitors, mass-produced at an overall cost approximating that of individual components, have been announced by Erie Resistor Corp. Called PAC, for Pin Assembly Circuit, the new modules can be plugged into holes of etched-wiring boards either manually or by machine, for lower-cost tv and radio sets as well as computers, industrial controls and other military and commercial electronic equipment.

▶ **General Details**—The mounting base used for each module is XXXP copper-clad paper-base phenolic. Sprocket-like terminal holes are punched along both sides of long strips of the material. The strips can later be chopped into shorter lengths holding up to 92 components. After applying embossed wiring to one side of the base for interconnections, terminals are installed on the other side by automatic machinery, to make contact through the board with the embossed wiring.

The terminals are like miniature fuse clips, for holding cylindrical leadless standard component bodies. One row of terminals has integral terminal pins. The components are pushed into these clips and the edges of the board are dipped in solder, after which the assembly is given a dipped or molded plastic jacket.

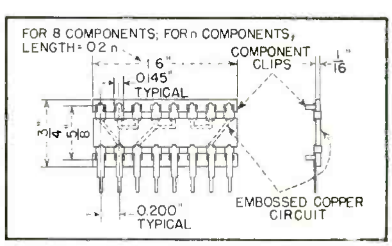
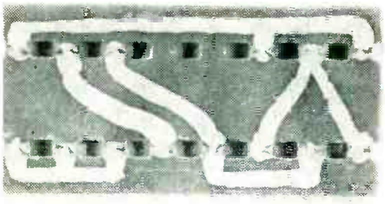


FIG. 1—Base and terminal dimensions

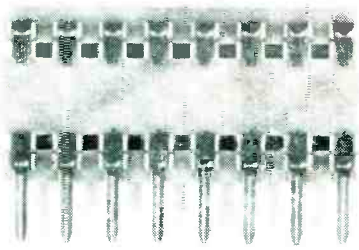
▶ **Dimensions**—The new modular assembly is based on use of uniform components $\frac{1}{8}$ inch in diameter and $\frac{5}{8}$ inch long. These outline dimensions have been standard for ceramic tubular capacitors and composition resistors for many years. Other components having these dimensions can be used equally well.

A standard center-to-center spacing between components of 0.200 inch has been selected, as shown in Fig. 1. This spacing provides maximum utilization of space, with corresponding economy of production cost both for the modules and the finished electronic equipment.

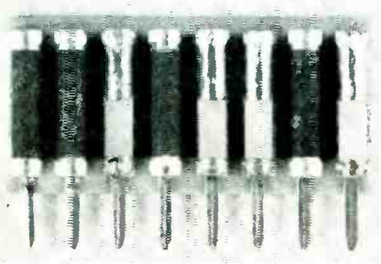
Resistors available for these dimensional requirements are rated at $\frac{1}{2}$ watt and 500 volts with tolerances of 5 percent or wider in values from 5 ohms to 50 megohms. Back-of-board wiring readily permits connecting components in series or parallel for higher wattage ratings. Capacitors are available



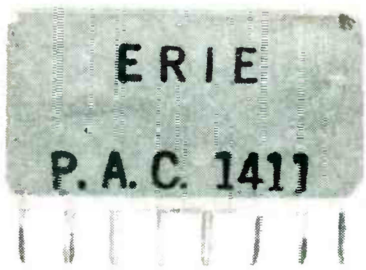
Embossed wiring on back of base



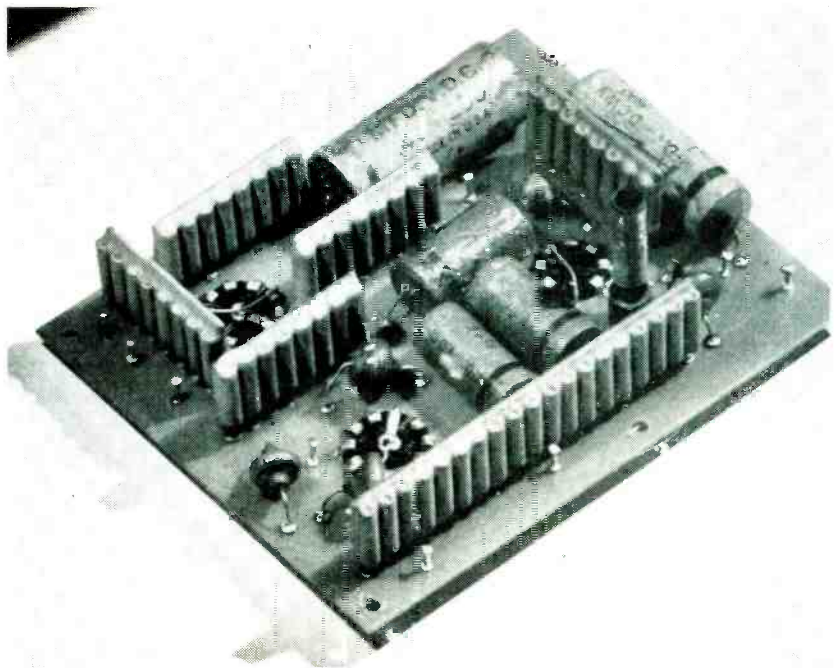
Front view of base after staking pins



Appearance after installation of component bodies and dip-soldering



Finished module in plastic jacket



Six of the new modules replace 59 individual components on this etched wiring board, reducing the original 69 insertion operations to only 16

in the range of 1 to 5,100 $\mu\mu$f.

► **Advantages**—Since each circuit element is individually made and tested prior to assembly, no compromises in characteristics and tolerances are needed. Tolerances can be as close as those available for individual components.

Individual capacitors mean complete diversity in selecting values and temperature characteristics. The same module can include low-capacitance temperature-compensating units and high-capacitance bypass units.

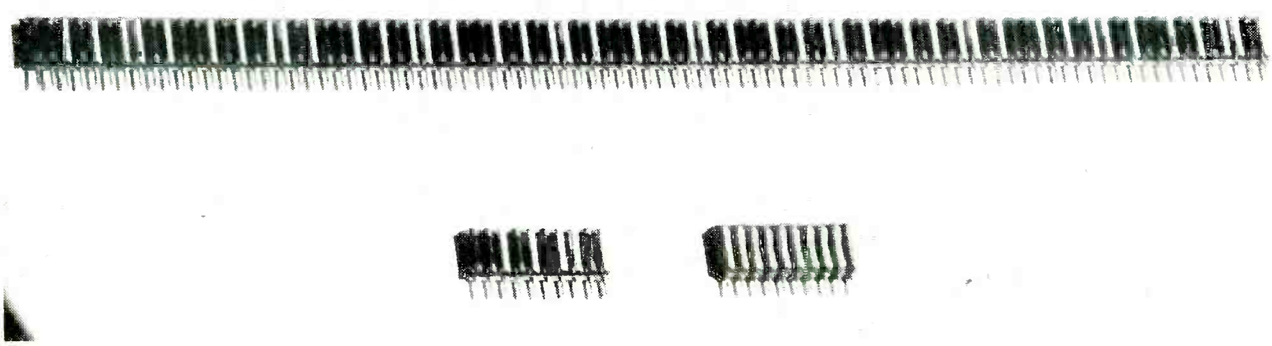
Since the components are mounted vertically with respect to the etched-wiring chassis, area requirements on the wiring board are greatly reduced. A pin-assembly circuit containing 15 components occupies only 1 sq in. of chassis area.

Design engineers can be supplied with mounting-base samples with clips attached. These, together with kits of resistor and capacitor bodies in a wide range of values, facilitate experimental breadboard layouts.

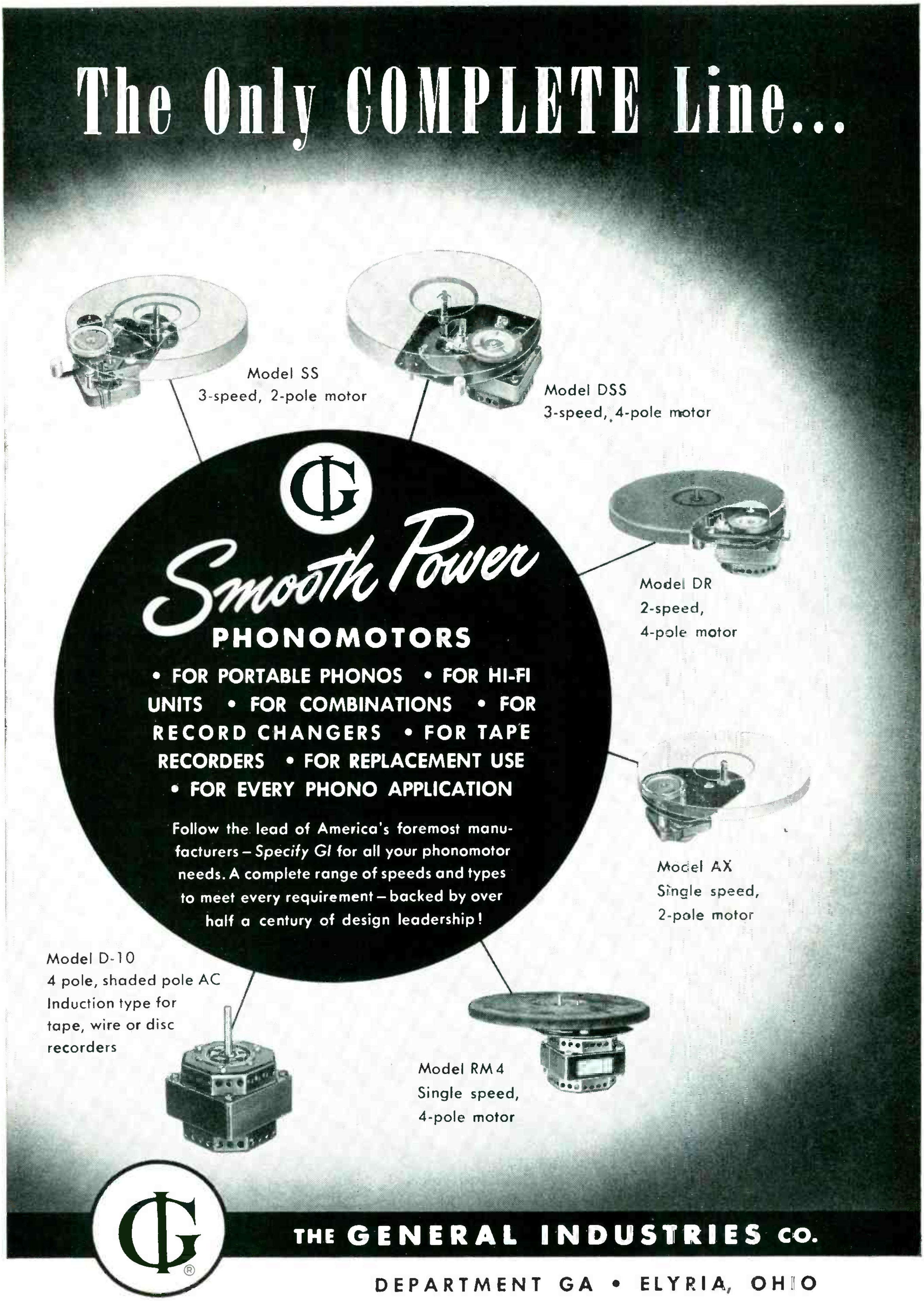
After a circuit is tooled and being produced, component value changes merely involve substituting new parts at the assembly station.

The laminated phenolic base strip insures against breakage in shipping and handling. Terminals are firmly staked to the base.

► **Wiring**—Connections between components are facilitated by embossing the copper wiring on the back of the base. This process is



Long strip has components in position before cutoff. At lower left is section cut from strip and at right is finished module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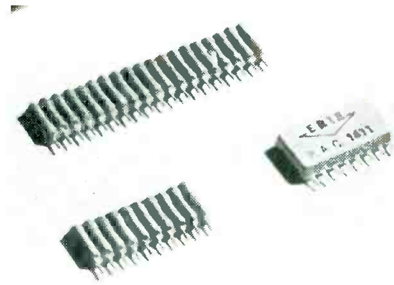


Comparison of dip-coated and molded packaging for modules

unique in that no chemicals are used in preparation of the circuit. The desired pattern of wiring is punched below the surface of the copper-clad laminate. Unwanted surface copper is then ground off to leave the wiring. Either 1-oz (0.00135-inch) or 2-oz (0.0028-inch) electrolytic copper foil is used.

Terminals are tinned flat stock having an enlarged portion near the unit to serve as an automatic stop for mounting. Dip-soldering gives intimate noise-free contact between terminals, contact clips, wiring and components.

The adhesive bond used with the laminate will withstand solder-dip temperatures up to 570 F for 2 seconds immersion or 500F for 10 seconds without causing blistering or weakening of the bond. When tested before soldering in accordance with NEMA standards, a peel strength of 6 to 8 lb is obtained.

Minimum line width and spacing is $\frac{1}{32}$ inch. Large conductor areas such as shields and grounds can be embossed if broken by picket-fence barriers.

After soldering, the unit is dipped or molded into a jacket of plastic for environmental protection and ease of manual or automatic handling. Finished dimensions are shown in Fig. 2.

PAC units are designed primarily for use with etched wiring boards. Components for one or several stages can be inserted in one plugging-in operation. If done manually, labor costs are drastically reduced as compared to individual insertion of components. If automatic insertion equipment is used, the number of insertion heads is correspondingly reduced.

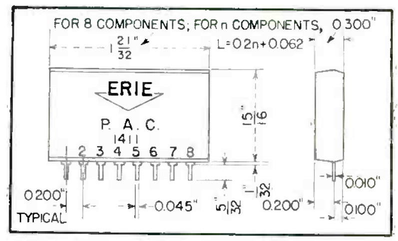
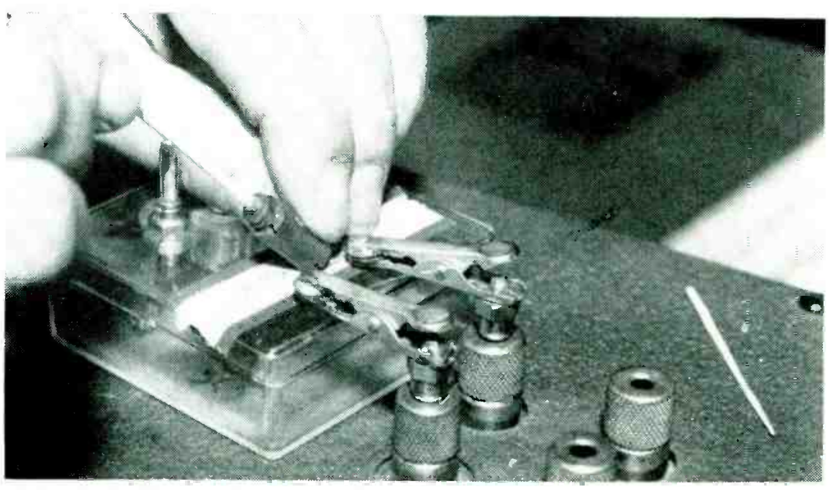


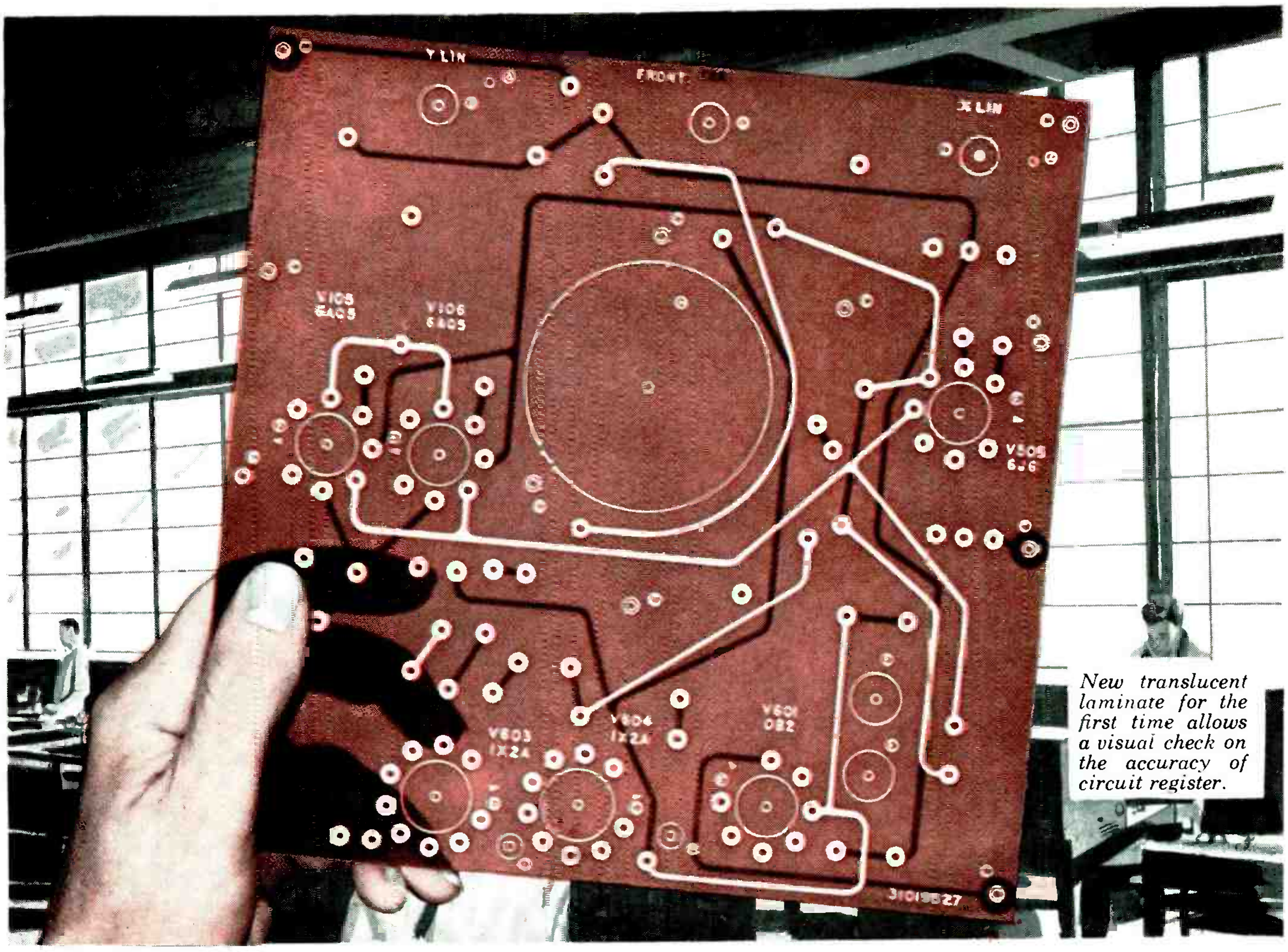
FIG. 2—Dimensions of finished unit and method of marking

Toothpicks Screwdrivers for Fragile Cores

WHEN SCREWDRIVERS snapped slot shoulders of sintered-iron cores during factory test adjustments in small coils for airborne radar, Fred Olney suggested using common toothpicks which would twist be-



Using toothpick to adjust sintered iron core while measuring inductance at production test setups



New translucent laminate for the first time allows a visual check on the accuracy of circuit register.

Formica Research perfects sensational new cold punching laminate

Brings 1,000,000 megohms resistance value, precision and translucency to printed circuitry . . . . .

Research, an important part of the exclusive new Formica 4-point service, has just perfected a new cold punching paper base laminate offering 1,000,000 megohms insulation resistance and valuable new translucent properties.

Known as XXXP-36, the new grade brings greater accuracy to printed circuitry. Because of its cold punching qualities, XXXP-36 requires no heat cycle. Therefore, the base laminate is not subject to dimensional change as in grades which must be heated before punching. This means that with Formica XXXP-36, you can now produce printed circuits with new and higher standards of accuracy.

XXXP-36 translucency can be doubly useful. Make this simple test: hold it to the light. You can see (1) the smooth, homogenous structure, the total absence of resin pockets, voids and imperfections that dissipate the insulating properties of ordinary paper base laminates . . . and (2) how perfectly the circuit on one side registers with that on the other. New XXXP-36 is ideal for terminal boards and tv insulators requiring high I. R. Formica's engineering skill can help you find new materials for new products and processes. For complete information on the new XXXP-36, or on the new "Formica-4" service, use coupon below. The Formica Co., 4640 Spring Grove Ave., Cincinnati 32, Ohio.

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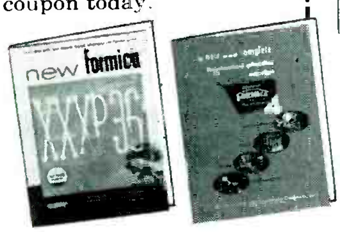
Make the Formica Translucency Test. Send for a sample XXXP-36 printed circuit. Fill out and mail coupon today.



Gentlemen:

☐ *I'd like a sample XXXP-36 printed circuit and complete information on this new grade.*

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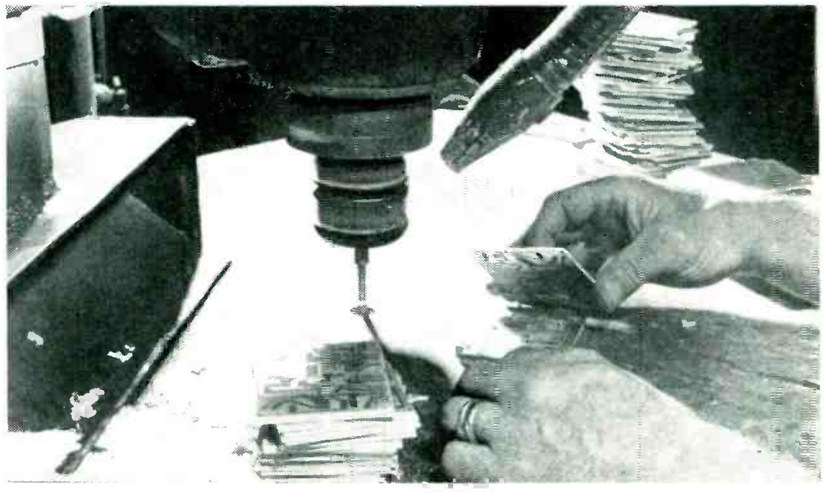
fore they snapped the shoulders and ruined the coils. The idea brought him a $225 suggestion award at General Electric's Light Military Electronic Equipment Dept. in Utica, N. Y.

Router Cuts Curves In Wiring Boards



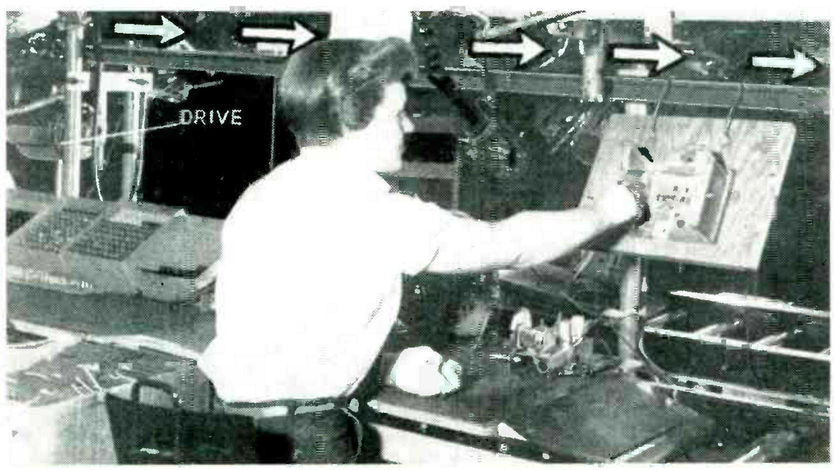
Placing board on template. Dust-collecting duct is at left of router

FINISHED etched wiring boards are cut to irregular shapes with the aid of a unique production setup involving a steel template and a router, in the Glen Cove, N. Y. plant of Photocircuits Corp. Each board in turn is placed over two positioning pegs on the template and the combination is then run under the router. A metal button directly under the router on the table of the machine serves as a stop for the template to give the required shape of cut without dulling the cutter through contact with the template.

A stream of compressed air is directed at the router to blow cut particles into a vacuum collecting duct just behind.

One-Way Pallet-Return Conveyor

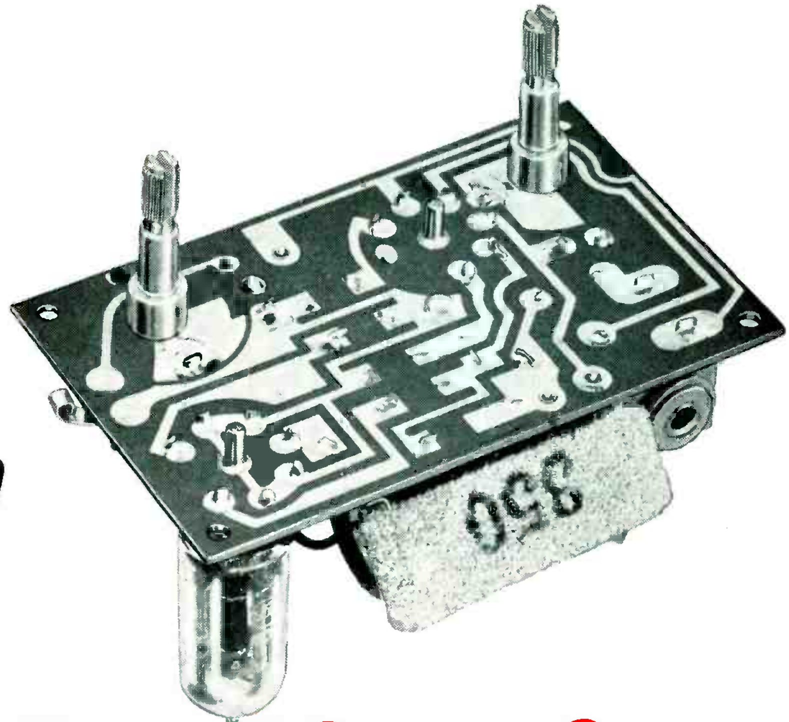
WHEN a new radio assembly line was first set up in Westinghouse's Metuchen, N. J. plant, delays were caused by the return of empty pallets to the start of assembly lines. With benches and equipment already installed, overhead and aisle space was at a minimum for me-

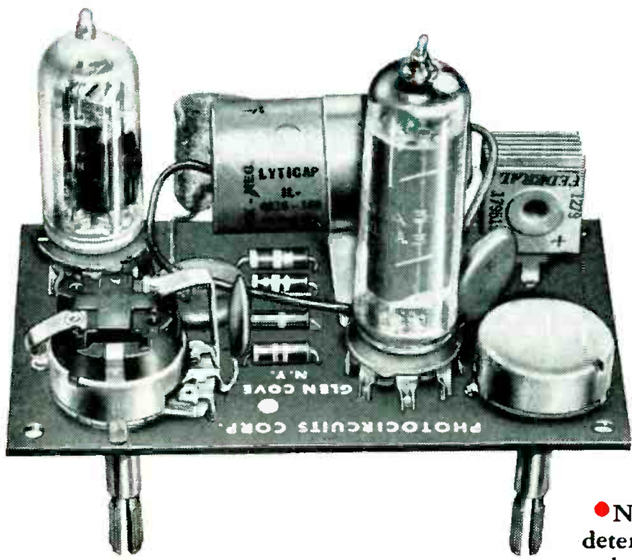


Hooks of empty pallet ride on rotating screw of monoflow conveyor

Speed up production with

REVERE ROLLED Printed Circuit Copper





Audio amplifier unit by Photocircuits Corp., Glen Cove, N. Y., using Revere Rolled Printed Circuit Copper.

Available NOW!

●Now that Revere *Rolled* Printed Circuit is available, nothing need deter you from switching to printed circuitry. This copper is supplied to laminators in standard coils of 350 lbs., in widths up to 38″, and in .0015″ and .0027″ gauges, weighing approximately 1 oz. and 2 oz. per square foot.

High in conductivity, uniformly dense through and through and side to side, Revere *Rolled* Printed Circuit Copper is easily etched and soldered.

When ordering blanks from your laminator, specify Revere *Rolled* Printed Circuit Copper.

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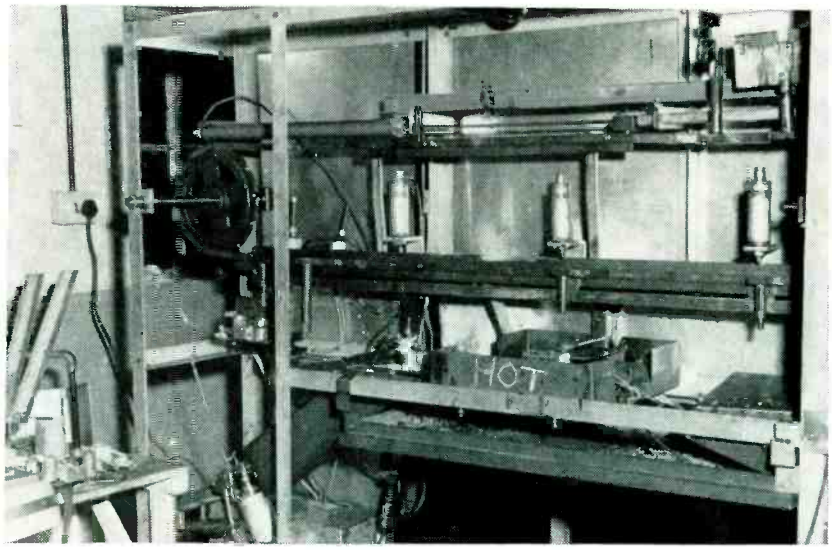
chanical handling of the pallet-return operation.

The problem was solved by ordering a rotating-cable conveyor 60 ft long, equipped with ½-hp motor drive. The conveyor extends the full length of the workers' bench lines at a convenient height of about 2½ ft above bench level. The conveyor consists of a flexible carbon-steel screw ¾ inch in diameter that turns in a metal retaining rail. The top of the rail is open to expose this screw. The wire hooks of empty pallets are hooked over the screw and are moved at approximately 12 feet per minute to a point at the start of production. These pallets can be placed on the conveyor at any time, at any point, in one motion.

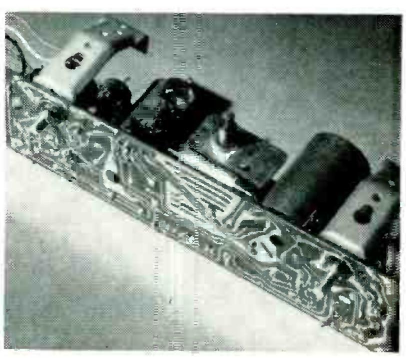
This type of rotating conveyor eliminates the need for a return strand or loop, thus permitting installation in minimum space. The conveyor was designed and installed by M-H Standard Co., Jersey City, N. J.

Double-Dip Soldering Uses Chassis Vibrator



Conveyorized dip soldering machine is operated by long air cylinder mounted horizontally at upper left. Assembled wiring board is taken from end of assembly line at left and hooked over bracket on lower chain. The three vertical air cylinders push the board down at the spray fluxing station (left), the soldering station (center) and the unloading or cleaning station (right)

By W. R. Cass
Pye Ltd., Radio Works
Cambridge, England



Appearance of board after soldering. Rubber caps protecting control shafts have been removed. Keyhole slots on brackets are used to attach chassis to carrier of soldering machine

A DIP soldering machine developed for use on radio etched wiring boards uses an overhead-chain conveyor driven intermittently by a long air cylinder. At the feed position, the operator hooks each assembled wiring-board pallet in turn onto brackets on the chain. The chassis is first moved to a flux spray position, then is given two dips in molten solder. During each dip and for a short period thereafter, the chassis is vibrated by air hammers to help break down oxide film on joints and to remove any excess solder.

Instead of having the chain conveyor dip down at each station, an air cylinder is mounted above each station. When the chain has come

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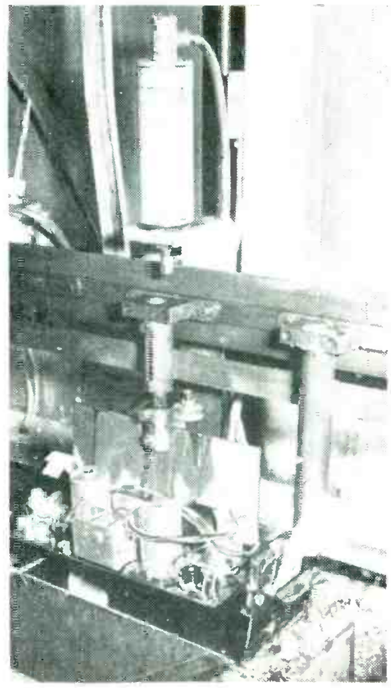
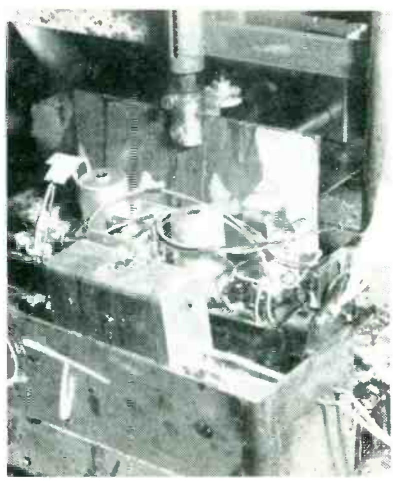


Spray fluxing station. Board is pushed down into baffles by air cylinder to minimize escape of spray during fluxing. Teflon wiper blade, mounted on conveyor chain ahead of wiring board bracket, wipes dross off solder pot at next station

to rest after an advance, the air cylinders are actuated to push the pallets down at their respective stations. The rod on the air cylinder comes down through a hole in the bracket on the chain to push down a spring-loaded inner shaft on which the pallet bracket is hung. The spring brings the chassis up again after the air cylinder has retracted entirely out of the bracket.

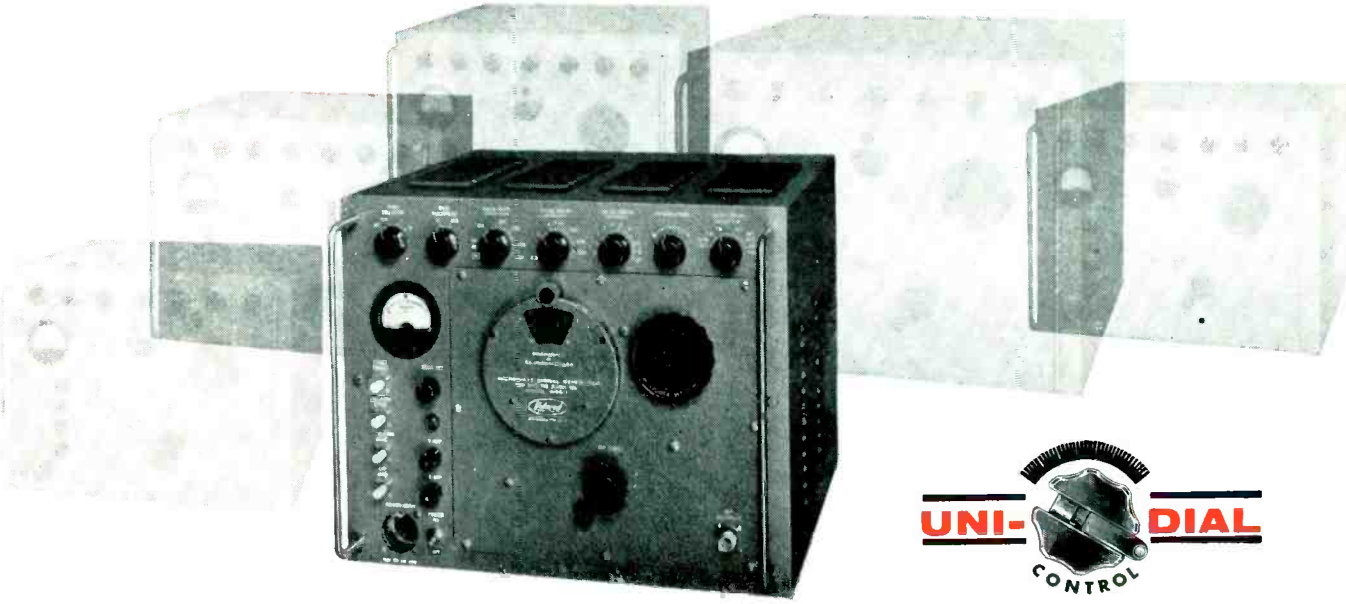
A hinged wiper blade is attached to a long rod bolted to the chain



Radio wiring board, hooked over conveyor bracket, is here in position over solder pot

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
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- 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**

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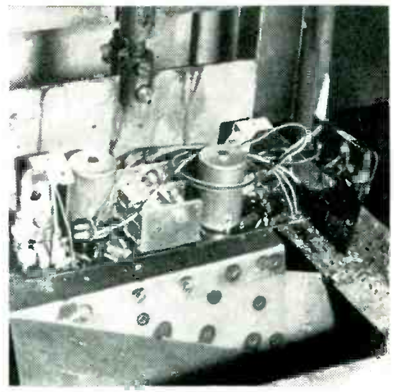


Unloading station. Air cylinder is provided here for use if cleaning is needed after soldering

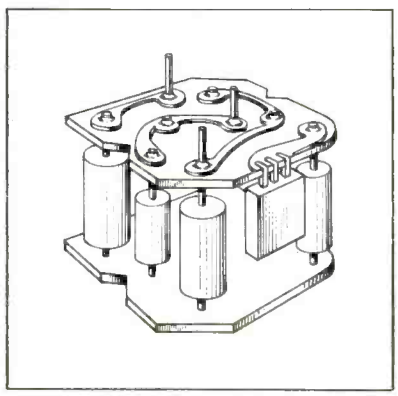
just ahead of each bracket, to sweep the dross off the solder pot just before dipping.

Silicone rubber caps are pushed over the shafts of the volume control and band-changing switch before dip soldering, to give automatic masking. The caps are gripped by the threads of the controls, and are easily removed afterward.

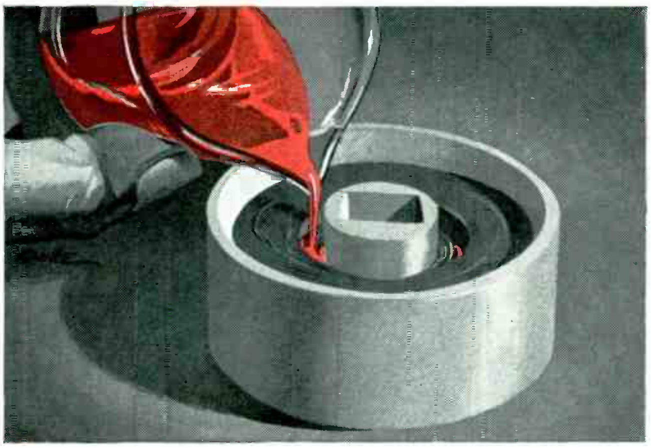
Modular Bundles Use Etched-Wiring Boards

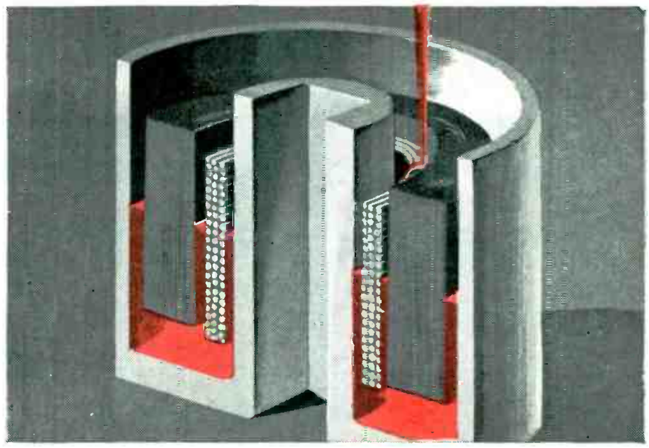
By Robert J. Roman
Eastman Kodak Co.
Rochester, N. Y.

Low-volume users of printed circuits look to mechanization for versatility and low tool cost, to permit frequent changes in the product without excessive change-over costs. This is very difficult to accomplish with machines alone. Great simplification of the problem has been achieved by stand-



Example of Paraplate bundle, showing how some leads can be left long after soldering, for use as interconnecting terminals. Multiple-lead couplates can be soldered into notches on edge of one plate, as on upper plate here



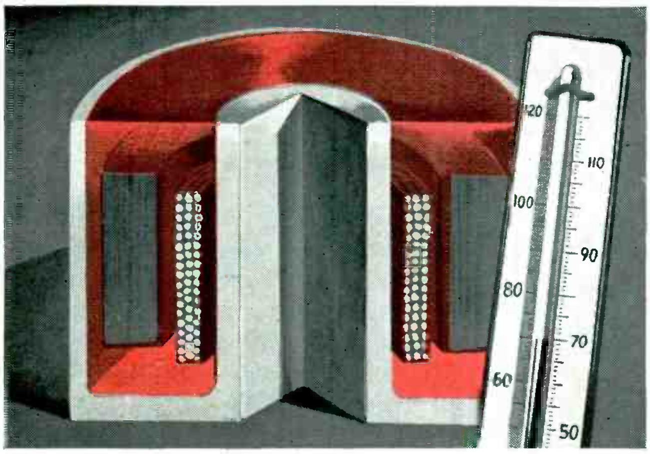


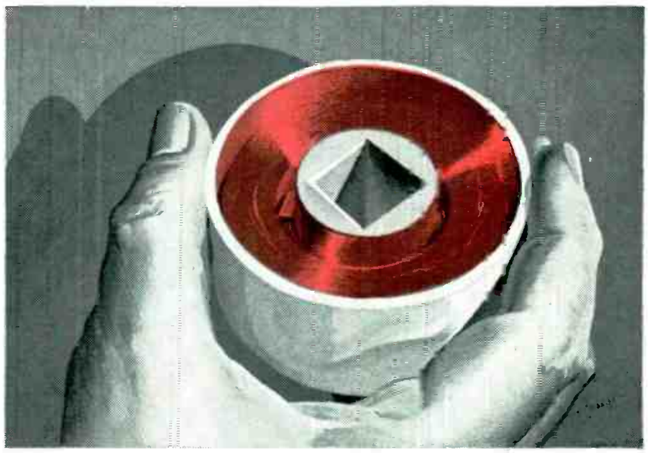
POURED AS A LIQUID

BAKELITE Epoxy Resin, mixed with hardener, is poured into place, without harm to fragile elements in the assembly. The mixture will cure with excellent adhesion to metal, ceramics or glass, bonding them firmly in position.

FILLS EVERY CREVICE

Low viscosity permits BAKELITE Epoxy Resin—hardener combination to penetrate extremely minute cavities. Air entrapment is minimized. Vibration or centrifugal casting reduces it further, aids in filling, and eliminates bubbles.





HARDENS WITHOUT HEAT

BAKELITE Epoxy Resins can cure at room temperature—another advantage where parts would be damaged by high temperatures needed to set other potting materials. Oven curing at low temperatures may be used for more complete reaction.

KEEPS ASSEMBLY SAFE

Cured BAKELITE Epoxy Resin resists shocks, chemicals, moisture. It keeps the assembly solidly embedded, safe from external hazards. Resin shrinkage is so slight as to be unimportant for most applications, but can be further reduced by use of fillers.

Potting and encapsulating with BAKELITE Epoxy Resins make delicate electrical assemblies stronger, easier to handle

Many electrical assemblies seem to grow more fragile as they become more efficient. But BAKELITE Brand Epoxy Resins are making them more serviceable than ever. Three different types of these resins are available for potting and encapsulating techniques. They can be cured by any of four specially formulated BAKELITE Epoxy hardeners designed to give a variety of viscosities and curing speeds, or by several conventional catalysts. We can help you pick the combination with the best set of properties for your product. In addition, there are BAKELITE Phenolic and Polyester Resins ideally suited to give you the widest selection of materials available. Find out what all these resins can do. Write Dept. BL-50.

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BRAND
EPOXY RESINS

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

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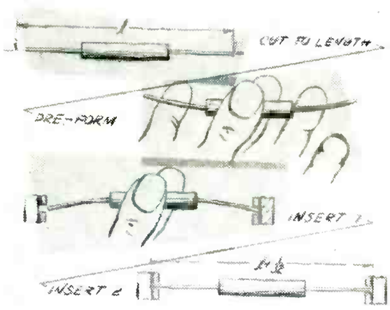
Method of soldering leads of subminiature tube to edge notches of board



Steps in inserting resistor manually

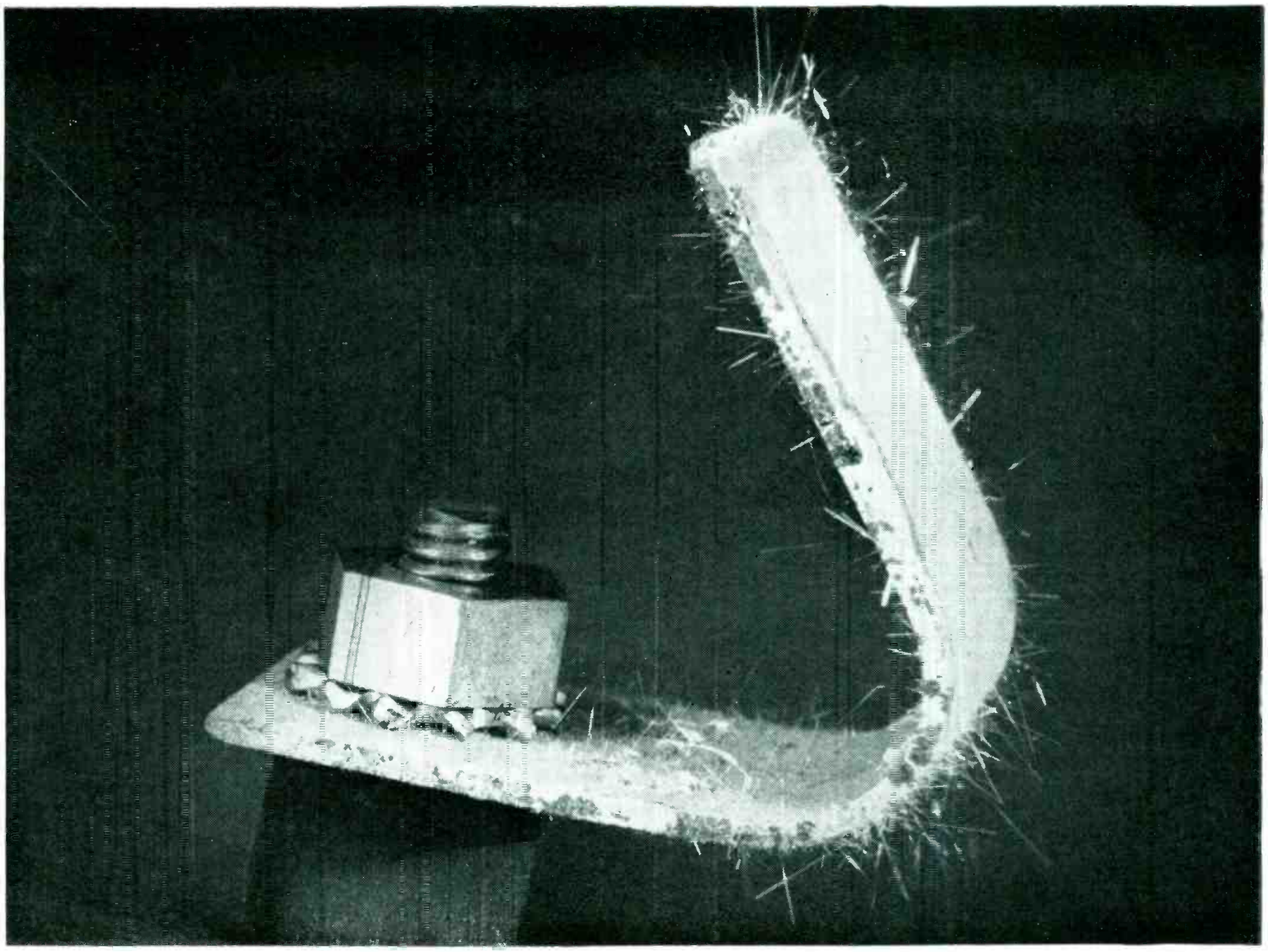
ardizing on a basic module for axial-lead components, called a Paraplate bundle. Here the components are installed between two parallel etched-wiring boards and the connections are dip-soldered in two operations.

Nonaxial-lead components, such as tubes, transistors and switches, can be added at any time by using slot-soldering terminations around the edges of the boards. A slotted termination is ideal for this application as it will not close up or bridge when dip-soldered without a wire inserted.

► **Advantages**—When properly supported, modules of this type satisfy varied environmental requirements at least as well as the average components they support. For most component groupings, the bundle requires less total etched-wiring-board area than most flat mounts.

Space characteristics are exceptionally good for most component groupings. The two-plate construction allows for crossovers without expensive, troublesome double-sided prints. Exclusive of any mounting structures which may be required, the bundles are self-supporting.

An improved new assembly method for the modular system



Whiskers on tin-plated steel, enlarged 6 times. Immense yield strength of metals in whisker form was discovered by Bell scientists.

The clue of the metal whiskers

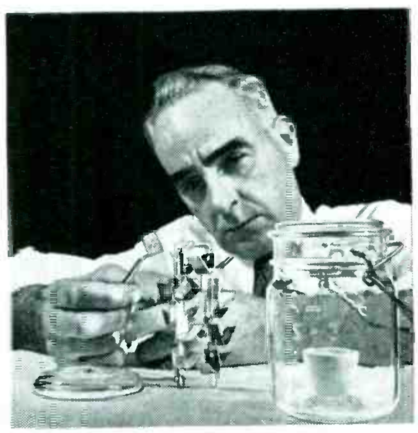
The habit of close observation at Bell Laboratories often turns "tremendous trifles" into important scientific progress. Such a case occurred when unexplained short circuits in wave filters seemed to be associated with a zinc-plated mounting bracket.

Close scrutiny disclosed a whiskery growth on the zinc plating. Similar whiskers of tin were found growing on tin-plated equipment. Studies showed the whiskers to be tiny single crystals of metal.

Suspecting that these unusual crystals might be of essentially perfect structure, alert Laboratories scientists saw an opportunity at last to test an important metallurgical theory.

The scientists studied the whiskers, grew larger ones, and showed that the crystals had enormously high yield strength as predicted by the theory for perfect crystals—a strength far greater than for the same metal in any other known form. This clue has opened new frontiers in the study of what makes metals strong or weak, and has excited metallurgists all over the world.

Thus, another new advance has come out of the Bell Telephone Laboratories practice of scrutinizing *everything* that can play a part in better telephone service.



Through the study of thousands of specially cultivated whiskers, Bell scientists seek to prevent treacherous growths in telephone equipment.

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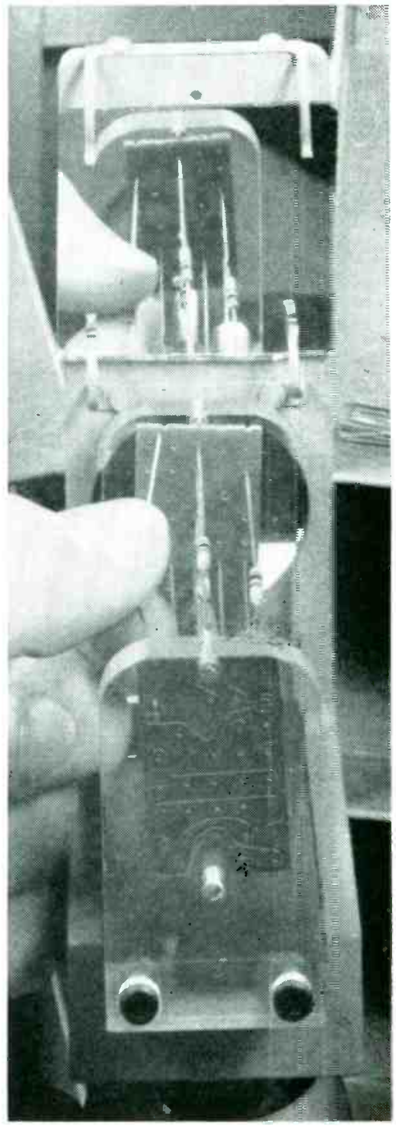

Method of inserting component by hand. Mirror at rear aids operator in putting lead into board closest to her

features ready adaptability to high or low production with negligible tool and equipment cost.

With the two $\frac{1}{16}$-inch-thick etched wiring boards held against back-up plates at some distance $L - \frac{1}{32}$ inch, where L is the cut length of all components, the component is inserted in four steps: (1) precut to length L; (2) preform slightly to decrease overall length approximately $\frac{1}{32}$ inch; (3) insert first component lead; (4) insert second component lead; (5) straighten leads.

▶ **Manual Assembly Fixture**—The U-shaped assembly cradle has a steel base with clear plastic back-up plates affixed to each end. As the printed circuit plates do not have to be accurately located, they are

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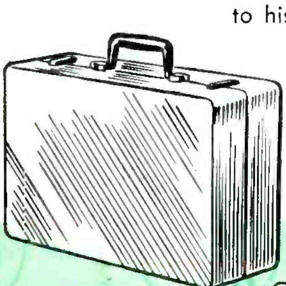

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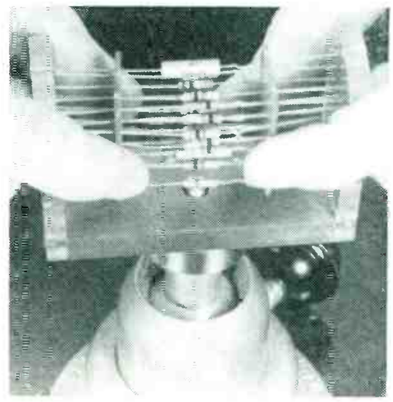
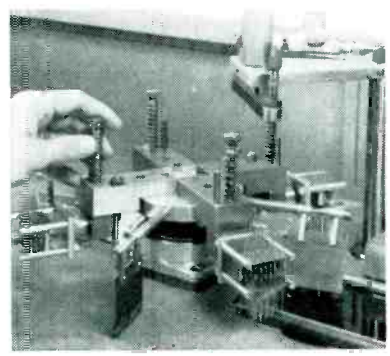
Work setup of manual assembly, using bench fixture to hold wiring boards



Pushing wiring boards together after inserting all components



Setup used for fluxing and dip soldering after loading boards manually

affixed to the back-up plates with simple spring clips. Each station has a universal holding fixture with an inset Alnico magnet for firmly gripping the cradle. An adjustable mirror on the holding fixture allows the operator to see both plates at once. Depending on the volume and complication of the bundle being run, two or more work stations can be lined up, with bundle cradles passing from one to the other.

When all components have been assembled, an operator removes the bundle from its cradle after first pushing the wiring boards together

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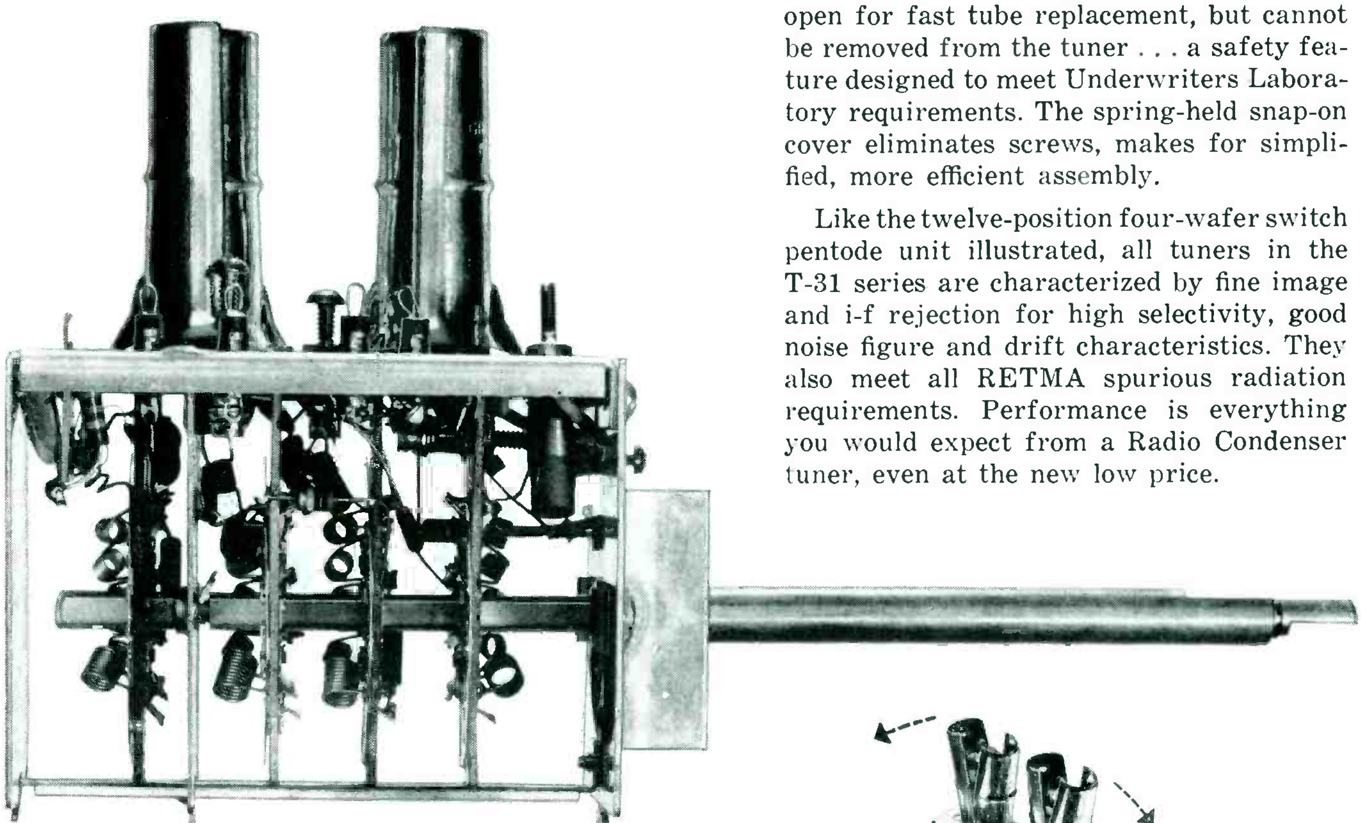
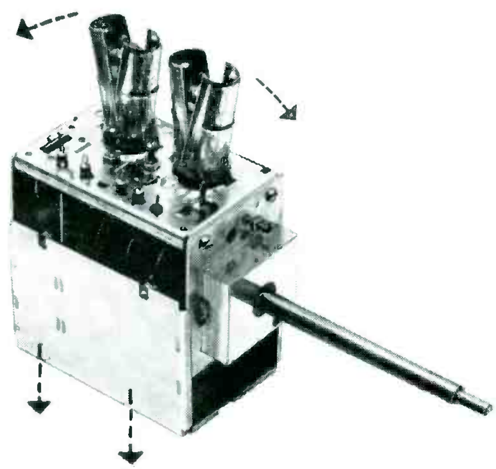
...in vhf-TV tuners

NOW . . . all the desirable performance characteristics of Radio Condenser's well known T-31 series vhf-TV tuners in a completely new package. Designed for greater safety and easier installation, the new T-31 carries an even *lower price*, because of mechanized production methods now in effect.

Here are just a few of the design improvements that make the new T-31 far superior to the original. As you can see in the illustrations, tubes are mounted at the extreme right, for easier installation beside large cathode ray tubes. Captive tube shields snap open for fast tube replacement, but cannot be removed from the tuner . . . a safety feature designed to meet Underwriters Laboratory requirements. The spring-held snap-on cover eliminates screws, makes for simplified, more efficient assembly.

Like the twelve-position four-wafer switch pentode unit illustrated, all tuners in the T-31 series are characterized by fine image and i-f rejection for high selectivity, good noise figure and drift characteristics. They also meet all RETMA spurious radiation requirements. Performance is everything you would expect from a Radio Condenser tuner, even at the new low price.





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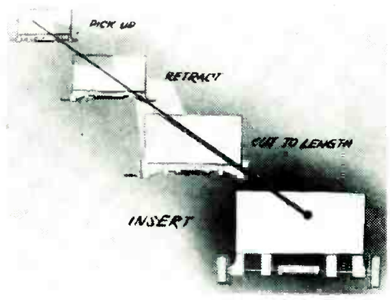
EXPORT: Radio Condenser Co., International Div., 15 Moore St., N.Y. 4, N.Y. *CABLE: MINTHORNE*

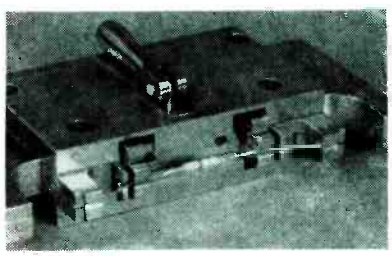
CANADA: Radio Condenser Co. Ltd., 6 Bermondsey Rd., Toronto, Ontario to the final bundle distance. The bundles are then inserted in the holders of a dipping machine, where all joints are dip-soldered automatically.

▶ **Automatic Insertion Head**—The basic principle of the retraction insertion head developed for mechanized assembly is not altogether different from the manual method. The component is first picked up by a four-jaw head. The two inner jaws lock against the wire when closed, but the two outer or metering jaws permit the wire to slip when closed. When the inner jaws retract in the second step, about $\frac{1}{16}$ inch of wire is pulled through each metering jaw and stored in the loop. After the excess wire is cut off in the third step the head has both wires in excellent length and coordinate control. The head is then placed in position between two etched-wiring boards and the inner jaws are returned to their original position to complete the insertion.

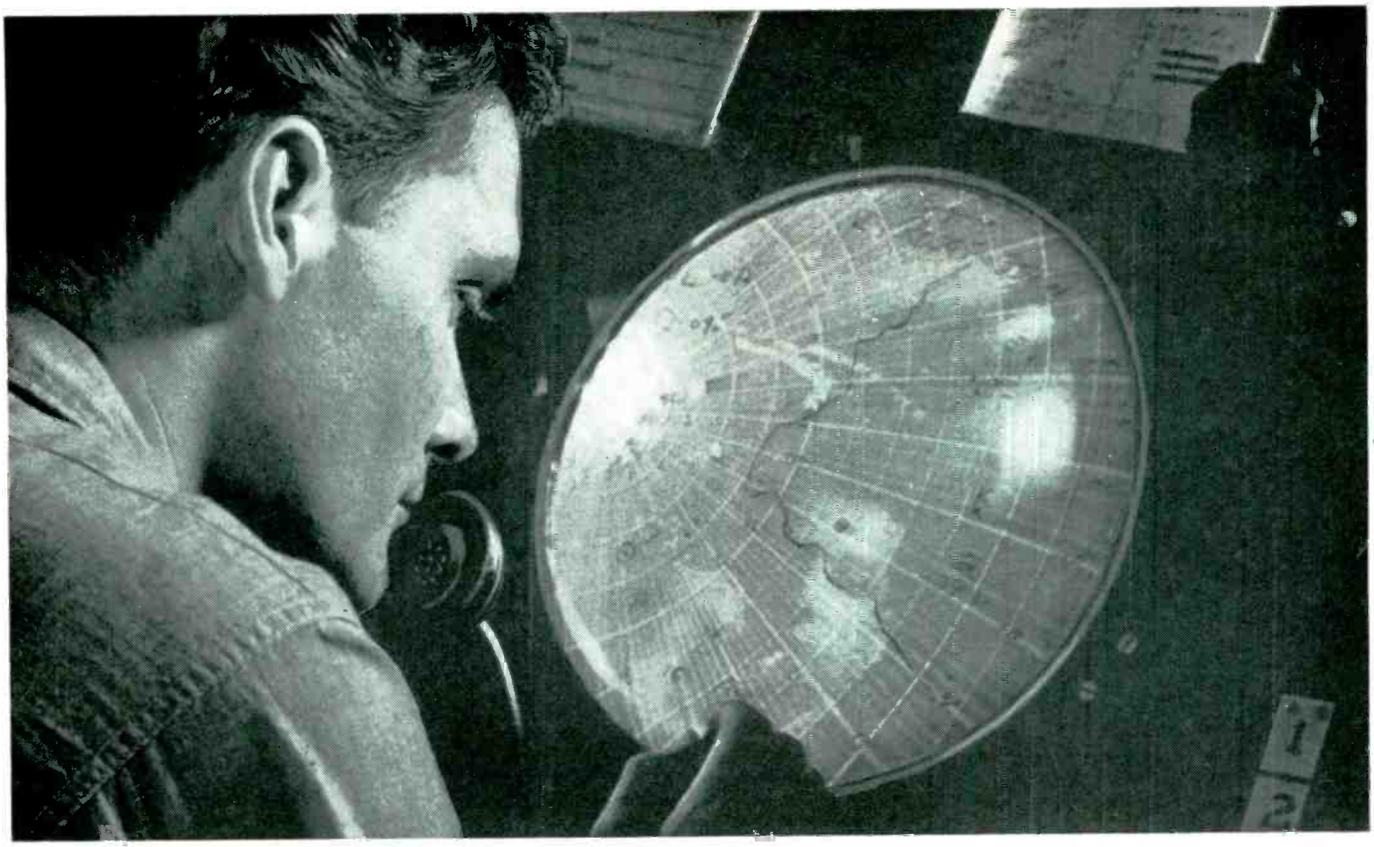
▶ **Automatic Assembly Machine**—A proposed in-line transfer machine has etched-wiring boards carried from station to station on platens or cradles in a manner similar to the hand method. Insertion head assemblies are mounted in pairs at each station. The head will pick up a component, retract and cut, then move between the circuit plates for an insertion. Horizontal and vertical



Steps in achieving automatic insertion



Basic tool used for automatic insertion



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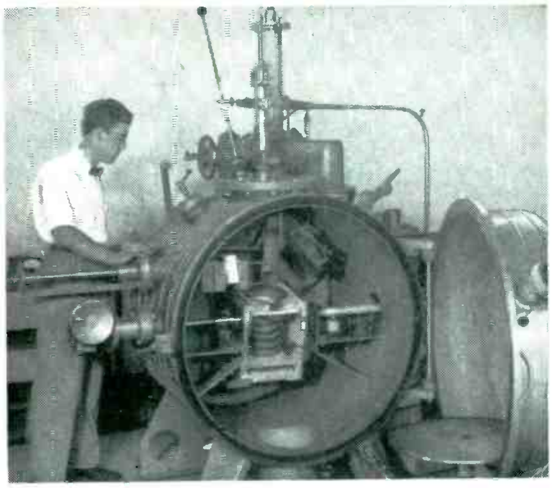

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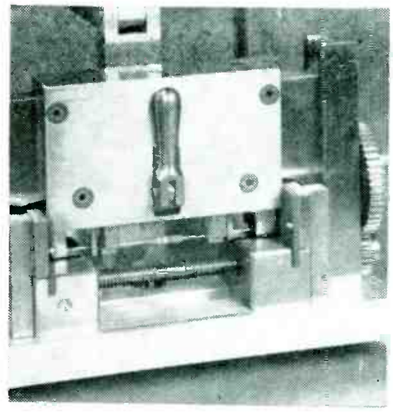


Inserting head, shown just as it is putting resistor into holes of etched wiring boards held on positioning pegs in fixture

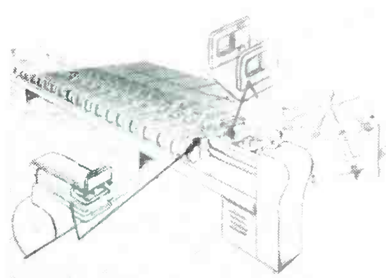
position adjustments are made independent of head motion. Since the head will accommodate a wide range of components, accurate direct-reading adjustment devices can be employed to minimize changeover time.

Etched wiring boards are fed in at one end of the machine and completely assembled bundles removed from the other. Although the machine is planned for magazine-type board feed and an automatic-bundle-transfer head, the feed and removal can be accomplished in any way consistent with the size of the run.

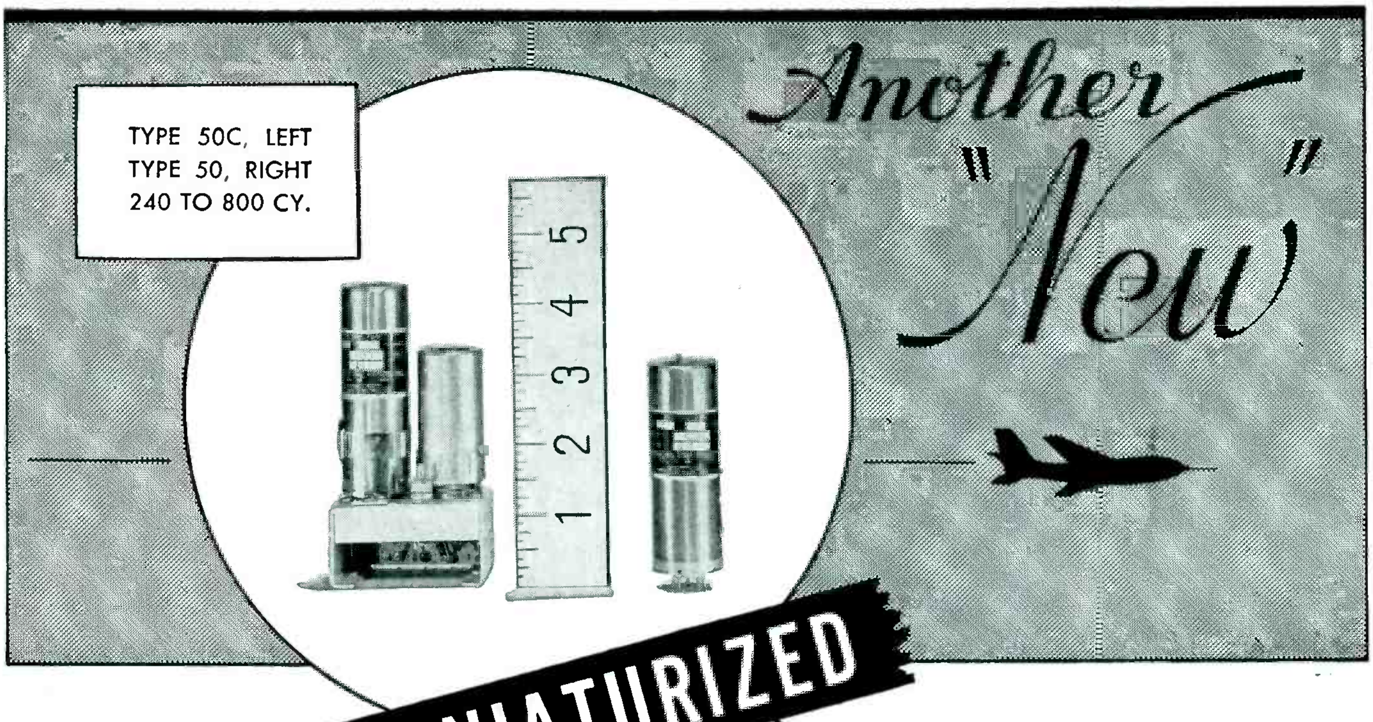
Here, as with the hand method, bundles are transferred to another machine for dip soldering.

▶ **Automatic Soldering Machine**—The transfer head at the output of the assembly machine would be equipped with cutter plates which cut excess wires during the transfer cycle. The bundle is transferred to a relatively simple holder on the dipping machine.

The soldering machine is basically an indexing-turret type with



Sketch of automatic assembly and soldering setup planned for use with Paraplate bundles



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SIZE....2 1/4" x 2" x 4 3/8" high. WEIGHT....8 ozs.
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OUTPUT.............................5V into 250,000 ohms
TYPE R50C......................Same as Type 50C with accuracy of ±.002% from 15° to 35°C

PICTURED AT RIGHT, ABOVE

TYPE 50 SPECIFICATIONS

SIZE....1" dia. x 3 3/4" high. WEIGHT....3.5 ozs.
ACCURACY............±.02% from —65° to 85°C
OUTPUT.............................5V into 250,000 ohms
TYPE R50..........................Same as Type 50 with accuracy of ±.002% from 15° to 35°C

For 17 years this company has produced precision frequency standards for integration in highly accurate instruments and timing devices of our own and other manufacture. We make frequency standards within a range of 30 to 30,000 cycles, a field in which we offer maximum accuracy, simplicity and durability. Our products are now serving in many and varied applications—in industry, government (including the armed services, particularly in the field of aviation) and for laboratory uses.

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OPERATING UNDER PATENTS OF WESTERN ELECTRIC COMPANY vertical-acting dipping arms, similar to the prototype operating on the hand line. The dipping machine features simplicity of action and peninsular location of solutions.

Making full use of advantages gained by modular restrictions and the reliable simplicity of retraction insertion, the inherently high-capacity multihead machine is easily adapted to economical low-volume operation. It is estimated that a 40-head machine equipped with suitable short-run component programming could be completely changed over in less than 15 minutes.

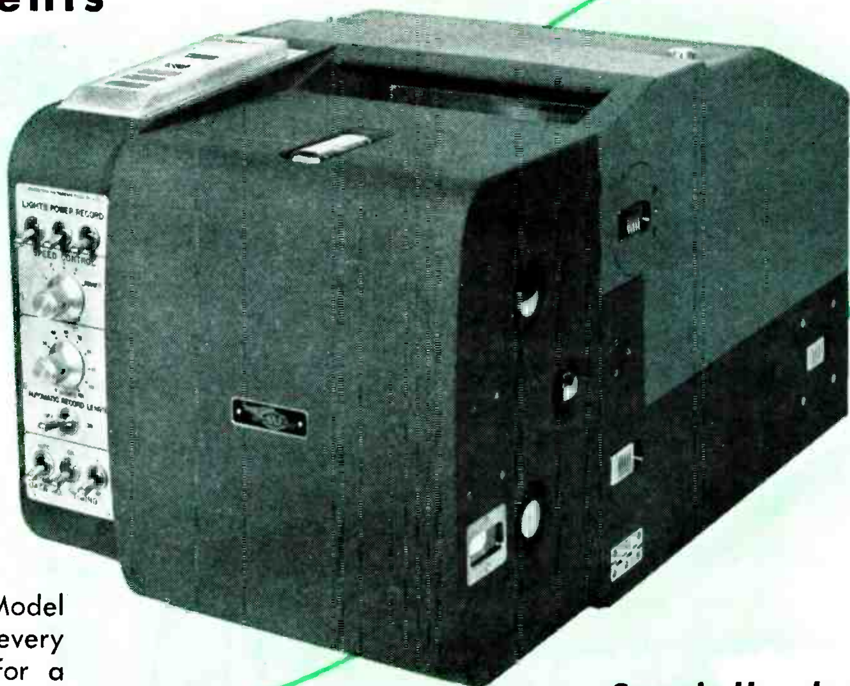
Dip-Soldering Clamp Masks Tube Socket

Immersing board in first soldering pot. Cake of beeswax in left hand will be wiped over next pot before transferring board to it

A SPRING-LOADED clamp assembly welded to the jaws of long-nosed pliers serves as a convenient tool for holding a small wiring board during dip soldering in RCA's Indianapolis plant. Squeezing the plier handles together opens the disk-shaped jaws of the clamp enough to permit placement over the tube socket. When the jaws are released, the entire tool serves as a handle for immersing the board in the pool of molten solder. The metal disks of the clamp prevent solder from getting into the tube socket contacts.

Two solder pots are used side by side. After immersing the board in the first one, the operator wipes a cake of beeswax over the surface of the second pot and immerses the board in this, to complete the

A uniquely NEW Oscillograph from Midwestern Instruments



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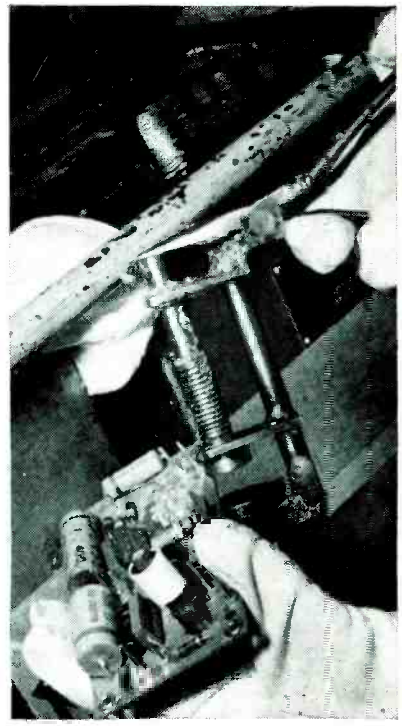
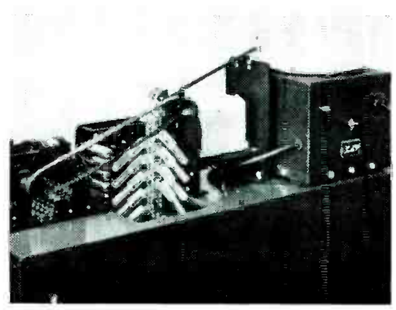


Method of placing clamp over socket of wiring board

buildup of solder over each of the clinched leads. The double-pot technique has greatly improved the reliability and uniformity of dip-soldered joints on etched wiring boards used in the firm's radio and television receivers.

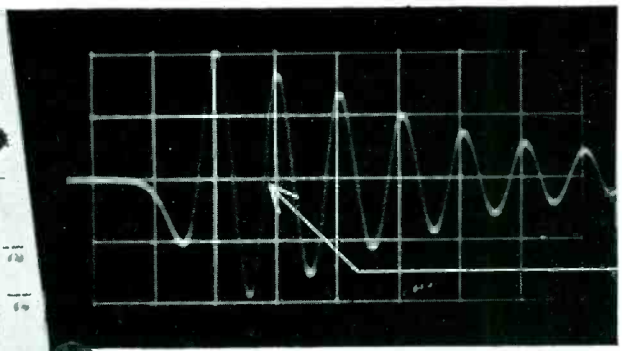
Automatic Tester for Ferrite Memory Cores

FERRITE storage cores are automatically tested and graded by International Telemeter Corp. of Los Angeles with a new machine incorporating a Syntron model EB-01-B vibrating parts feeder. The cores are placed in the feeder, which lines them up and delivers them down a chute to a mechanism that sorts into sixteen uniform

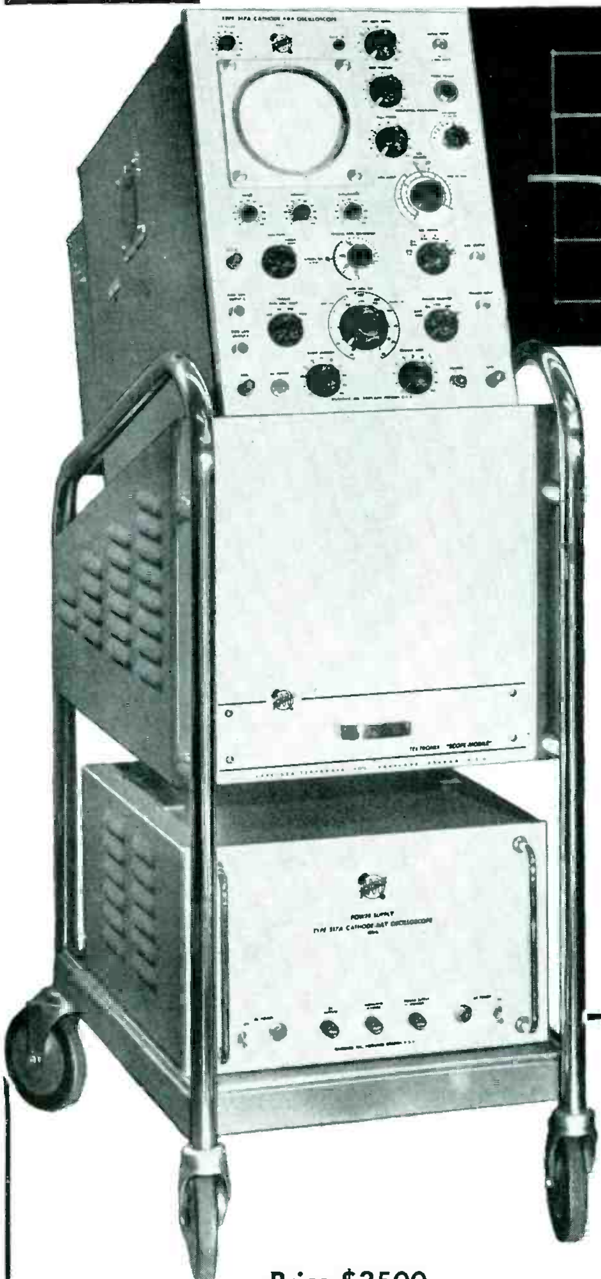


Core tester, with feeder at right, sorting mechanism at center and motor drive at left

1100-cm/μsec writing rate!



Arrow indicates 1100-cm/μsec writing-rate point on 100-mc damped oscillation, displayed on single 0.01 μsec/cm sweep of Type 517A Oscilloscope with T54P11H crt. Recorded on 35-mm TRI-X film at f 1.9 with 4.2 to 1 reduction, developed 26 minutes in D-19 at 68° F.



The Tektronix Type 517A Cathode-Ray Oscilloscope has the high writing rate, faithful transient response, fast sweeps, and dependable stability necessary for accurate analysis of single high-speed occurrences. Improvements in several performance areas, made possible by the development of a new Tektronix high-voltage cathode-ray tube, make the Type 517A even more useful than its famous predecessor, the Type 517. Sensitivity of the Type 517A is double that of the Type 517, both sweep and vertical linearity are improved, and the viewing area is increased to a full 4 cm by 8 cm. An automatic duty-cycle limiter prevents accidental damage to sweep-circuit components. The exceptional performance characteristics and accurate display of the Type 517A can speed up progress in work involving high-speed transients.

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15 to 15,000 cycles, accurate within 5% of full scale.

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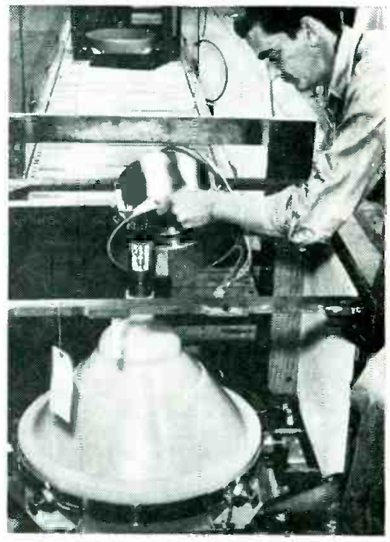
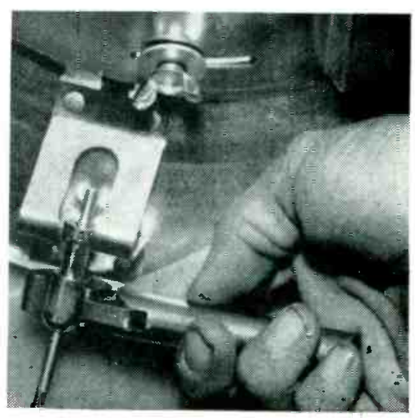
grades on the basis of magnetic properties. The tester is able to handle one core per second; in this time, as the core passes through the test contacts, 5,000 separate trials of each of two tests are made.

Mounting Picture Tube in Color TV Cabinet



Placing yoke assembly over neck of color picture tube. Tube rests on molded plastic ring which can be seen in cabinet at rear on conveyor

ON THE final cabinet assembly line for 26-tube color-tv consoles in RCA's Bloomington, Ind. plant, the cabinet is placed face down on a wood slat conveyor. This position simplifies the installation of the molded plastic support ring for the picture tube, which is fastened with wood screws driven by an air gun. The picture tube, with molded plastic jacket over its metal wall and



Using special cam-action ratchet wrench to tighten knurled nut on one of three tie rods that hold picture tube assembly against front of cabinet

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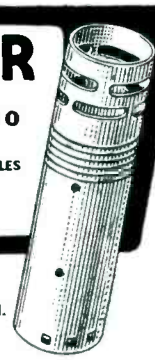

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Method of degaussing yoke assembly. Earth's-field compensating magnets can be seen on band surrounding rim of picture tube. Yoke tie-rods go to metal inserts in wood corner brackets

with the earth's-field compensating magnets mounted around its rim, is then lowered into position on the plastic ring.

The yoke assembly is brought down over the neck of the picture tube, and three steel tie rods are run from the cabinet to the frame of the yoke to hold the entire picture tube assembly in position. A special ratchet wrench is used to tighten the knurled nut that goes

New 26-tube color-tv consoles on wood shipping pallets ride down slat conveyor at lower level and are pushed up over rollers on incline to start of next slat conveyor at higher level, for passage through screened and partially darkened final test rooms

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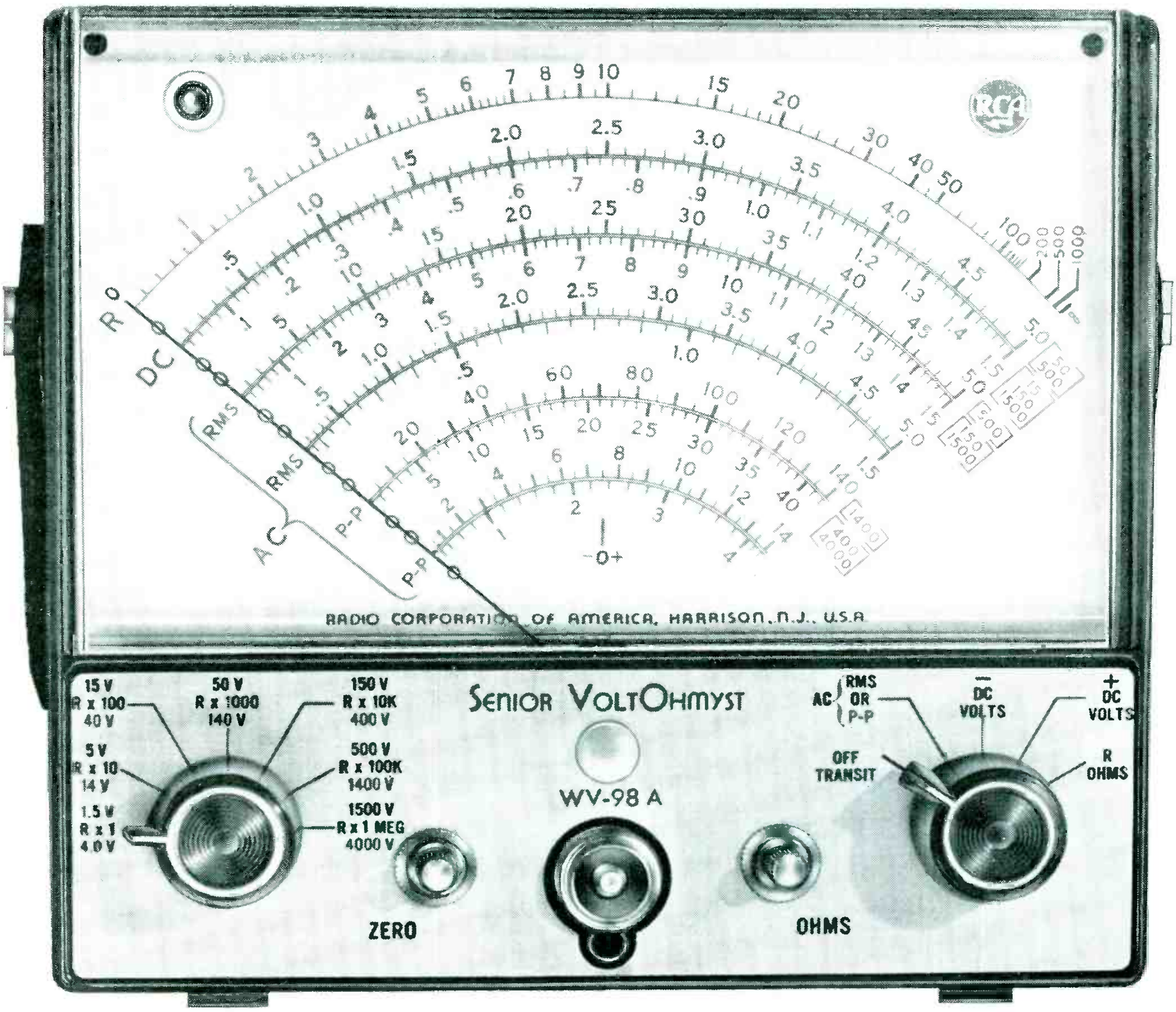

Senior VoltOhmyst, RCA WV-98A, only $75.00 User Price* including probe and cable, instruction booklet, complete and ready-to-use . . . Shown slightly smaller than actual size.

* Optional

New!

You can work faster, more accurately—when you own and use the new RCA WV-98A SENIOR VOLTOHMYST with the extra-large full-vision meter-face. "Speed-up" in your service work—without the slightest sacrifice in quality—means a "build-up" in your profits. Look at the easy-to-read expanded scales. Then look at some of the other advanced features you also get.

- Large, easy-to-read, wide-vision meter (6½" w).
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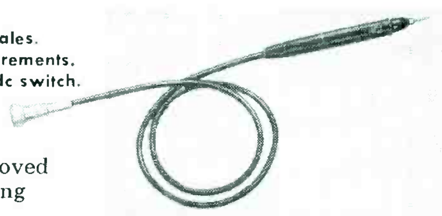
The all-new WV-98A has all the important, time-proved performance features of earlier VoltOhmysts including direct reading of peak-to-peak voltages of complex waveforms. See this highly accurate, versatile, service instrument at your RCA Distributor! Order now.



NEW! WG-299A slim, single unit DC/AC-Ohms Probe and Shielded cable is provided with the RCA WV-98A. Probe has handy built-in switch permitting instant selection of dc or ac/ohm operation.

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RADIO CORPORATION of AMERICA

TEST EQUIPMENT ***HARRISON, N. J.***

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over the threaded end of each tie rod.

The final step is degaussing the yoke structure. This is done by lowering over the neck of the picture tube a large coil connected to the 115-volt a-c line, leaving it there about 10 seconds, then slowly lifting up the coil.

After mounting the picture tube, the cabinet is turned upright and assembly is completed at subsequent positions on the conveyor. The back cover and the removable top of the cabinet are put on last. The top is made removable so that servicemen can reach in from above to adjust the earth's-field compensating magnets around the rim of the picture tube.

Substitutes for Eyelets in Etched Wiring

By L. J. MARTIN and M. J. VAVRA
Weapon Systems Development Laboratories
Hughes Aircraft Co.
Culver City, Calif.

OPEN circuits and poor joints are a major threat to etched circuit reliability. Open circuits are most apt to occur in the vicinity of connections to component leads, either through failure of soldered connections or through breakage of the etched conductors. Bond strength between the conductor and laminate is limited and may be impaired if a connection is overheated by hand-soldering, as in replacing components. These conductors are unable to withstand heavy stresses applied by component leads if these stresses tend to pull the conductor away from the laminate or even to rotate or shear the bond. They are, however, amply immune to stresses directed toward the laminate. This is illustrated in Fig. 1.

Connections should be protected

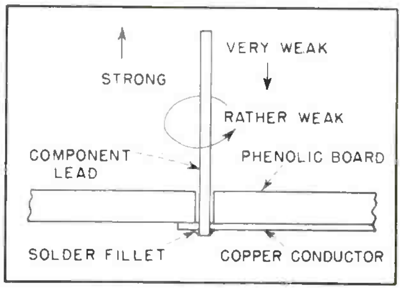

FIG. 1—Ability of conventional lead to withstand stresses in various directions when soldered to etched wiring board

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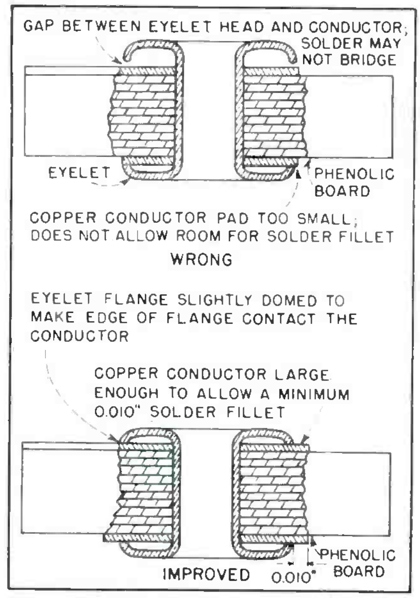

FIG. 2—Forming of eyelets on etched wiring

from those stresses to which they are weak, either by forming the leads and placing the components to prevent these stresses or by reenforcing the connections with eyelets.

▶ Drawbacks of Eyelets—Eyelets frequently are used to provide interconnection between etched wiring on opposite sides of the board, as well as to provide mechanical bonding of the conductors to the board. This use of eyelets allows repeated change of components without danger of lifting the conductors from the base material. These eyelets, however, form additional links in the wiring and unless properly used may be a source of unreliability. Gold-plated or solder-plated eyelets wet readily when solder-dipped, this being essential for obtaining reliable joints. After plating, the eyelets should be cleaned, dipped in stearic acid flux and baked dry.

Installation of eyelets is accomplished by applying controlled pressure to a pair of eyelet-heading dies. The shape of the forming cavity of the die is important. Improper forming of the eyelet heads may cause poor solder joints, as illustrated in Fig. 2. Improper eyeletting can, and has, caused unreliability of the most troublesome kind because, when corrosive flux residues become trapped under their heads, failures may develop

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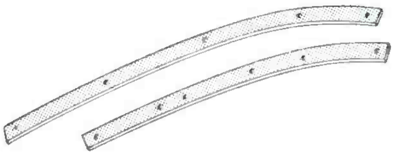
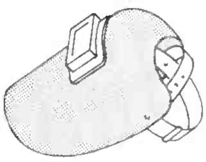


Sealing strips for crew doors of 4-engine commercial transport plane are made from Taylor canvas base phenol laminate . . . chosen for its flexibility and long-wearing qualities.



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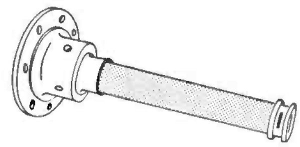

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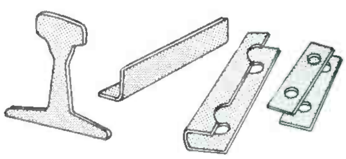

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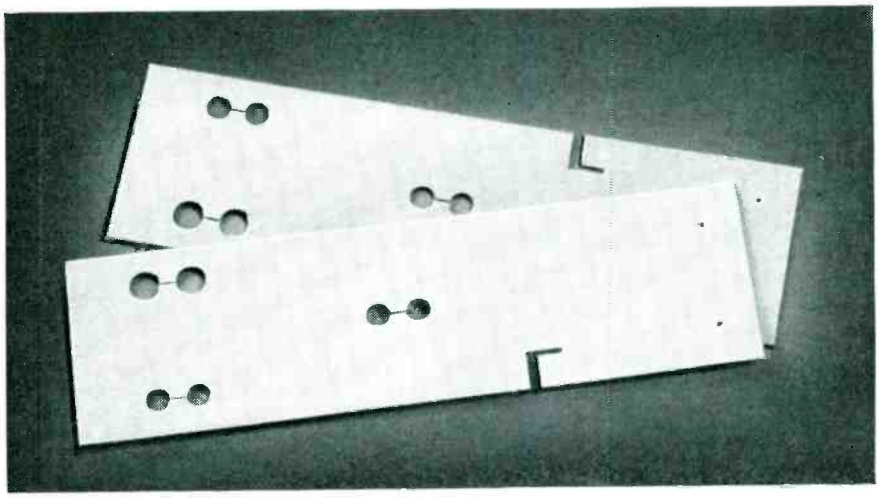

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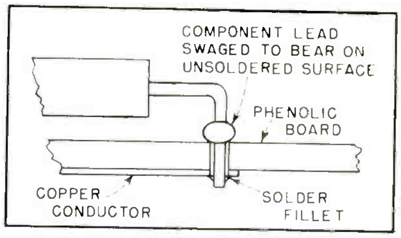

FIG. 3—Method of swaging component lead to obtain greater mechanical strength in etched wiring assembly

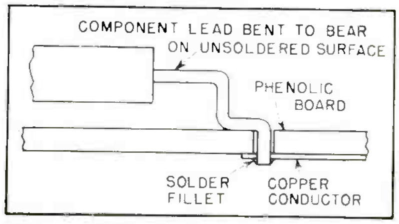

FIG. 4—Method of forming component lead to obtain greater strength

later. Not only are proper forming and soldering difficult, but the labor required is costly and this destroys much of the economic attractiveness of dip-soldered etched circuitry. Consequently, there is a trend toward eyelet elimination.

►**Eyelet-Eliminating Techniques**—If wiring boards are to be produced without eyelets, provision must be made to insure that the stresses applied to the leads of components cannot be transmitted to the conductor on the board in such a manner as to tear it away from the base material or fracture it. This can be done by swaging the component lead on the unsoldered side, as shown in Fig. 3. Another method is to form the lead in such a manner that it bears against the unsoldered surface for a short distance before it enters the hole (Fig. 4). Still another way is to arrange the components for edge-dipping as in Fig. 5. This provides

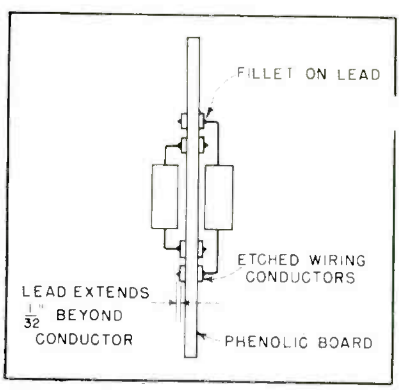

FIG. 5—Arrangement of components for edge dip soldering, to obtain strong fillets on both sides of board

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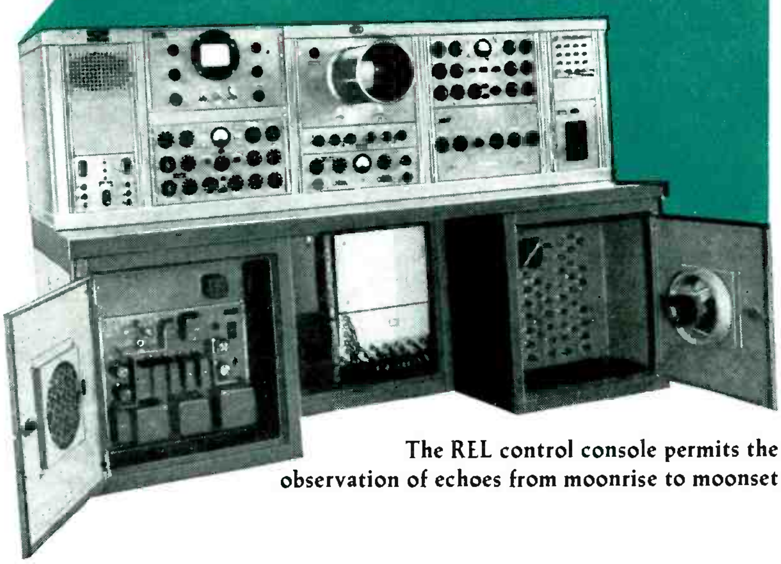

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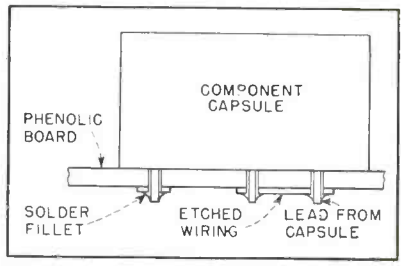


FIG. 6—Mounting component flat on board gives greater strength

a fillet of solder around the lead on both sides of the board, preventing the stripping of conductors from the board by a force exerted on the lead from the component side of the board. Eyelets also can be eliminated when leads emerge from the bottom of a component capsule, as in Fig. 6.

► **Coatings for Wiring Boards**—After the etched circuit assembly has been completed, it often is desirable to coat the board to control subsequent surface contamination. The requirements of a good protective coating are: high humidity resistance consistent with good recovery properties; adequate electrical properties; cure at 75C or less so that the coatings can be cured in the presence of temperature-sensitive components; good physical properties such as adhesion to the board; transparency so color coding can be recognized; easy application in the required thickness.

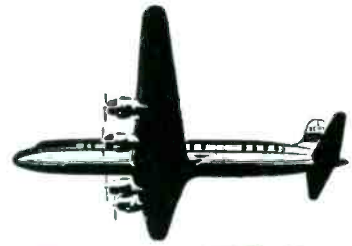
Although the ideal coating which will meet all of the above requirements has not been found, coatings can be selected which will most closely meet the desired application.

A 5-mil coating, although difficult to apply, gives a reasonable compromise between good humidity protection and rapid recovery. Thicker coatings show greater resistance to humidity exposure but show slower recovery after long exposure and also make component replacement very difficult.

Grounding Wiring Boards

AFTER installation of the assembled etched-wiring boards on the metal chassis with self-tapping screws, an operator on Admiral's assembly line solders certain of the screws to the chassis to insure good per-

AEROCOM'S 1046 H. F. TRANSMITTER



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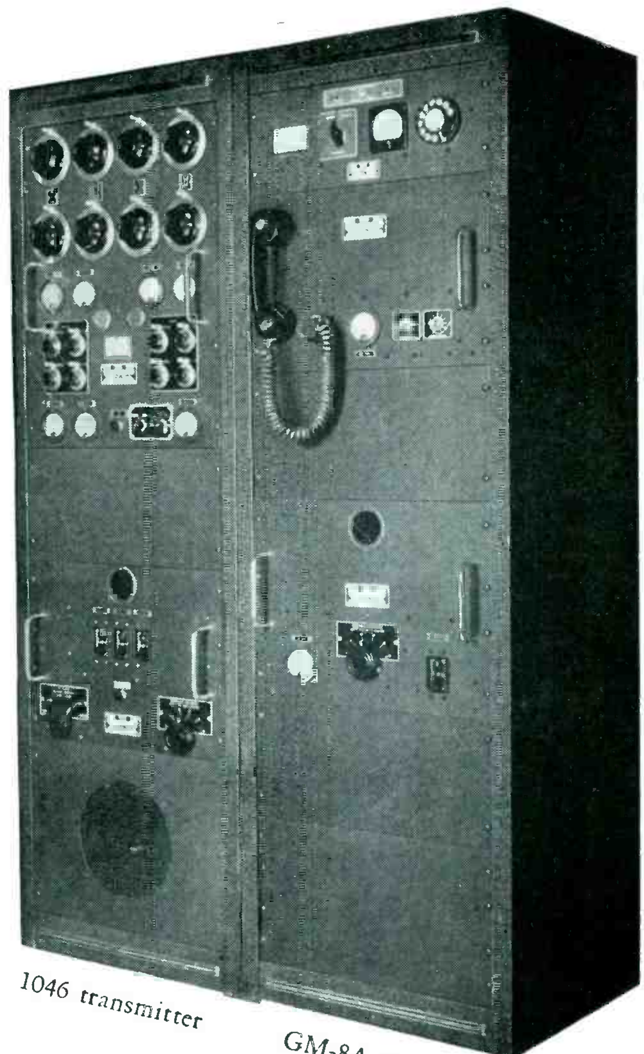

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Transmitter cabinet has 8¾ inch panel space available for either local dial control panel or frequency shift keyer.

Model 1046 operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.0—24 Mcs. Operates on one frequency at a time; channeling time 2 seconds. Operates into either balanced or unbalanced loads. Operates in ambient -35° to+50° C. Power supply: nominal 220 volts, 50-60 cycles, single phase.

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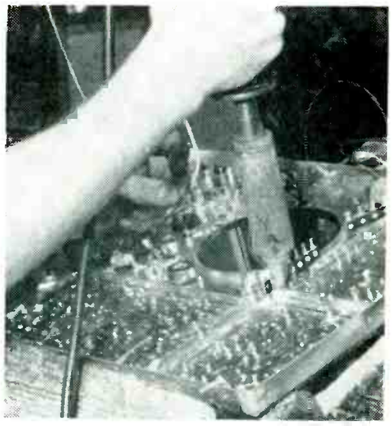

Soldering insures good ground to etched wiring by anchoring mounting screw permanently in position. The solder here doesn't reach the etched wiring itself

manent r-f grounds for the etched wiring in critical circuits. Solder from an overhead spool is fed freely to each of these grounds after heating with the iron. Two irons are used alternately, since the metal chassis cools an iron faster than it can heat up again on a moving conveyor line operating at about a 30-second cycle.

Terminal and Marking Tools Added to Wire Cutter

THE ADDITION of terminal-attaching and wire-printing mechanisms to an Artos automatic wire-measuring, cutting and stripping machine brings further speed and production economy in preparing large quantities of wire leads for use in electronic equipment. The new TA-20-S machine made by Artos Engineering Co., Milwaukee, can be op-

Wire-cutting machine with terminal attacher at right end. Reel of prefabricated terminals can be seen at upper right, with wire supply reel just below. Terminals are attached at only one end of each lead. Wire printer, not shown here, mounts on bar projecting at left of machine another outstanding feature . . . REEVES

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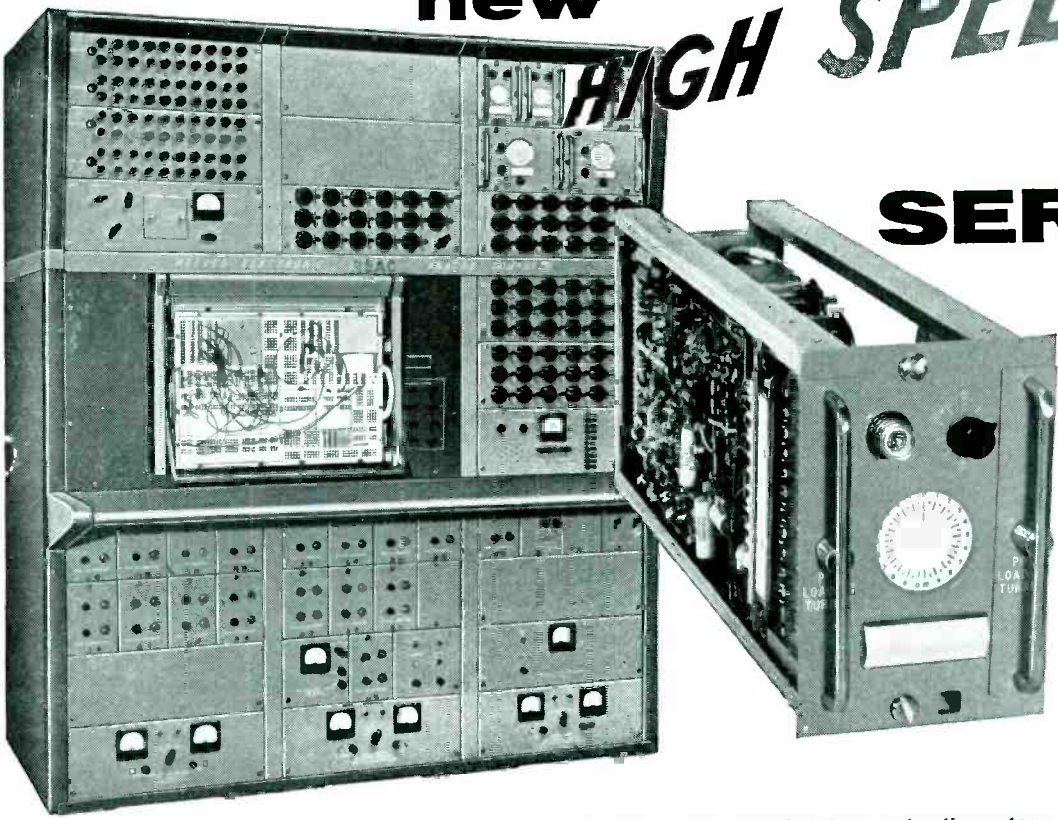

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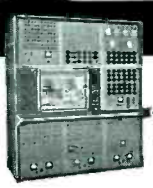
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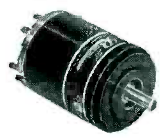
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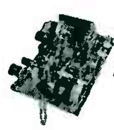
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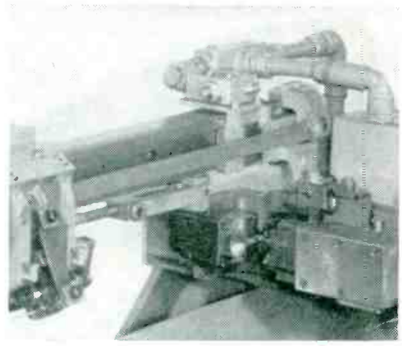
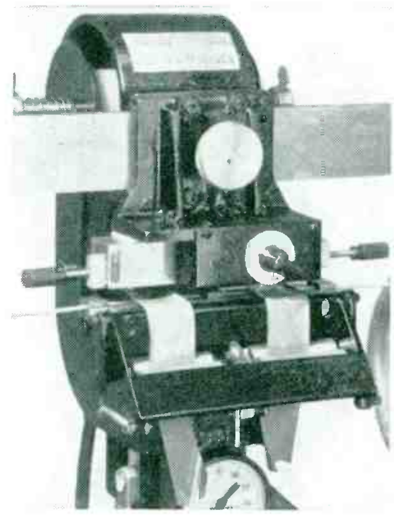


Terminal attacher, showing cone-shaped die into which the traveling overhead wire gripper pushes the stripped end of a lead



Lead-marking attachment mounted on steel bar at input end of machine

erated by unskilled labor once it is set up. Die units are simply and quickly changed.

▶ **Terminals**—The motorized terminal attacher is mounted at the right-hand end of the machine and synchronized with the operation of the wire cutter. The traveling overhead wire-gripper pulls out the wire the desired distance for cutting, then moves further to the right to bring the stripped end into the terminal die unit. Simultaneously, a switch is actuated by the overhead mechanism to operate the terminal-attaching unit. Various types and sizes of terminals can be handled if available in strip form on reels.

▶ **Printer** — The attachment for printing identifying nomenclature on the wire is clamped to a steel bar projecting out from the input of the machine, so that printing is done before cutting and stripping. This bar also supports the

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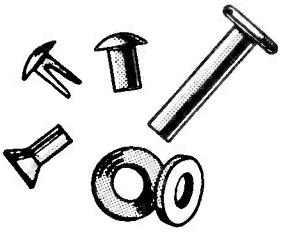

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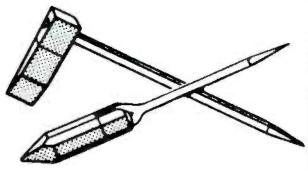

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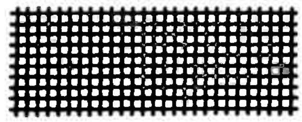

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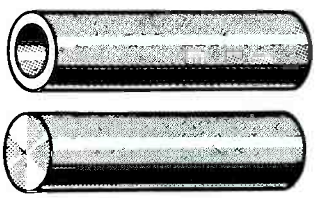

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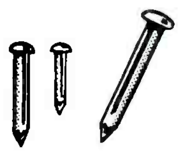

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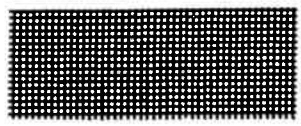

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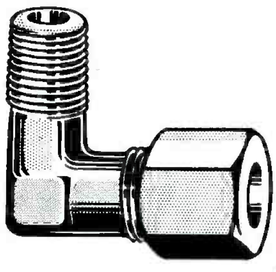

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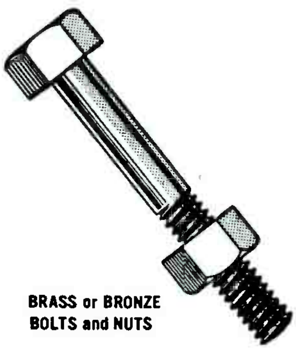

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compensating mechanism for the wire prefeeder. The printer is a dual unit, with the printing units about 3 inches apart. The printer is positioned in such a way that it is centered on the point at which the wire will later be cut. It operates each time the wire puller stops, so as to give a printed identification near each end of each lead.

Production of Curved Etched-Wiring Boards

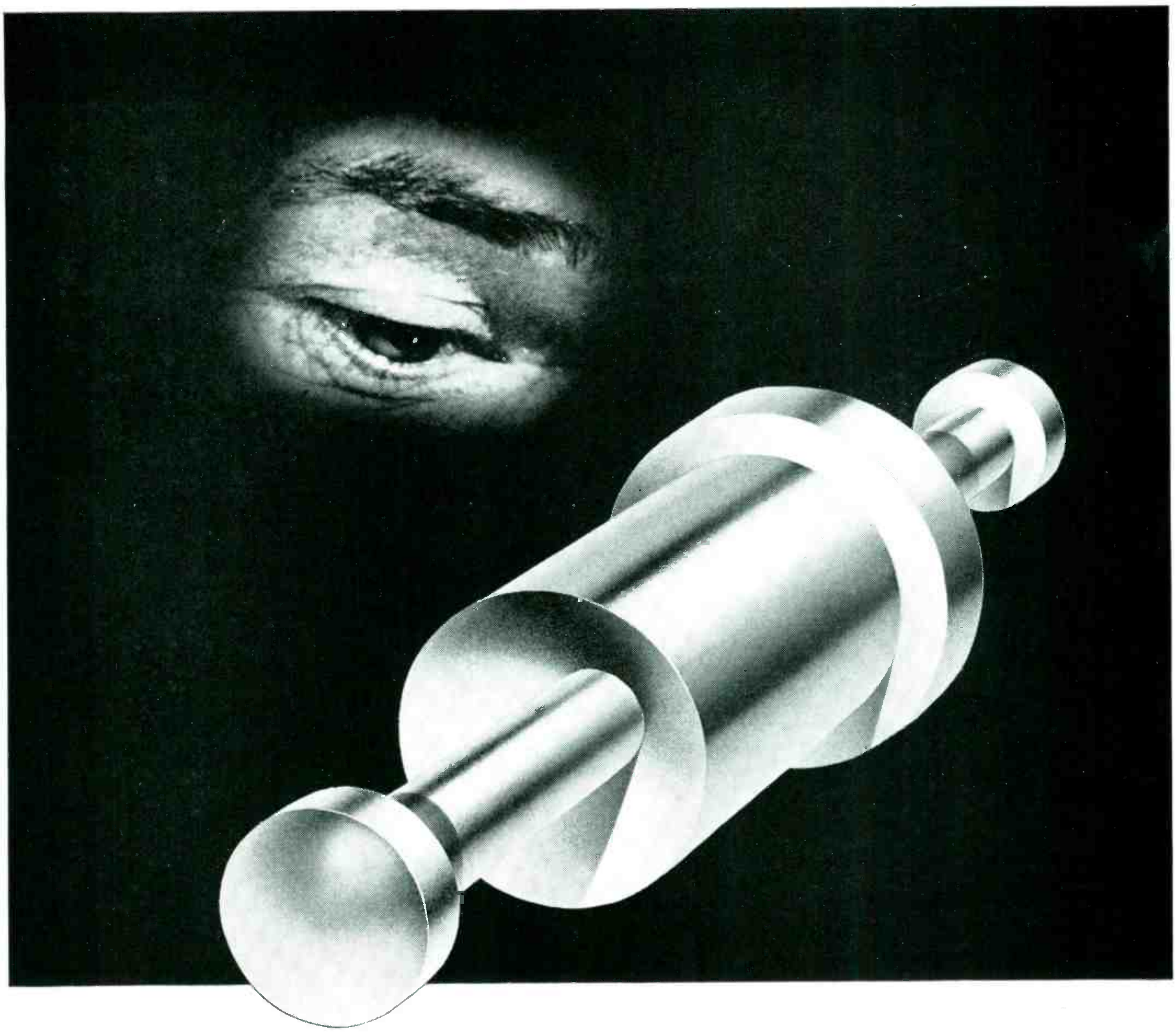
POST-FORMING of etched-wiring boards has been placed on a production basis in the Minneapolis plant of Bureau of Engraving, Inc. Thermocontact presses provide preheating and special rollers do the actual forming.

Partially cured laminates, rigidly tested for forming ability, shrinkage, delamination and ability to hold the radius after forming are used for the base material. Nylon-base phenolics and glass-base epoxy resins are examples of materials that have proved satisfactory.

▶ **Forming Procedure**—After the board is etched on one or both sides, it is placed in a timer-controlled hot-plate press for 30 to 120 seconds at 250 F to 350 F, depending on the material. High-temperature rubber plates in the press provide good overall thermal contact. The timer automatically opens the press at the end of the selected heating cycle. The board is then immediately transferred to a specially designed roller-type press for the actual forming.

The board is sandwich-rolled

Placing board in heating press to soften base material



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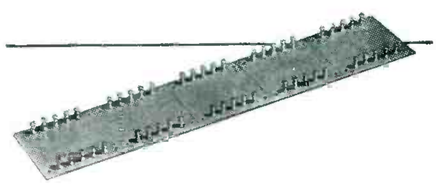
Besides terminals, we pay close attention to the production of CTC terminal boards, capacitors, swagers, hardware, insulated terminals, coil forms and coils. For all specifications and prices, write to Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast Manufacturers contact: E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 and 988 Market St., San Francisco, California.

Terminal Data: Our standard terminal line includes 30 types, each in varied shank lengths. Made of silver plated brass, coated with water dip lacquer to keep them chemically clean for soldering. Also available: combination screw and solder terminals in 3 sizes, and a complete line of phenolic and ceramic insulated terminals. All materials, processes and finishes meet applicable government specifications. Special order finishes include hot tin, electrotin, cadmium plate or gold plate.

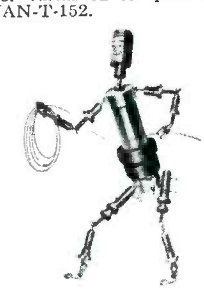


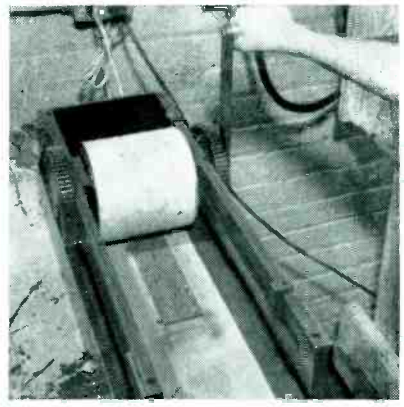
Standard CTC Terminal Boards as well as those made to your own specifications by CTC are available. Standard in cotton fabric phenolic, nylon phenolic or grade L-5 silicone impregnated ceramic. Custom made in cloth, paper phenolic, melamine, or silicone fibreglas laminates, imprinted as required and lacquered or varnished to specifications MIL-V-173 and JAN-T-152.

CTC

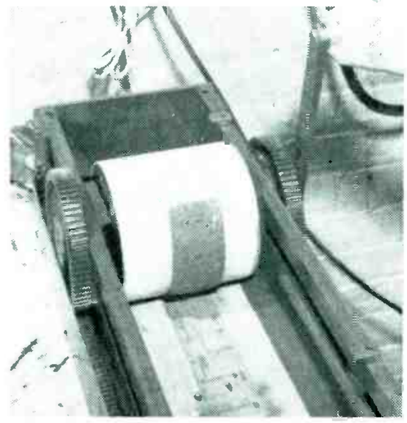
CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components, custom or standard





Board in loading position on bed of forming press



Curved board emerging from roller after slow cooling

within a felt layer that extends the cooling time to prevent thermal shock. Even pressure of the roller prevents damage to the delicate wiring on both sides of the board, permitting forming to an inside radius as small as three times the thickness of the material. Studs and components are now added after forming, but experiments are under way involving forming after insertion of components.

Locating Heater Shorts

When a cathode-heater short develops during aging of tubes in batches of 100, a heavy-duty relay or switch is closed to burn out the heater and thereby eliminate the short. This technique saved $375.00 per year when first introduced in Sylvania's Emporium plant as a result of a suggestion by Donald Crawford.

The previous technique involved pulling tubes out of the aging rack one at a time until the shorted tube was located. This meant pulling up to 100 tubes.

John O. Gantner, Jr., President of Gantner of California, reveals why

"She always has the last word!"

"They say a woman will always have the last word. It's certainly true when she shops for a swimming suit!

"She waits till the last possible minute, and insists she get the 'last word' in style. Pressure on stores is terrific. If 'hot' styles run out of stock, those sales are gone forever.

"But our retail accounts know they can depend on Gantner. "Gantner styles can be restocked to any store in the country in a few hours, *while the ads are running*. Not a moment is lost — not a sale is lost — thanks to Air Express!

"And one last word — about costs. Specifying Air Express can save you money, too. 15 lbs. from San Francisco to Chicago, for example, costs $10.91. That's $1.09 less than any other complete air service!"

Air Express

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

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

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New Products

Edited by WILLIAM P. O'BRIEN

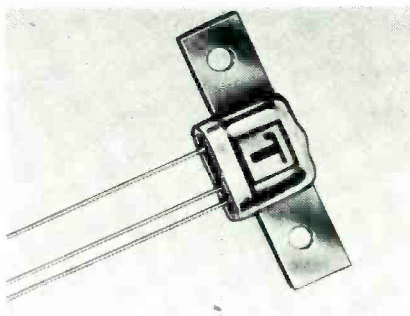
71 New Products and 63 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

TRANSISTORS

of the medium-power type

TRANSITRON ELECTRONIC CORP., Melrose 76, Mass. The new medium-power type transistors are designed for high power dissipation with linear operation over a wide collector current range. They are hermetically sealed under vacuum to insure reliability under the most severe operating conditions.

Efficient thermal connections provide greater power dissipation at elevated temperatures (up to 750 mw dissipation at 25 C). Maximum



dissipation ability of 2N85, 2N86 and 2N87 medium power transistors is obtained by chassis mounting

▶ **Output**—These transistors are intended for Class A or B output or driving stages, and will provide high output with a minimum of distortion. Approximately 1.5-w output can be obtained from a pair of 2N86 medium-power transistors operated in push-pull class B, even at temperatures up to 70 C when mounted on an aluminum chassis for heat-sink purposes.

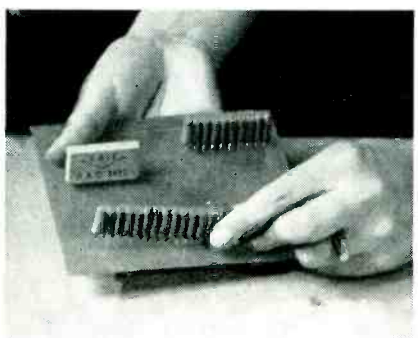
Prices range from about $3.00 each to approximately $4.50.

PLUG-IN MODULES

use standard component bodies

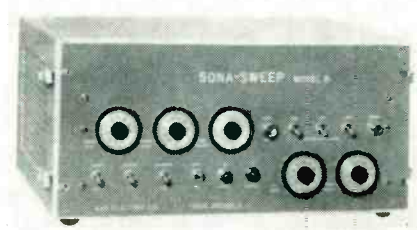
ERIE RESISTOR CORP., Erie, Pa., announces a new packaged subassembly that can be mass-produced at an overall cost approximating that of individual components, while greatly reducing the cost of assembly labor and equipment. Called PAC, for Pin Assembly Circuit, the new module permits installation of resistors and capacitors as a unitized plug-in package in etched wiring boards either manually or by machine, for lower-cost tv and radio sets, computers, industrial controls and other military or commercial electronic equipment.

The modules employ standard composition resistor and ceramic tubular capacitor bodies without leads, fitting into miniature fuse clips anchored in holes along the sides of the XXXP phenolic base plate. Interconnecting wiring is applied to the other side of the plate by an embossing process giving the equivalent of etched wir-



ing without immersion in chemical solutions.

▶ **Components**—Development engineers can readily make their own experimental modules. Up to 92 individual components may be combined by using an appropriate length of base plate, for insertion in a single operation. Basic component size is $\frac{1}{8}$ inch diameter and $\frac{5}{8}$ inch long, for which resistors are rated as $\frac{1}{2}$ watt and 500 volts, with tolerances of 5 percent or wider, in values from 5 ohms to 50 megohms. Multiple pins are connected in series or parallel for higher wattage ratings. Capacitors range from 1 to 5,100 $\mu\mu$f. The adhesive bond of the conductive pattern on the back will withstand solder dip temperatures up tc 570 F for 2 sec immersion or 10 sec at 500 F.



SWEEP GENERATOR

with sync pulse added

KAY ELECTRIC CO., 14 Maple Ave., Pine Brook, N. J., has announced the Sona-Sweep model TV, which permits overall visual examination of the low end of the video spectrum. Features include separate

Now available the revolutionary ELECTRO TEC process* for your *LARGE* SLIP RING ASSEMBLIES

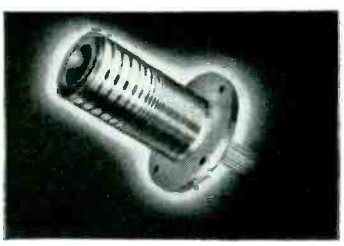
featuring

• 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. 5 3/8".

Now a Complete Service in all sizes of Slip Ring Assemblies



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. 3 3/4" long with 24 hard silver rings. 1 5/8" O.D. with wall thickness less than 1/4".

*PAT. NO. 2,696,570

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.

ELECTRO TEC CORPORATION
SOUTH HACKENSACK • NEW JERSEY

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controls on sync pulse and sweep generator, r-f output and adjustable equalizer for better than 0.5-percent accuracy in any one region in the band.

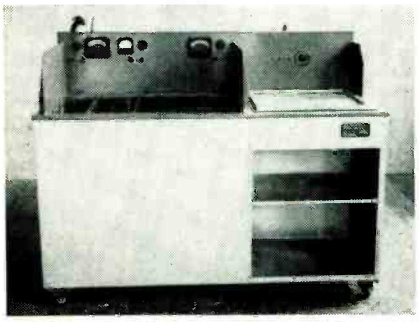
Blanking is added to provide zero level base line; permits locking of scope at test receiver end. Output is attenuated in steps for all of the sync and sweep pulse signal. A frequency vernier control permits observation of specific portions of the spectrum when sweep is turned down to narrow range.

▶ **Specifications**—Range is 0 to 350 kc; r-f output, 0 to 1 v peak-to-peak into 75 ohms; flatness of sweep over entire range, 0.5 percent; output attenuator, 2, 4 and 6 db for whole signal; variable sweep rate, 2 to 0.5 cps; variable sweep width, 0 to 350 kc; sync pulse output, 0.3 to 1 v into 75 ohms; sync pulse duration, 5-milliseconds; sync pulse frequency, adjustable 15,750 cps ±750 cps (accuracy: ±10 cps).

PROTOMAKA

makes etched circuit in ½ hr

PRINTED ELECTRONICS CORP., 15 Willow St., Natick, Mass. The Protomāka, a unit for making production prototypes of printed electronic circuits, measures only 60 in. long by 50 in. wide by 45½ in. high, but can produce an average printed circuit in only 30 to 40 min. Circuits up to 10 in. by 16 in. in size can be manufactured.



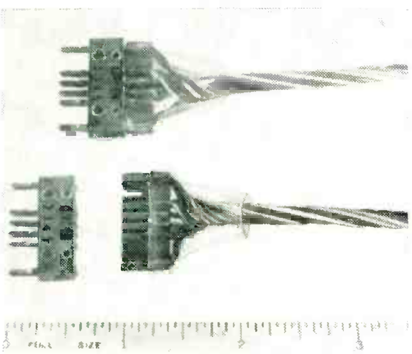
▶ **How It Works**—The Protomāka is simply plugged into a standard 110-v line, one hose is connected to a cold water faucet and another to a waste drain. With these simple connections the unit is ready to operate. It produces etched wiring by the photographic process. Copper clad material is coated with photosensitive resist on a whirler. The board is held by a pair of quick-acting clamps while the solution is poured on the surface. Centrifugal force spreads the resist evenly, any excess flowing into the aluminum bowl in which the whirler spins. An infrared lamp dries the resist as the piece rotates. The circuit board is then exposed on the light table where the negative is placed under the resisted panel, and pressed firmly to it by the vacuum frame table top. Exposure time is only 30 sec. A developing tank with an overflow water rinse is conveniently located to complete the printing cycle.

The compact unit will sell between $3,000 and $3,500.

MALE CONNECTOR

ups printed circuit progress

CIRCON COMPONENT CO., 17544 Raymer St., Northridge, Calif., announces the new male connector for electronic, instrument and printed circuit uses. Available in both miniature and subminiature series, the connectors show five improvements over previous models.



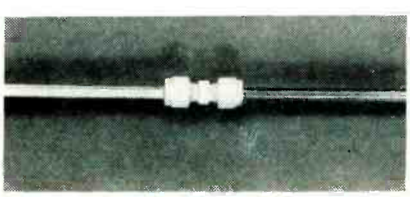
They provide higher insulation resistance and humidity performance due to new phenolic base material which exceeds all requirements of MIL-P-15035, type PRE-P. A sustained near-perfect contact is maintained with the new shot-burnished gold deposition process employed in the production of the contact surfaces.

Interface bond between the contact and the body of the connector is such as to eliminate virtually any damage to the contact bond due to careless application of wires to contacts. Increase in width of extremity contacts provides sound cabling and relief of strain at these critical points. Vinyl insulating hood provides built-in mold for potting of connectors should user desire.

▶ **Prices**—A schedule is available listing prices of 16 models (subminiature and miniature series), which range from 73 cents to $4.72. Quantity discounts are also shown.

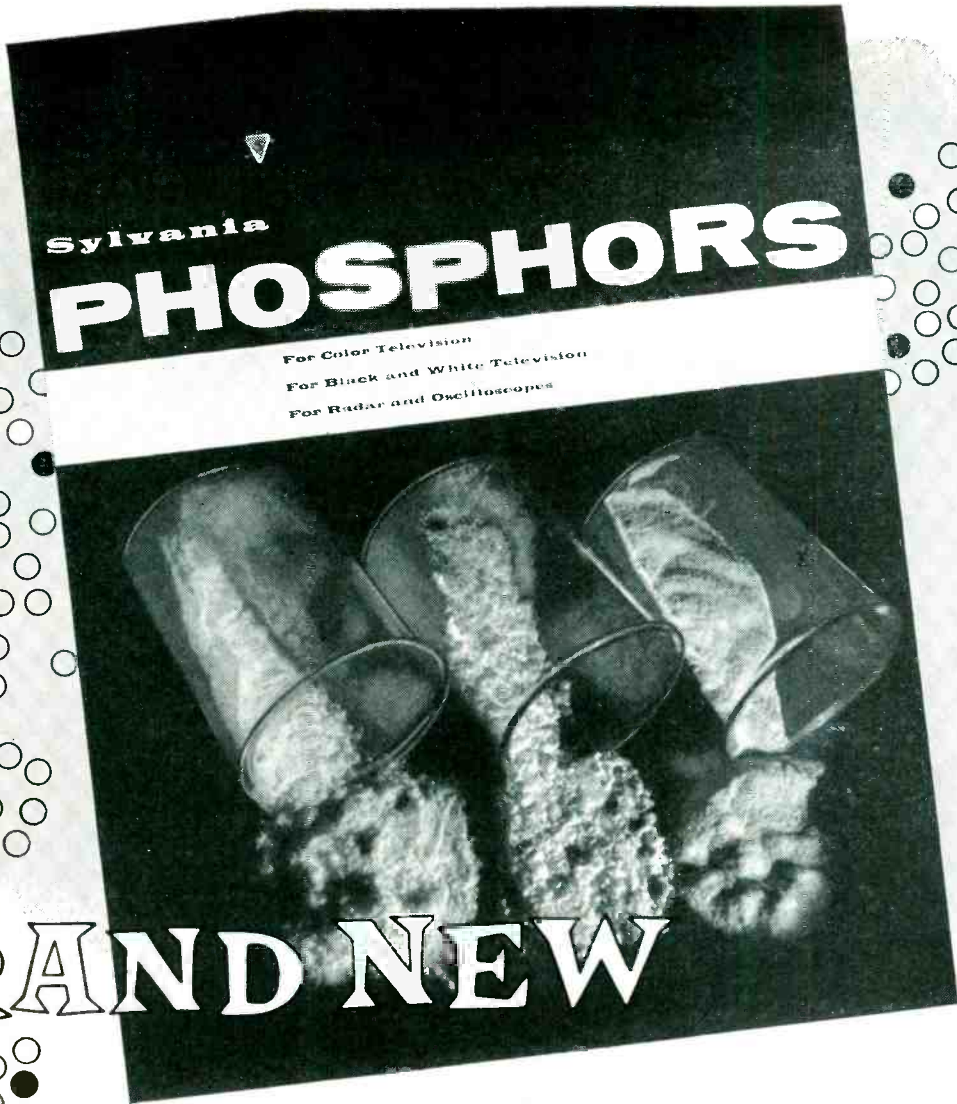
GALVANIC INSULATORS

of Zytel polyamide resin



CRAWFORD FITTING CO., 884 E. 140th St., Cleveland 10, Ohio, has announced the latest addition to the line of Swagelok tube fittings—Swagelok galvanic insulators of Zytel polyamide resin. The insulators offer a new method of eliminating galvanic action which results from joining dissimilar metals.

▶ **Uses**—With their use, brass, aluminum, copper and steel may now be joined. Moreover, they will find many applications at junction



BRAND NEW

and waiting for you . . .

INTERESTED in high-purity phosphors . . . for color, black and white television tubes . . . for radar or oscilloscope tubes? Here is your opportunity to get the latest information directly from Sylvania—your prime source of phosphors and screen settling chemicals.

This new 24-page publication contains specifications and more than forty performance charts to guide in the selection of phosphors for every application. You will find helpful hints on almost every page, based on Sylvania's own experience in manufacturing the world's finest television and cathode ray tubes.

Something worth keeping in mind, too: Sylvania phosphors and chemicals are manufactured under a rigid control system that assures high performance from *every* batch. Prove this to your satisfaction by placing your next order with Sylvania!

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1740 Broadway, New York 19, N. Y.
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University Tower Bldg., Montreal

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Name__________ Title__________

Company__________

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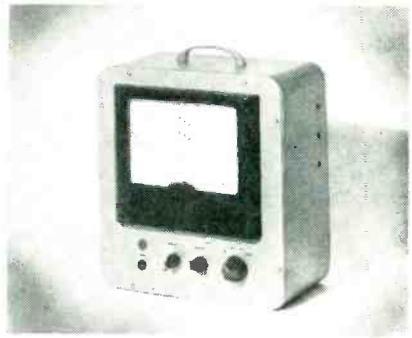
boxes, panel boards and bulkheads.

The insulators are made in a complete line of shapes and in $\frac{1}{16}$ in. to 1-in. tube and pipe sizes.



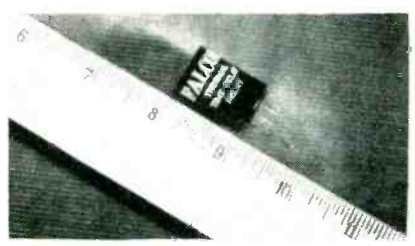
VTVOM gives automatic reading

LEITCH ENGINEERING CORP., Manchester, N. H., has announced a new vtvom, the Meter-Matic, with completely automatic range switching. Application of the probes to points being checked gives an immediate reading on a large $8\frac{1}{2}$-in. meter. Each set of calibrations is complete without the need of adding zero multipliers. Measurement of a-c and d-c voltages is from 0.1 v to 1,500 v. The unit is particularly valuable when dealing in unknown voltages.

Similarly, in measuring resistance, automatic reading is possible from 0.5 ohm to one billion ohms in 6 ranges.

▶ **Protection**—The entire instrument is protected from burn-out or damage up to 2,000 v. On ohms the unit is similarly protected against accidental application of voltages up to 300 v, a-c or d-c. This protection applies equally to the equipment under test.

The entire unit sells for $149.50.

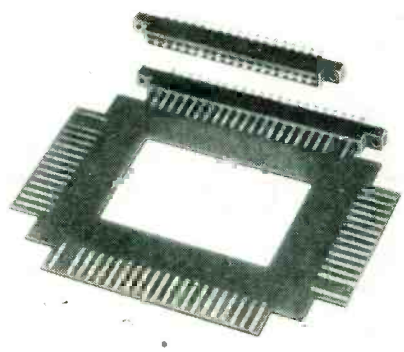


SUBMINIATURE RELAY 1 sec to 5 min delay

FALCON ELECTRONICS CORP., 308 William St., Harrison, N. J., has

announced the new subminiature Shorty relay ideal for guided missiles and printed circuits. Height when seated is less than 1 in.

▶ **Specifications**—Delay range is from 1 sec to 5 min; power drain, approximately 4 w; heater voltages, up to 125 v (230 v available if required); interchangeable on d-c or a-c of any frequency; insulated for test voltages of 1,000 v a-c (1,250 v a-c on special order). Contacts are rated at 6 amperes 115 v a-c, noninductive load, 3 amperes d-c spst only. The relay is hermetically sealed, fully compensated for ambient temperature ranges of −60 C to +85 C; up to 125 C if required. It will withstand vibration of from 5 to 500 cps at accelerations of 10 g; shock up to 50 g.

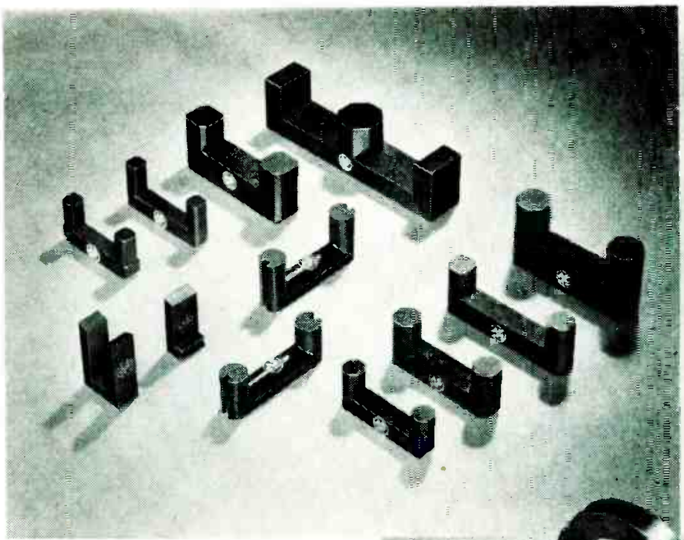


CONNECTORS
with Bellows type contacts

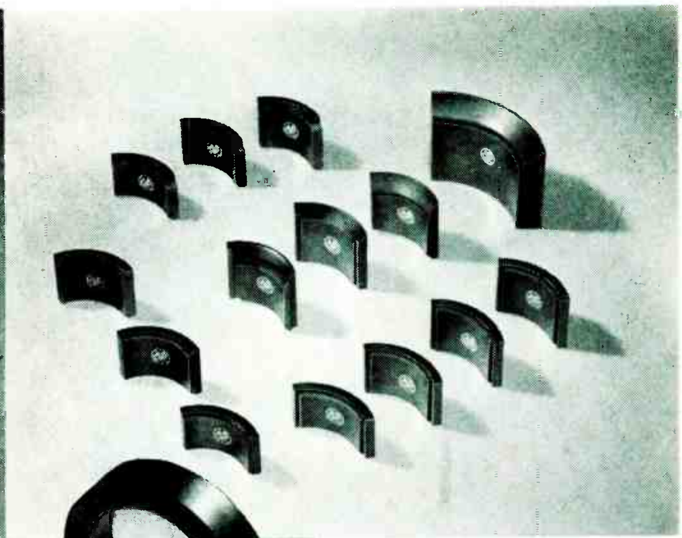
DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. The newly developed Bellows type contacts are now supplied with the company's printed-circuit receptacles. They are available in single and double-row construction of 6, 10, 15, 18 or 22 contacts.

▶ **Features**—The new design provides longer contact life and smoother engagement. The connector accepts 0.054 in. to 0.071 in. variation of standard $\frac{1}{16}$ in. copper clad printed circuit laminated card (receptacle to accommodate $\frac{1}{8}$ in. board also available on special order).

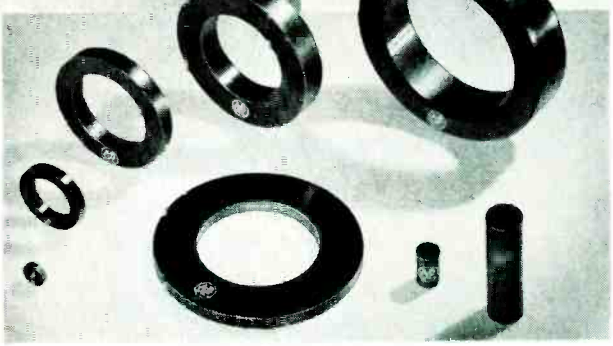
Wiring styles include solderless wire wrap, solder lugs or taper pins for AMP 53. A choice of mold-



E-cores, L-cores & U-cores



Deflection yoke cores—¼ section



Toroid, cylinder, & ring cores

HIGH EFFICIENCY FERRITE COMPONENTS

For TV and Electronic Circuits

Three performance standards—WO-1, WO-2, and WO-3—have been established for the performance characteristics of Allen-Bradley ferrite parts:—

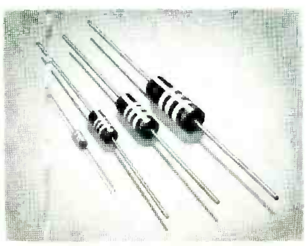
WO-1 and WO-3 are somewhat more efficient but are interchangeable with other makes of ferrite components.

Allen-Bradley WO-2 ferrite parts have much lower losses and higher permeability with greater flux density at maximum operating temperature. Their higher magnetic efficiency permits reduction in size of the ferrite parts and the use of less copper. Lower over-all cost is often the result.

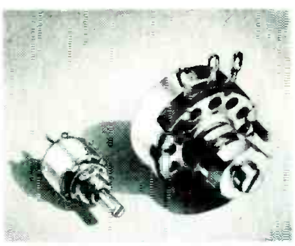
In some color TV circuits, Allen-Bradley WO-2 ferrites have eliminated two tubes and related parts. It will pay you to investigate the use of Allen-Bradley ferrites in your electronic circuits.

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada—Allen-Bradley Canada Limited, Galt, Ont.

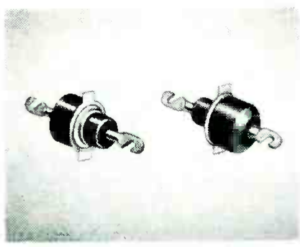
OTHER QUALITY COMPONENTS FOR RADIO, TV & ELECTRONIC APPLICATIONS



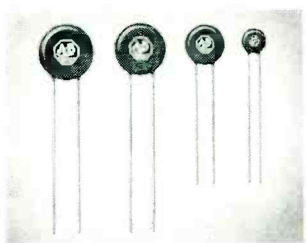
Fixed Molded Resistors
1/10, 1/2, 1 & 2 watt



Variable Molded Resistors
1/2 & 2 watt



Ferri-Cap Feed-thru Filters
with ferrite material



Ceramic Dielectric Capacitors
for by-pass and filtering

ALLEN-BRADLEY

RADIO, ELECTRONIC AND TELEVISION COMPONENTS

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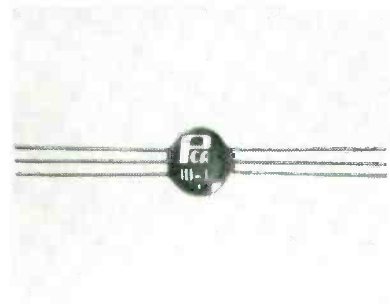
ing compounds is available: mineral filled Melamine, Plaskon reinforced (glass) Alkyd 440A, and Orlon filled diallyl phthalate.



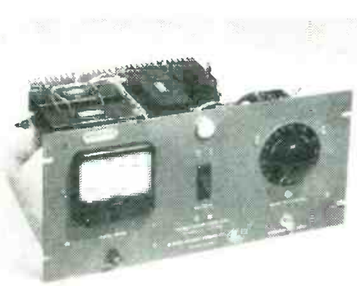
PULSE TRANSFORMER is highly miniaturized

PCA ELECTRONICS INC., 2180 Colorado Ave., Santa Monica, Calif. The MPT miniaturized pulse transformer is available in 2, 3 and 4 windings, and a pulse-width range of 0.01 to 25 μsec.

As an encapsulated unit, it is commonly mounted by soldering into a circuit. Because of its small size, there are no shock or vibration problems. The transformer meets MIL-T-27A, wherever applicable.

► **Applications**—It is ideally suited for: blocking oscillators, impedance matching and phase inversion; as wide-band input and output transformers; l-v interstage coupling; triggering and counting circuits; d-c isolation; pulse shaping and many other applications.

Prices range from $4.45 each to $8.05 each, depending on design and quantity.



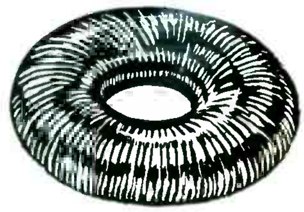
POWER SUPPLY is focusing-magnet type

LEVINTHAL ELECTRONIC PRODUCTS, INC., 2760 Fair Oaks Ave., Redwood City, Calif. Designed for use with

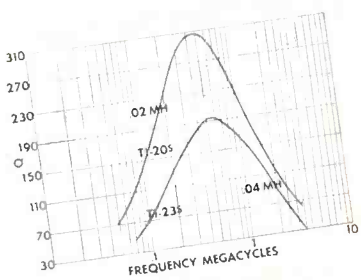
FEATURING TEMPERATURE COEFFICIENTS AS LOW AS 10 PARTS PER MILLION PER DEGREE C. BETWEEN — 55° AND +85°

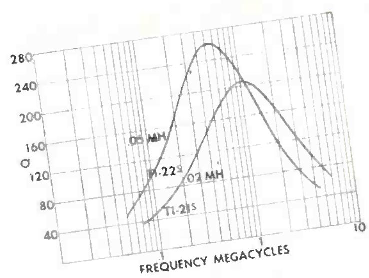
NEW FREED HIGH FREQUENCY — HIGH "Q" TOROIDAL INDUCTORS

PRODUCTS OF QUALITY — DEPENDABILITY RESULTS OF EXTENSIVE ENGINEERING



HIGH FREQUENCY TOROIDAL INDUCTORS featuring very high Q, temperature stabilization and low pickup utilizing the latest materials and techniques.





TI-20S
14 stock values from 0.05 Mhy. to 4.5 Mhy.

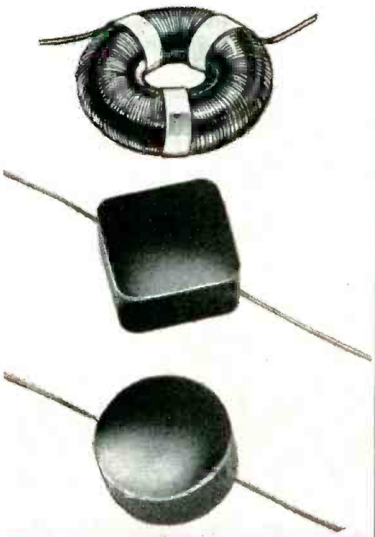
TI-23S
15 stock values from 10 Mhy. to 700 Mhy.

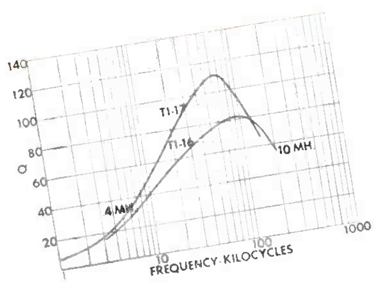
TI-21S
15 stock values from .01 Mhy. to 1 Mhy.

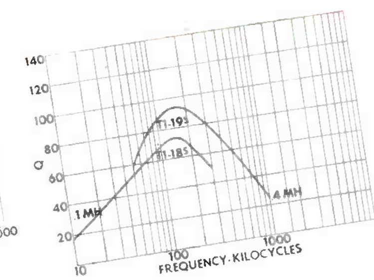
TI-22S
10 stock values from 10 Mhy. to 150 Mhy.

	OD	H
TI-20	1"	9/16
TI-21	5/8	5/16
TI-22	7/8	3/8
TI-23	7/8	3/8

Can be supplied hermetically-sealed, encapsulated or in a metal can.







THESE TOROIDS ARE FEATURING HIGH Q AND SUBMINIATURE SIZE. Our unique winding and impregnation process insures very low distributed capacity and consequently self-resonant frequencies far removed from the operating range.

TI-16
20 stock values from .1 Mhy. to 100 Mhy.

TI-17
18 stock values from .1 Mhy. to 100 Mhy.

TI-18
18 stock values from .1 Mhy. to 100 Mhy.

TI-19
13 stock values from .1 Mhy. to 5 Mhy.

NOW AVAILABLE FROM STOCK FOR IMMEDIATE DELIVERY

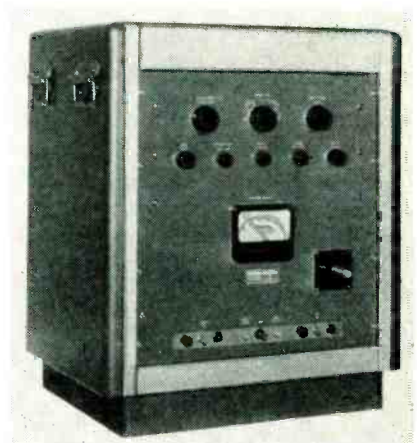
FREED TRANSFORMER CO., INC.
1722 WEIRFIELD ST., BROOKLYN (Ridgewood) 27, NEW YORK
Phone: EVergreen 6-1300

high-power klystrons and traveling-wave-tube focusing magnets, a continuously-variable 150-v 4-ampere power supply with less than 0.1-percent current ripple is now available.

It is designed to operate from 115-v 60-cps single-phase power.

▶ **Components**—Units include an undercurrent relay to interlock with tube beam supply and indicator light, main power switches, pilot light, and appropriate fusing.

The power supply is designed to fit standard 19-in. relay-rack mounting. Price is $275.



SWEEP GENERATOR
covers the entire X-band

ROGER WHITE ELECTRON DEVICES, INC., 12 West Island Road, Ramsey, N. J. The SWM-5 sweep generator is designed to permit rapid evaluation, measurement and adjustment of microwave circuits and systems.

Incorporating the BC-X10m backward-wave oscillator, the generator supplies a microwave signal swept in frequency across a waveguide range or any portion of it from 66 mc to 60 kmc. The unit can also operate as a manually controlled c-w source if desired.

▶ **Sweep Width**—The range of frequencies covered in each sweep can be adjusted to cover the entire range or any portion as small as 10 percent of the band. This makes the unit equally useful for examining the performance of components over narrow bandwidths or across the full waveguide range.

Power output may vary as much

Now Puerto Rico Offers 100% Tax Exemption to New Industry

by BEARDSLEY RUML

"We don't want runaway industries" says Governor Muñoz. "But we do seek new and expanding industries." Federal taxes do not apply in Puerto Rico, and the Commonwealth also offers full exemption from local taxes. That is why 325 new plants have been located in Puerto Rico, protected by all the guarantees of the U.S. Constitution.


Beardsley Ruml

In a dramatic bid to raise the standard of living in Puerto Rico, the Commonwealth Government is now offering U. S. manufacturers such overwhelming incentives that more than three hundred new factories have already been established in this sunny island 961 miles off the Florida coast.

First and most compelling incentive is the 100% tax exemption for most manufacturers who set up new plants in Puerto Rico.

For example, if your company is now making a net profit after taxes of $53,500, your net profit in Puerto Rico would be $100,000—a gain of 87 per cent, simply because Federal corporate income taxes do not apply in Puerto Rico and all local taxes are waived as well.

Your dividends in Puerto Rico from a corporation there could be $50,000 against $25,000 net in the U. S.—because Federal personal income taxes do not apply either.

What About Labor?

Puerto Rico's labor reservoir of 637,000 men and women has developed remarkable levels of productivity and efficiency—thanks, in part, to the Commonwealth's vocational training schools. These schools also offer special courses for managers and supervisors.

The progress made in technical skills may be gauged from the fact that there are now twenty-eight factories producing delicate electronic equipment.

Among the U.S. companies that have already set up manufacturing operations in Puerto Rico are Sylvania Electric, Carborundum Company, St. Regis Paper, Remington Rand, Univis Lens, Shoe Corporation of America, and Weston Electric.

CORPORATE TAX EXEMPTION

If your net profit after U. S. Corporate Income Tax is:	Your net profit in Puerto Rico would be:
$ 17,500	$ 25,000
29,500	50,000
53,500	100,000
245,500	500,000
485,500	1,000,000

DIVIDEND TAX EXEMPTION

If your income* after U. S. Individual Income Tax is:	Your net income in Puerto Rico would be:
$ 3,900	$ 5,000
7,360	10,000
10,270	15,000
14,850	25,000
23,180	50,000
32,680	100,000
43,180	200,000
70,180	500,000

*These examples are figured for dividends paid in Puerto Rico to a single resident. Based on Federal rates effective Jan. 1, 1954.

"Close to Paradise"

Listen to what L. H. Christensen, Vice President of St. Regis Paper, says:

"The climate is probably as close to paradise as man will ever see. I find Puerto Ricans in general extremely friendly, courteous and cooperative.

"This plant in Puerto Rico is one of our most efficient operations, in both quality and output. Our labor has responded well to all situations."

Mr. Christensen might have added that the temperature usually stays in the balmy 70's twelve months a year.

The swimming, sailing and fishing are out of this world. Your wife will rejoice to hear that domestic help is abundant.

The Commonwealth will leave no stone unturned to help you get started. It will build a factory for you. It will help you secure long-term financing. It will even screen job applicants for you—and then train them to operate your machines.

Transportation

Six steamship companies and five airlines operate regular services between Puerto Rico and the mainland. San Juan is just 5½ hours by air from New York.

Light-weight articles such as radar components come off the line in Puerto Rico one day and are delivered by air freight next day in Los Angeles, Chicago and other mainland cities. And, of course, there is no duty of any kind on trade with the mainland.

Are You Eligible?

Says Governor Muñoz: *Our drive is for new capital. Our slogan is not "move something old to Puerto Rico," but "start something new in Puerto Rico" or "expand in Puerto Rico."*

To get all the facts, and to find out whether you and your company would be eligible for complete tax exemption, telephone our nearest office.

New York ...... MU 8-2960 .... 579 5th Ave.
Chicago .... AN 3-4887 .... 79 W. Monroe
Los Angeles ..... WE 1-1225 .... 5525 Wilshire

OR MAIL COUPON

Commonwealth of Puerto Rico
Economic Development Administration
579 Fifth Ave., New York 17, N. Y.
Dept. V4

Mail me "Facts for Businessmen." I am interested in the advantages of Puerto Rico for the industry I have checked.

☐ Electronics ☐ Plastics ☐ Apparel
☐ Leather ☐ Optical ☐ Metals

Other ______________________

Name ______________________

Company ______________________

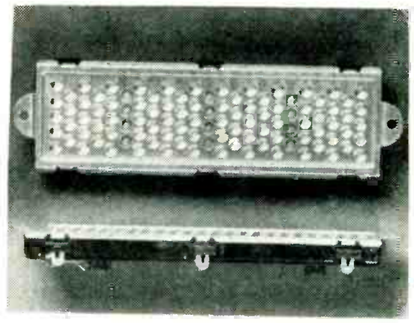
Address ______________________

____

Want more information? Use post card on last page.

as 10 db from minimum to maximum in the band but the variation over any 100-mc band is usually small.

Price of the unit is $2,800. A data sheet is available giving additional information.

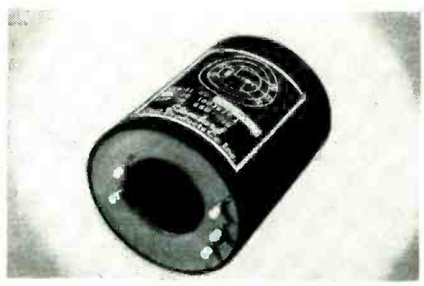


LOUDSPEAKERS
Isophon electrostatic types

ARNHOLD CERAMICS, INC., 1 E. 57th St., New York 22, N. Y., announces the new Isophon line of electrostatic loudspeakers, manufactured in West Germany. Two types are available—the rectangular type St H 5/16 (illustrated) and round type St H B7.

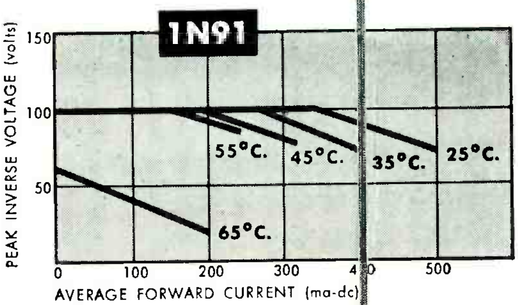
► **Frequency** — The loudspeakers are suggested for use over a 7,000 to 20,000-cycle frequency range. Special construction of the membrane results in far reaching and evenly distributed volume and sound even in the higher frequencies, where cone speakers often develop trouble.

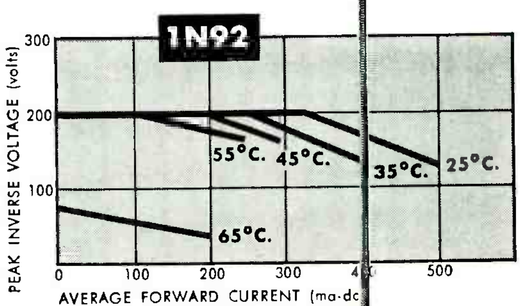
The small size, in particular the thickness of less than 1 in., and the low cost make the speakers desirable for manufacturers of radio, tv, high-fidelity and other applicable sound equipment.

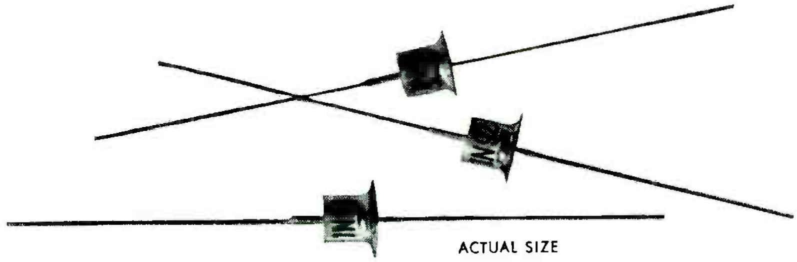


DEFLECTION YOKE
has high linearity accuracy

STANDARD COIL PRODUCTS CO., INC., 2085 N. Hawthorne Ave., Melrose







ACTUAL SIZE

CLEVITE TRANSISTOR PRODUCTS

IMMEDIATE DELIVERY
PRODUCTION QUANTITIES*

POWER DIODES

THREE TIMES ACTUAL SIZE

AN ADVANCE IN ELECTRONICS

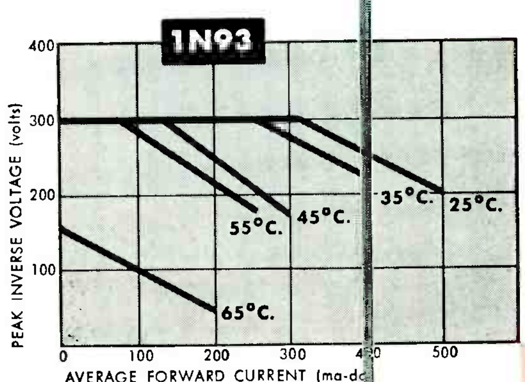
Germanium Junction Power Diodes Types 1N91, 1N92, and 1N93 achieve characteristics never before possible in either thermionic or other types of solid state rectifiers. For example:

- **SMALL SIZE-HIGH POWER**—approximately four times the rectified power in the same space as other devices.
- **HIGH EFFICIENCY** — combines very low forward resistance with high back resistance . . . 100% rectification efficiency is approached.
- **LONG LIFE** — unlike other semi-conductor metals, Germanium does not age . . . in addition, hermetically sealed construction.

100% RIGID CONFORMANCE TO SPECIFICATIONS

Quality control of Clevite Transistor Products Power Diodes is based on a *100% sampling*. Each and every unit is individually tested for rigid conformance to specifications.

- **ELECTRICALLY TESTED** — each unit must meet or surpass performance requirements.
- **HIGH PRESSURE HUMIDITY TESTED** — each unit is checked to assure perfect hermetic sealing.



CLEVITE TRANSISTOR PRODUCTS

241-257 CRESCENT STREET
WALTHAM 54, MASSACHUSETTS

CLEVITE T P

A DIVISION OF THE CLEVITE CORPORATION

TRANSISTORS • DIODES • SEMI-CONDUCTOR DEVICES

ABSOLUTE MAXIMUM RATINGS (for 60 cycle, 55°C. resistive load)

	1N91	1N92	1N93
Peak Inverse Voltage (volts)	100 v. at 2.7 ma	200 v. at 1.9 ma	300 v. at 1.2 ma
Peak Forward Current (amps)	0.47	0.31	0.24
DC Output Current (ma)	150	100	75
DC Surge Current (amps)	25	25	25
Full Load Voltage Drop (volts)	0.5	0.5	0.5
Continuous Reverse Working Voltage (volts)	30	65	100
Operating Frequency (Kc.)	50	50	50
Storage Temperature (°C.)	85	85	85

*ARMED SERVICES and A.E.C. Source Inspection Available

Write for Power Diode Bulletin PD2

Want more information? Use post card on last page.

Park, Ill. Designed for accurate control of the spot position in a crt intended for radar application, the new precision deflection yoke has a linearity accuracy in the azimuth direction of better than ¼ percent. Linearity in the range direction is better than ½ percent.

▶ **Orthogonality**—Angle between azimuth and range directions is held to an accuracy of 1/10 deg. This performance is brought about as a result of a special winding technique and the use of molded coil forms combined with equipment for measuring deflection accuracy to within 0.03 percent.

A cylindrical iron core surrounds the windings for shielding purposes. The entire assembly is pressed into a phenolic cylinder, then completely impregnated and sealed to prevent entrance of moisture.

Dimensions are as follows: inside diameter, 1½ in.; outside diameter, 3⅛ in.; length, 3¾ in. Windings can be made to suit practically any specified requirement. Size can also be varied where required.

AMPLIFIER-VOLTMETER is highly sensitive

ALLEN B. DUMONT LABORATORIES, INC., 750 Bloomfield Ave., Clifton, N. J. Type 346 sensitive amplifier-voltmeter can make precise measurements of a-c signals from 100 μv to 300 v at frequencies from 10 cps to 2 mc.

The 4½-in. meter scale is illuminated to facilitate use under low ambient light conditions. Readings are provided from −72 to +52 db. Calibration is in two linear voltage scales (0 to 1 and 0 to 3) and

NOW **2** *different methods*

FOR **2** *different requirements*

AEROVOX PRINTED WIRING

You are now offered the choice of TWO different printed-wiring methods: (1) The Aerovox exclusive **Pressed Silver** or (2) The Aerovox **Etched Copper.** Each has its particular field of applications.

Furthermore, Aerovox also offers a choice of different base materials, such as: Phenolic-paper Base, Phenolic Fabric, Epoxy Glass, Melamine Glass, Teflon Glass, Polystyrene and Methacrylite, each with certain characteristics for given usages.

PRESSED SILVER

Produced by a hot die-stamp process in which the conducting pattern is mechanically embossed in one or both sides of the selected base material. Does not rely on any adhesive agent for the bond between conductive and base materials. Pure silver conductors are partially imbedded in base support. Compared with copper, the silver is more resistant to oxidation, solders more readily, and provides superior electrical contact surface with greater resistance to wear, particularly for switching applications.

ETCHED COPPER

Produced by applying an etch-resistant pattern on to a metal foil, usually copper clad. Unprotected metal areas of printed pattern are then etched away leaving desired wiring pattern. The resistant enamels may be applied by (a) Direct photographic means, or (b) Screen printing. The former achieves maximum definition of lines held to close tolerances at relatively modest costs; the latter effects cost savings where extremely fine detail is of secondary importance.

PRINTED WIRING PRIMER . . .

Write on your business stationery for this practical guide on printed wiring. And let our printed wiring specialists collaborate on your particular applications.

AEROVOX Capacitors

AEROVOX CORPORATION

SPECIAL PRODUCTS DIVISION

NEW BEDFORD, MASSACHUSETTS

In Canada: AEROVOX CANADA LTD., Hamilton, Ont.

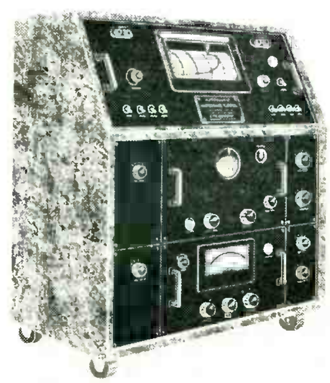
Want more information? Use post card on last page.

a db scale (-12 to $+2$ dbm). The rectifier is of the full-wave average type to offer greatest accuracy when dealing in complex waveforms.

► **Specifications** — Meter ranges are 0.001, 0.003, 0.01, 0.03, 0.1, 0.3, 1.0, 3.0, 10, 30, 100 and 300 v full scale. Accuracy is ± 3 percent, 20 cps to 1 mc; ± 5 percent, 10 cps to 2 mc. Stability is ± 1 percent at any line voltage between 105 and 130 v. Input impedance is 10 megohms shunted by 24 $\mu\mu$f.

► **Physical Characteristics** — It measures $6\frac{1}{2}$ in. high, $4\frac{1}{4}$ in. wide and $7\frac{1}{2}$ in. deep overall. Weight is $6\frac{1}{2}$ lb.

Price of the unit is $200.



IMPEDANCE PLOTTER for instantaneous recording

CHESAPEAKE INSTRUMENT CORP., Shadyside, Md., announces an automatic impedance plotter for instantaneous recording of real and imaginary components of impedance as a function of frequency, temperature or other variables. It eliminates point by point plotting procedure, thereby serving as a practical production control tool as well as a valuable research instrument.

► **Ranges**—Frequency range is 10 cps to 100 kc with a rated accuracy of ± 2 percent. Resistance range is 0 to 10,000 ohms; reactance range, $\pm 10,000$ ohms.

The apparatus uses Mosely Autograf recorder which plots on standard $8\frac{1}{2}$ in. by 11 in. graph paper.

► **Applications**—The AIP has demonstrated its usefulness in the de-

Picture Quality Is Our Business Too!

Set designers assure their customers steady, clear pictures by careful component selection. Good-All backs that selection with reliable capacitors at economical cost. The enthusiastic acceptance of **GOOD-ALL MARBELITE** and **SERAMELITE** tubulars is a measure of the confidence designers have in these capacitors. Tens of millions are in use today in TV and Radio Sets of leading manufacturers.

Good-ALL capacitors

MARBELITE

Marbelite capacitors are best known for their physical and electrical ruggedness. The Good-All type 503-M capacitors provide solid plastic construction at a surprisingly low cost. A miniature series of Marbelites is also available for applications in which the space is limited.

SERAMELITE

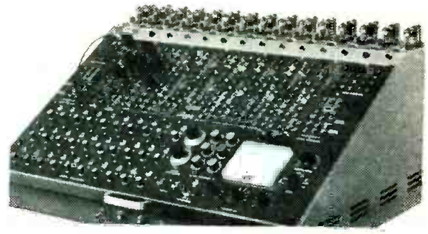
The seramelite family of capacitors is housed in ceramic tubes with end-seals of a tough, dense plastic. Their performance under conditions of high temperature and humidity is outstanding. Seramelite types with "MYLAR" dielectric are becoming increasingly popular.

Get full information by writing Good-All direct or by contacting our nearest sales representative.

GOOD-ALL ELECTRIC MFG. CO. • GOODALL BLDG. • OGALLALA, NEBRASKA

sign and control of electroacoustic transducers, loudspeakers, electrical filters, electromechanical filters, microphones, accelerometers, transformers and similar devices.

Literature is available.

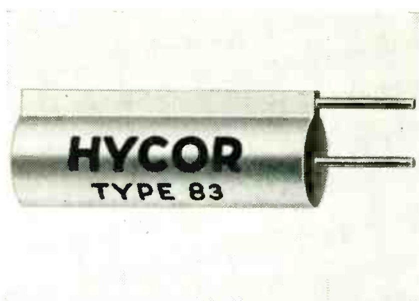


ANALOG COMPUTER available in kit form

HEATH CO., a subsidiary of Daystrom, Inc., Benton Harbor, Mich., has available an inexpensive electronic analog computer in kit form. It incorporates such features as: 30 coefficient potentiometers, each of which is capable of being set to an accuracy of better than 0.1 percent; one standard reference supply for all d-c voltages; a nulling meter for accurate setting of computer voltages; and a unique patch-board layout which enables the operator to see his computer block layout.

▶ **Makeup**—The computer is comprised of the model ES-400 computer cabinet, model ES-200 amplifier, model ES-100 power supply, model ES-100 initial conditions and model ES-600 function generator.

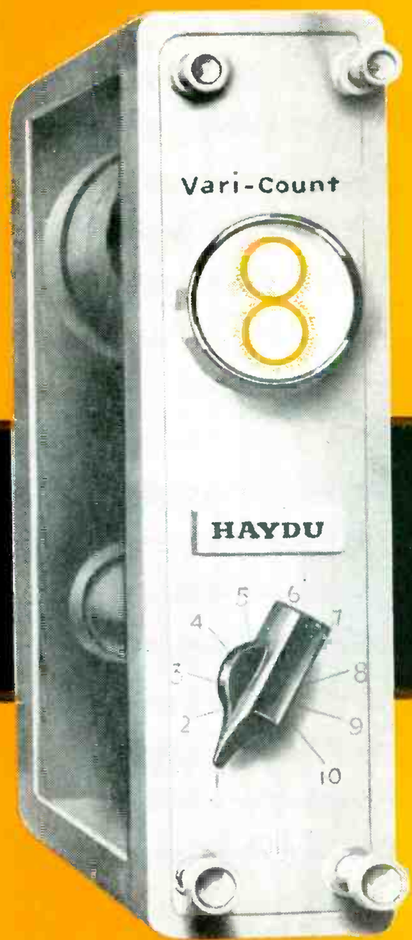
Selling price is under $700.



WIRE-WOUND RESISTORS for mechanized production

HYCOR CO., INC., 11423 Vanowen St., North Hollywood, Calif., has announced the series A precision wire-wound resistors for use in

New COMPONENTS PRODUCE MICRO-SECOND Vari-Count

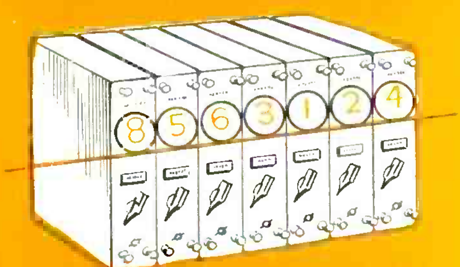


H-B101
Haydu Beam Switching Tube MBS

Haydu Numerical Indicator Tube "Nixie"

Two outstanding basic electron components . . . Haydu's "Beam Switching Tube" and "Nixie" the numerical indicator tube . . . are combined to make possible this *versatile* new instrument.

- **VARI-COUNT**
  - Static to megacycle counter distributor
  - Microsecond electronic preset
  - Microsecond variable scale output
  - Microsecond recycling
  - Microsecond clearing
  - Preset gating
- **BEAM SWITCHING TUBE** (6700)
  - Replaces 20 Tubes
  - Megacycle counting 0-9
  - Megacycle preset
  - Low power consumption
  - Electronics most reliable distributor
  - Pentode "working" output
- **NIXIE** (HB106)
  - 1" x 1"
  - 10 digit 0-9 gas indicator tube
  - "Two-dimensional"
  - In-line readout
  - Common anode prebiasing
  - Low power



Large, in-line numbers assure quick, accurate readings

Write for complete technical data to:

HAYDU
BROTHERS OF NEW JERSEY
PLAINFIELD, NEW JERSEY

SUBSIDIARY OF BURROUGHS CORPORATION

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printed wiring circuits. They are designed to conform to specifications proposed by RETMA for components to be used in automatic assembly equipment.

▶ **Encapsulation**—The resistors are encapsulated in a tough epoxy compound for protection against extreme humidity, mechanical and thermal shock. The plastic is filled with heat-conducting mineral which dissipates the heat and equalizes hot spots in winding. Sealed-in terminal connections are welded. They satisfy military requirements of MIL-R-93A and JAN-R-93.

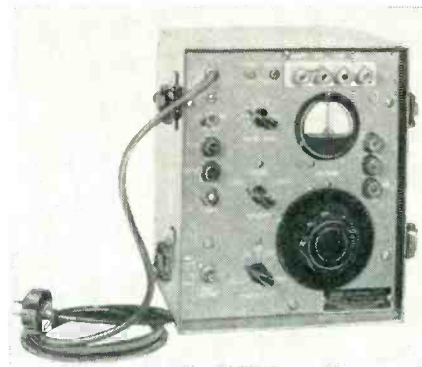
▶ **Specifications**—Temperature coefficient is ±0.0022 percent per deg C; operating temperature, −65 C to + 125 C; wattage range, from 0.25 w to 1 w with tolerances to 0.1 percent.

FIVE-MC OSCILLOSCOPE for lab and production line

EICO, 84 Withers St., Brooklyn 11, N. Y. The No. 460 5-mc oscilloscope is designed for laboratory, production line, and monochrome and color tv servicing. Kit price is $79.95; factory-wired price, $129.50.

▶ **Features**—Some of its outstanding features include: reproduction of the 3.58 mc sync burst and 3.58 mc oscillator signals in color tv sets; flat from d-c to 4.5 mc, usable to above 5 mc; built-in voltage calibrator; vertical amplifier push-

pull throughout for reduced distortion, and choice of direct or capacitive coupling; 25 mv per in. vertical sensitivity; and full d-c horizontal and vertical positioning.



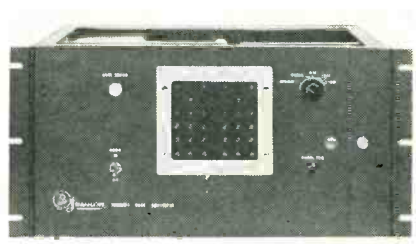
MEGOHM BRIDGE
uses encapsulated networks

TELECTRO INDUSTRIES CORP., 35-18 37th St., Long Island City 1, N. Y. Model 750 megohm bridge is a portable self-contained instrument for measuring resistance values to 1 million megohms. It contains a specially designed highly sensitive electronic detector and galvanometer for null indications. Overall accuracy is better than 2 percent of scale reading.

▶ Uses—Model 750 is designed to measure resistances, voltage coefficient of resistors, insulation resistances of transformers, and resistances of three terminal networks.

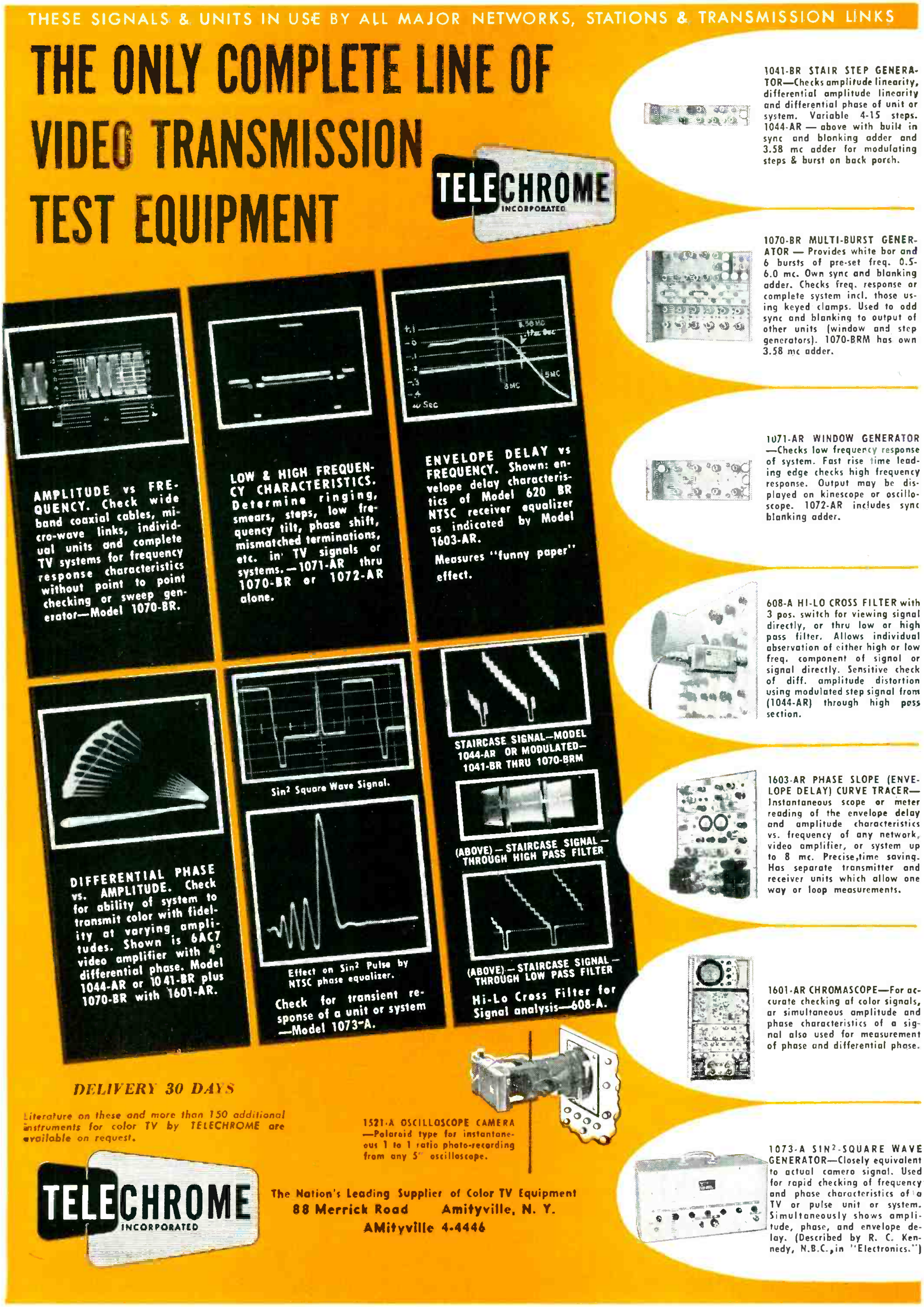
A special feature of the construction is the use of encapsulated networks to assure maximum stability of components.

Price is $550.



CONVERTER
card data into analog form

LIBRASCOPE, INC., 808 Western Ave., Glendale, Calif. Model 250 punched card converter is an automatic data processing accessory that



Want more information? Use post card on last page.

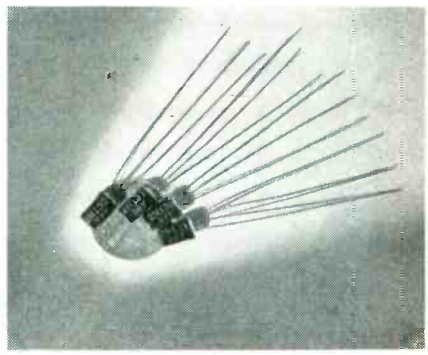
translates the decimal code punched into cards into an analog signal for automatic point plotting by X-Y plotter and recorder model 200-A.

▶ **Accuracy**—The punched card converter has an accuracy of 0.1 percent when used alone and an accuracy of 0.25 when used in conjunction with a plotter.

When used with the Librascope X-Y plotter the instrument will plot approximately 60 cards per minute. Used with the IBM 523 punch machine, cards are simply loaded into the hopper, no special panel connections being necessary.

Individual punched cards may be read separately on a visual display located on the front panel of the instrument. The chart scale of the converter can be expanded independently by a factor of 10 to 1 for special data process applications.

Current price of the instrument is $2,450.

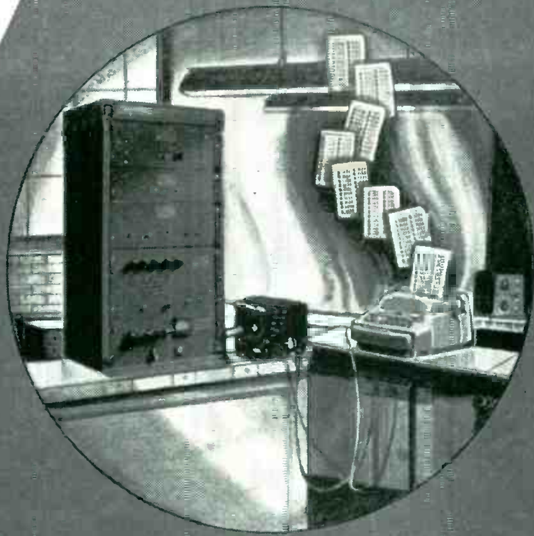


GERMANIUM TRANSISTOR
in much smaller size

RAYTHEON MFG. CO., 55 Chapel St., Newton 58, Mass., announces four new transistors which are ¼ to ⅓ the size of former units. These *pnp* fused junction germanium transistors have a volume of only 0.0087 cu in. and are designated types 2N130, 2N131, 2N132 and 2N133. The first three are intended for use in audio or low r-f applications; the fourth is a low-noise transistor for use in low-level audio circuits.

▶ **Noise Factor**—Average noise factor of the 2N133 is 6.5 db and will not exceed a maximum limit of 10 db. This is an improvement over the older type 2N106/CK727,

TO SOLVE A PROBLEM . . .



To eliminate manual null detection, visual dial reading and hand-typing of each calibration point, with costly man-hour waste, plus the possibility of human error . . THE **AUTO-CAL** WAS BORN!

AUTOMATIC FREQUENCY CALIBRATOR

CONCEIVED and DEVELOPED BY LORAL

Imprint of Integrity

***Only* the AUTO-CAL can:**

AUTOMATICALLY Calibrate over 1000 Frequencies in ONE HOUR! and SIMULTANEOUSLY

AUTOMATICALLY Type these Frequencies on CALIBRATION DATA CARDS

The **LORAL** AUTO-CAL has slashed CALIBRATION and RECORDING TIME by 533% within an accuracy of .005%

Only LORAL HAS THE AUTO-CAL!

Your inquiry for CALIBRATION or RECALIBRATION of FREQUENCY METERS — Military, Industrial or Commercial — is solicited!

LORAL ELECTRONICS CORPORATION

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Serving in AVIONICS • AIRBORNE NAVIGATIONAL EQUIPMENT • COMMUNICATION SYSTEMS • RADAR EQUIPMENT • TEST EQUIPMENT

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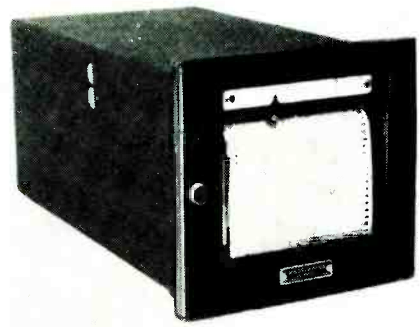
now discontinued, which had a maximum noise factor of 12 db.

Maximum ambient temperature is 85 C. These transistors are electrically similar to and are designed to replace the CK731 series. Technical catalog sheets are available.



RECORDING POT
with thermocouple calibrations

WESTRONICS, INC., 3605 McCart St., Fort Worth, Texas, has announced a miniature strip-chart recording potentiometer weighing less than 25 lb. It is available with standard charts and ranges for copper-Constantan, iron-Constantan and Chromel-Alumel thermocouples, and has internal cold-junction compensation.

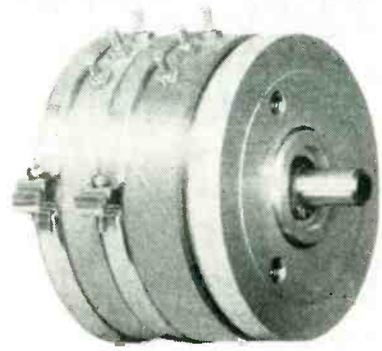
This recorder, of the null-balance potentiometer type, records on a 5-in. strip chart, with a pen speed of 1 sec full scale and an accuracy of better than 0.5 percent.

►**Prices**—The standard recorder with single speed chart drive is $425. Manual change gears to provide three speeds are optional with single-speed instruments for $15. The three speed, quick change, gear shift chart drive feature is $50.

►**Special Features**—Backset Micro Switches for alarm or auxiliary control, additional chart speeds, other than standard ranges and transmitting slidewires are some of the special features which can be incorporated in the recorder.

POTENTIOMETER
for 50 to 70,000-ohm range

FAIRCHILD CONTROLS CORP., Hicksville, L. I., N. Y. Type 747-E potentiometer provides a resistance range of 50 to 70,000 ohms with a standard linearity of ±0.15

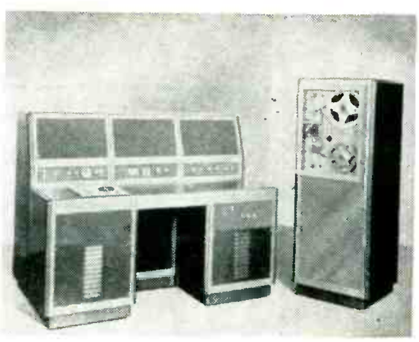


percent. A special clamp provides an unrestricted tapping area allowing up to 19 taps and presents a simplified means of phasing units in a ganged assembly without disassembling the units.

▶ **Uses**—The low noise level and high resolution of these units make them particularly desirable for computer assemblies, calibration controls, servomechanisms and other similar applications.

Type 747-E has a diameter of 2.100 in. and a cup width of 0.984 in. and up to 6 units can be ganged on a single shaft. The units are furnished with welded taps and end leads. Low starting torque is only 1.0 oz-in. per cup section.

Prices range from $30 to $40 a cup in sample quantities; $15 to $25 a cup in production quantities.



CONVERTER
analog-to-digital type

J. B. REA CO., INC., 1723 Cloverfield Blvd., Santa Monica, Calif., has available a high-speed, accurate analog-to-digital converter with capacity of up to 100,000 conversions per sec, 30 mv resolution and 0.1 percent guaranteed accuracy. It will accept signals from transducers, f-m discriminators, f-m or pwm magnetic tapes, film

The Standard of Accuracy for

FREQUENCY MEASUREMENT and CONTROL

FREQUENCY STANDARDS

Offers a Comprehensive Line of—

MICROWAVE FILTERS AND PRESELECTORS

- SINGLE SHAFT TUNING AVAILABLE
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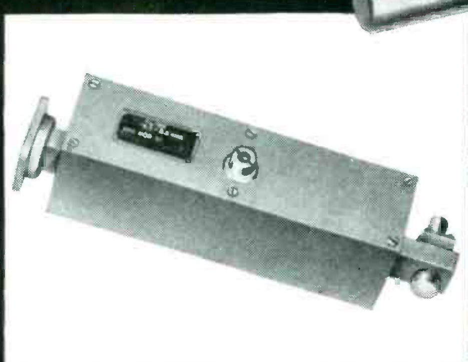
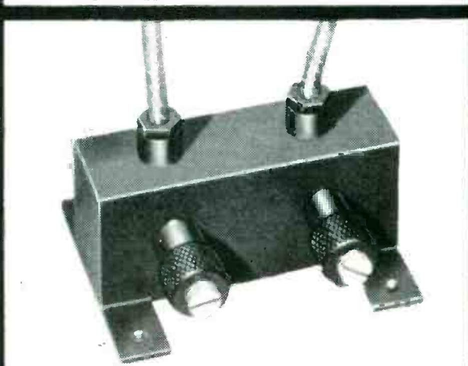
- COMPACT DESIGN
- USABLE OVER WIDE TEMPERATURE RANGES
- HERMETIC SEALING AVAILABLE





In order to utilize the crowded microwave spectrum to the greatest possible advantage, Frequency Standards now offers a comprehensive line of filters and preselectors. These units are engineered and constructed with the same exacting care and precision which has made Frequency Standards' wavemeters a standard in the industry.

Frequency Standards is proud of its reputation to undertake development and production work in the fields of preselection, frequency measurement and control which approaches the "state of the art." Our engineering services are available at all times to assist you with your problems.

RESONANT FREQUENCIES AVAILABLE

	L	S	C	X
Bandwidth (Maximum available)	5%	3%	2%	1%
Number of Sections*	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4
Insertion Loss (For 1% bandwidth)	≤ 1.5 db	≤ 1. db	≤ 1. db	≤ 1. db
Rejection (F_0 ±2xBW) (db)	24 36 48	24 36 48	24 36 48	24 36 48
Input VSWR (Matched Load)	≤ 1.5	≤ 1.5	≤ 1.5	≤ 1.5

*More Sections Available without Gang Tuning.

NEW CATALOG ON REQUEST—Call or write for new Brochure with complete data on precision-built Microwave Filters, Preselectors, Frequency Meters and Field Test Instruments.

Frequency Standards
ASBURY PARK, NEW JERSEY

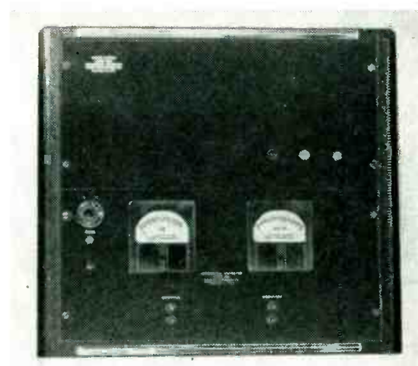
Please address inquiries to BOX 504A

readers or other analog sources, and convert them to any desired digital code.

► **Sampling**—Used with appropriate commutating, it will sample, in sequence, data from any number of analog sources. Digital output may be printed out, or used as input to a digital computer. Interim storage of the digital data can be accomplished, if desired, by a programmed magnetic tape unit.

► **Price**—The basic converter price is $12,000, with the price adjustable depending on the speed required by the application. The price of a complete conversion system varies of course with the extent of the requirements of each individual application.

A Rea high-speed input commutation switch, digital output magnetic recorders and programming circuits are among the new features offered in complete converter systems. An 8-page illustrated brochure is offered.



VOLTMETER measures differentials

FREED TRANSFORMER CO., INC., 1715 Weirfield St., Brooklyn 27, N. Y. Type 1560 differential voltmeter is extremely useful when checking response and attenuation of filters, transformers, amplifiers and other applications where a small difference in two voltages is to be measured, as it measures differences in voltage levels as low as 0.01 percent regardless of their relations.

Because of its stability and sensitivity, it may also be used to observe drift in amplifiers, meters and filters. The a-c input signals a

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are amplified, then rectified and compared, so that an accurate comparison may be obtained regardless of the phase of the input signals.

▶ **Specifications**—Difference voltage range is −10 percent to +5 percent in 0.01 percent increments. Input voltage levels are from 0.1 v to 100 v. Frequency range is 30 cps to 20 kc. Input impedance is 500,000 ohms. The instrument is entirely self-contained and operates from a 115-v, 60-cycle line.

GAMMA GUN
is fully transistorized

UNIVERSAL ATOMICS CORP., 19 E. 48th St., New York 17, N. Y., has available the fully transistorized gamma gun, a self-contained, hand-portable scintillation counter giving 500,000 counts per minute—300 time as sensitive as a single Geiger tube. It has a $2\frac{1}{4}$ in. sodium iodide crystal, a built-in preamplifier and a full-view ore evaluation meter.

▶ **Uses**—The gamma gun is designed for use both on the ground and in the air. Its light weight and small area permit it to be used comfortably in the smallest plane.

It has six operating ranges to give maximum sensitivity and four time constants ranging from 1 to 60 seconds. The use of transistors in combination with mercury cells completely eliminates drift.

The gamma gun will operate for over 1,000 hours of continuous field use with no battery charges. It sells for $995.

POTENTIOMETER
for 80 to 150,000 ohms

FAIRCHILD CONTROLS CORP., Hicksville, N. Y. Type 748-E potentiom-

When headers, connectors,
single terminals
or transistors
delay YOUR production
— consult L. L. Constantin & Co.

Constantin's
progressive design
and engineering,
plus 2 plant production
facilities assure you
prompt delivery
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Transistor Mounts • Single Terminals • Compression Headers • End Seals • Crystal Bases • An Connectors • Miniaturization

eter offers a high degree of accuracy in a resistance range of 80 to 150,000 ohms.

▶ **Linearity**—Standard linearity tolerance for the potentiometer is ±0.10 percent. On special order linearity up to ±0.05 percent can be obtained on higher resolution windings.

Low starting torque is only 1.0 oz-in. per cup.

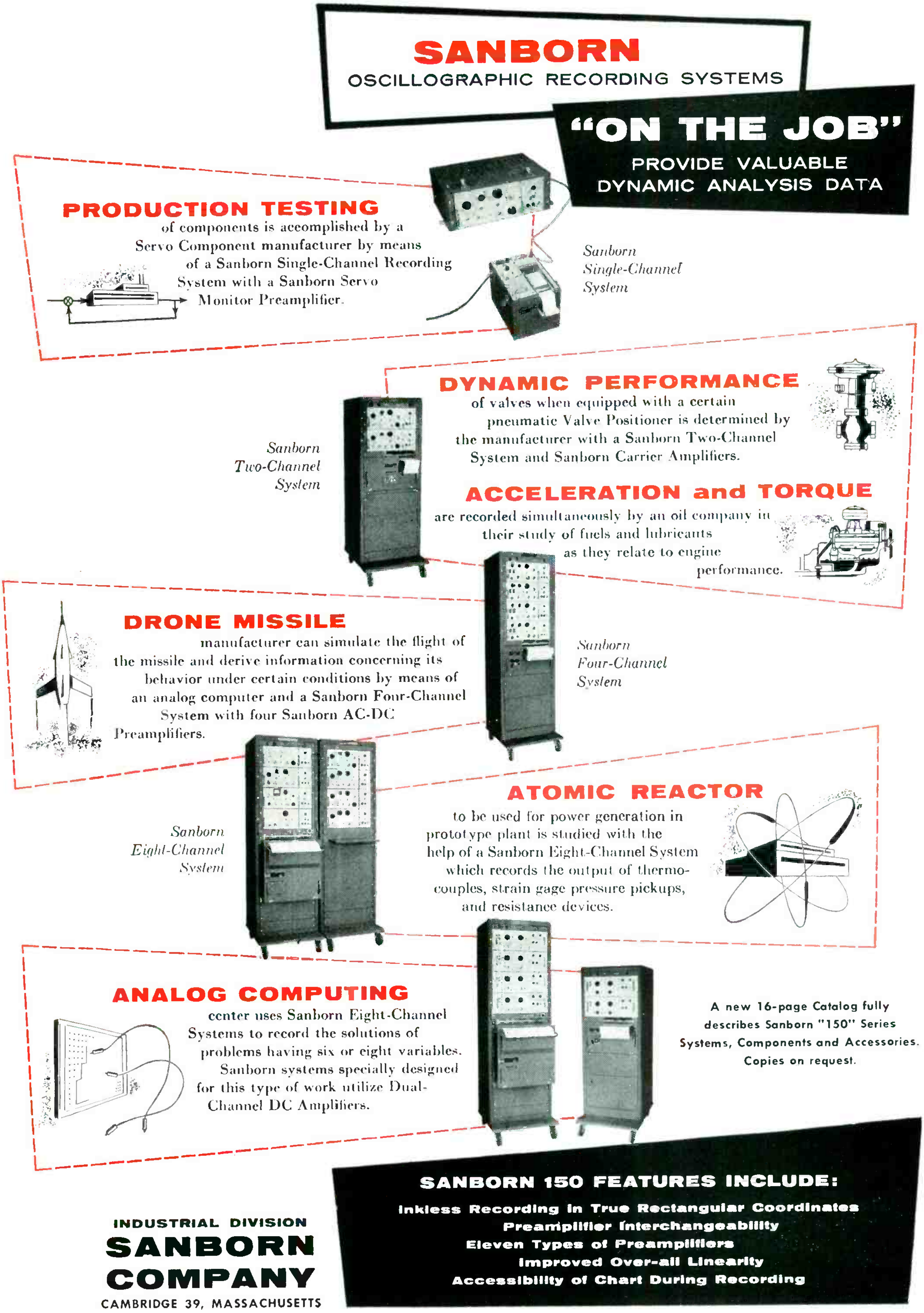
▶ **Tapping Area**—A special clamp-band feature provides an unrestricted tapping area allowing up to 33 taps and presents a simplified means of phasing units in a ganged assembly without disassembling the units. The unit is furnished with welded taps and leads.

The potentiometer is gangable in assemblies of up to 6 cup units on a single shaft. It has a diameter of 3⅛ in. maximum and a cup width of 0.984 in.

Prices range from \$30 to \$40 a cup in sample quantities; \$15 to \$25 a cup in production quantities.

GROUNDOMETER is completely portable

BORDEN ENGINEERING CO., Division of M. J. Johnson Aircraft Engineering Co., 39 E. Hanover Ave., Morris Plains, N. J. The new type W4 Groundometer is a null-reading Wheatstone bridge for measuring the resistance to ground of driven



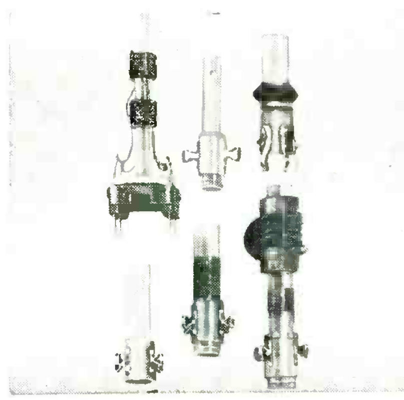
Want more information? Use post card on last page.

ground rods, transmission line towers, radio and tv antenna grounds and industrial plant grounds. It has full scale ranges of 1-5-10-50-100-500-1,000-5,000 and 10,000 ohms.

The instrument has, in its portable carrying case, a compartment for all the necessary reference rods and test leads, which are of the proper lengths to serve as measuring lines for the correct reference electrode spacing. Due to its patented circuit, only the 10-in. reference rods need be used and the Y-reference electrode may be as high as 400 times the resistance of the ground being measured.

►**Other Use**—The W4 can also be used as a d-c Wheatstone bridge from 0.01 ohm to 100,000 ohms at 0.1 percent accuracy by connecting an exterior d-c galvanometer.

The complete instrument is 7½ in. by 7½ in. by 12 in. and weighs only 16 lb. Price is $160 plus $25 for the galvanometer if it is desired.



COIL FORMS
less production time, costs

RADIO INDUSTRIES, INC., 5225 Ravenswood Ave., Chicago 40, Ill. New, one-piece coil forms reduce coil production time and costs by eliminating the need for mounting clips and minimize the number of assembly operatons.

RI-1 on precision molded forms of high temperature plastic are being used in the manufacture of RI-tran transformers and coils for countless r-f applications.

The RI-1 form construction is used in both conventional and printed-circuit type applications and is available in a variety of colors for easy identification. RI-tran

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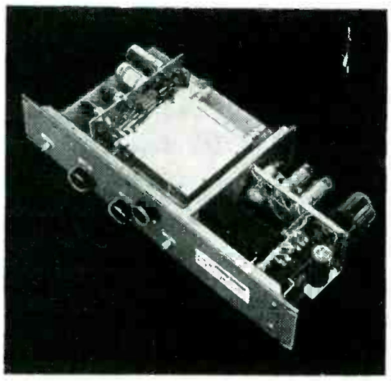
transformers are available in 8-32 or ¼-28 RI-lon tube construction.

▶ **Design**—A new snap-in keyed design eliminates the need for mounting clips, but is interchangeable with clip-mounting chassis cut out. RI-lon one-piece forms resist electrolysis indefinitely, have uniform characteristics and simplify components for automatic insertion in printed-circuit type applications.

RESISTORS
are deposited carbon type

DALE PRODUCTS, INC., Columbus, Neb. The Dalohm deposited carbon resistors are now being supplied with an improved coating material. The material incorporates such features as extreme toughness for rough handling; low temperature cycling (to −85 C); resistance to humidity, and high-temperature characteristics, making these resistors suitable for printed circuit solder dipping without the added space required for sleeving.

Identified as types DC (per Spec MIL-R-10509A) and CC (commercial grade). Dalohm deposited carbon resistors are available in 8 standard sizes from ⅛ w to 5 w, and resistance range to 500 megohms. Standard tolerance is 1 percent.

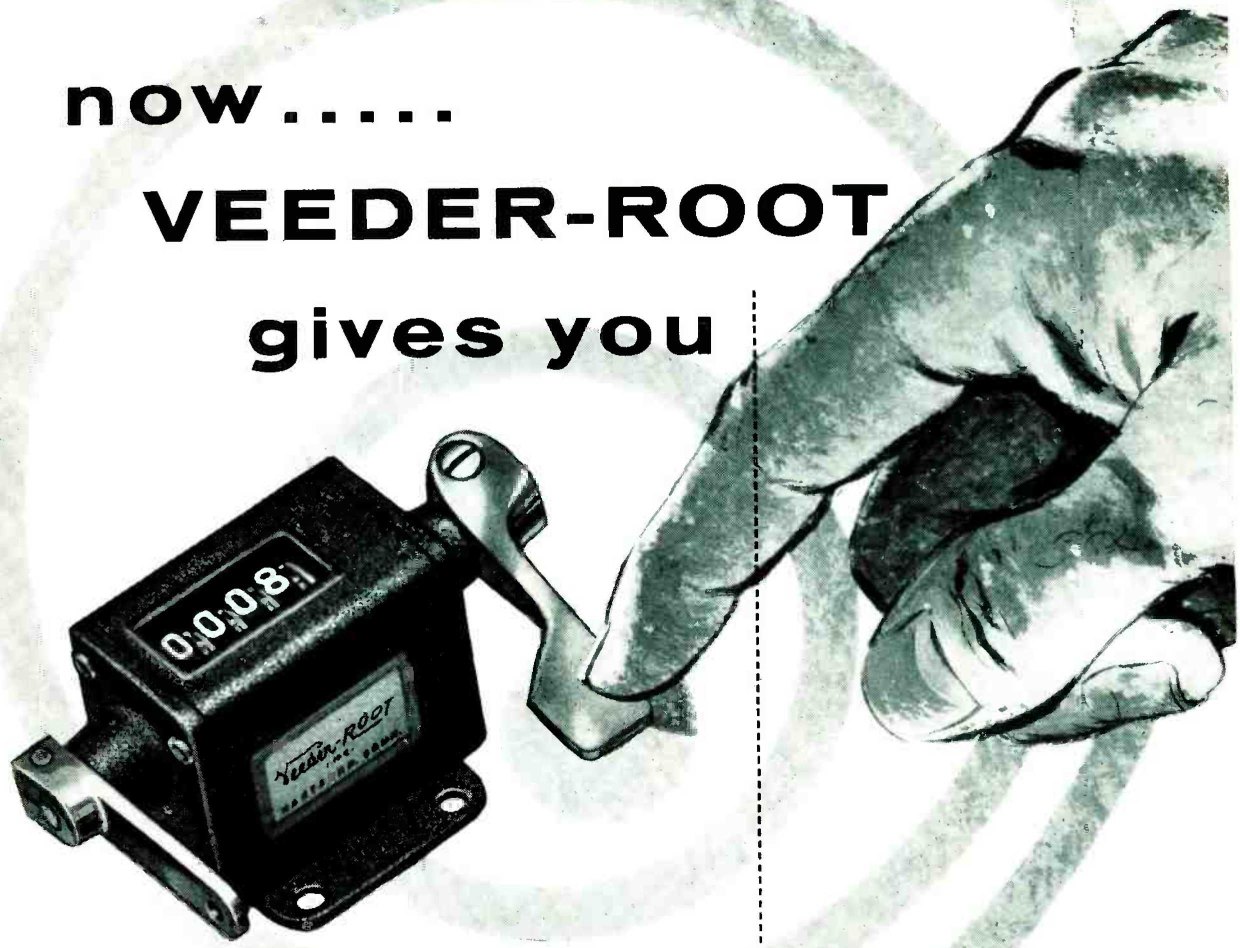


DELAY CHANNEL
available as complete unit

STURRUP, INC., Middletown, Conn., has announced the model 500 ultrasonic delay system available as a complete unit. The unit includes a compact solid ultrasonic delay line with predelay and post-delay circuits, and a self-contained, regulated power supply, particularly suiting it for radar, computer and now.....

VEEDER-ROOT

gives you



instant "push-button" resetting

Just press the easy-acting lever on this Quick-Reset Ratchet Counter . . . *and all 4 figures reset to zero as instantly as though you used a push-button.* This saves time and speeds work on short machine runs, inspection and many other jobs. Counter is compact . . . 2.69″ long, 1.44″ high, 1.29″ wide. The 4 white-on-black figures are .166″ high. You can order it (Series 1126) from stock right now . . . just like scores of other Veeder-Root Counters for manual, mechanical and electrical operation in every field from electronics to atomics.

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autocorrelation systems as well as general laboratory use.

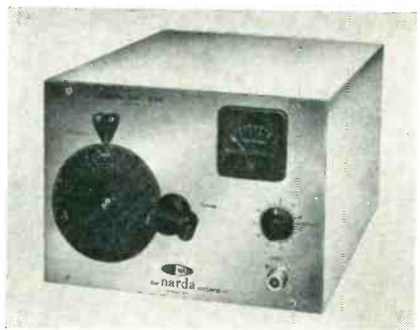
▶ **Specifications**—The unit illustrated has a delay of 500 μsec ± 5 percent. Characteristics include a video response of -3 db between 10 cps and 4.5 mc and a signal-to-noise ratio of 40 db. Several units may be cascaded for longer delays.

VARNISH
for printed circuits

THE INSL-X SALES CO., 26 Rittenhouse Place, Ardmore, Pa. A new varnish designed especially as a protective insulating coating for modular assemblies, printed circuits and printed circuit components has been developed by the Schenectady Varnish Co.

▶ **Complete Sealing**—Far more flexible than conventional coatings, the Schenectady No. 642 printed-circuit varnish can be baked or air-dried to a tough resilient coating that completely seals the laminate and component leads against arc-producing moisture. A $2\frac{1}{2}$ mil coating of this water-white varnish withstands 1,250-v—even after 72 hours exposure at 100 percent relative humidity.

▶ **Other Features**—The highly arc-resistant varnish will not support tracking, nor will it char. It is completely free from aging characteristics or discoloring and may be readily thinned with Xylol or its equivalent.



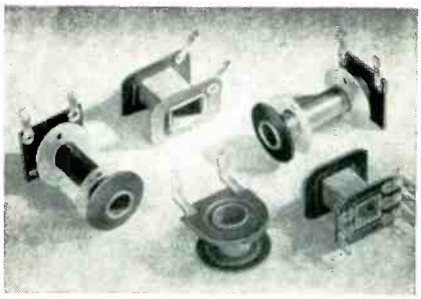
ECHO BOX
tests airborne radar

THE NARDA CORP., 66 Main St., Mineola, N. Y. Model 833 echo box is a high Q resonant cavity, specifically designed for rapid test-

ing of the overall performance of C-band (5,350 to 5,450 mc) airborne weather radars. The cavity is coupled to the radar transmission line through a directional coupler or with a pickup antenna placed near the radar antenna.

▶**How It Works**—During the radar transmitted pulse, microwave energy is stored in the echo box. Immediately following the pulse, the energy is returned to the radar over the same path producing a signal or target on the radar indicator. At the end of the pulse the returned energy decays exponentially, finally disappearing into the background noise clutter at a point determined by the receiver sensitivity and transmitter power output.

Therefore, the time interval between the beginning of the transmitted pulse and the point where the signal on the radar indicator disappears into the noise (called the ring time) measures the overall performance of the radar. Price is $970.



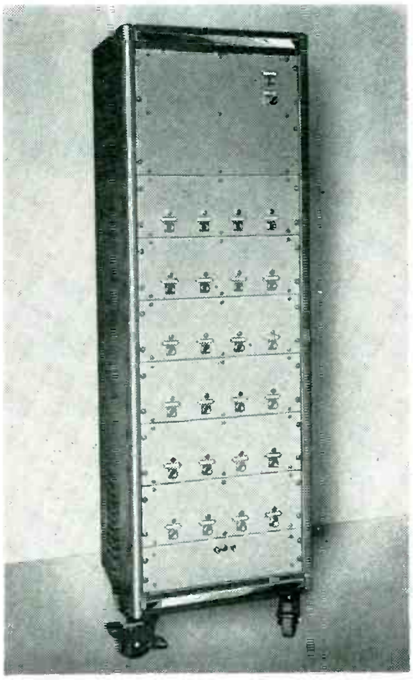
COIL BOBBIN
lug terminals attached

PRECISION PAPER TUBE CO., 2035 W. Charleston St., Chicago 47, Ill., can supply coil bobbins with any desired number of lug terminals attached. The attached lug feature perfectly adapts the bobbins for use with printed circuits.

▶**Another Advantage**—These coil bobbins can be insulated from the coil winding by washers as an integral part of the assembly. This not only improves insulation, but it greatly facilitates easier and faster production of the finished coil.

Bobbins are available in any size with round, square or rectangular core, and flanges of all shapes. Cores are wound from dielectric kraft, fish paper, acetate or combinations, including DuPont Mylar. They can also be supplied Resinite impregnated.

Since the bobbins are made to order, cost will be affected by such factors as specifications, the number of lugs attached and the time element involved in making them.



DATA REDUCER
shows vibration frequencies

HYCOR CO., INC., 11423 Vanowen St., N. Hollywood, Calif., announces a data reduction filter set for analyzing vibration frequencies in aircraft and missiles. In use, a tape recorder containing the complex wave form is fed into the unit which separates the component frequencies into 24 components.

▶ **Cathode-Follower Amplifiers**—The unit consists of 24 cathode-follower amplifiers which feed 23 band-pass filters ranging progressively from 30 cps to 2,000 cps, and one 20-cycle low-pass filter.

Output of each filter appears on jacks on the front panel. A channel-level control is provided for each filter. A set of jacks is also included on the front panel for oscilloscopic viewing of the complex waveform at the input.

The individual frequencies may be analyzed separately to determine the exact nature of the mechanical

 For additional information on all items on this page, use post card on last page.

vibration. The entire unit, including power supply, is contained in a standard enclosed 5-ft cabinet rack.

AXIAL BLOWER
is smaller and lighter

JOHN OSTER MFG. CO., Avionic Division, 1 Main St., Racine, Wisconsin, has developed a smaller, lighter 2-in. axial blower with exceptionally high air delivery in relation to volume and weight.

▶ **Performance** — Type AXB2249 puts out 25 to 30 cu ft of air per minute at zero static pressure yet weighs only 8 oz and measures only 3.375 in. long by 2.87 in. o-d. Operating temperature range is from −55 C to +71 C. Other military aircraft environmental requirements are also met.

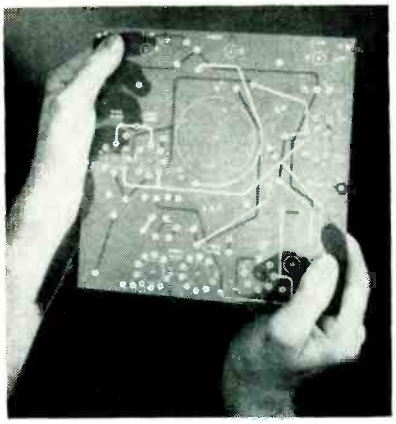
The device consists of an aluminum blower housing black anodized, a 2-in. aluminum fan and a 115-v 400-cycle motor.

Type AXB2249 is used for cooling a wide variety of electronic equipment in aircraft and industrial applications.

LAMINATED PLASTIC
for printed circuitry

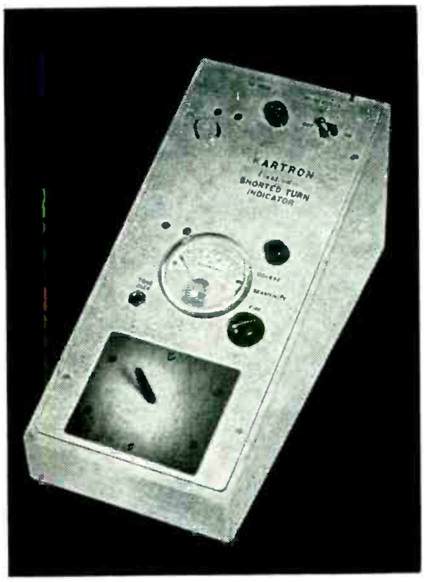
THE FORMICA CO., Cincinnati 32, Ohio. The XXXP-36 Formica cold-punching laminate brings translucency, greater accuracy and super-insulation to printed circuitry. Since it punches cold in thicknesses up to and including $\frac{1}{16}$ in., no heat cycle is required. Thus the base laminate is not subject to dimensional change as in grades which must be heated before punching. Circuits made from the new grade will be more accurate.

Formica XXXP-36 also offers



high dielectric strength, greater heat resistance and superior bonding strength. Simply by holding the Formica sheet to the light it is possible to see the smooth, homogenous structure, and to note how well the circuit printed on one side registers with that on the other.

For a free sample, write the company.



INDICATOR
checks coils for shorts

KARTRON, Drawer 472, Huntington Beach, Calif. Model 101-D electronic shorted turn indicator is sensitive, rugged and nonshocking when checking unmounted electrical coils for shorts. Mandrel size is small enough for all but the smallest coils; large enough for coils up to about a 2-in. cube outside, or equivalent volume in most other shapes.

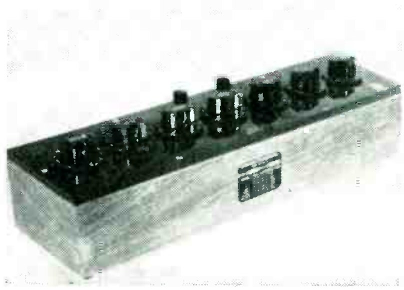
The unit is designed to detect

one shorted turn of No. 44 wire and built for years of production line high speed testing. Shorts are indicated on the 1-ma meter by a downward deflection $\frac{1}{3}$ to $\frac{1}{2}$ full scale.

SMALL OSCILLOSCOPE weighs 8½ lb

PROBESCOPE CO., 44-05 30th Ave., Long Island City 3, N. Y., has designed a portable miniature oscilloscope weighing 8½ lb and taking up less than ¼ sq ft on the bench. It measures 9 in. high, 6 in. wide and 5 in. deep.

Model MO-1 has the following features: an input impedance of 2 megohms shunted by 15 $\mu\mu$f; a 10-to-1 attenuator; vertical sensitivity of 100 mv full scale; sweep rate of 20 cycles to 30 kc in 5 steps. It is ideal for waveform analyzing and quick troubleshooting.

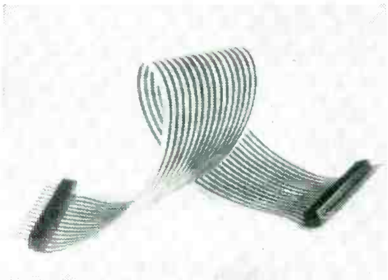


RESISTANCE DECADE has seven dials

INDUSTRIAL INSTRUMENTS, INC., Cedar Grove, N. J. A new resistance decade featuring accuracy of better than ±0.1 percent of each resistance increment is announced. The instrument has 7 dials having decade steps of 0.1, 1, 10, 100, 1,000 10,000 and 100,000 ohms. Decades are available with each dial having 9 or 10 steps.

Resistance coils are of manganin wire, bifilar wound, with the exception of 10,000 ohms and over which are low temperature coefficient nickel-chromium-iron alloy wound. All resistance coils are wound on ceramic cores, oven-aged and varnish impregnated.

Switches are the self-cleaning type with 4 phosphor-bronze spring wipers and detent mechanism for positive location of switch points. Switches and resistors are mounted below the panel for maximum protection from dust.

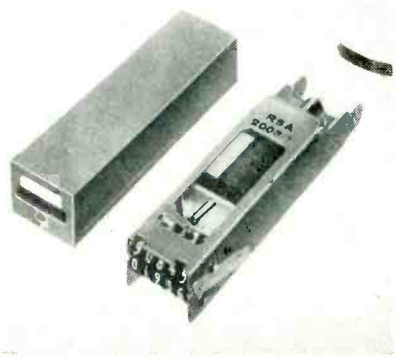


FLEXIBLE CABLES for printed circuits

SANDERS ASSOCIATES, INC., Nashua, N. H. Flexible printed circuit cables—made by a process of laminating the versatile plastic Kel-F with copper in thin sheets—are now being introduced. The new cables have excellent electrical and mechanical properties for operation over a wide range of environmental conditions.

Complete encapsulation of the conductors in Kel-F ensures maximum protection against moisture. Glass cloth can also be included in the laminations for increased strength and high temperature stability. The new lighter and thinner cables are adaptable to many types of connectors or terminations and are easily secured by clamps, rivets or cement. The manufacturing technique eliminates wiring errors.

Additional conducting and insulating layers can be added to the basic cable to provide a greater number of separate conductors. Stacked circuits have been built up to 5 layers and may go higher depending on the application.

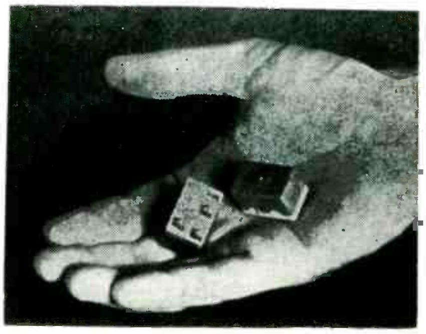


ELECTRICAL COUNTER
wheels cannot jam

NORTH ELECTRIC CO., Galion, Ohio, has announced a 5-digit electrical counter designed for reliable high-speed impulse recording. Type E-RSA-200 is compact and light in weight, and is suitable for installation in small spaces, measuring $\frac{3}{4}$ in. by $1\frac{3}{16}$ in. by $4\frac{1}{16}$ in. overall. Each counter is enclosed in a sturdy metal cover, available either as an individual unit or in strips of ten, with a common cover.

A flexible spring clip holds each unit firmly in place on the mounting plate. The mechanism of the counter is built so that the wheels cannot jam or get out of mesh. Each counter wheel is made of nylon for extra long wear. The coil of the unit is terminated with soldering lugs in rear.

Final inspection tests are made at a rate of 20 impulses per second.



SINE SWITCH
has high shock resistance

METALS & CONTROLS CORP., Spencer Thermostat Division, Attleboro, Mass., has announced the Klixon K series sine switches, for aircraft and industrial controls, actuators, relays and instruments. A highly precise sensitive snap switch is available for applications requiring small movement differential with high resistance to shock and vibration. The sine-curve switching element withstands from 0 to 500 cps at 10 g while continuously loaded the within 0.0002 in. of the actuation point.

Movement differential as well as operating and release forces can be adjusted and set to meet a wide variety of application requirements.

Once calibrated, the Klixon sine switch precisely maintains its operating characteristics throughout its life. Movement differential is 0.0005 in. minimum; shock, 200 g; temperature, −65 F to + 350 F; life, 100,000 cycles minimum; and size, $1\frac{1}{8}$ in. by $\frac{7}{8}$ in. by $\frac{11}{16}$ in.

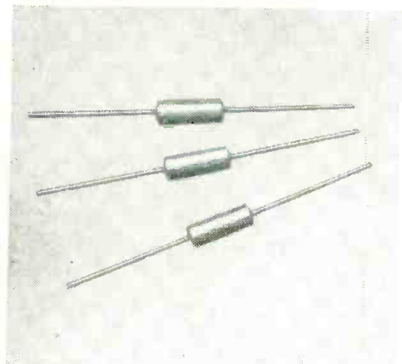
CAVITY WAVEMETERS cover 2.6 kmc to 90 kmc

DEMORNAY-BONARDI, 780 South Arroyo Parkway, Pasadena, Calif., is in production on a line of precision cavity wavemeters designed to give unusually broad coverage of microwave bandwidths. Only 11 sizes are needed to serve the entire range from 2.6 kmc to 90 kmc. Hence fewer sizes are required to cover wide segments of the total range. Each instrument measures all frequencies within the range.

Accuracy of these units is so high that they may be used as secondary standards, suitable for calibrating all other laboratory cavities. Units are nitrogen filled, and hence unaffected by changes in humidity or atmospheric pressure.

High resolution is accomplished with a precision micrometer-type turning screw which resolves plunger travel into 0.001-in. increments, and also with a multipage calibration chart furnished with the instrument.

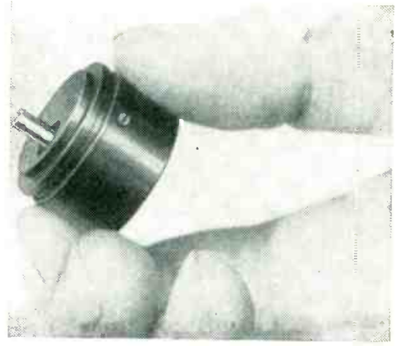
The units are designed for operation in a temperature range of −30 C to + 70 C. The line comprises reaction types, absorption and transmission types, all priced low. Literature is available.



MOLDED RESISTOR
with double insulation

ELECTRA MFG. CO., 4051 Broadway, Kansas City, Mo., has announced a new ½ w molded deposited carbon resistor. Its double insulation results in these advantages: complete mechanical protection, longer load life, better electrical insulation, greater moisture resistance and performance that exceeds all electrical requirements of MIL-R-10509A.

Complete information may be had by writing for bulletin No. 70.



GEAR HEAD
for subminiature motors

BOWMAR INSTRUMENT CORP., 2415 Pennsylvania St., Fort Wayne, Ind., has introduced a new subminiature motor gear head. The device measures 0.937 in. in diameter and adds just $\frac{5}{8}$ in. length to size 10 motors in its 26.4-to-1 reduction ratio.

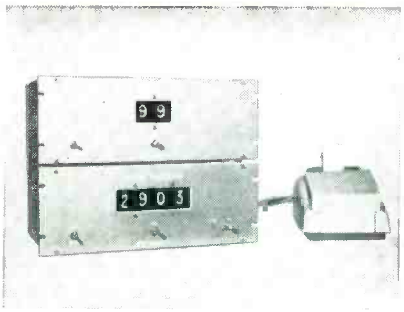
Model 937 speed reducer contains internally, in addition to its gear clusters, a unique adjustable slip clutch. Backlash is less than 30 minutes, and its weight is $1\frac{1}{4}$ oz.

Applications include computers, servo controls and general instrumentation where weight and size limitations are critical.

MAGNETIC TAPES
for electronic computers

ORRADIO INDUSTRIES, INC., 120 Marvyn Road, Opelika, Ala., has announced 50 different types of magnetic tapes for electronic computers. Reading and writing are performed at the rate of 15,000 alphabetical or numerical characters per second on Irish instrumentation tape No. 311.

The 50 types of tape will include tapes on acetate and Mylar films in 1,200 ft, 2,400 ft, and 4,800-ft lengths, and in $\frac{1}{4}$, $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$ and 1-in. widths. The manufacturing technique produces a mirror-finish, and a tape virtually drop-out free, which is so important in electronic computer applications.



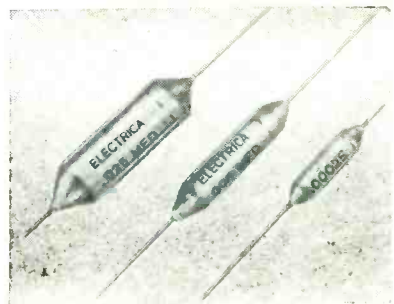
INPUT SCANNER
selects 100 data channels

ELECTRO INSTRUMENTS, INC., 3794 Rosecrans St., San Diego 10, Calif. The IS100 input scanner sequentially selects 100 channels of data. When used in conjunction with the company's digital voltmeters and ohmmeters (and printer), one has a complete automation system for component and system testing. The IS100 consists of a series of stepping switches with all necessary controls and power supplies.

It is rack mounted (7 in. by 17 in. by 16 in.) and operates on 115-v power. When used with digital voltmeter and printer, 100 channels can be printed out in approximately 5 minutes.

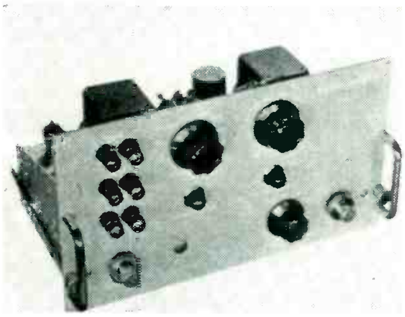
GENERATOR
for signal and sweep

DECADE INSTRUMENT Co., 14 Maple Ave., Pine Brook, N. J. The Sweepalator serves as a combined signal generator and sweep generator. It features decade switching, crystal c-w or center frequencies and wide range calibrated output. Specifications include the following: range, 10 kc to 1.5 mc; steps, 1 kc in 3 decades; interpolation, calibrated 0-1 kc; accuracy, 100 cps; short term stability, ±25 cps; harmonic content, 3 percent maximum; output, 3 v rms; attenuator, 3 v, 1 v, 0.3 v, 0.1 v, 0.03 v, 0.01 v full scale; meter, calibrated 0-1 and 0-3 v.



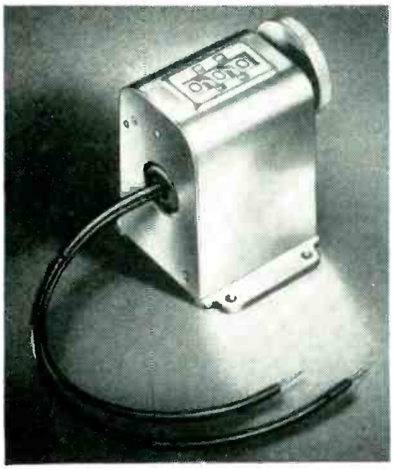
CAPACITORS
with immersion-proof shell

ARNHOLD CERAMICS, INC., One East 57th St., New York 22, N. Y. The new Electrica capacitors function at temperatures from −20 C to +110 C and meets the demands of broadcast, tv and measurements fields for light weight and minimum size. Thermoplastic protective covering makes the capacitors air-tight, moisture and fungus proof. Coating remains stable at all normal operating temperatures and insures high mechanical strength. The capacitors are economically priced. For complete data write for bulletin E.



PREAMPLIFIER
for oscillographic recording

SANBORN CO., 195 Massachusetts Ave., Cambridge, Mass., has developed a preamplifier which converts an average value of a-c watts into a proportional d-c voltage suitable for recording. Model 150-2300 a-c wattmeter preamplifier is designed as a front-end for plug-in installation in a model 150-200 driver amplifier unit, used in Sanborn one-to-eight-channel recording systems. Complete performance data and specifications are available from the company.



MAGNETIC COUNTER
is miniature type

VEEDER-ROOT INC., Hartford 2, Conn., has developed a small reset magnetic counter for moderate counting duty on the many applications where extreme long life is not required. Compact and easily

For additional information on all items on this page, use post card on last page.

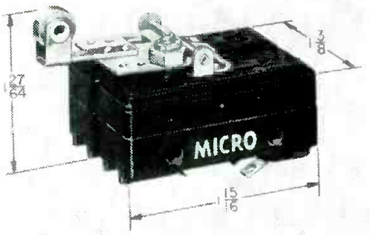
connected in series with any device having a contact arrangement, the series 1507 counter may be actuated by any type of switch, relay or photoelectric unit. Maximum recommended speed is 700 counts per min. Watt consumption is 4.5 at rated voltage (24 and 110 v a-c/d-c types are standard). Voltage variation is permissible up to 10 percent but not more than 10 v. The counter measures approximately 2¼ in. wide by 2½ in. high. Figures are 0.188 in. high.

BREAKDOWN TESTERS with range to 100 kv

INDUSTRIAL INSTRUMENTS, INC., 89 Commerce Road, Cedar Grove, N. J. Type PA-50 h-v a-c breakdown tester permits tests from 0 to a maximum of 100,000 v, continuously variable. It is rated at 5 kva available at breakdown. The PA-50 is entirely self-contained eliminating the dangers in multiple unit setups. The entire instrument is housed in a 30-in. relay rack, 6½ ft high. It is designed for either laboratory or production testing of such items as insulating tapes, transformers or any application requiring a variable, safe, dependable source of high a-c voltage.

DUAL SWITCH is single-actuated

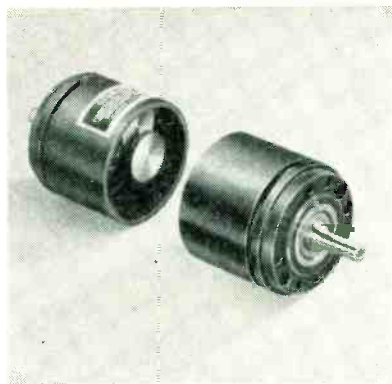
MINNEAPOLIS-HONEYWELL REGULATOR CO., 4428 Wayne Ave., Philadelphia 44, Pa., has developed a new single-actuated dual switch designed for a wide range of in-



dustrial control and electronic applications. The 6AS13 is a low-force, double-pole switch consisting of two basic switching units operated by a single roller-lever actuator. It is available with a variety of lever lengths, either straight or formed levers, with or without roller. Basic switching units of the 6AS13 are listed by UL at 15 amperes—125, 250 or 460 v a-c, ½ ampere—125 v d-c and ¼ ampere—250 v d-c. Various other basic switching units can be used to provide higher electrical capacity for d-c circuitry, or for special circuit applications. Operating characteristics may be had for the asking.

AUDIO ATTENUATOR manufacturers' type

Cinema Engineering Co., Aerovox Corp., Burbank, Calif., is producing a new manufacturers' type audio attenuator for sound attenuation, sound mixing, special measuring and calibration units. The item, featuring self-wiping contacts of nickel silver, carbon composition and wire-wound resistors, is available in 150, 250 and 600 ohms. Resistance element values are standard 5-percent accuracy. Audio ladder controls have a 6-db inherent insertion loss. All other network types of mixer controls have zero loss. The attenuator comes without knob and dial, but they are available as accessory items. Shipping weight is 8 to 12 oz per section.



GEAR HEAD
used with servo motors

STERLING PRECISION INSTRUMENT CORP., 34-17 Lawrence St., Flushing 54, N. Y. Designed for use with most Bureau of Ordnance servo motors, the model 600 series standard gear heads will fit units from $1\frac{1}{16}$ in. diameter to $1\frac{3}{4}$ in. diameter. Special heads can be designed for servo motors outside this group. The company's standard gear heads have the output shaft concentric with the servo mounting diameters. Attaching these gear heads to a servo motor creates a clean, fully enclosed self-contained unit.

DELAY LINES
are continuously variable

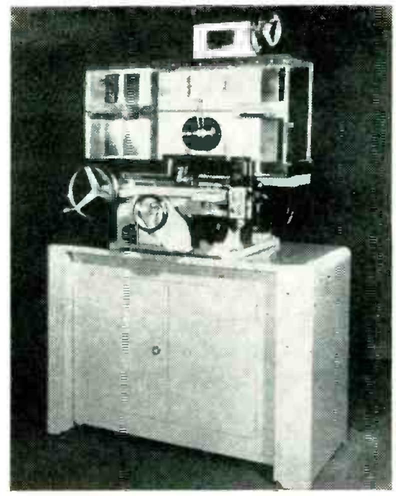
ADVANCE ELECTRONICS CO., INC., 451 Highland Ave., Passaic, N. J. Type 611 variable delay lines are continuously variable from 0 to beyond 10 μsec. The continuously variable delay line in type 611a is essentially a condensed r-f cable with one conductor changed into a long thin coil and the other spaced closely to the first, thus producing a large amount of time delay, yet maintaining low attenuation at high frequencies. The tapped delay line in type 611b has 10 or more sections of m-derived LC networks with similar electrical performance to that of the step variable delay line.

DATA TRANSLATOR includes visual readout

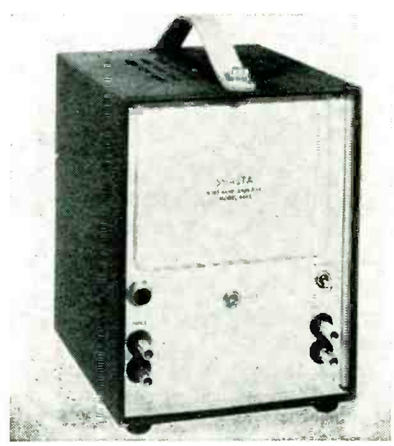
EPSCO INC., 588 Commonwealth Ave., Boston 15, Mass., announces the new Datrac data translator for ultraprecision voltage-to-digital and digital-to-voltage conversion. Model E Datrac converter provides 2 voltage-to-digital conversions per sec or 30 digital-to-voltage conversions per sec to an accuracy of ± 0.01 percent ± 1 least significant digit. The converter includes a visual readout and output conversion for direct control of printers, typewriters, or card punching equipment. Five decimal digits are provided. Three floating decimal ranges provide full-scale readings of ± 99.999, ± 9.9999, and ± 0.99999 v, thus providing 10-μv sensitivity. A number of optional features may be provided.

WAFERING MACHINE is fully automatic

MICROMECH MFG. CORP., 1020 Commerce Ave., Union, N. J. The Micro-Matic precision wafering machine is made specifically for use

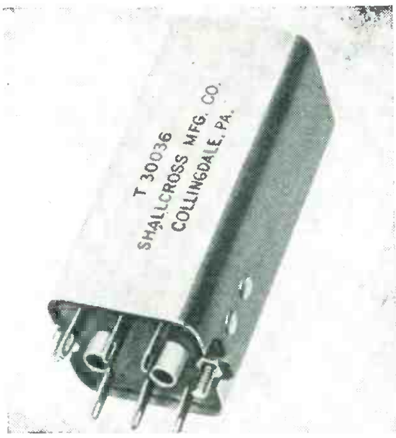


by the electronic industry for slicing and dicing germanium, silicon and quartz used in transistor and diode manufacture. It is equipped with control mechanisms and other automatic devices together with inbuilt accuracy. The wafers produced are consistent in thckness, and parallelism is controlled to within several ten thousandths variation. Any predetermined thickness may be obtained, ranging from 0.010 to 0.225. A 4, 5, or 6-in. diamond impregnated metal saw may be used for slicing and dicing. The working capacity of the machine is 6 in. transverse, 12 in. longitudinal and up to 12 in vertical.



AMPLIFIER for 10 cps to 1 mc

SHASTA DIVISION, Beckman Instruments, Inc., P.O. Box 296, Station A, Richmond, Calif. Model 854A amplifier provides a choice of two fixed voltage gains of 10 and 100 times, over the frequency range of 10 cps to 1 mc. The instrument is usable to higher frequencies with some slight sacrifice in uniformity of response, namely, ± 1 db, 5 cps to 2 mc at a gain of 100 times. The circuit used introduces distortion of less than 1 percent when operating into recommended loads. Equivalent input noise is 20 μv on 100 times gain setting, and 80 μv with a gain of 10. Output voltage is a maximum of 10 v into a minimum load of 3,000 ohms. The input impedance is one megohm shunted by approximately 15 $\mu\mu$f.

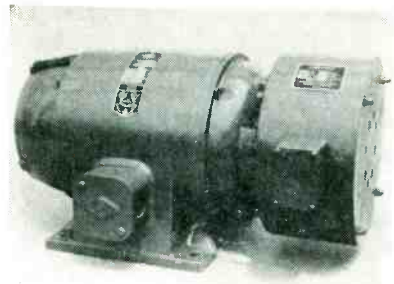


DELAY LINE
for color television

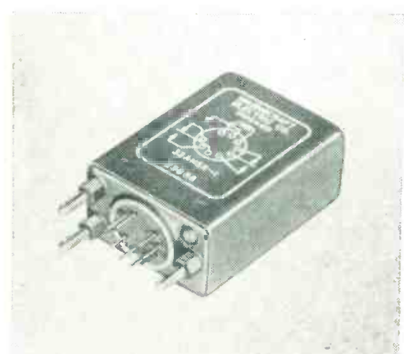
SHALLCROSS MFG. CO., Collingdale, Pa., has announced an inexpensive, distributed-constant delay line designed for use as a compensating delay in the luminance channel of color tv receivers. The type T30036 delay line has an impedance of 4,300 ohms and uniform response to 4 mc. Phase characteristics also are linear within 5 percent to 4 mc. Total delay is 0.8 μsec. Rise time is only 0.1 μsec. The unit is enclosed in an aluminum can only $1\frac{3}{8}$ in. square by $3\frac{1}{8}$ in. high, exclusive of terminals. Modifications of the basic electrical and physical characteristics can be made for quantity users.

FREQUENCY CHANGER
uses synchronous motor drive

GEORATOR CORP., Manassas, Va. Answering the need for a compact supply to furnish constant 420 cycles, with output frequency as invariable as the input, the unit pictured has been developed. Motor

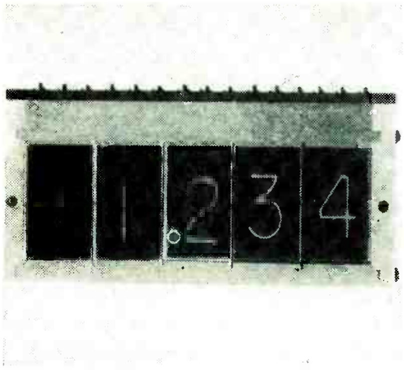


is synchronous type, direct coupled in a compact unitary combination with a Nobrush 420-cycle generator. The resulting combination is free of brushes, exciter and slip rings, yet delivers as constant a 420-cycle frequency as the input 60 cycle. Without any regulator or delicate auxiliary, the unit will maintain output voltage to better than 2 percent for a given load. The generator creates no radio interference, is immune to damage from short circuits, will withstand moisture, dust and grit. Converters are available in this design (150 va to 5 kva), with any desired combination of single or three-phase input and output.



RECTIFIER RELAYS
for better a-c reliability

MAGNECRAFT ELECTRIC CO., 3350 W. Grand Ave., Chicago 51, Ill. Increased operating reliability throughout the wide range from 25 to 400 cycles a-c is provided in recently announced rectifier relays. Full wave rectifiers incorporated in these relays convert a-c to rectified d-c; thus providing d-c operation from a-c power supply. Advantages obtained in comparison with conventional a-c operation include: increased operating sensitivity, higher contact pressures, greater resistance to vibration, reliable operation through much wider variation in voltage or current, freedom from a-c hum and, in many cases, reduced size. The rectifier relays are available with a wide range of contact combinations in hermetically sealed or dust-proof enclosures as well as open. Literature is available on request.



DIGITAL READOUTS with advanced design

NON-LINEAR SYSTEMS, INC., Del Mar Airport, Del Mar, Calif. The NLS 3W series is the most recent and advanced design of the company's in-line, luminous digital readouts. Standard readouts are available with from one to six windows arranged horizontally. The edge-lighted Lucite plates are engraved with numbers from 0 through 9, decimal points and polarity signs. The numbers are ½ in. wide and 1 in. high, spaced 1⅛ in. on centers to provide maximum legibility. A new quick change terminal strip to which connecting wires can be soldered retains the lamps, maintains spring-loaded contact with each lamp, and eliminates resoldering connections when replacing lamps. Improved design of the interlocking frame members provides maximum precision and sturdiness. Volume production tooling and assembly methods provide high quality and variety at low cost.

NOISE GENERATOR used with analog computers

AUTOMATION LABORATORIES INC., 517 W. 207th St., New York 34, N. Y. The low-frequency Gaussian noise generator provides a random voltage whose amplitude probability distribution is Gaussian to within 1

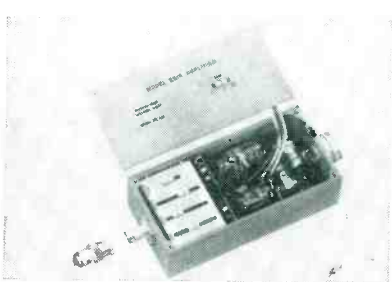
percent. The output frequency spectrum is flat to within 1 db from d-c to 27 cps in the standard model, but the frequency spectrum can be modified upon special request. Output voltage is 5 v rms, regulated to within 0.1 db, and available from a low source impedance. A continuously adjustable calibrated attenuator permits the output to be decreased from this value. A front panel meter continuously monitors the rms value of the output voltage. The instrument can be removed from the cabinet and mounted in a standard rack. It is intended for use with analog computers, simulators, servo testing and many other applications.

RELAY
operates at 10 milliseconds

Hedin Tele-Technical Corp., 87 Dorsa Ave., Livingston, N. J. Relay 100-MS operates at 10 milliseconds and incorporates a thorough wiping effect. Available either hermetically sealed or with dust cover, it is designed for d-c applications in contact combination from spst to dpdt. Capacity is up to 1.5 amperes inductive and 5 amperes resistive with coil resistance to a maximum of 30,000 ohms. Bounce and chatter are eliminated by the built-in wiping action in the contact movement. Drop-out if desired can be adjusted to about 65 percent of pickup. Wattage requirement is 250 mw per pole. The relay's applications include controls, recording, signal systems and electronic instrumentation, particularly in plate circuits and in circuits employing transistors.

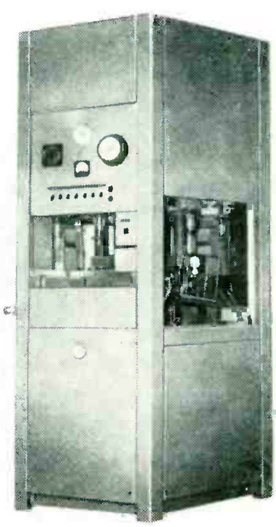
TEN-MC SCALERS
for high-speed counting

ELECTRICAL AND PHYSICAL INSTRUMENT CORP., 42-19 27th St., Long Island City 1, N. Y. Model 4104 and 4124 10-mc scalers have a binary or decade scale of 4.096 or 1,000 respectively, or larger if desired. A five digit electrical reset register with any count predeterminable, a predetermined timer, a regulated h-v supply (0 to 2,500 v) for photomultipliers and the availability of a general purpose 10-mc preamplifier and pulse height discriminator make these units ideal for high-speed scintillation counting in nuclear and medical applications.



PREAMPLIFIER
for use with pickups

ENDEVCO CORP., 180 E. California St., Pasadena, Calif., announces a new probe type of preamplifier for use with piezoelectric pickups permitting the user to trim the self-generating pickup output sensitivity to an even or standard value so that direct reading of physical parameters such as acceleration, force and pressure is possible with standard v-t voltmeters. Model 2614 features an input selector switch for the choice of 3 input conditions: 1,000 megohms for use with vibration pickups, extending the 1-f range of piezoelectric pickups to 2 cps; 1,000 megohms with d-c isolation for general uses; and 22 megohms for shock pickups, and fast recovery from overloads. In addition, a subminiature 3 decade shunt capacity switch is provided with a total capacitance from 10 $\mu\mu$f to 9,990 $\mu\mu$f in 10 $\mu\mu$f steps. The unit features amplifiers gains of 1, 3 and 10, with stability of 1 percent or better, a frequency response from 2 cps to 15,000 cps, and an output of 5 v into 2,500 ohms.



WET BLAST UNIT cleans tube leads

THE CRO-PLATE CO., INC., 747 Windsor St., Hartford 1, Conn. Designed for the high production rate cleaning of electronic receiving tube leads to insure good welding bond, a new rotary automatic is capable of blast cleaning, rinsing, drying and unloading at the rate of approximately 1,200 parts per hour. All chemical cleaning is eliminated through the use of the wet blast method. Mounted vertically within the cabinet is a 6-station, air-operated rotary indexing table to which 6 vertically positioned work holding spindles are attached. Each spindle supports a chuck which, in turn, carries the tubes through each of the separate, baffled operating stations. The use of different work holding fixtures makes the unit highly adaptable to the finishing of a wide variety of other parts.

SILICON POWER RECTIFIER
for miniaturization purposes

AUTOMATIC MFG. CORP., subsidiary of General Instrument Corp., 65 Gouverneur St., Newark 4, N. J. The tiny silicon power rectifier illustrated, designed for use in equipment where miniaturization and high temperature reliability are vital, takes up only 3/100 cu in. of space and weighs only 7/100 oz. It should play an important role in electronic gear for guided missiles, supersonic aircraft and other military equipment. In the commercial and industrial field, the new rectifiers are designed for manufacturers of power supplies, magnetic amplifiers, communications equipment, and many types of computers, whose bulk can be greatly reduced by use of the tiny semiconductors instead of vacuum tubes or selenium rectifiers. They are available in 6 voltage ranges, capable of handling voltages as high as 1,000 v, with d-c output currents on the order of 300 to 400 ma. They operate at temperatures as high as 200 C.

Literature

Electronic Test Instruments. Shasta Division, Beckman Instruments, Inc., P. O. Box 296, Station A, Richmond, Calif., has available a new 8-page catalog describing its line of electronic test instrumentation including expanded scale voltmeters and frequency meters, vtvm's, oscillators, resistance bridges, power supplies, wide-band amplifiers, WWV receiver, decade inductor and various accessories.

Fluorocarbon Plastics. United States Gasket Co., P. O. Box 93, Camden, N. J. Those interested in Fluorocarbon plastics in their products will find a 20-page brochure helpful. "Inside U.S.G." is a concise, word and picture story of the company—fabricators of Teflon, Kel-F, Bakelite Fluorothene, and similar engineered plastics—and how it functions as a supplier of these plastics for electronic purposes. It highlights the specialized engineering and production facilities available to customer manufacturers to assure sound application and the most economical production of their requirements.

Ask for bulleting No. IN-554.

Electronic Design and Manufacture. Electronic Products Corp., 322 State St., Santa Barbara, Calif., has released a bulletin describing facilities for the design and manufacture of electronic equipment for military and industrial applications. The bulletin describes the company's facilities for the fabrication of cables and electrical wiring harness assemblies including facilities for braiding and molding.

The bulletin also tells of the company's activities in the assembly of electronic devices, design and manufacture of specialized electronic test equipment, power supplies, subminiature electronic assemblies and etched-circuit wiring.

Vibration Measurement. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. A 64-page booklet covers the meaning of vibration terms, description of vibration-measuring instruments, procedures, typical examples, and interpretation of results. Unwanted vibration, like noise, plagues nearly every industry and plant at one time or another.

There are also many types of

desirable vibrations. The first step toward understanding what is happening in all these cases is the measurement of the vibration, and a useful guide for this work is the "Measurement of Vibration."

Calibrator. Allegany Instrument Co., 1000 Oldtown Road, Cumberland, Md. A single-sheet bulletin illustrates and describes the type C calibrator, a universal tool for the standardization of wire strain gages, transducers and thermocouples. Features, operation information and specifications are given. Price of the unit discussed is $650.

Electronically Regulated Power Supplies. Tarc Electronics Inc., 48 Urban Ave., Westbury, N. Y. A new data sheet describes a line of four power supplies, electronically regulated and designed to meet the extremely close tolerances encountered in color and monochrome television. Specifications for units with output currents ranging from 50 ma to 600 ma are given.

High-Frequency Resistors. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa., has announced catalog data bulletin F-3 containing comprehensive data on characteristics, applications, resistance values, tolerances, terminations, insulation and voltage rating for type HFR high-frequency resistors. Included are charts and graphs.

Electronic Frequency Meter. Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif. Volume 7, No. 1 of the *Journal* illustrates and describes the model 500 B electronic frequency meter, a 3-cps to 100-kc unit with discriminator output and expandable scale. Complete technical specifications are listed. Also included are specifications for the electronic tachometer indicator.

Master TV Manual. Blonder-Tongue Laboratories, Inc., 526 North Ave., Westfield, N. J. A 12-page master tv installation manual discusses all types of multiple tv systems, industrial tv systems and the proper use of Masterline equipment. Illustrated sections cover antenna and line installation, signal

Corrections of Product Listings for the 1955-1956 Electronics Buyers' Guide

BOLD FACING AND ADVERTISING PAGE NUMBER ARE OMITTED IN THE FOLLOWING:

AUTOMATIC ELECTRIC MFG. CO.,
62 State St.,
Mankato, Minn.

ADVERTISING PAGE 560

RELAYS
- Impulse
- Latching
- Power
- Sensitive
- Sub-Miniature
- Telephone
- Time Delay

SWITCHES—Time

TIMERS—Automatic Cycle
TIMERS—Automatic Interval
TIMERS—Automatic Reset
TIMERS—Cycle
TIMERS—Motor Operated
TIMERS—Multicontact
TIMERS—Sequence

* * * * *

DIMCO-GRAY CO.,
207 E. 6th St.,
Dayton, Ohio

ADVERTISING PAGE 678

FASTENERS & FASTENING DEVICES

INSULATION PARTS
- Plastic Insulation Parts—Molded

KNOBS

RELAYS
- Time Delay

SWITCHES—Time
TIMERS—Automatic Interval
TIMERS—Motor Operated

* * * * *

EMELOID CO., INC.,
1239 Central Ave.,
Hillside 5, N. J.

ADVERTISING PAGE 539

KNOBS

distribution, closed-circuit tv, system maintenance and trouble-shooting procedures.

Simplified charts and tables, with specific examples, show how to calculate signal levels at any point. All the company's amplifiers, converters, tapoffs and accessories are fully described. Also offered is free engineering assistance.

Infrared Radiation Pyrometers. Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y. A new 4-page brochure describes 2 infrared radiation pyrometers. The IR-2 is an industrial instrument designed for temperature measurement of moving objects in process as well as the location of hot spots in inaccessible equipment.

The IR-1 discussed covers a nominal temperature range of ambient to 1,000 C. As a control instrument, the unit described is highly suitable for fine measurements. As a control instrument it is outstanding for processes requiring high sensitivity near ambient.

Bobbin Winder. Geo. Stevens Mfg. Co., Inc., Pulaski Road at Peterson, Chicago 30, Ill., has available a data sheet on the new compact front-loading multiple-head adjustable-length bobbin winder. Model 314-AM3 is pictured and completely described.

Technical data include dimensions, weights, types of windings, coil o-d and length, maximum distance between winding centers, wire sizes, tension equipment, built-in adjustable cam, gears, slow-start and winding speed, new one-way clutch, set up time, motor equipment, brake, counter, instant reset and start, automatic one-shot lubrication and new instant automatic brake release.

Dielectric Capacitors. Corson Electric Mfg. Corp., 540 39th St., Union City N. J. A 2-page, 2-color catalog sheet describes and lists a new line of ultrahigh-stability polystyrene dielectric capacitors. The capacitors discussed are designed for use where low leakage and low dielectric absorption are important. The sheet shows standard units which come in bathtub and rectangular can types in 200, 400 and 600-v ratings, from 0.05 to 25 μf. Also described are special units which may be ordered with a variety of housings and terminals, still lower temperature coefficients, higher insulation resistance, silicone impregnation, lower power factors, lower retrace, and other special specifications.

Resistors. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. Catalog data bulletin P-2a covers types PW-7 and PW-10 resistors. Comprehensive data on applications, design and construction, characteristics, ranges, power ratings, tolerance, stamping and derating are given. Charts and graphs are included.

Electromanometer. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif. Bulletin 1547 illustrates and describes the type 37-103 Electromanometer, a precision, pressure-measuring instrument. A functional diagram is included, along with pressure balance information, specifications, applications and readout methods. A price list for the type 37-103 Electromanometer system is also included.

Captured Spot Displacement Follower. The Optronic Co., 136 Caputo Lane, San Jose, Calif. A 12-page folder illustrates and describes the Optron, a device for measuring displacement, runout or vibration of oscillating or rotating parts from 1μin. to 5 in. with frequency response from 0 to 100,000 cps.

The captured spot displacement follower discussed may be used to measure amplitude and frequency of any displacement or vibration within the specified ranges. Principle of operation, component description, overall assembly and specifications are included.

Cable Harness Tester. Industrial Instruments Inc., 89 Commerce Road, Cedar Grove, N. J. A single-sheet bulletin illustrates and describes the type A-1 electric cable harness tester, a compact, rugged instrument. The tester discussed makes continuity measurements, insulation resistance tests, dielectric strength tests, and provides terminations for the use of external instruments. It is designed for use in production or maintenance work. Price is included.

Precision Instruments. Allen B. DuMont Laboratories. Inc., 760 Bloomfield Ave., Clifton, N. J. A recent pocket-sized folder covers 13 new precision instruments. Included are 5 cro's including 21-in. indicator, portable field unit, and others to cover the range of d-c to 20 mc; 4 new oscillograph-record cameras; new high-quality vtvm and 2 low-distortion oscillators. Illustrations, brief details and prices are given.

Precision Cleaning. Cobehn, Inc., Caldwell, N. J. An 8-page folder deals with a solvent and equipment that safely spray cleans electronic components, contact points and precision instruments; and removes oil and grease, rosin flux, abrasives, lapping compounds and dust, dirt and lint.

The Cobehn solvent and equipment are described with an illustration of a typical installation of a bench unit. The booklet discusses the company's engineering service which is available without cost or obligation. Also available is a single page list of satisfied user companies of this technique of precision cleaning.

Boron-Carbon Precistors. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. An illustrated description of ½-watt molded Boron-Carbon precistors is contained in catalog data bulletin B-8a. It includes comprehensive data on characteristics, applications, wattage rating, tolerance, dimensions and insulation. Charts and graphs are also shown.

Lubricants. The Alpha Molykote Corp., 65 Harvard Ave., Stamford, Conn. Bulletin 103-A is a 4-page 2-color catalog of the variety of Molykote lubricants now available to industry. It lists 17 types of this molybdenum disulfide lubricant line and features a complete explanation, with diagrams, of the importance of this compound in extreme bearing pressure, and high, low and normal temperature lubrication applications. Five new Molykote lubricants are discussed.

Also included is a selector chart which describes each Molykote type, the kind of carrier used in it, the temperature range in which it operates best, and the proper method of application.

Subminiature Relays. Elgin-Neomatic, Inc., 2435 N. Naomi St., Burbank, Calif., has issued a new brochure illustrating rugged subminiature relays designed for a wide variety of high-precision applications. The brochure includes the Neomite, a tiny precision relay, built in a standard transistor case for transistorized circuitry.

Also featured are the Neomatic VK and VR series, lightweight, compact units with excellent vibration resistance due to counterbalanced armature design. The brochure lists a variety of enclosures available in the VR and VK series and a complete rundown on specifications.

Wire-Wound Resistors. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. Type MW wire-wound resistors are covered in the 4-page bulletin B-2a. Comprehensive data on construction, tolerance, power rating, marking, humidity, adaptability and frequency characteristics are given. Detailed charts and graphs are included.

Precision Indicators. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Data sheet No. 10.02a gives specifications, dimensions and operating characteristics of the Brown-Rubicon precision indicator. Now available in two overall ranges, the instruments described greatly speed laboratory-type electrical measurements.

Infrared Detectors. Barnes Engineering Co., 30 Commerce Road, Stamford, Conn. The latest type of infrared detectors used as sensing elements in radiometers, pyrometers, infrared spectrometers and other infrared instruments are described in a new bulletin called "OptiTherm Infrared Detectors." It covers the characteristics, construction, circuitry and uses of these high-speed thermistor-type sensing elements.

Four-Watt Resistors. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. Catalog data bulletin P-1a illustrates and describes the type PW-4 4-watt resistors. It contains comprehensive data on tests, applications, ranges, tolerance, stamping, rating and derating. Two graphs are included.

Power Supply. Technical Advisory Associates Corp., 30 Broad St., New York 4, N. Y. A single-page bulletin covers the AC700 power supply, a unit designed for use in critical resistance heating applications, for example the heat sealing of glass diodes.

The automatically recycling timer discussed allows precise timing of the heating cycle over a wide range. Output current is continuously variable up to 25 amperes. Full specifications are listed in the bulletin. Price of the power supply described is $350.

VTVM's. Technology Instrument Corp., 531 Main St., Acton, Mass., has prepared an 8-page brochure describing the outstanding features of its new extended range type 800A and 800B vtvm's. The 800A is priced at $275; the 800B, $325. Die-cut into the shape of the instruments, the brochure explains their operation and use in simple terms.

Also available is Laboratory Report No. 16, entitled "Basic Theory of the Type 800A Vacuum Tube Voltmeter," which discusses in detail the design consideration, giving basic circuits and development logic. Die-cut brochure No. I-105 and Laboratory Report No. 16 are available upon written request.

Delay Lines. Helipot Corp., 916 Meridian Ave., South Pasadena, Calif., has available the second technical paper on Helidel delay lines, entitled "Criteria and Test Procedures for Electromagnetic Delay Lines." Technical paper No. 491 discusses general types of fixed and variable electromagnetic delay lines and defines conventional terminology. Common delay-line distortions are illustrated, methods for correction are analyzed, test procedures (both pulse and sinusoidal) and methods for measuring linearity and phase shift are described.

Deposited Carbon Resistors. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. Comprehensive data on tests, applications, specifications, tolerance, ranges, performance and dimensions of deposited carbon resistors are available. Detailed charts and graphs are given in the 4-page catalog data bulletin B-4a.

Vitreous-Enameled Resistors. Ohmite Mfg. Co., 3680 Howard St., Skokie, Ill. A 2-page bulletin, No. 147, gives specifications and features of the company's new line of small wire-wound, vitreous-enameled resistors with axial leads. It shows the two sizes, rated at 5 and 10 w, that are carried in stock in a wide range of resistance values. Also shown is a price schedule.

Connector Bulletin. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. A 2-page illustrated color bulletin describes features of the new 37-contact Continental connector suitable for airborne electronics. It includes electrical and mechanical ratings, mounting and clearance dimensions and diagrams. Write for bulletin CCC20.

Building Blocks. Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y. A 12-page brochure describes a versatile array of electromechanical general purpose analog computer components. Called the Servomation building blocks, various component combinations provide the means for industrial control, design and mathematical problem solving, classroom demonstration and data processing. The units discussed are coordinated modular assemblies which match each other in all the important mechanical and electronic specifications. Featured are the Servoscope for analysis of phase and gain shifts, the Servoboard for breadboarding electromechanical assemblies, amplifiers, modulators, demodulators, corrective network, power supplies, jack panels and cabinetry.

Nuclear Reactor Brochure. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa., has available a brochure reviewing the amplifiers, power supplies, detectors and recorders applicable to nuclear reactor control. An illustration of typical reactor-control instrumentation is also shown along with panels in operation. Readers are invited to request the brochure on their own letterheads.

Magnetic Cores. General Ceramics Corp., Keasbey, N. J. A 4-page folder illustrates and describes Ferramic magnetic cores. Specifications and data on standard grades of Ferramic H are given. A table of magnetic properties of other Ferramic bodies is included.

Precision Oscilloscope. Laboratory For Electronics, Inc., 75 Pitts St., Boston 14, Mass. The model 411 Easy-Six, a wide-band, adaptable, precision oscilloscope, is described in a new 4-page brochure. The leaflet describes the way ease of operation has been brought to a complex, precision piece of test equipment. It also describes six plug-in packages which make it possible to use the oscilloscope as a delayed or undelayed model, a gated marker generator, a tv test instrument, a video switch and a long sweeps generator.

Plug-In Units. EECO Production Co., 506 E. First St., Santa Ana, Calif. The new 40-page illustrated catalog 827 presents circuit drawings and specifications on 36 of the company's different plug-in units for the design, development and production of electronic equipment. A number of typical applications are also presented to show the use of the units.

Magnetic Components. Milwaukee Transformer Co., 5231 North Hopkins St., Milwaukee 9, Wisc. A 16-page catalog lists various transformers and other magnetic components manufactured by the company. Case dimensions and ratings of many of the company's stock types are given and illustrated. The components described are engineered for commercial, industrial, laboratory and government applications.

Elapsed Time Indicators. Haydon Mfg. Co., Inc., Subsidiary of General Time Corp., Torrington, Conn., announces availability of product engineering bulletin No. 5 describing the new 60 and 400-cycle hermetically sealed total hour indicators now being manufactured for military applications. Complete specifications are listed. The rugged running time meters described indicate and repeat hours-of-operation up to 10,000 on a dial-type face.

Potentiometer Checker. Analogue Controls Inc., 37 W. 20th St., New York 10, N. Y. A 2-page flyer describes the model PC-15 potentiometer checker. The calibration standard instrument discussed finds wide application in receiving inspection of potentiometers and in calibration use where system performance may be improved by trimming potentiometers in accordance with individual error distribution as determined by comparison with an accurate standard. Complete operation information and technical specifications are included.

Electronic Instruments. Krohn-Hite Instrument Co., 580 Massachusetts Ave., Cambridge 39, Mass. Catalog D is a 36-page booklet giving illustrated descriptions, chief features and specifications for a line of versatile electronic instruments. It covers 8 models of ascillators, 6 filters, 6 power supplies and an amplifier. Included are 4 pages of reference material and suggestions for ordering.

Electronic Thermostat. Minneapolis-Honeywell Regulator Co., 4428 Wayne Ave., Philadelphia 44, Pa. A 16-page illustrated booklet tells how electronic flexibility lets you sequence from your thermostats when you want to, locate your thermostats where you want to, and compensate your thermostats as much as you want to. The booklet explains how electronic control of heating and air conditioning is as flexible as a strand of wire.

Selenium Rectifier Design. Federal Telephone and Radio Co., 100 Kingsland Road, Clifton, N. J., has issued a 12-page booklet entitled "Federal Selenium Rectifier Design Data Guide." It gives engineers the factors that should be considered in the design of industrial and military rectifiers and tells why these factors are important. The explanations are given simply and briefly, and cover a wide range of rectifier applications.

Included in the data guide is a questionnaire which may be filled in and returned to the company for full evaluation of any specific design. The company's complete line of industrial rectifier products is also briefly described and illustrated.

Electronic Controls. Eaton Manufacturing Co., Kenosha, Wisc. Complete with illustrations and circuit diagrams, the 16-page bulletin EC-1 contains nontechnical, simplified information on the installation, performance and maintenance of the basic Dynamatic electronic control. The principles utilized to accomplish stepless speed control of Dynamatic eddy-current rotating equipment, using an a-c line as the power source, are described in detail. Precise speed control in addition to many other features which provide individual control requirements are presented.

Photoelectric Systems. Worner Electronic Devices, Box 118, Rankin, Ill. A new 20-page booklet on photoelectric systems covers the uses of electronic equipment in industry. It is written in nonengineering terms for easy understanding. Copies are available by request made on business stationery.

R-F Connectors. American Phenolic Corp., 1830 South 54th Ave., Chicago 50, Ill., has released a new 64-page D3 catalog covering the following r-f connector series: N, BN, C, LC, UHF, BNC, HN, between series adapters, coaxial cable fittings, push-on and Subminax. Dimensions, mounting holes, weights, impedance, materials and matching cable types are given for each connector. The DC3 also contains illustrated connector cable assembly methods for each series. Requests for the catalog on company or government letterhead will be promptly filled.

Horn Antennas. Waveline Inc., Caldwell, N. J. Microwave optimum standard gain horns are illustrated and described in a single-page looseleaf perforated leaflet. The leaflet describes a set of 8 horn antennas covering the frequency range from 2.6 to 40.0 kmc. Gain of each horn discussed is 15.0 db ± 0.2 at the specified frequencies.

Sine and Pip Generator. Dalmotor Co., 1329 Clay St., Santa Clara, Calif. A new leaflet, form GPM-3, describes a small generator suited for continuous-indicating duty in radar instrumentation and similar applications. It produces simultaneously a two-phase sine-wave and two indicating pips per revolution.

Included in the leaflet are an illustration of the unit, a dimensioned outline drawing, a list of mechanical and electrical specifications and performance curves relating output voltage in volts to load resistance in ohms for both 20-cps (1,200 rpm) and 35-cps (2,100 rpm) operation.

Resistor Engineering Guide. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. Comprehensive data on the company's complete line of resistors and special products are listed in the revised 1955-1956 official resistor engineering guide. Data given include JAN or MIL equivalent, rated wattage, standard tolerances, temperature rise, temperature coefficient, maximum operating temperature, ohmic values available, dimensions and approximate prices.

Precision Potentiometer. Helipot Corp., 916 Meridian Ave., South Pasadena, Calif. A recent technical paper, No. 573, tells what happens to the operating characteristics of a precision potentiometer during its working life. Entitled "Precision Potentiometer Life and

Reliability," the paper discusses the effects of wear on operating characteristics (linearity, total resistance, noise, torque and shaft play) and the operating characteristics of potentiometers which are affected during use. Suggestions for increasing useful life are also given.

Punched-Tape Control System. Barnes Engineering Co., 30 Commerce Road, Stamford, Conn. A brochure describing the application of Binotrol, a punched-tape control system, to a turret lathe to make it completely automatic, has recently been published.

The 8-page booklet describes the operating principles of Binotrol and relates in detail how all of the motions of the lathe are completely controlled by the system.

Preparation of the punched tape, application of binary number coding to the lathe's functions, and advantages of the new lathe are also discussed. The Binotrol system described has an operating principle that is digital-to-analog, and contains few vacuum tubes.

Four-Channel Carrier System. Lenkurt Electric Co., San Carlos, Calif. Volume 4, No. 10 of the *Demodulator* illustrates and describes the type 45CB carrier system, which operates in the 40 to 76-kc frequency range, and transmits up to 4 high-quality voice and signaling channels over an open-wire pair.

New design features incorporated in the system include transistors. Design features, block diagrams, frequency allocation and modulation plan, as well as possible applications, are given.

Photoelectric Pyrometer. Photoswitch Division, Electronics Corp. of America, 77 Broadway, Cambridge 42, Mass. The 4-page illustrated bulletin PT556 contains descriptive data, specifications and dimensions on pyrometer type P2T, which provides new and greater flexibility in the fast and accurate measurement and automatic control of high temperatures.

The photoelectric pyrometer described operates over a range of from 1,000 to 5,000 F and will respond to temperature changes of 5 F, indicating this change on a meter and providing relay action to give a signal or to control heating devices. Accuracy of the unit is practically unaffected by oxides or scale formation on the work, or by smoke or vapors between the pyrometer scanner and the hot object. Plug-in chassis design of the pyrometer simplifies maintenance, and the use of rugged industrial-quality components assures on-the-job dependability.

Instrument Catalog. Norden-Ketay Corp., 555 Broadway, New York 12, N. Y. Bulletin No. 364 is a 4-page folder dealing with solid front Acragages. Specifications are given on pressure, vacuum, compound, pneumatic and electric transmitters, receiver, test, chemical protectors and gages. Dimensional diagrams are included.

Potentiometers. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa. Complete information about the type K-2 potentiometer is available in a 4-page data sheet. The publication points out the widespread use of this potentiometer in industrial and research labs for potential difference measurements, for instrument checking, and for precise temperature measurements.

This concise sheet describes the circuitry and construction of the type K-2 in detail, and lists the accessories required for typical measurements. Ask for data sheet E-51(3).

Variable Inductance Coils. North Hills Electric Co., Inc., 203-18 35th Ave., Bayside 61, N. Y. A single-sheet bulletin deals with a new series of miniature variable inductance coils covering the 1 to 1,000-μh range completely.

Designed for such applications as video peaking, r-f and i-f amplifiers and filter networks, the coils described feature ceramic forms, split bushings and locknuts, and single D-hole type mounting.

Recording Oscillograph. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15,

Calif. Bulletin 1521B illustrates and describes the type 5-116 recording oscillograph. The unit discussed was developed to provide the dynamic test-measurement field with a high-precision, compact, reliable and extremely rugged multichannel recording oscillograph.

Features, specifications, prices and data on associated equipment and other Consolidated products are included.

Flexible Electrical Insulations. Irvington Varnish & Insulator, Division of Minnesota Mining & Mfg. Co., Irvington, N. J., has available a general catalog of flexible electrical insulation materials. It is a compilation of technical data sheets of the company's products which are grouped into three categories: coated products, varnishes and plastic products.

Included also are many useful charts and conversion tables. The catalog is supplied in a loose-leaf binder which makes it possible to change or add additional sheets as required.

Measurement and Control Systems. Daytronic Corp., 216 S. Main St., Dayton 2, Ohio. A 6 page folder covers linear variable differential transformer measurement and control systems for laboratory and industry. Illustrations, specifications and operating principles are included.

Plastic Dielectric Capacitors. The Gudeman Co., 340 W. Huron St., Chicago 10, Ill. A 6-page engineering bulletin (No. XC-201-4) illustrates and gives complete technical information on high temperature 165 C XC plastic film dielectric hermetically sealed tubular capacitors with exceptionally high insulation resistance, low power factor, and low dielectric absorption.

Included are capacitance listings, dimensions and voltages, dimensional drawings, and engineering data on test voltage, life test, power factor, insulation resistance, capacitance change, moisture resistance, vibration and typical curves.

Control Relay. Clark Controller Co., 1146 E. 152nd St., Cleveland 10, Ohio. A new line of sectional-pole heavy-duty 10-ampere control relays, to occupy minimum panel space, is described in an 8-page bulletin. Bulletin PL 7305-PM completely describes the new relays, available in models with from 2 to 12 poles. (Up to 8 poles are available without double-decking).

The bulletin pictures each of the 10 models in the line; gives dimensions, enclosures, features and data on maintenance and pole conversion from normally-open to normally-closed; and lists the other literature and layout template kits which are available.

Magnetic Shields. Magnetics, Inc., Butler, Pa. Catalog MS-104, "Performance-Guaranteed Magnetic Shields," describes the shield alloys which are used, the dry hydrogen annealing process used for controlling shielding properties, fabrication and finishes.

Some discussion is devoted to mounting brackets and availability of single or multiple nested shields made from Mumetal alone or with alternate layers of Mumetal and copper. Thirty-three pages of working drawings are included showing the diversity of shields which the company manufactures, and describing materials used.

Battery-Operated pH Meter. Photovolt Corp., 95 Madison Ave., New York 16, N. Y. Bulletin No. 118 covers the battery-operated pH meter model 125. It illustrates and describes the unit which is powered by three ordinary radio batteries that last 2,000 hr. Price of the unit described is $145 including batteries and electrodes. The bulletin discusses a number of useful accessories which have recently been developed.

Portable Potentiometers. Allegany Instrument Co., 1000 Oldtown Road, Cumberland, Md. A 4-page folder contains descriptive information and illustrations of a line of portable potentiometers and millivolt sources used to calibrate amplifier gain and linearity, recording potentiometers, millivoltmeters and thermocouples. Prices of the units described are as follows: models P-55 and P-55M, $215; model P-55MB, $240; and model P-102, $345.

Plants and People

Edited by WILLIAM G. ARNOLD

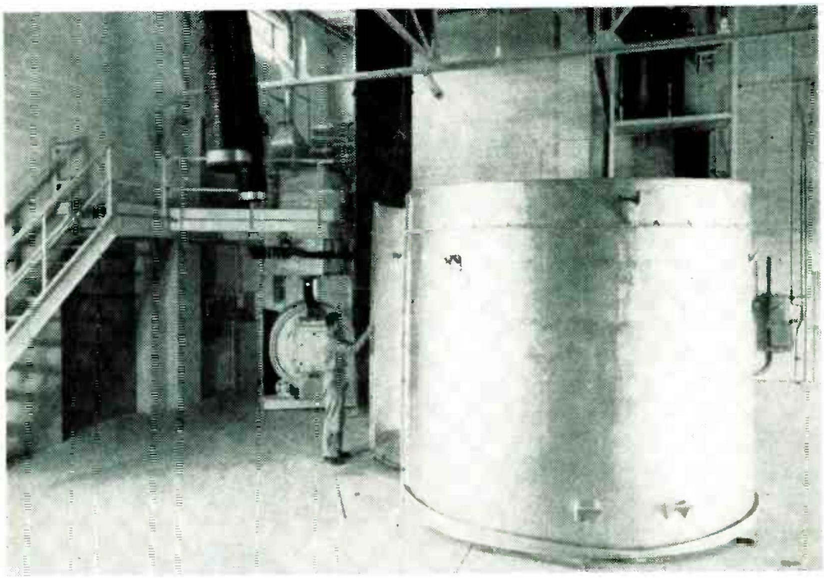
Manufacturers continue to expand plants and facilities for future growth. Technical societies elect new officers, honor engineers for technical accomplishments. Engineers are promoted and move to new positions in the industry

Mycalex Opens Synthetic Mica Plant In New Jersey

PLANT designed solely for the production of synthetic mica was formally opened in Caldwell Township, N. J. by Synthetic Mica Corp., wholly owned subsidiary of the Mycalex Corp. of America.

Production of the highly strategic material, under the trade-name Synthamica, has been under way for several months. At first the bulk of the synthetic mica produced will be pulverized and bonded with electrical glass to produce an electrical insulation material called Supramica. The material is currently being used in supersonic aircraft, guided missiles and nuclear development.

The formal opening of the new plant marked a 10-year effort to produce mica synthetically to reduce U. S. dependence on foreign sources for the material.



Production furnace and auxiliary processing equipment in new mica plant

In the first batch of synthetic mica, produced at the new plant, the crystals, although not large, were larger than any produced in earlier pilot plant operations, and the chemical purity of the new batch was "above expectations." The company has also announced an expanded research and development program whose twin goal is to produce synthetic mica in forms that will eventually service all the critical markets where natural mica is used today, and to evolve modern mechanized methods to supersede the present laborious hand processing associated with natural mica.

New Transistor Firm Expands Into Aviation Field

ACQUISITION of National Aircraft Corp., Metropolitan Airparts Co. and Florida Aviation's western division, was announced by Reagan C. Stunkel, who recently acquired the transistor facilities of Hydro-Aire. Stunkel was formerly vice-president of Hydro-Aire.

Metropolitan Airparts, Florida Aviation and the former Hydro-Aire facilities, now called Mar Vista Electronics, will operate as separate divisions of National Aircraft under the presidency of Stunkel.

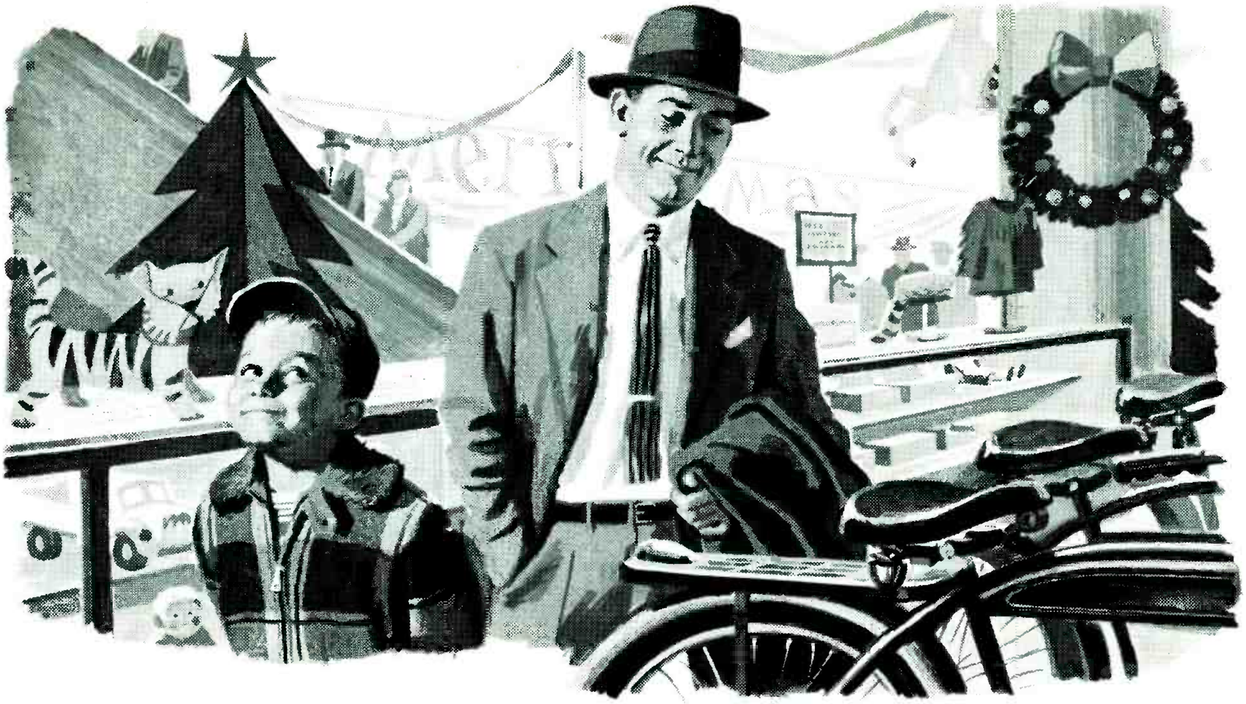
Total employment of the combined operation is more than 300 employees, all of whom will be retained under the new organization.

R. C. Stunkel, president of National Aircraft, right, and H. H. Roads, president of Hydro-Aire

Headquarters of National Aircraft will be located in Burbank, Calif. adjacent to Lockheed Air Terminal. Some 30,000 sq ft of office and manufacturing facilities have been leased there from Pacific Airmotive Corp.

The Mar Vista Electronics division also will be located there. The manufacture of diodes, transistors, and other semi-conductor devices under the trade name, Marvelco, will be conducted under the direction of Robert Vaughn, vice-president of the firm.

Twenty-two acres of manufacturing buildings and hangars are occupied in Van Nuys, Calif. and will house the aircraft and manufactur-



Best for meeting customer demand . . . all year round

United Air Lines Air Freight

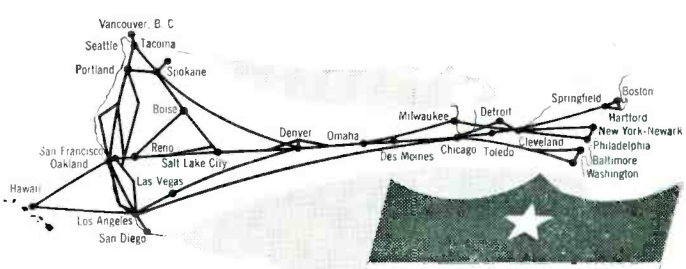
Many businesses first learned the advantages of United Air Lines Air Freight by using it to "fill in" inventories during peak buying seasons.

Now they use it profitably and enthusiastically throughout the entire year for many other good reasons—to maintain a better control of inventories . . . to improve customer service . . . to obtain higher prices through better service . . . to reduce the number of cancelled orders through faster delivery . . . to protect the condition and appearance of goods at destination by reducing in-transit damage . . . and to bring down the cost of packing, crating and warehousing.

Why not plan to use United Air Lines Air Freight regularly during the coming year? The cost is lower than you might think. For example, a leading dress manufacturer ships children's dresses coast to coast for only about 14¢ each!

Remember, too, only United offers Reserved Air Freight space on all equipment—not only over its own routes, but world-wide through connecting airline agreements.

For speed, dependability and economy, learn the advantages of United Air Lines Air Freight Service. Call the nearest United Air Lines Representative or write for free booklet, "Industry's Flying Partner." Cargo Sales Div., Dept. V-12, United Air Lines, 5959 S. Cicero Avenue, Chicago.



UNITED
AIR LINES

ing divisions of the firm.

Combined operation under the name of National Aircraft Corp. began in October. New officers in addition to Stunkel include: Jack Ferris, vice-president; L. D. Harrison, vice-president and treasurer; J. Guenette, secretary; Ruth Fitzgibbons, assistant secretary, and Charles Thompson, chief counsel.

Stromberg Begins $5 Million Expansion

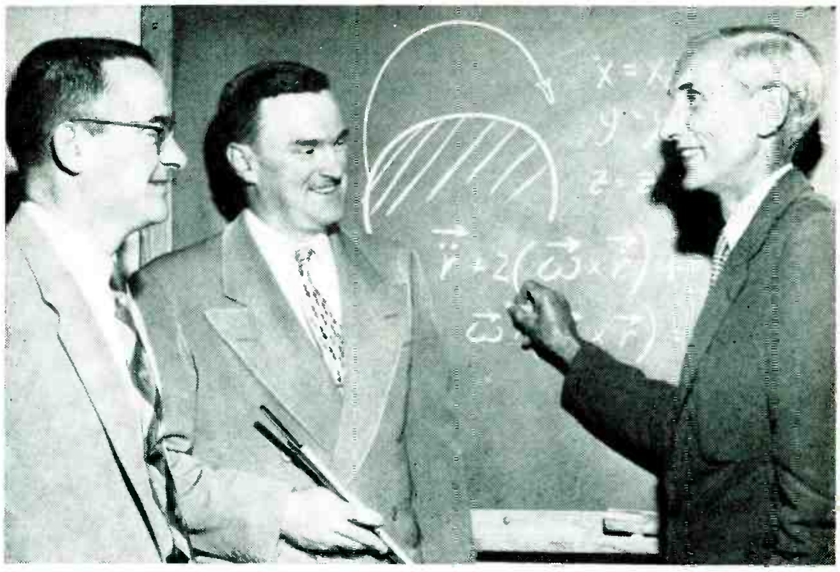
A FIVE-MILLION-DOLLAR expansion program has been started at the main plant and offices of Stromberg-Carlson, a division of General Dynamics.

More than a quarter of a million sq ft of floor space will be added to the firm's facilities.

The new building will adjoin the north side of the company's main plant in Rochester. It will be completed in 1957.

The building will be divided into three main sections: an administration and research building, providing more than 100,000 sq ft of space; a kitchen and cafeteria section; and a factory building providing approximately 110,000 sq ft.

Sylvania Dedicates Plant, Starts Another



NEW WALTHAM Laboratories of Sylvania, where guided missiles and the development of electronics means to detect and destroy them are a primary concern, were recently dedicated. Discussing the problems presented by an enemy missile and equations of its path are, left to right Dr. Oliver G. Haywood, manager of the Waltham laboratories; Paul Black, manager of the avionics laboratory and Dr. Edwin G. Schneider, manager of the missile systems laboratory.

Some 700 mathematicians, physicists, electronic engineers, and other members of the firm's avionics and missile systems laboratories work in the 120,000 sq ft building.

Sylvania also began construction of its new data processing center in Camillus, N. Y.

The 50,000 sq ft center, scheduled to begin operations February 1,

RETMA Board of Directors And Officers For 1955-56

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1956, will house a Sperry-Rand Univac and will be the focal point of a 12,000-mile private electronic communication system linking the firms facilities in 51 cities.

By the leased Western Union network, these various installations will feed financial and production information to the center.

RCA Expands Research In Canada

James R. Whitehead

DR. JAMES RENNIE Whitehead of McGill University has been appointed to head the new RCA Victor Research Laboratories in Canada. Dr. Whitehead's work will be in the field of pure physics and electronics research not necessarily connected with company projects or developments.

Associated with him will be Dr. Sydney Wagner, also of McGill University, and a staff of Canadian physicists. The new laboratories will be opened before the end of the year.

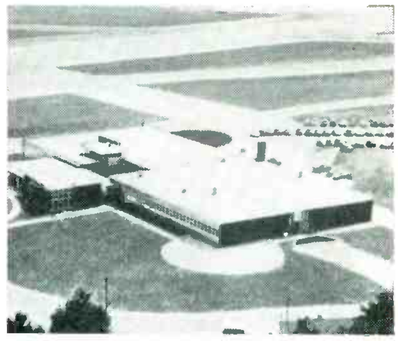
From 1939 to 1951 when he joined McGill, Dr. Whitehead was associated with the British Government Telecommunications Research Establishment engaged on important war and defense projects. Beginning with work on the Mark I prototype aircraft system for radar identification, he put in 1,500 hours of actual flight testing of radar systems. He then designed the Mark III airborne equipment which was fitted to all Allied ships

Want more information? Use post card on last page.

and aircraft and was named head of the research group responsible for ground and airborne systems.

Dr. Wagner joined the physics department at McGill in 1946, and was appointed associate professor in 1954. From 1950 until this year, he also held a research appointment in the Eaton Electronics Research Laboratory, where he did research on electronic beams and traveling wave tubes.

Marion Instrument Moves To New Plant



MARION Electrical Instrument Co. transferred all its operations to a new, half-million-dollar plant erected at Grenier Field, Manchester, N. H. The facilities produce more than 85% of the components used in Marion panel instruments, meters, aircraft instruments and mechanisms.

The new plant has 40,000 sq ft of space.

Hoover Buys Control Of Electronics Firm

THE HOOVER Company has purchased controlling interest in Phebco, a Baltimore electronics firm.

The purchase will involve no changes in the personnel of Phebco, or changes in its current research and production programs. Phebco specializes in designing and making electronic equipment for industrial use, radar and guided missiles.

Hoover plans to expand and develop Phebco's current activities, and later to coordinate some of its work with that in the international Hoover organization.

Plans are to secure larger quarters for Phebco so it can expand its research work on electronic equipment for industrial uses. Phebco is currently devoting most of its efforts toward developing and making guided missile electronic equipment.

Centralab Names Three Engineers

Robert L. Wolff

ROBERT L. WOLFF has been elected vice-president in charge of engineering of the Centralab division of Globe-Union.

Wolff, an employe of the company since 1937, has been director of products engineering since 1951.

Other appointments are W. S. Clark as division manager of the Badger Centralab plant and R. C. Anderson as division manager of Keefe plant. Anderson has been with the company since 1950 and Clark since 1948.

Columbia Acquires Armstrong's Station

COLUMBIA University's school of engineering has acquired the steel radio tower and laboratory building in Alpine, N. J. from the estate of the late Major Edwin H. Armstrong, inventor of f-m radio and long a professor of electrical engineering at Columbia. The installation will be known as the Edwin H. Armstrong Field Laboratory and will be used by the department of electrical engineering for research in radiation and propagation of various types of radio waves, particularly with respect to their behavior in the atmosphere, ionosphere and upper atmosphere. It will also be available for military

and industry projects.

In addition to the Alpine site, Columbia also acquired from the Armstrong estate, 57 acres of land in the towns of Catskill and Hunter, New York. This area includes one of the taller peaks of the Catskill Mountains. These two sites plus Columbia's engineering camp near Litchfield, Connecticut, will form a triangular range for extensive field studies in radar and radio.

The tower and laboratory were built in 1938 by Major Armstrong to perfect frequency modulated radio transmission. During World War II the station was also used in radar developments.

Beckman Instruments Plans Expansion

BERKELEY Division of Beckman Instruments plans to build an addition to its plant in Richmond, Calif. The $350,000 expansion program will add 44,000 sq ft of working area to the plant. It is to be completed by mid-January. The addition will permit doubling of the work force and a 100 percent space increase for all departments.

General Ceramics Appoints Bouwmeester

JOHN H. BOUWMEESTER has been appointed vice-president of manufacturing and a director of General Ceramics Corp.

He was associated, until recently, with the Indiana Steel Products

Company in a similar position.

Appointment of James W. Schallerer to the position of project engineer developing magnetic memory devices and allied equipment was also announced.

He was formerly with Lincoln Laboratory of M. I. T. as a staff member in charge of a magnetic material testing laboratory.

Texas Instruments Builds New Plant

CONSTRUCTION has begun on the new main plant for Houston Technical Laboratories, the geophysical instrumentation subsidiary of Texas Instruments. The 40,000 sq ft plant is being built on a five-acre tract in Houston, Texas.

When the modern new building is completed next spring, the lab's research, design, and manufacturing operations now being carried on in several rented buildings in Houston will be consolidated.

The new building will provide facilities for more than a hundred occupants.

Union Switch & Signal Realigns Engineers

G. W. Baughman, F. E. Lowance and E. F. Brinker, right to left, discuss a new inert train-carried coil for an electronic train identification system

UNION Switch & Signal, division of Westinghouse Air Brake Co., has made the following personnel and organization changes:

George W. Baughman, vice-president, formerly in charge of the railway signal engineering department, has been appointed to the staff of the vice-president and general manager.

A newly established position,

director of research and engineering, will be filled by Dr. F. E. Lowance, formerly on the staff at Air Brake executive headquarters.

The present research department and the present development group in railway signal engineering will be merged to form a new research and development department, with E. F. Brinker as manager and D. P. Fitzsimmons as assistant manager.

In addition to his other duties Dr. Lowance will be acting manager of the railway signal engineering department with H. L. Ludwig assigned as assistant manager.

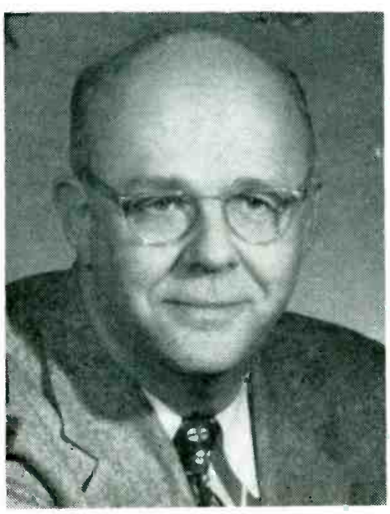
L. M. Engineering Constructs New Plant

THE L. M. ENGINEERING CO. of Los Angeles, Calif. plans to build a 36,000 sq ft building in Hawthorne, Calif. It will consolidate activities now housed in separate buildings.

The new $600,000 project, to be completed early in 1956, will include electronic, engineering and fabrication operations and office facilities. It is expected to increase production four-fold.

L. M. Engineering designs and manufactures special machinery, tooling, handling equipment, and electronic shakers. The electronics division makes testing equipment.

Rea Appoints Three Executives



D. T. Gundersen

D. T. GUNDERSEN, who joined J. B. Rea as chief engineer in 1954, has been appointed vice-president in charge of engineering and production. He was with Cook Research Laboratories as chief administrative engineer. Prior to that he was chief engineer for the Askania Regulator Co.

L. E. Schumacher, who has been sales manager of the Rea Company since 1953, has been appointed vice-president in charge of sales and customer relations. He was formerly sales manager for Logistics Research.

Francis A. Oliver has been appointed as manager of the newly created data storage devices unit of the company.

The new unit will be responsible for the development and manufacture of magnetic storage components.

Oliver, designer of the new magnetic components, was formerly head of research and development of magnetic storage devices at National Cash Register's electronic division. Prior to that he headed a similar division at the computer division of Bendix Aviation Corp.

Kester Enlarges Plant

KESTER SOLDER Co. of Chicago has expanded its plant facilities at Newark, N. J., by more than 50 percent. All phases of its Newark factory, manufacturing operations, warehouse and shipping areas, have been enlarged.

William Barkley Joins Rust Co.

WILLIAM J. BARKLEY has been appointed as vice-president of Rust Industrial Co.

He founded the Wireless Specialty Co. of Boston, Mass., in 1907, manufacturing crystals, receiving sets and spark transmitters.

Barkley later was associated with Dr. Lee DeForest as vice-president of the DeForest Radio Co.

His later associations included the position of general manager of the power and transmitting tube division of Sylvania. Following that, he joined the staff of Collins Radio Co. of Cedar Rapids, Iowa, where he acted in the capacity of general sales manager and executive vice-president from 1934 until April 1, 1955.

Barkley will head up an expansion program at Rust Industrial in the manufacture of remote control equipment and other electronic devices in the communication and navigation fields.

IBM Plans Swiss Research Lab

IBM PLANS to establish a research and development laboratory in Zurich, Switzerland. It is expected to be in operation the first of next year.

The new laboratory is intended to establish closer contact between the domestic IBM organization and development activities being conducted by European scientists and engineers in the accounting and data processing equipment field. The firm expects to be able to incorporate in its machines the technical advances of both European and American scientists.

Dr. Ambros P. Speiser, associate professor at the Swiss Federal

Ambros P. Speiser

Institute of Technology, has been appointed as director of the laboratory and will assume his new position after completing present work as head of the computer group at the Institute.

IBM also has leased a 20,000 sq ft building in San Jose, Calif., for development and pilot production of a new machine. Work at the new facility will start in December. The newly-acquired space boosts total working area of the IBM research and development laboratory in San Jose to 52,000 sq ft.

Bourns Adds Plant In Iowa

BOURNS Laboratories of Riverside, Calif., manufacturer of precision potentiometer instruments, has added a subsidiary plant in Ames, Iowa, devoted to the manufacture of miniature instruments.

Managed by Arthur J. Miller, the plant will have 25 employees and occupy an area of 12,000 sq ft.

IRC Appoints Iowa Plant Head

Guy B. Entrekin

GUY B. ENTREKIN has been appointed plant manager of International Resistance's fifth and newest manufacturing branch plant located in Burlington, Iowa.

He was formerly IRC chief product engineer, and led a special research and development project on carbon composition resistors. Prior to joining the company seven years ago, he was product engineer

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for Western Electric.

The Burlington plant is expected to start production of deposited and boron carbon type resistors on or about December 1, 1955.

Bristol Engineering Expands Plant

BRISTOL Engineering Corp. has doubled its working area by leasing a 33,000 sq ft factory in Bristol, Penna. The newly acquired building will house the firm's electronic division and also its experimental and fabricating shops.

Harrington Joins Arthur D. Little

JOSEPH HARRINGTON, formerly of United Shoe Machinery, has joined the staff of the mechanical division of Arthur D. Little, consulting industrial research firm of Cambridge, Mass. Dr. Harrington will be concerned with the design, development and fabrication of automatic machinery for the assembly of intricate equipment, particularly in the electronics field. He will also assist in the technical audit services offered by the company. Dr. Harrington joined the research division of the United Shoe Machinery Corp. in 1932, where he became assistant director of research in 1947.

Precision Radiation Acquires Radio Craftsmen

PRECISION Radiation Instruments of Los Angeles, producers of radiation detection units, has acquired

Radio Craftsmen of Chicago, manufacturers of high fidelity components and equipment.

The new, wholly-owned subsidiary will be operated as a division of PRI, with the executives of Precision Radiation operating as the governing body of the new subsidiary.

Radio Craftsman, which has been selling directly to the consumer, will now market its products through dealers in a one-step distribution plan.

Sanborn Selects Engineering Head

Maurice S. Hartley

MAURICE S. HARTLEY has assumed the post of director of engineering for Sanborn Co. of Cambridge, Mass., manufacturers of medical and industrial instruments.

He was with Raytheon as product manager. He has also been connected with Imperial Oil of Canada, as senior research physicist, and previously was engaged as manager of the technical-commercial division of Philips Industries, also of Canada.

Raytheon Shuffles Equipment Operations

RAYTHEON has established two new integrated organizations in its equipment operations. One is responsible for commercial equipment and the other for government equipment. Each will have its own engineering and development facilities.

Two new positions created by the change have been filled by John H. Beedle as manager of commercial equipment, and Gordon S. Humphrey as manager of government equipment. Each man has had more than a dozen years' service with the company.

Raytheon also announced that it has built a room with solid lead walls, for use in the x-ray study and inspection of electronic vacuum tubes.

The structure, weighing several tons, was designed by Raytheon engineers to house a powerful x-ray machine which is capable of maximum operation at 300,000 volts. Initial facilities make it possible to photo-inspect 20 tubes at a time.

Kuthe Labs Elects President

WILLIAM P. MAGINNIS has been elected president of Kuthe Laboratories of Newark, N. J., subsidiary of IT&T. He succeeds Dr. Herman Kuthe, founder and first president, who has been elevated to chairman of the board.

Prior to his present appointment, Maginnis was vice-president and works manager of the components division of Federal Telephone and Radio. For 21 years before his affiliation with Federal, which he joined in 1951, he was with RCA. His last position with that company was as head of component engineering at the Camden plant. Before that he was chief engineer at Bloomington, Indiana.

GE Expands Control And Radio Plants

PILOT operations will start this fall at GE's new multi-million dollar plant near Roanoke, Va. The plant of more than 600,000 sq ft will house manufacturing and office facilities for the company's industry control department, currently headquartered in Schenectady, N. Y.

The new plant is expected to be completed about January, 1956, and the transfer should be completed early in 1957.

The plant will employ some 1,800

persons upon completion of the move from Schenectady.

The company also has expanded its communication equipment manufacturing, warehouse, and office facilities in Utica, N. Y.

The company has signed a lease for 60,000 sq ft, or roughly half of the former Oneida Bleachery building in Utica.

The new space is to be used to augment two-way radio manufacturing operations and to consolidate various office and warehousing activities now at several locations throughout the Utica area.

The electronics division also announced that Lawrence R. Cohen has been appointed to the newly-created position of manager of application engineering in the laboratories department. He was previously sales manager for Army equipment. He joined GE in 1946 as a design engineer.

The new position will include liaison with outside customers, including the military services, to determine their technical trends and requirements and to advise them of General Electric's facilities for applied electronic research and advance electronic development.

Shannon Receives Ballantine Medal

Dr. Claude E. Shannon, member of the technical staff of the Bell Telephone Laboratories, received the Stuart Ballantine Medal of The Franklin Institute for outstanding achievement in the field of communication.

Among Dr. Shannon's early contributions to the field of communication was the development of a mathematical theory of switching circuits which led to switching algebra.

His other contributions have dealt with the fundamental theory of transmission. Using statistical concepts in communication theory, he devised a quantitative means of measuring the size and complexity of the communication facilities needed to handle messages. He recognized that the fundamental factor limiting the ability to transmit information is noise. Using

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statistical notions, he devised a quantitative measure for the information handling capacity of communication means. The theory of these researches is contained in his paper "The Mathematical Theory of Communication." The contents of this paper have become known as information theory, and by virtue of their generality form a new and basic philosophy for the communications industry.

The AIEE presented him with the Alfred Noble Prize in 1940. During 1940-41, he was a National Research Fellow. He joined Bell Telephone Laboratories in 1941.

In 1949 the Morris Liebman Memorial prize of the IRE was awarded him for his "original and important contributions to the theory of the transmission of information in the presence of noise."

Sensitive Research Expands Facilities

SENSITIVE Research Instrument Corp. moved to new and larger production and engineering laboratories in New Rochelle, N. Y.

The building has complete facilities for manufacturing electrical indicating instruments. It gives Sensitive about three times the production and engineering facilities heretofore available.

Servo Promotes Three Executives

A. ERIC THEIS has been promoted to vice-president in charge of manufacturing at Servo Corpora-

A. Eric Theis

tion of America. Charles F. Healey was named vice-president in charge of administration; and H. Gordon Hawthorne, treasurer. Dudley L. Miller continues as secretary of the company.

Theis was production manager of Servo before his recent promotion. He is an engineer with over twenty years experience in the manufacture and production of radio communication, navigation, and electronic control systems and instruments.

Lenkurt Electric Enlarges Facilities

LENKURT Electric signed a two-year lease for use of a new building being constructed in San Carlos, Calif.

The building will have 14,400 sq ft of space.

When completed in December, some of the company's business divisions and some manufacturing operations will be transferred there.

The company now has 155,000 sq ft of floor space and owns or leases approximately 45 acres in the San Carlos industrial area.

Most of the equipment produced by Lenkurt goes to telephone companies in the United States and Canada for use in increasing long-distance circuits.

The company has more than 1,000 employees and a monthly business volume exceeding $1,000,000.

Clevite Units Select Executives

J. KNEELAND NUNAN has been named to the new position of vice-president and general manager of Clevite Research Center in Cleveland, Ohio.

Nunan has been president of Consolidated Vacuum Corp.

Transistor Products, an operating unit of Clevite, announced the appointment of E. F. Giguere as vice-president for sales.

He joined Transistor Products in 1953 and served as director of sales prior to his promotion to vice-president.

He was associated with Federal Telephone & Radio Co. for 14 years, rising to the position of broadcast sales manager. During 1952 and

1953 he served as a consultant to the FCC and the CAA.

Transistor Products also announced that Allen J. Dusalt, formerly semiconductor sales manager for CBS-Hytron, has been appointed general sales manager for Transistor Products.

Samuel Rubinovitz, formerly assistant to the director of sales, has been named government sales manager.

In Clevite's Brush Electronics Co., John H. Harris, formerly vice-president and general works manager, has been made vice-president in charge of planning, and Wallace T. Gray has been appointed general works manager.

Perry C. Smith has been appointed manager of the equipment department of Brush Electronics.

He joined Brush earlier this year. He was formerly general manager of the electronics instruments division of Burroughs Corp. Prior to that he was manager of scientific instruments engineering for RCA.

CBS-Hytron Builds Tenth Warehouse

CBS-HYTRON plans to build a 55,000 sq ft warehouse in Chicago for tubes. Completion is scheduled for early spring.

The new warehouse will have an engineering application laboratory, sales, service, and engineering offices, branding and packaging facilities.

The new structure will bring to ten the number of the firm's warehouses in operation.

General Mills Adds Five Engineers

L. K. LEE, former head of the advanced techniques laboratory at Stanford Research Institute, and George H. Geick of Emerson Radio, have joined the mechanical division of General Mills.

Lee, a specialist in miniaturization and automatic production techniques for electronics, will be technical advisor to the engineering research and development department. He will concentrate on design for automatic production.

Geick will be assistant manager

of systems analysis. He was assistant to the executive vice-president of Emerson, concerned with the administration of commercial and military design and production in radio, television and related fields.

Three German scientists have also joined the division.

Dr. Otmar M. Stuetzer has been named to head the electron physics lab. He was radar section chief of the German Research Council and coordinator of the German radar and countermeasures program during World War II. He comes to General Mills from the U. S. Air Force Wright Air Development Center at Dayton, Ohio, where he was chief of the advanced development branch in the electric components lab.

His staff will include Dr. Gottfried K. Wehner and Ludwig J. Mayer, who worked with him at WADC. Dr. Wehner, a specialist in gas discharge and surface physics, was a branch chief at Flugfunkforschungs, the German Air Radio and Radar Research Institute, during World War II. Mayer was chief of the microwave tube laboratory at the same establishment.

Telerad Elects New President

CHARLES GEORGE has been elected president and chairman of the board of Tetrad Manufacturing. George, who has served as vice-president and general manager for

Charles George

Want more information? Use post card on last page.

eight years, purchased controlling interest in the company.

Telerad has expanded its operations into the guided missile field and will manufacture beacons and guidance equipment in its new Flemington, N. J. plant.

Kinevox Purchased By Electromation

KINEVOX, of Burbank, Calif., manufacturer of synchronous magnetic recording equipment, has been purchased by the Electromation Co., an enterprise of F. Kirk Johnson of Fort Worth.

Kinevox will be a division of Electromation. A second division specializes in automation systems and components and a third division is responsible for the development and sale of Radad, a radiation exposure safety device which warns of dangerous radiation exposure.

C. A. Hisserich, as chief engineer, will direct research, development and engineering for Kinevox as well as the other two divisions. He will be aided by William C. B. Evans who will continue in his capacity of electronic engineer for Kinevox, and assume the duties of production engineer for Electromation.

Burroughs Research Appoints Two

ROBERT V. D. CAMPBELL has been named to fill the newly created office of deputy director at the Burroughs Corporation's research center. In this new position he will have responsibility for the line management of the research activity.

Prior to joining Burroughs, Campbell was a member of the staff of the equipment engineering division of Raytheon Manufacturing.

He joined the research activity of Burroughs in 1949 as supervisor in the planning department. In 1953 he became technical consultant on the technical planning staff and in 1954 he was named associate director.

Howell K. Fesq has been appointed manager of the administrative engineering department of the special products division at the center. He has been staff engineer with Sperry Gyroscope, senior project engineer with Curtiss-Wright and administrative engineer of Simmonds Aerocessories. Prior to his present appointment he was contract engineer for Fairchild Aircraft Corp.

Eitel-McCullough Expands For Super Klystrons

A NEW 17,000 sq ft building with facilities for the production of super klystron amplifier tubes up to twenty feet long will be added to the main San Bruno, Calif., plant of Eitel-McCullough. Present plans call for completion of the building in early Spring.

According to the company, the need for additional klystron facilities arises from an increasing number of electronic applications, including forward-scatter.

One section of the building will include a two-ton crane to handle the giant klystrons.

The new extension will bring the total area at the main Eimac plant in San Bruno to approximately 170,000 sq ft.

Norden-Ketay Sets Western Division

NORDEN-KETAY Corp. has established a Western Division in Gardena, Calif.

The division consists of two plants, one in Gardena, the other in nearby Hawthorne, Calif. Together the plants comprise a unit of 30,000 sq ft, equipped for research, design, development and quantity production of synchros and resolvers and other components.

General manager is Arnold Raines, who was previously assistant general manager of the Arga division of Beckman Instruments.

Manager of the engineering department is Herbert Galman, who was previously chief development engineer of Beckman's Arga division.

The division will have a research and development department under the direction of Harold H. Sarkissian. He was previously vice-presi-

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Arnold Raines

dent and a member of the board of Computer Research Corp. and chief engineer of National Cash Register Co.

Norden-Ketay's present manufacturing operation in California, under Harry Loveman as operations manager, has been integrated into the new divisional organization.

Norden-Ketay also announced that George D. Butler has been appointed director of sales.

Before joining the firm, he was vice-president in charge of sales of Warren Electronics. Prior to that, he was district sales manager of Beckman Instruments.

During the war he was a project engineer at Bendix Aviation Corp., and also senior engineer at Carl L. Norden in New York.

Tracerlab Builds New Plant

CONSTRUCTION has been started by Tracerlab on a new 164,000 sq ft plant in Waltham, Mass.

The new plant will be ready in the Summer of 1956. Tracerlab's operations have grown from $30,000 in 1946 to over $12,000,000 in 1954.

The new plant will also house certain operations of Keleket X-Ray Corp., a Tracerlab subsidiary.

Erie Resistor Promotes Foster

JAMES H. FOSTER has been appointed general manager of Erie Resistor's electro-mechanical division. Since joining the firm five years ago he has served as chief of electronic research and assistant general manager of the division he now heads.

New Firm Formed By RC Controls

COMPUTER-MEASUREMENTS division of Detectron Corp. has been acquired by RC Controls Corp. of North Hollywood and formed into a new company to be known as Computer-Measurements Corp. The firm has a new plant in North Hollywood, Calif. Development, design, manufacturing and sales will take place there under John K. Rondou, president and J. L. Cassingham, vice-president.

Baldwin-Lima Elects Three V-Ps

ROBERT B. MURRAY, JR., former Undersecretary of Commerce, has been promoted to vice-president and has been elected a member of the board of directors of Baldwin-Lima-Hamilton Corp. He has been assistant to the B-L-H president since leaving his government post.

James M. White has been elected vice-president in charge of manufacturing for B-L-H, resigning a similar post at ACF Industries to accept the new position. He formerly also was manufacturing vice-president for Allis-Chalmers.

Colonel John R. Martin, who recently retired from the U. S. Air Force as director of procurement for the Air Research and Development Command at Baltimore, Maryland, has been appointed vice-president in charge of electronics and instrumentation operations.

U. S. Officials Honor Canada's Browne

IN CANADA, the Department of Transport's retired controller of telecommunications, G. C. W. Browne was presented with a scroll and a wrist watch from his friends and acquaintances in Washington, D. C. The presentation was made on behalf of U. S. officials in the communications field of the State Department, Military Services, Coast Guard, CAA, FCC, the

Department of Agriculture and the Department of the Interior.

Previously RETMA of Canada and the Department of Transport had honored him.

Moloney Electric Promotes Two

C. M. LOVELL, formerly vice-president and chief engineer of Moloney Electric, transformer manufacturer, has now been named vice-president in charge of engineering and research.

He joined the firm in 1920 as an engineer. He was made chief engineer in 1928. In 1942, he was appointed as vice-president and he was also elected to the board of directors.

Lovell has been instrumental in the development of concentric-layer winding and its application to transformer manufacture at Moloney.

The company also announced that David F. Winter has been appointed vice-president, chief engineer and director of research. He will continue in his recently-appointed post as director of the newly-formed engineering research and development laboratory of Moloney Electric.

He has served as a staff member at the radiation laboratory of MIT. In 1948 he joined the staff of Washington University as an assistant professor of electrical engi-

C. M. Lovell

D. F. Winter

neering.

On leave of absence, Winter joined the DuMont Laboratories as a senior engineer and then as an engineering consultant to the instrument division in 1949. From 1950 to 1952 he served first as a senior engineer under special contract with the Naval Ordinance Plant at Indianapolis, Indiana, and then as project head.

In 1951, Winter was made an associate professor at Washington University in St. Louis. He came with Moloney Electric in 1952 as a consultant.

In 1954, Winter joined Moloney on a full time basis with a leave of absence from Washington University.

Winter received a full professorship at Washington University in 1955 and is now an affiliate professor with that institution.

Tharpe Leaves Du Mont, Petersen Named

JAMES B. THARPE has joined Visual Electronics Corp., of New York as president.

He resigns as manager of the Du Mont television transmitter sales department to associate himself with the independent selling agents representing Du Mont in the sale of TV broadcast equipment. He will directly handle all New York City and network accounts, and, in conjunction with Herbert Bloomberg, will handle key television broadcast equipment accounts in the area between New York and Chicago.

Kenneth F. Petersen succeeds Tharpe at Du Mont. He was formerly marketing manager for Du Mont tv transmitter sales and before that director of engineering facilities for WPIX in New York.

Alto Scientific Adds Engineers

PRINCIPALS of the Alto Scientific Co. now include president Lester L. Libby, vice-president Thomas F. Turner and secretary-treasurer Dr. David D. Cherry. Together, the background of the trio includes experience in development, manufacturing or sales with Tung Sol, Federal Telegraph Co., Federal Telephone and Radio Corp., Kay Electric, Ohmega Laboratories, Civil Aeronautics Administration, Northrop Aircraft Co., Sierra Electronic Corp. and Bell Telephone Laboratories.

New engineers joining Alto recently include James F. Melton, formerly with the Stanford Research Institute and Hewlett-Packard Co., Lawrence R. Teeple of California Research & Development and Consolidated Aircraft, and Kenneth A. McQueeney who came to Alto from Sierra Electronic Corp.

New Glass Seal Company Established

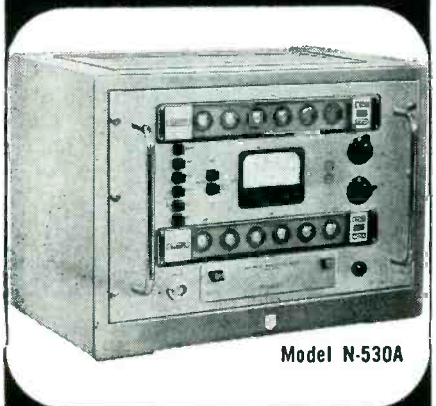
W. P. SPEER, formerly manager of the glass seal division of Cannon Electric, has organized Seals, Ltd. in South Pasadena, Calif.

The company specializes in the design, manufacture and sale of glass-seal type connectors.

Summers Gyro Appoints Romig

HARRY G. ROMIG has been appointed staff engineer at Summers Gyroscope Co.

He comes to the Santa Monica concern with 30 years of varied experience in industry. Twenty-



five of these years he was with Bell Telephone Laboratories, New York, N. Y., as a member of the technical staff specializing in quality control. He was with Hughes Aircraft Co., Culver City, Calif., for almost three years, serving ultimately as technical director of quality control after being quality manager of central quality control. Recently, in addition to consultant work, he was employed by International Telemetering Corp., Los Angeles, as quality director.

Midwestern Elects New President

G. R. MORROW, vice-president and manager of Midwestern Instruments, has been elected president.

M. E. Morrow, founder and president, became chairman of the board.

E. J. Handly was elected vice-president of finance. Other re-elected officers were D. G. O'Brien, vice-president in charge of engineering and production; A. E. McCoy, vice-president in charge of sales; John F. Y. Stambaugh, secretary-treasurer and Truman R. Howell, assistant secretary-treasurer and comptroller.

The company now occupies its new million dollar plant in Tulsa, Okla.

NBS Appoints Parts Chief

ROBERT D. ELBOURN has been appointed chief of the components and techniques section of the National Bureau of Standards. This section investigates new components and devices for electronic computers and explores techniques for applying them.

Elbourn is a member of the original team that developed in 1950 the Bureau's electronic computer, SEAC.

He has been with the Bureau since 1947.

Prior to joining the Bureau's staff, he was an electronic engineer with the Naval Ordnance Laboratory and with C. G. Conn of Elkhart, Ind.

New Books

Elements of Electronics

By Henry V. Hickey and William M. Villines. *McGraw Hill Book Co., New York,* 1955, 487 *p,* $5.00.

In this volume the authors get right down to business; they introduce the vacuum tube soon after describing the basic behavior of the electron. This may seem an unconventional approach, but it steers the beginner immediately to the most important electronic device with which he is to become intimately acquainted. To make the story particularly pertinent in the first chapter, the explanation of direct currents and static electricity are immediately entered together with a brief introduction to mathematics involving the power of ten.

A-C and D-C Circuits

The principles and operation of simple d-c circuits, natural and electromagnetism plus a working knowledge of meters, follow in simple logical sequence.

Alternating-current theory is treated with sufficient detail and is accompanied by two chapters, one on trigonometry and one on phase relationships; these three chapters adequately fill out the picture on a-c fundamentals with a minimum of confusion.

The action of capacitive and inductive circuits as described in the following two chapters are relatively simple since the reader has first been given a background in alternating-current theory.

Electron Devices

The remainder of the volume deals with vacuum tubes and their application to electronic equipment. The primary vacuum-tube functions of amplification and oscillation, are covered in six chapters, five of which are devoted to types of amplifiers. The relationship of the basic electronic functions to concrete operating equipment is covered in ten chapters—five on transmitter theory and operation—five on receivers.

A short chapter on transistors follows, to end the book rather abruptly.

Granted that receivers and transmitters form the major portion of electronic gear, it would have been pertinent to round out the volume with a few pages more on electronic circuitry as applied to control, measurement, photoelectricity and television.

On the whole, the book gives a well planned and clear explanation of electronic principles. Circuit functioning and practical commercial applications are covered with excellent technique.

Enough restraint has been exercised in the descriptive matter to give a clear picture without letting the text become confused with redundant material.

HARRY E. THOMAS, *Senior Project Engineer, Federal Telecommunication Laboratories, Nutley, N. J.*

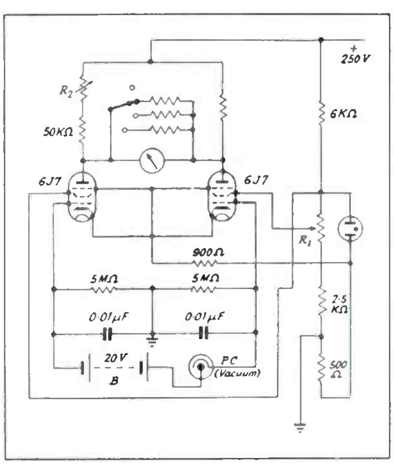
Electronic Measuring Instruments

By E. H. BANNER. *The Macmillan Co., New York,* 1955, 395 *p*, $8.50.

INTENDED primarily for the information of instrumentation engineers, this book is neither a text nor a handbook. It covers basic theory of electronic devices useful in instrumentation and their application. The instruments described include industrial, scientific and medical instruments. Electronic test equipment is not covered in this book.

Arrangement

The book is presented in three parts. The first discusses eletronic devices such as vacuum and gas-filled tubes, cathode-ray tubes,



Bridge circuit for measuring low light intensity phototubes, solid-state devices and particle detectors.

Part two discusses electronic measuring instruments making use of these devices. Part three covers other measuring instruments including electronic and other counters, electromechanical transducers, electrical instruments and instruments for measuring physical quantities.

Usefulness of the book to American engineers is somewhat limited in that many of the electron tubes and commercially available instruments described are, understandably, of British origin.

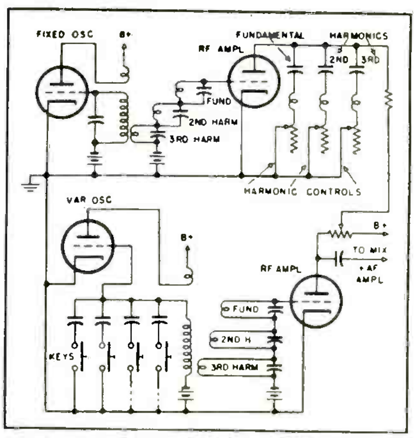
Striking a humorous note in the preface, the author suggests that thermopiles might have been used at Thermopylae or that diodes and triodes are extensions of the Odes of Horace.—J.M.C.

Electronic Musical Instruments

By RICHARD H. DORF. *Radio Magazines, Inc., Mineola, New York,* 1955, 326 *p*, $7.50.

THAT THERE is a need for a book covering the field of Electronic Musical Instruments is obvious since there have been so many new and interesting applications of electronic (and electric) devices to the music world. The book "Electronic Musical Instruments" does describe most of the innovations currently on the market.

It is apparently written for three groups: the musician, the engineer-technician, and the build-it-yourself enthusiast. As a result—interested musicians find it lacking since



Heterodyne instrument with harmonic synthesis it does not delve into the musical aspects of the subject in sufficient detail. The engineer-technician finds many instances where subjects are excessively simplified, and the build-it-yourself enthusiast finds not enough detail to permit finished construction.

Further, a speaking-to-class presentation is used rather than a less verbose and more professional writing technique. The book is well illustrated with pictures showing the various instruments, and schematic drawings are used profusely and advantageously for greater clarity. The book is well printed with exceptionally few typographical errors. The appendix of electronic music patents is quite extensive.

G. EDWARD HAMILTON, *American Broadcasting Company, New York, N. Y.*

Thumbnail Reviews

The Mobile Manual for Radio Amateurs. American Radio Relay League, West Hartford, Conn., 1955, 352 p, $2.50 (paper). Selected articles from *QST* dealing with design of station equipment for mobile operation. Articles described receivers, transmitters, antennas and power supplies.

Basic Synchros and Servomechanisms. Van Valkenburg, Nooger & Neville, Inc. John F. Rider Publisher, Inc., New York, 1955, two volumes: 272 p, $5.50 (paper), $6.95 (cloth, one volume). Material from Navy course on Basic Synchros and Servomechanisms. Pictorial presentation, quite elementary. Covers servo components, servo fundamentals and design, error detectors, amplifiers and control circuits.

Handbook of Engineering Materials. D. F. Miner and J. B. Seastone. John Wiley & Sons, Inc., New York, 1955, 1,391 p, $17.50. Includes sections on general information about materials, metals, nonmetals and construction materials. Covers common chassis metals, papers, fibers, plastics and rubbers, organic finishes, carbon products and ceramics.

Proceedings of the First Conference on Training Personnel for the Computing Machine Field. A. W. Jacobson. Wayne University Press, Detroit, Mich., 1955, 104 p. Proceedings of a conference held at Wayne University June 22-23, 1954. Includes 17 papers, reports on 3 panel discussions and roster of persons attending conference. Subject headings include: manpower requirements, educational programs, influence of computers on technical and general education and cooperative efforts for training and research.

Backtalk

Resistance Analyzer

DEAR SIRS:

WE BELIEVE you will be interested in knowing that your printer must have dropped one or two lines of type when making the break in that story between pages 290 and 292, September 1955.

The last sentence on page 290 should have read: "It was designed to check such characteristics as d-c resistance, temperature coefficient, and voltage coefficient of resistors according to JAN specifications. Voltage coefficient of any resistor up to a capacity of 2 w can be determined down to as low as 0.0002 percent per volt."

RICHARD G. MORRIS
Manager
Advertising, Public Relations
The Kuljian Corporation
Philadelphia, Pennsylvania

Patent Examiners Needed

DEAR SIRS:

THERE is a serious delay in the processing of patent applications in the U. S. Patent Office because the size of the examining staff has not kept pace with the increased number of patent applications filed. This creates uncertainty as to the patent status of new products and processes and tends to slow down or defer their adoption by industry and their introduction to the public.

This is a matter that can handicap the larger corporation and can be critical for the individual inventor and the small business whose operations revolve around patented products and processes.

Congress has appropriated additional funds for new patent examiners, but with the existing demand for engineers and scientists in industry it has been difficult to obtain enough candidates having the necessary technical qualifications . . .

There are vacancies in the examining staff which should be filled promptly this fall and we appeal to you . . . since ELECTRONICS is read by the technically and scientifically trained people whom the Patent Office is trying to reach. Steps have already been taken

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in this direction and over 100 new patent examiners have been added to the examining staff since June of this year, and it is understood that the Patent Office plans to build this number up to a total of 350 new examiners by the end of 1956 . . .

Salaries for examiners start at $4,345 a year, and it is possible to reach a salary of $7,570 in 5½ years. The Patent Office also offers liberal vacations and sick leave and pension benefits.

Engineers and scientists holding a college degree in engineering or applied science, or a degree with a major in chemistry or physics, or with certain combined credits in these fields, are eligible for appointment as patent examiners, without examination, upon application to the Commissioner of Patents in Washington.

HENRY E. SHARPE
The New York Patent Law Assoc.
New York, N. Y.

Face-Plate Seal

DEAR SIRS:

THE STATEMENT in the news story on p 22 (Nov. 1955) that "a low temperature solder glass seal is used to seal the face plate to the funnel . . ." is incorrect. The face plate and cone of the all-glass color television tube are sealed by the same method used regularly to seal the face plate and cone of black and white television tubes.

H. C. MCDANIEL
Westinghouse Electric Corp.
Pittsburgh, Pa.

Transistor Symbol

DEAR SIRS:

I HAVE found it quite convenient and, I believe, also appropriate to use the symbol *XR* to indicate or label a transistor in schematic diagrams and as an abbreviation in written material.

I under stand the name transistor was originally a combination of *trans* (across) and *resistor*. Since *X* is often used in place of *trans* and *R* is, of course, the symbol for a resistor, *XR* could very well be the symbol for a transistor.

WILLIAM G. SHEPARD
Seattle, Washington

CONTACTS

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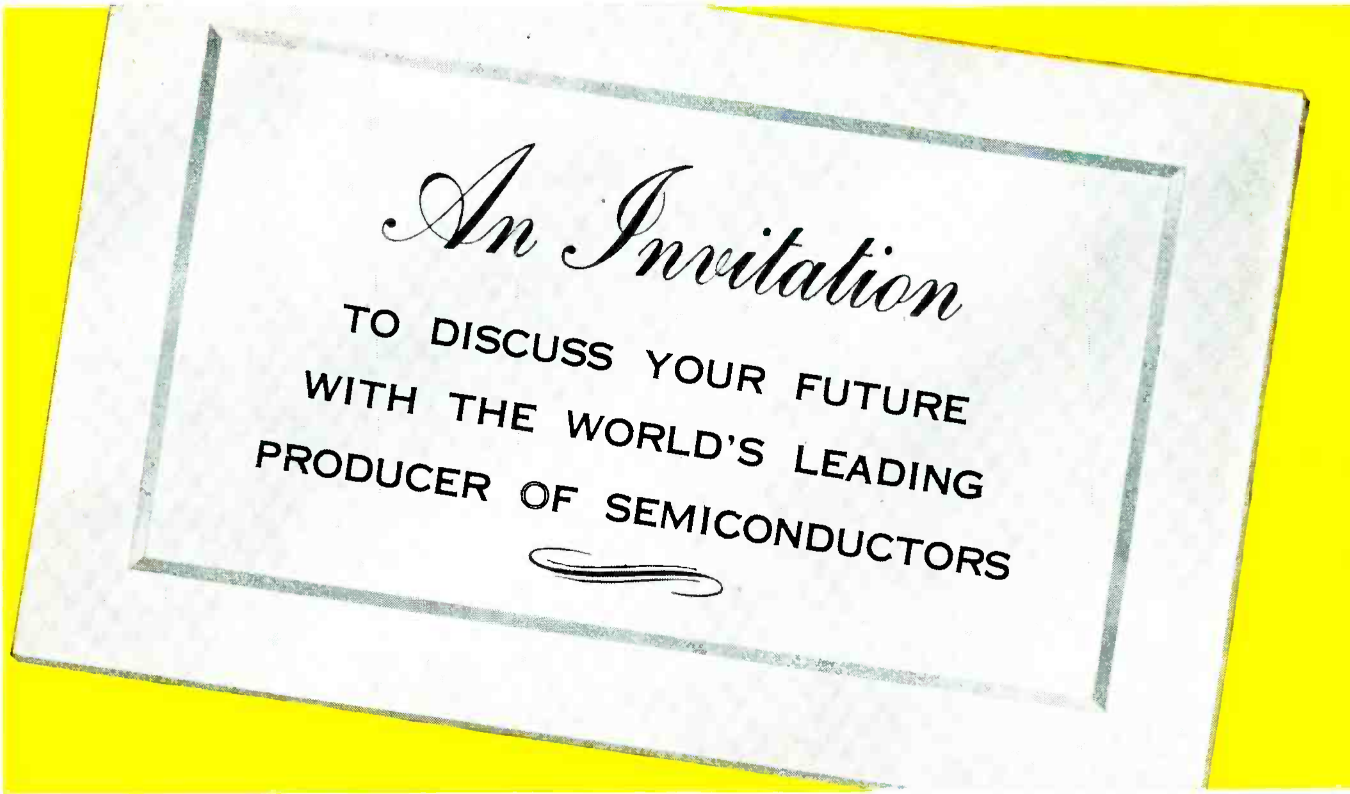

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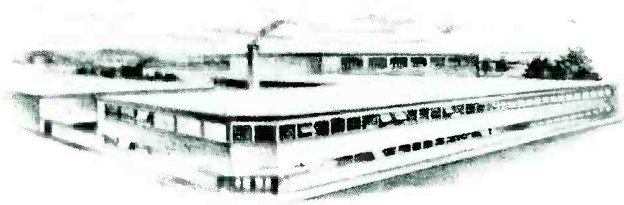

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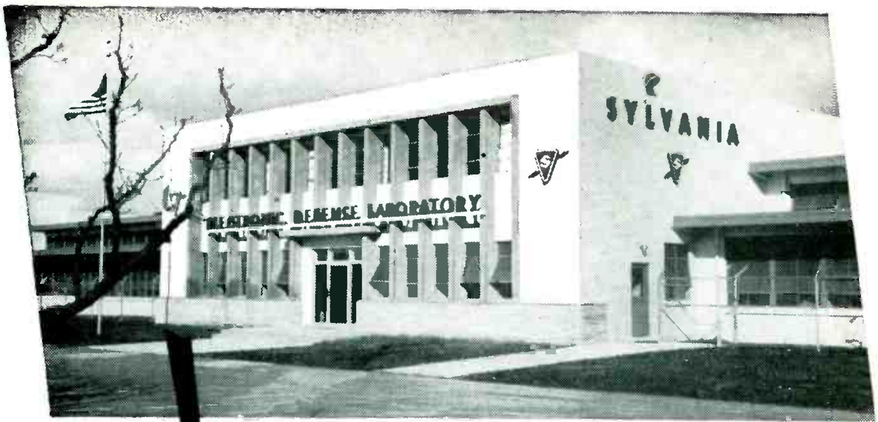

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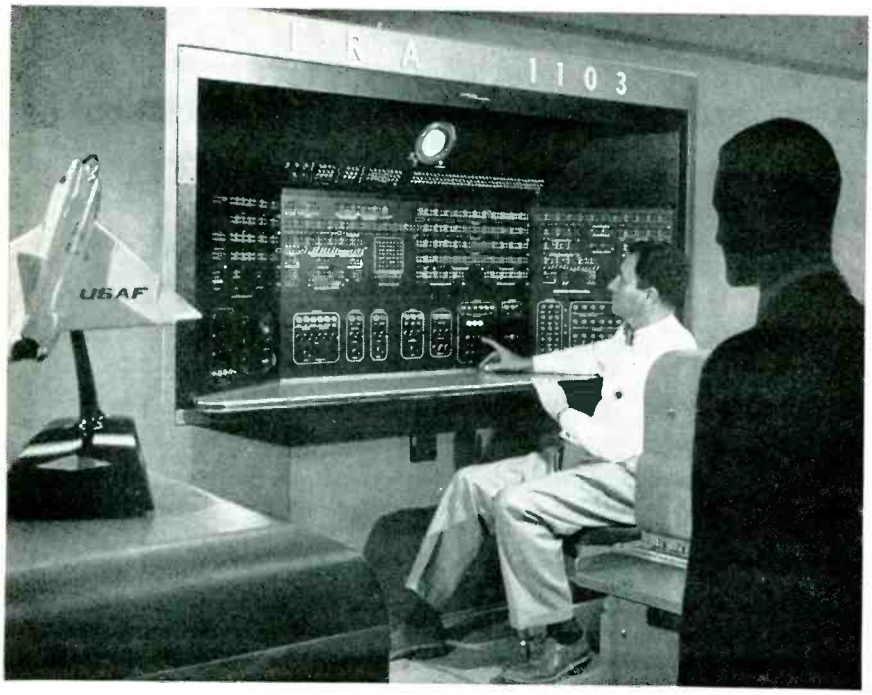

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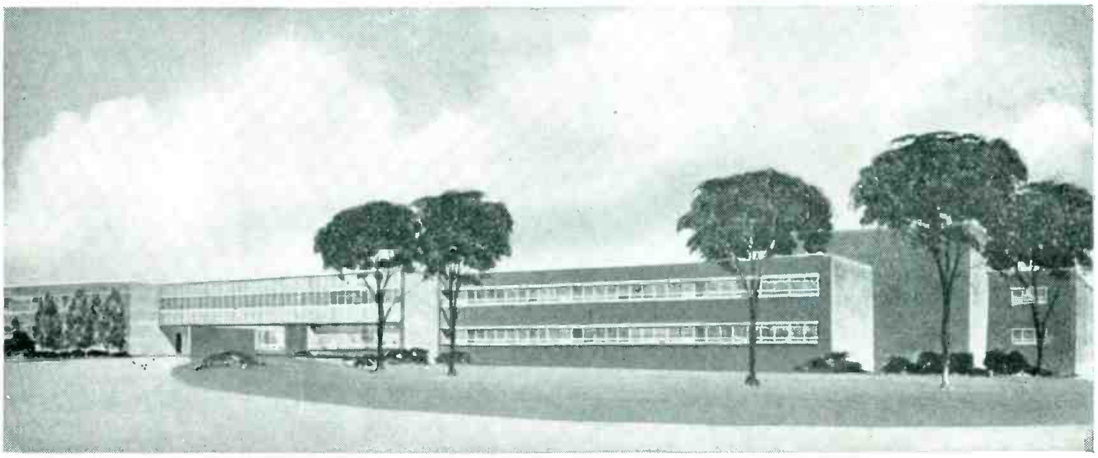

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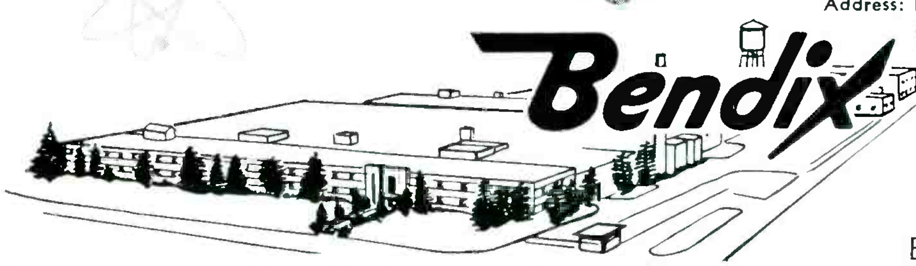

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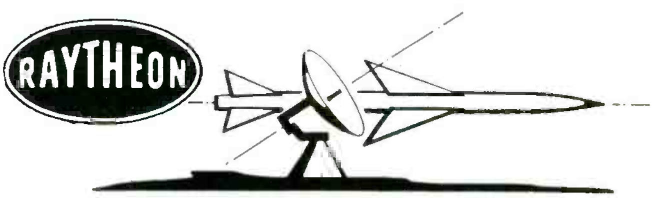

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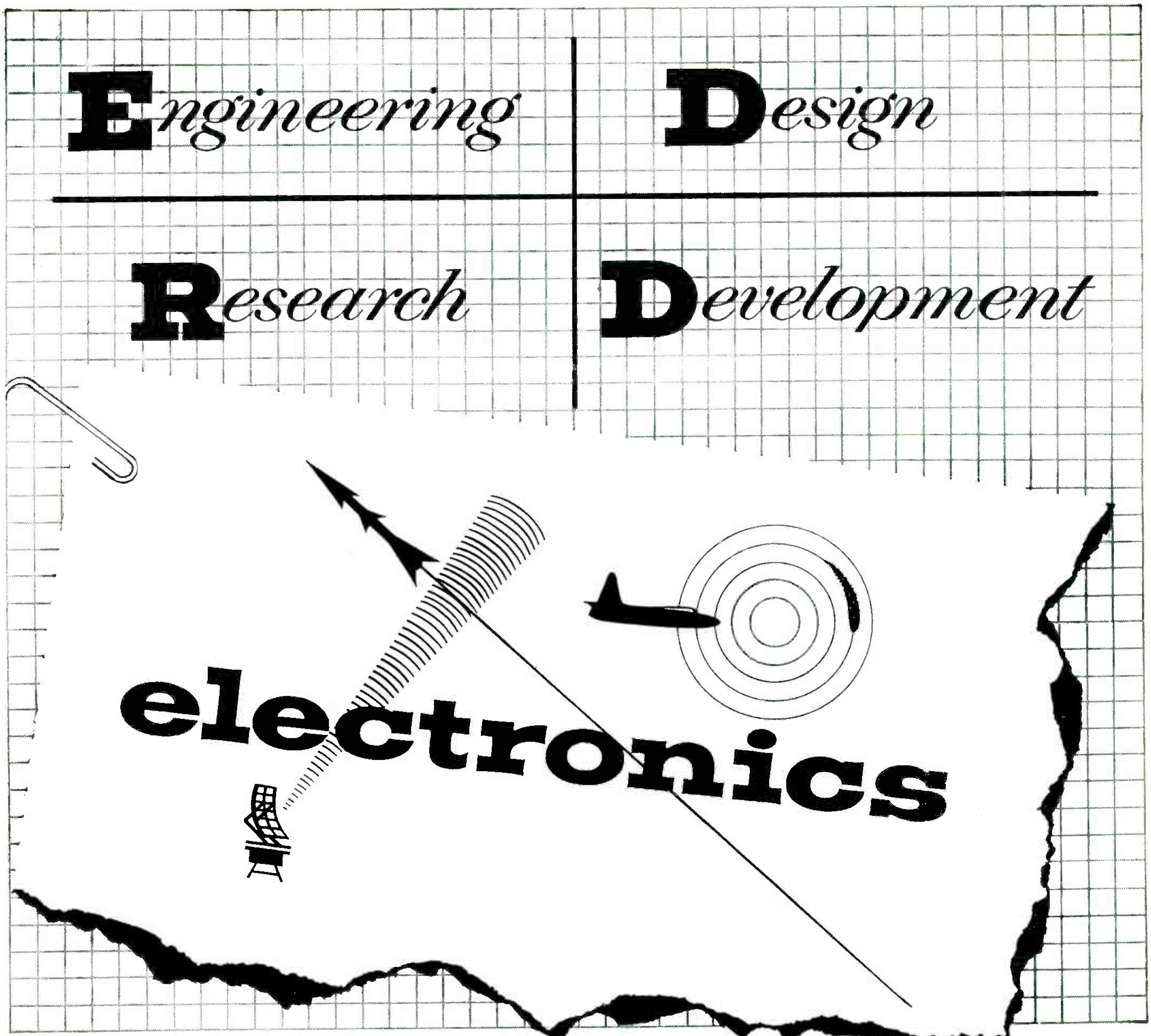

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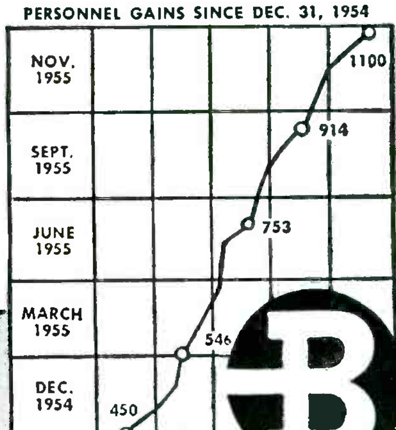

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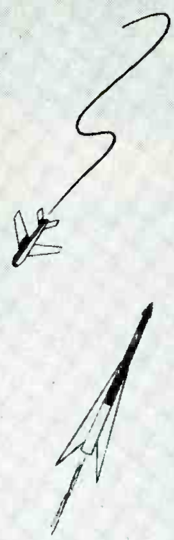

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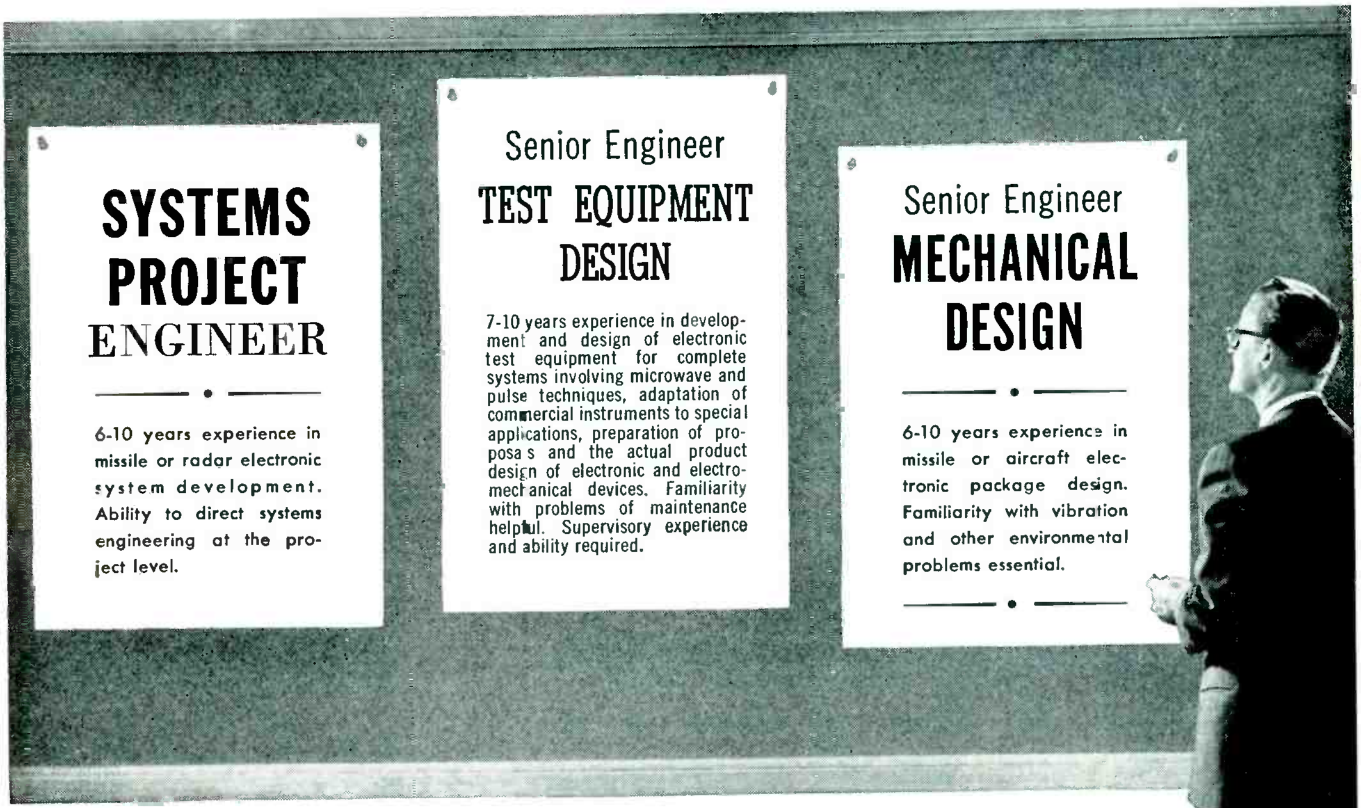

Here are three especially attractive job opportunities for engineers who want to get on the ground floor in the important, interesting, and challenging phase of a new industry—guided missiles.

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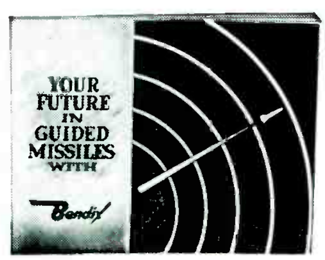
23 OTHER ENGINEERING POSITIONS!

Bendix also offers unusual job opportunities for assistant engineers, junior engineers, and technicians, as well as a score of other assignments. A 30-page book describing in detail every phase of our guided missile operation will be sent to you on request. If you are interested in guided missiles, this book is bound to interest you. Write for it today.



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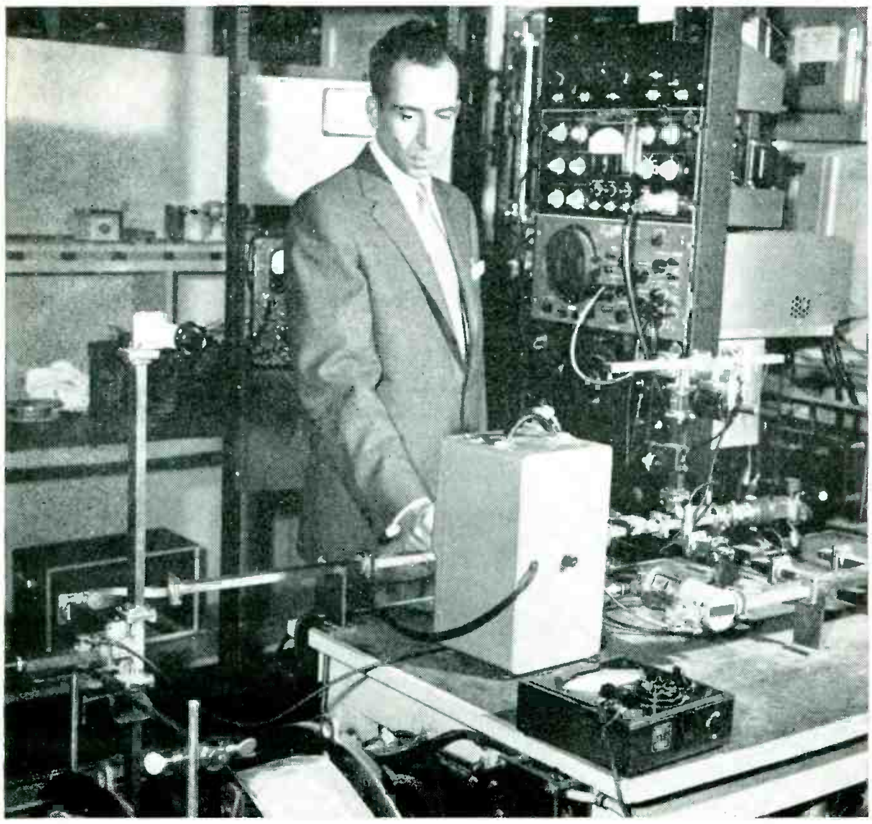

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Enjoy full use of your skill and imagination, and friendly, professional give and take with top men in the field of electromechanical precision equipment.

You will perform studies related to airborne weapons control and guidance systems with the object of determining requirements, feasibility, performance and specifications of computers and over-all systems.

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Technical Personnel Dept. 2-590

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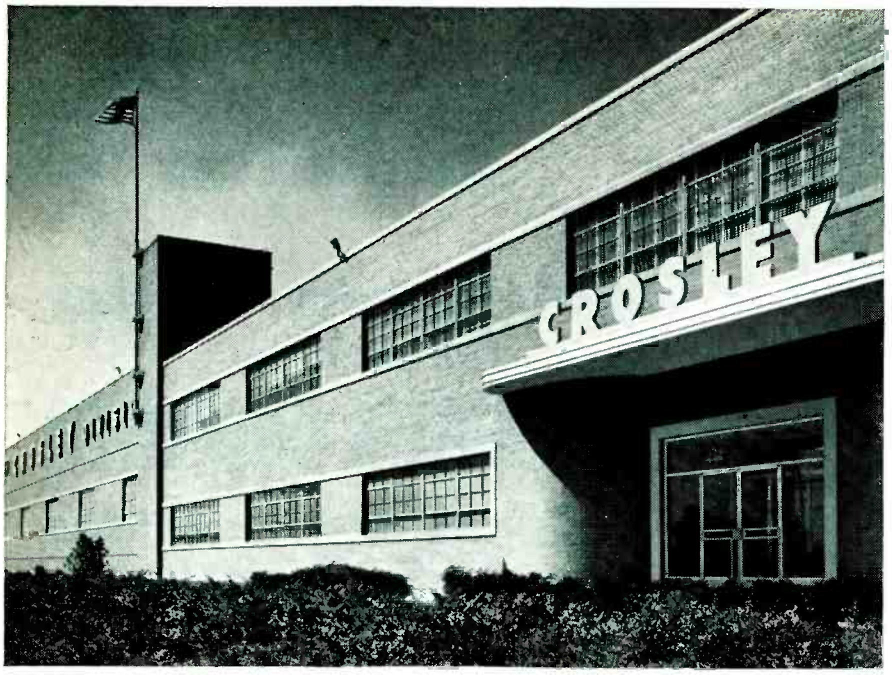

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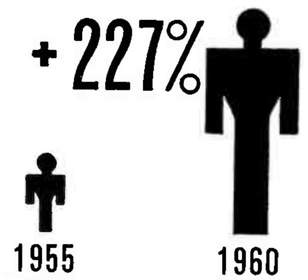

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Research facilities that enable you to test out your most revolutionary ideas and encouragement to publish original work available to the engineer experienced in precision gyroscopic equipment.

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Armour Research Foundation
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SORENSEN & COMPANY, INC.
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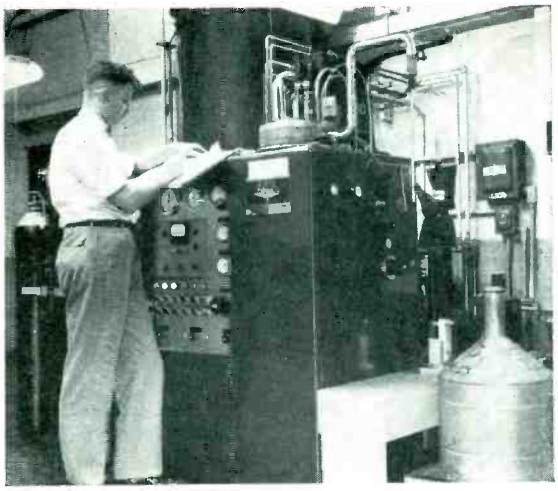

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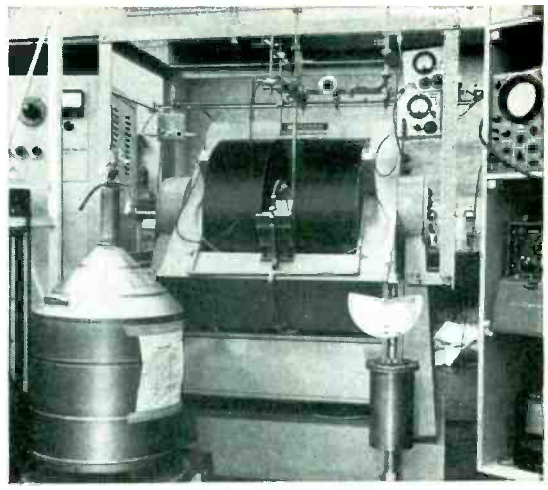

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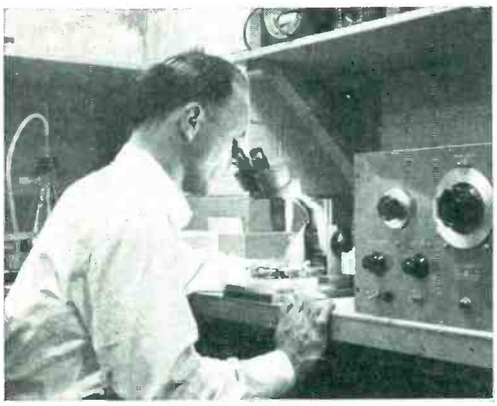
ENGINEERS, PHYSICISTS, CHEMISTS



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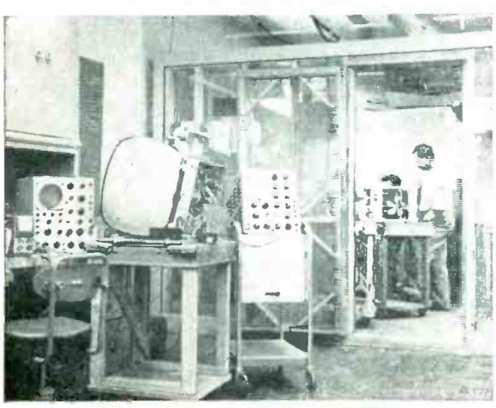

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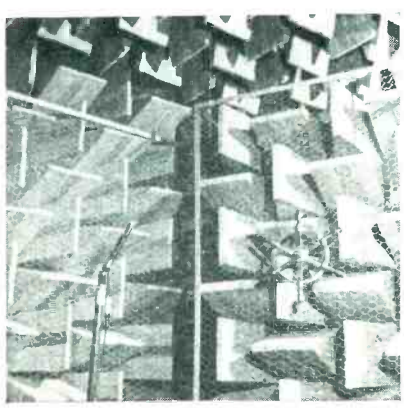

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Vice President, Engineering
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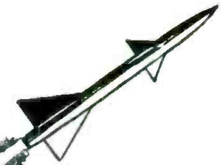

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Excellent opportunities for several engineers with well established East Coast instrument manufacturer now expanding its line of aviation products which includes electronic and electro-mechanical components for jet engines and guided missiles. Electrical engineering background essential. Must have established contacts with the aircraft industry. Openings in Los Angeles, Dallas, and East Coast areas. Generous company paid benefits include hospitalization, pension, insurance, and vacation plans.

P-7913, Electronics
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RW-2178, Electronics
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Instruments for Industry, Inc.
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Of Electronics published monthly at Albany, New York for October 1, 1955.

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[SEAL] ELVA G. MASLIN.
(My Commission expires March 30, 1956)

ELECTRONIC ENGINEERS

What Should an EE Know About Atomics?

Quite a bit these days, with so many companies getting into the field. While many new firms are now starting to explore the field, Electric Boat Division of General Dynamics Corporation led the way with the building of the first nuclear powered submarines, Nautilus and Sea Wolf.

In addition to increasing its engineering force for work on new and greatly advanced nuclear submarines, Electric Boat is expanding Research and Development operations to include the development of additional practical uses for nuclear energy.

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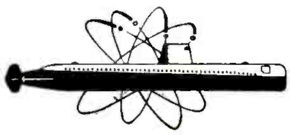
Study for bachelor's or advanced degrees is encouraged at Electric Boat, with courses in mathematics, naval architecture, nuclear engineering and nuclear submarine systems offered within the plant, and tuition paid by the company for study in these or other fields at leading colleges and universities.

Men interested in these openings should write complete details of background and experience including initial salary requirements. Interviews will be arranged promptly for qualified applicants. Address Mr. Peter Carpenter.



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To design or supervise the design of Radio Frequency components for radar, radio equipment, antennas, horns, mixers, directional couplers, rotating joints and radomes. Must know cost estimating of this equipment and be able to advise shops on the best fabrication methods. Should be capable of setting up RF section. Approximately 10 years experience in design of RF components and systems.

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Product Design, Production liaison on electronic packaging and mechanisms. Involves gear trains, printed circuits and electronic layout work. Knowledge of military specifications. Minimum 6 years experience in electronic equipment design and manufacture.

ELECTRONIC ENGINEERS

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And remember that AMF is well-known for its liberal benefits program.

Please send complete resume to:

Personnel Manager, Electronics Division

American Machine & Foundry Co.

1085 Commonwealth Ave — Boston, Mass.

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Excellent opportunity to join an expanding, stable company, with an outstanding position in the precision electronic control industry.

Opening now available for an engineer able to assume responsibility for the development of complete systems for fire control and guidance, or major portions of such systems. Work will include research and development in the field of complex analog or digital computers.

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Technical Personnel Dept. 2-500

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Please send resume to:
Dept. 12-5-E — Technical Personnel

GENERAL ELECTRIC

ELECTRONICS PARK, SYRACUSE, N. Y.

ELECTRONIC ENGINEERS

Research & Development
Physicists - Engineers
(SENIORS)

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(SENIORS)
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—Flight Simulators
—Radar & Sonar Trainers
—Fire Control Radar
—Electronic installation and maintenance.

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Practical experience acquired in the field has enabled many of our former Field Engineers to qualify for responsible positions. These men are now Assistant Vice-Presidents, Division Managers, Department Managers, Assistant Managers, Department Supervisors, District Supervisors, Consultant Staff Engineers, Product and Development Engineers.

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Applied Physicists

Write to Personnel Manager

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Permanent, responsible positions for qualified, creative men to develop, design and apply special instruments and equipment to our pilot plant and process operations.

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Employment Opportunities

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with some experience in:

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ENGINEERS

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. . . . it's only one of many "firsts" achieved by this company since its founding 4 short years ago.

. . . . it's typical of the way this organization—run BY engineers, FOR engineers—is shaping the future of electronics.

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INDEX TO THE SEARCHLIGHT SECTION ADVERTISERS

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Transducer, Modulator, Transmitter Designers

Progress in guided missile development at this major company, located in upper New York State, has resulted in an opening for a transducer designer able to design circuits or components to transform vibration, temperature, electrical currents, and other data into voltage form compatible to telemetry or recovery instrumentation. This includes application of existing designs, and testing all designs.

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(Continued on pages 413-427)

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Large Quantities BC-312, BC-342
100 BC-224. Checked Out

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EE-8 Complete Units and Components
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MAGNETRAN SURPLUS CO.
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WANTED

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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.

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VC 7" P.P.I. Upright deck mount Repeater. 4 Ranges are provided from 4-200 miles. Input 110 Volt 60 Cyc.

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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.

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.

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X and S Band High and Low Power Racons
We can supply the following Beacons in Portable and Stationary Models. The X-BAND models will operate with the new Weather Radars.

AN/CNP-6 X-Band high power Radar Beacon. This is a 40 KW set for use at an Airport. This set will Interrogate X-BAND Radars up to 200 miles. Variable Coding is provided as well as monitoring facilities. Input is 110 V 60 CYC.

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 interogate X-BAND Radars up to 60 miles. Variable Coding is provided. Input 12 Volts D.C. Weight approx. 40 Lbs.

AN/UPN-1 and 2 S-BAND Portable beacons. This set will interrogate a S-BAND Radar up to 60 Miles. Variable Coding is provided. Input is 12 Volts D.C. and 110 Volts 60 Cyc. Weight Approx. 50 Lbs.

TOWERS and ANTENNA EQUIPMENT

TRIANGLE TOWER
(Illustrated) Galvanized Steel Tower, 12½" Base. 30 Ft. High—in 10 Ft. Sections. Knocked down. Complete with Hardware, two 50 Ft., one 80 Ft. Guys; three 5 Ft. Anchors, and Base Plate. Each section weighs 45 lbs. Complete with Erection Manual. Shipping Weight: Approx. 350 lbs. F.O.B. Ky.—Price..........**$31.95**

MAST BASES—INSULATED
MP-22 BASE—Ins. spring action, direction of bracket can be raised or lowered easily..........$2.95
MP-S-33 BASE—Ins. type with heavy coil spring and 5" dia. Ins. Requires 2" hole for mounting. Weight: 9 lbs..........$5.95
MP-37 BASE—Ins. type with heavy coil spring, 7" dia. Ins. Requires 1⅜" hole for mounting. Weight: Approx. 10 lbs. ...$8.95

MAST SECTIONS FOR ABOVE BASES:
Tubular steel, copper coated, painted—in 3 ft. sections, screw-in type. MS-53 can be used to make any length with MS-52-51-50-49 for taper. Any section.....@ 50¢ Each. Larger Dia. Section MS-54 75¢ Ea.

DYNAMOTORS:

INPUT VOLTS:	OUTPUT: VOLTS:	MA.	STOCK No.	PRICES: USED:	NEW
12 VDC	625	225	DM-35	$8.95	$12.95
12 or 24	230	100	DA-12		8.95
12 or 24	540	450	DA-14		14.95
12 or 24	500	50	USA/0515		4.95
24	250	60	PE-86		8.95
14 VDC	330	150	BD-87	3.95	5.95
14	250	50	DM-25	6.95	8.95
14	1000	350	BD-77	14.95	29.95
28	1000	350	PE73	8.95	
12 or 24	275	110	USA/0516		4.95
12	230	90	PE-133	4.95	6.95
14 VDC	375	150	BD-83	3.95	4.95
12 VDC	220	80	DM-4	2.95	4.95

BLOWERS:

12/24 VDC—AC CAST ALUMINUM BLOWER (Pictured at left)—100 CFM: 3" intake: 2" outlet, Shunt Motor 4"x2": 3000 RPM @ 24 VDC..$5.95

6 VDC SINGLE—100 CFM—No. 6100..........$4.95

6 VDC FLANGE—150 CFM—No. 6150..........$6.95

24 VDC DUAL 20 CFM—Min—No. 2420.....$7.95

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
Same as above, 12 VDC operation: Price..........$5.95

115 V. 400 CYCLE—10 CFM—Eastern Air Devices Motor J31A—7200 RPM. 1/100 HP. L-R #2 Blower Assy. Overall Size: 4-½" x 3-½". No. 3110....$5.95

10 CFM BLOWER (Pictured at left)—28 VDC—.6 A; 5000 RPM. Pioneer Motor SS-2345. Aluminum Blower Housing; Overall Size: 4-½" x 3-¼". Price..........$5.95

115 V. 60 CYCLE BLOWERS:
115-VAC 60 cycle SINGLE TYPE—100 CFM; 2-¼" intake: 2" outlet. Complete size: 5" x 6"—No. 1C939.......... **$8.95**

115 VAC 60 cycle DUAL TYPE—100 CFM; 4" intake; 2" Dis. Each side. Complete size: 8" x 6"—No. 1C880.......... **$13.95**

115 VAC 60 cycle COMPACT TYPE—108 CFM; Motor built inside quirrel cage; 4-½" intake; 3⅝" x 3" Dis. Complete size: 4-½" W x 8-⅜" H x 8-⅛" D—No. 2C067.......... **$14.95**

115 VAC 60 cycle FLANGE TYPE—140 CFM; 3-½" intake; 2-½" Dis. Complete size: 7-½" W x 7-¼" H x 6-¾" D—No. 1C807.......... **$13.95**

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115 VAC 60 Cycle BLOWER—200 CFM; 4" intake; 3" x 5" outlet. Overall size: 8" x 7" x 6". Bodine Motor NSI-33. Removed from New Equipment. #BOD-200.......... **$14.95**

115—VAC 60 Cycle BLOWER—100 CFM; 3-¾" intake; 2" outlet; Rd. Flange with Flap Director. Overall size with bracket; 8" L x 6-½" W x 7" H. Removed from New Equipmet. Diehl Motor FB-2106-6 No. FDBL-2106.......... **$6.95**

Same as above, but with 12- Curved Director. No. CDBL-2106.......... **$7.95**

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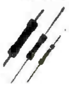

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1.03	300	2080	7900	51000	300000
2.5	320	2150	8000	52000	314000
3	350	2187	8200	55000	316000
3.83	360	2195	8500	56000	325000
4	390	2200	8770	57065	330000
5	426.9	2250	9100	60000	350000
7	430	2300	9900	61430	360000
7.8	470	2400	10000	62000	375000
8	500	2500	10500	64000	380000
10.38	520	2600	11000	68000	390000
12	540	2700	11600	70000	400000
14.2	560	2860	12000	80000	420000
16	580	2900	12500	82000	425000
17	588	3000	13000	84000	430000
20	620	3290	14000	85000	450000
23	750	3300	14400	88000	458000
25	800	3333	15000	90000	470000
28	820	3500	16000	91000	478000
30	850	3600	16500	93000	500000
48	910	3730	18000	95000	510000
50	917	3760	19000	100000	520000
51.78	978	3900	20000	110000	543000
55	1000	4000	21500	120000	550000
56	1056	4220	22000	130000	560000
62	1100	4300	23000	135000	570000
68	1110	4440	24000	145000	575000
74	1200	4500	25000	150000	600000
75	1225	4700	26000	160000	660000
82	1250	4900	27000	169000	680000
95	1300	5000	28000	175000	690000
100	1488	5100	29000	180000	700000
110	1500	5600	29990	190000	750000
120	1518	5730	30000	200000	800000
125	1600	5770	31000	205000	813000
130	1640	6000	32000	210000	820000
134	1800	6100	33000	220000	850000
150	1850	6200	35000	225000	900000
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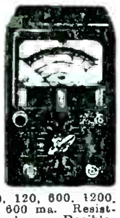

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2K42	149.55	815	3.98	5881	2.70
2K43	130.00	829B	8.49	5893	7.55
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2K50	315.00	864	.34	5927	89.45
2P23	298.00	927	1.36	5932	5.00
3B24W	8.48	954	.18	5950	6.45
3C22	72.50	955	.65	5959	17.25
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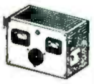
High Current Power Supplies



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 Stee Cabinet Std 115V/60 cy Input or 220V† (3 phase) to order.

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T28V5ACC	5 Amp (1% Ripple)	$85
T28V5A2CC	5 Amp 0.01% Ripple	$145
T28V12A	0-28 VDC at 12 Amp	$125
T28V12ACC	12 Amp (1% Ripple)	$160
T28V12A2CC	12 Amp 0.01% Ripple	$220
T28V24A†	0-28 VDC at 24 Amp	$155
T28V24ACC†	24 Amp (1% Ripple)	$225
T27V24A2CC†	24 Amp 0.01% Ripple	$310
T28V50A†	0-28 VDC at 50 Amp	$285
T28V50ACC†	50 Amp (1% Ripple)	$410
T28V100A†	0-28 VDC at 100 Amp	$500
T28V100ACC†	100 Amp (1% Ripple)	$700

Variable 75 to 135 VDC Completely Built, Ready to go. Includes F. W. Selenium Bridge Rectifier 4" Rectangular Volt & Ammeter Over-Load output Dsgnd for cont. service.
Specify for 115 or 230 VAC 1 phase, 60 cy Input

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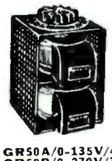
T120V5ACC	5 Amp (1% Ripple)	$240
T120V10AC	75 to 135 VDC at 10 Amp	$245
T120V10ACC	10 Amp (1% Ripple)	$295

New Variable Voltage X-fmrs



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LN, Like New (*) New (†) 3 Phase New

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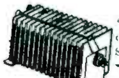
NEW "TABTRON" SELENIUM RECTIFIERS
ENGINEERED for INDUSTRY



"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	$1.60	$2.70	$4.30	$5.15	$9.45	$25.25	$2.40	$17.10	$33.25
2	2.40	3.40	6.15	6.75	11.50	33.15	2.70	18.25	35.50
3	3.45	4.76	6.70	9.00	14.65	42.35	3.05	20.00	38.50
4	4.25	8.45	13.05	16.50	28.45	44.65	3.40	21.70	42.45
6	5.10	10.05	14.75	19.85	36.80	63.05	3.70	24.00	45.90
10	7.50	14.35	22.40	28.50	47.55	97.55	5.45	42.40	82.70
12	9.20	18.10	25.40	34.20	50.85	114.80	6.80	48.15	94.20
20	15.00	28.80	42.80	56.05	90.25	184.95	9.15	58.50	112.60
24	18.40	36.74	51.15	66.30	97.75	219.45	11.45	103.35	183.90
30	22.70	45.60	64.95	81.65	125.35	271.20	Q	135.55	259.80
36	28.45	54.60	74.75	100.00	154.10	340.20	17.20	155.10	310.40
50	33.90	62.50	111.95	122.30	200.10	466.15	27.50	206.85	413.90

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TR5004 50 Amp* .$58.50; 2/$115
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18 Volt 2 Amp ....$1.98; 2 for $3.50
† Wndgs in Series at Ratings shown; Parallel 2/Amps; Voltage one half max.
* Dual Pri 115 & 220V 60cy; Tapped 36VCT

"TABTRAN" Rectifier Chokes
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CR6002/2 Amp/0.1 HY/.67 Ohm $5.75; 2 for $11
CR6003/5 Amp/07 HY/6 Ohm.. $7.90; 2 for $15
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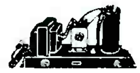
CR6005/24 Amp/.004 HY/025 Ohm $29 50: 2/$58

DC Power Supply



6 or 12V DC Power Supply Full Wave Rectification 6000MFD Condenser Filter Ready to Operate Input 115V 60cy Output 6.3 or 12.6V.
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Model 5DCF (5 amp) $29.95
5DCF ACC/5 amp/1% Ripple $38.95

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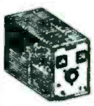
Model CR30 ....$14.00

New Variable 0 to 6 & 12 Volt/12 Amp
DC POWER SUPPLY



Battery Eliminator Charger Model RR Plater Aircraft Marine or any DC Reg. Extra Hvy Duty Selenium Rectifier, 2 Meters V. & A. Dsgnd for Cont. Service and up to 20 Amp intermittent overload. **New Model T612V12AC SPECIAL** $29.95

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CE603M 3000MFD 60V..........$3.98; 2 for $7

New! *Quality* VOLTAGE REGULATOR
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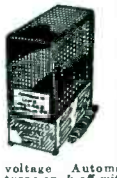
ONLY $16.98



Line Voltage Stabilizer
Stabilizes line voltage within plus or minus 3% regardless of **VOLTAGE & FREQ.** shift. Ideal for **INDUSTRIAL, LAB** or **TV & RADIO** use. Insures full size, strength, & sync of TV picture regar less 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 plus or minus 3% 50/60 cycles—**Sold on "TAB" Money Back GUARANTEE. ORDER SIX ADDITIONAL 10% DISCOUNT.**

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2C35	2.50
2C39	7.50
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2J33	14.50
2J34	14.50
2J36	20.00
2J39	10.00
2J40	14.50
2J42	60.00
2J48	35.00
2J49	40.00
2J50	35.00
2J51	150.00
2J55	35.00
2J56	50.00
2J61	15.00
2J62	5.00
2J62A	50.00
2JB51	.35
2K22	14.50
2K25	12.00
2K26	45.00
2K28	35.00
2K33A	60.00
2K34	99.50
2K39	100.00
2K41	100.00
2K43	125.00
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3B29	5.50
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3C23	5.00
3C24	1.50
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4B23	6.00
4B24	6.00
4B26	6.00
4B27	2.50
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4C28	25.00
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4E27	8.75
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4J28	35.00
4J29	35.00
4J31	65.00
4J34	50.00
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714A	12.50
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717A	.50
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721A	.75
721B	7.25
722A	3.50
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802	2.75
803	1.40
804	9.75
805	4.00
806	7.50
807	1.20
807W	4.00
808	1.25
809	2.25
811	2.90
812	2.50
813	11.00
814	1.75
815	1.50
826	.75
829	6.00
829B	8.50
830B	.75
832	3.75
833A	27.50
834	5.00
836	1.50
837	1.00
838	.75
838W	3.00
842	2.00
845	5.00
849	22.50
851	10.00
852	5.00
860	3.00
861	15.00
865	.50
872A	1.35
874	.60
878	.50
884	1.00
GL889	50.00
GL889A	65.00
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902A	3.00
902P1	3.00
917	2.75
919	2.25
922	1.25
927	1.00
SN930	4.50
931A	2.50
935	4.00
954	.35
955	.35
956	.35
957	.35
958A	.35
959	1.50
991	.35
CK1005	.35
CK1006	2.75
CK1007	.75
1603	3.00
1620	3.25
1623	2.25
1624	1.00
1625	.30
1626	.35
1630	.50
1636	1.90
1641	1.35
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5636	4.00
5637	5.50
5651	1.40
5654	1.50
5656	7.00
5657	125.00
5663	1.50
5667	125.00
5670	1.50
5672	1.25
CK5678	1.00
5686	2.00
5687	3.00
5691	4.75
5692	5.00
5693	4.75
5696	1.00
5702	1.40
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2C24	.75
2C25	.35
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2C38	10.00
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2C46	6.00
WE-2C51	3.00
2C53	10.00
2D21	.65
2D21W	1.40
2E22	2.00
2E24	1.95
2E25	1.85
2E26	3.25
2E29	1.00
2E36	1.25
2E41	2.00
2J21A	2.75
2J26	4.75
2J27	4.75
2J29	15.00
2J30	15.00
2J31	14.00
2J32	14.00
2J33	14.00
2J34	14.00
2J36	15.00
2J37	5.00
2J38	10.00
2J39	10.00
2J40	14.00
2J50	35.00
2J51	100.00
2J52	50.00
2J53	25.00
2J54	50.00
2J55	50.00
2J56	75.00
2J61	15.00
2J62	4.75
2J62A	50.00
2JB51	.35
2K25	12.50
2K28	35.00
2K30	100.00
2K33A	65.00
2K41	75.00
2K45	40.00
2K47	125.00

2K54	7.50
2K55	5.00
2P21 (image—orthicon)	50.00
2V3G	1.35
2X2	.35
2X2A	.90
3A4	.50
3A5	.50
3AP1	3.00
3B21	5.00
3B22	1.50
2B23	3.50
3B24	1.00
2B24W	5.00
3B25	3.00
2B26	2.85
3B27	3.00
3B28	5.50
3BP1	2.50
EL-3C	5.00
EL-3CJ	8.50
3C23	3.50
3C24	2.50
3C31	2.00
3C33	9.50
3C37	10.00
3C45	6.00
3D21A	5.00
3D22	9.75
3DP1	3.75
3DP1A	7.50
3E29	8.50
3EP1	2.00
3FP7	2.00
3FP7A	3.50
3GP1	2.00
3HP7	3.00
3J21	50.00
3J31	35.00
3K27	150.00
3KP1	6.00
3RP1	7.25
3X2500A3	125.00
4-400A	40.00
4AP10	3.75
4B22	6.50
4B23	6.50
4B24	5.00
4B25	8.00
4B26	3.00
4B27	2.75
4B28	3.00
4B30	.75
4B32	10.00
4C22	7.50
4C25	3.00
4C27	3.50
4C35	15.00
4E27	8.00
4J34	35.00
4J52	35.00
4X100A	18.50
EL-C5B	1.00
EL-5BHD	6.50
EL-5B2.5	6.50
5AP1	3.00
5B21	2.00
5BP1	2.50
5BP1A	7.50
5BP2A	5.00
5BP4	2.00
5C21	7.50
5C22	25.00
5C30	1.00
5CP1	2.00
5CP1A	8.50
5CP7	8.50
5D21	5.50
5D23	7.00
5FP7	1.35
5FP14	5.00
5GP1	5.00
5J29	7.50
5J30	5.00
5J32	15.00
5JP1	12.50
5JP2	7.00
5JP4	7.00
5JP5A	7.00
5JP11	10.00
5LP1	7.50
5LP1A	20.00
5NP1	2.50
5R4GY	.90
5R4WGY	2.25
5X3	3.00
5X3P1	75.00
5Z2P7	50.00
5Z4P11	100.00

EL-C6A	6.00
EL-C6J	6.50
EL-C6L	3.75
EL-6C	8.00
6AC7W	.75
6AJ5	1.15
6AJ6	2.00
WE-6AK5	1.35
6AK5W	1.35
6AL5W	.65
6AN5	2.75
6AR6	1.25
6AS6	1.25
6AS6W	1.50
6AS7G	2.35
6BM6	20.00
6C21	17.50
6G4	2.00
6J4	3.00
6J6W	1.25
6L6WGB	3.35
6SC7GTY	2.00
6SN7WGT	1.50
6SU7GTY	2.00
7BP7	5.00
7CP1	12.50
7EP4	10.00
9GP7	5.00
9LP7	3.50
9MP7	7.50
10Y	.25
CE-11V	2.25
12A6	.50
12DP7A	25.00
12GP7	17.50
12J5WGT	1.50
12K8Y	.50
12L8GT	.75
LM-15	50.00
NE-16	.30
FG-17	2.75
RK-19	.85
RK-20A	7.50
TZ-20	1.75
CE-21C	2.00
RK-21	.85
RK-22	3.50
CE-23C	1.40
PJ-23	2.00
RK-23	2.50
HK-24	2.85
HK-24G	2.00
CE-25A/B	2.00
RK-25	2.25
25E6WG	4.00
25T	2.85
25TG	2.50
CE-28D	2.50
RK-28	2.50
28D7	.75
23D7W	1.50
CE-29	1.25
CE30C	1.25
Twin 30	7.50
HY-30Z	2.65
CE-31V	2.00
FG-32	6.00
FG-33	15.00
RK-33	.50
VX-33A	2.50
RK-34	.35
35T	4.50
35TG	3.00
RK-38	6.50
RK-39	1.50
T-40	2.35
TZ-40	3.50
VX-41	2.50
CE-42C	1.50
RK-44	1.00
QK-47	50.00
RK-47	1.75
CE-48	1.75
RK-49	2.85
HY-51B	.75
FP-54	44.00
HK-54	2.00
T-55	3.50
RK-57	4.50
RK-58	.90
QK-59	25.00
QK-60	25.00
RK-60	1.35
HY-61	1.25
QK-61	25.00
RK-61	2.75
QK-62	25.00
RK-62	1.75
RK-63	18.50
HY-65	1.85

RK-65	7.00
FG-67	9.00
RK-69	2.00
RK-72	.50
RK-73	.50
HY-75	3.00
RK-75	.85
VR-75	.90
75TL	5.50
VR-78	.50
FG-81A	5.00
VR-90	.75
CV-92	3.50
FG-95	17.50
VT-98BR	12.50
HF-100	7.50
100R	5.00
100TH	6.50
WE-102D	2.50
FG-105	12.00
VR-105	.70
VU-111S	1.00
HY-114B	.75
WE-121A	3.50
WE-122A	1.50
F-123A	3.50
WE-123A	5.00
WE-124A	3.75
VT-127A	2.50
F-128A	15.00
HF-130	.90
VR-150	.70
FG-154	15.00
HK-154	5.00
FG-166	15.00
FG-172	15.00
QK-181	20.00
FG-190	7.50
HF-200	10.00
CE-201	2.75
CE-203	5.00
203A	2.50
203Z	5.00
204A	25.00
WE-205B	.75
207	50.00
211	.50
WE-211C	10.00
WE-211D	8.00
WE-212E	25.00
217A	1.50
217C	3.00
WL-218	20.00
CE-220	.50
CE-221	8.00
221A	2.00
CE-222	1.50
CE-224	5.00
CE-225	3.00
CE-226	3.00
WE-231D	2.00
RX-233A	.75
CE-235A	5.00
WE-242A	5.00
WE-242C	8.00
WE-249B	2.50
WE-249C	2.50
250R	4.75
250TH	18.50
250TL	15.00
WE-251A	47.50
WE-252A	9.50
WE-253A	3.50
WE-254A	4.75
HK-257B	8.50
WE-257A	3.50
FG-258A	100.00
WE-261A	10.00
WE-262B	7.00
WE-264C	3.00
WE-267B	10.00
WE-268A	7.50
FG-271	25.00
WE-272A	5.00
WE-274A	3.00
WE-274B	1.00
274B	.50
WE-275A	5.00
WE-276A	7.50
276A	2.50
WE-282A	7.50
WE-283A	4.00
WE-285A	5.00
WE-286A	6.00
287A	3.50
WE-295A	5.00
WE-296A	25.00
HF-300	17.50
WE-300B	6.50
CE-302	3.50

EL-302.5	5.00
CE-303	2.25
WE-304B	7.50
304TH	8.50
304TL	15.00
WE-305A	3.00
CE-306	7.50
307A	.85
CE-309	2.75
WE-310A	3.50
WE-311A	5.00
WE-313C	2.85
316A	.50
WE-323A	7.50
323B	4.50
WE-328A	3.50
WE-331A	7.50
WE-337A	10.00
WE-339A	10.00
WE-347A	3.00
WE-349A	7.50
WE-350A	3.00
350B	2.50
WE-352A	15.00
F-353A	2.00
WE-353A	3.50
WE-354A	14.00
WE-355A	15.00
WE-356B	7.50
WE-368A	2.00
WE-368AS	2.50
371A	1.00
371B	1.50
WE-388A	1.50
WE-393A	5.00
394A	1.85
WE-394A	3.00
WE-396A	3.00
WE-404A	10.00
410R	100.00
WE-417A	10.00
WL-417A	2.85
WE-418A	12.50
WE-421A	7.50
GL-434A	10.00
446A	.50
446B	1.85
451	5.00
WL-460	8.50
464A	2.25
WL-468	12.50
RH-507	20.00
CK-510AX	.50
527	15.00
WL-530	25.00
WL-531	7.50
WL-532A	1.00
GL-546	2.00
559	.50
GL-575A	10.00
WL-579B	10.00
631-P1	5.75
WL-632A	17.50
WL-655/658	100.00
WL-670A	8.00
WL-681/686	25.00
WE-701A	2.00
702A	.50
702B	1.00
703A	1.50
WE-704A	.85
705A	.75
707A	3.00
707B	4.50
WE-708A	.75
WE-709A	1.00
713A	.35
715A	2.00
715B	4.00
715C	12.00
WE717A	1.00
717A	.35
WE-719A	9.50
721A	.75
721B	7.25
722A	3.50
723A/B	9.00
WE-724A	.85
WE-724B	.85
WE-725A	3.00
WE-726A	5.00
WE-726B	25.00
WE-726C	20.00
WE-730A	7.50
WE-732A	2.00
WL-735	2.00
WL-741	1.40
750TL	40.00
WL-759	12.50
WL786	15.00

800	1.50
801A	.50
802	2.25
GL-803	2.00
803	1.40
804	9.00
805	4.50
806	5.00
807	1.20
807W	3.85
808	1.00
809	2.50
810	10.00
811	2.75
811A	3.50
812	2.25
RCA-813	12.50
814	1.75
815	1.50
816	1.25
822	10.00
826	.75
828	7.50
829	6.00
829B	8.50
830B	.75
832	3.75
832A	5.00
833A	30.00
834	5.75
835	5.00
836	1.50
837	.90
GL-838	2.00
838	.75
842	2.25
843	.35
845	5.00
845W	8.50
849	18.50
851	10.00
852	5.00
860	3.00
861	15.00
865	.35
866A	1.10
866-JR	1.25
868	2.00
869B	30.00
GL-872A	2.50
CE-872A	1.50
872A	1.35
874	.50
876	.75
878	.50
879	.35
884	1.00
885	1.00
902P1	3.00
905	2.00
913	20.00
917	2.25
918	1.85
919	2.00
920	2.00
921	1.00
922	1.20
923	1.40
924	1.35
925	2.00
926	2.50
927	1.00
928	2.50
929	1.25
930	1.25
931A	3.00
SN-948	7.50
954	.30
955	.35
956	.35
957	.35
958A	.35
959	1.50
972A	3.50
991	.30
1000T	100.00
CK-1005	.25
CK-1006	2.00
CK-1007	.65
CK-1009	3.50
CK-1026	3.00
R-1100	5.00
R-1130B	10.00
1500T	115.00
1603	3.00
1608	3.75
1611	1.50
1612	1.25
1613	1.00
1614	1.50

1616	.50
1619	.30
1620	3.25
1622	1.50
1623	2.35
1624	.95
1625	.30
1630	.40
1631	1.40
1635	1.50
1636	1.00
1641	1.35
1642	.50
1649	1.00
1654	3.50
1656	6.50
1661	6.00
1846	50.00
1851	1.75
1904	9.00
1960	.50
1984	10.00
2000T	175.00
2050	.95
2051	.65
2172	10.00
2183	5.00
ZB-3200	75.00
R-4100	5.75
R-4330	8.50
5528	3.75
5550	25.00
5551	35.00
5553	100.00
5556	6.75
5557	2.75
5560	17.50
5610	1.00
5632	8.50
5637	5.00
5644	7.50
5645	6.50
5650	85.00
5651	1.35
5654	1.35
5656	6.50
5670	1.50
5687	2.50
5691	4.50
5696	1.00
5703	1.00
5720	15.00
5725	1.50
5726	.65
5727	1.40
5728	9.00
5740	44.00
5763	1.00
5801	2.50
5819	25.00
5820	400.00
5827	2.50
5829	1.50
5842	10.00
5847	10.00
5932	4.00
5933	4.00
5948	250.00
5963	1.25
5981/5650	85.00
5998	7.50
6031	4.75
6097	.65
6187	1.50
6188	2.00
R-6210	15.00
UX-6653	.75
8001	8.50
8002R	15.00
8005	4.75
8008	6.00
8011	.75
8012	1.00
8012A	2.50
8013	2.75
8013A	3.50
8016	2.50
8020	1.50
8021	.75
8022	.75
8025	1.50
8025A	2.00
8026	3.50
PD-8365	50.00
9001	.85
9002	.65
9003	.90
9004	.35
9005	1.40
9006	.25

The prices quoted above are FOB shipping point

western engineers

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GEORGE WHITING, OWNER

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Type	Price
AB-150	52.95
CEP-220	.94
CK-508AX	.99
CK-521AX	.99
CRP-72	.79
DG-1290	3.99
EF-50	.39
E-1148	.39
EC1	.39
EM3GA	39.99
F173A	5.99
F127A	4.99
F128A	19.50
FG-105	14.44
FG-154	16.99
HF-100	6.99
HF-150	15.99
HF-200	10.99
HF-300	19.99
HK-24	3.99
HK-54	3.49
HY-114B	.69
HY-615	.29
KU-610	4.99
QK-59	39.50
QK-61	63.60
QK-62	69.00
QK-185	110.00
RK-34	.29
RK-38	5.89
RK-59	1.89
RK-60	2.49
RK-65	9.95
RX-21A	5.99
UH-50	1.99
10S/VT-25A	.29
VR-78	.89
VR-90	.82
VR-105	.89
VR-150	.80
VT-52	.29
30S/VT-67	.19
VT-127A	2.99
VT-158	15.99
VU-111	.89
OA2	.84
OA3	1.10
DB2	.86
1B22	1.49
1B24	5.99
1B26	1.19
1B29	2.59
1B32/532A	.99
1N21	.69
1N22	.69

Type	Price
1N23	1.29
1N27	1.89
1P28	9.00
1P30	2.49
2AP1	5.99
2B22	1.49
2BP11	7.99
2C22	.36
2C23	3.99
2C26	.22
2C26A	.49
2C30	4.95
2C33 RX233	.99
2C39A	8.40
2C39A (boxed)	12.40
2C40	8.99
2C43	10.40
2C43 (boxed)	14.40
2C44	.85
2C46	6.99
2C51	3.29
2C53	11.75
2D21	.79
2D21W	1.85
2E22	2.49
2E24	3.29
2E36	1.19
2G-22	1.19
2J-21	3.79
2J-22	3.59
2J-26	4.99
2J-27	6.99
2J-31	14.99
2J-32	15.99
2J-33	16.99
2J-34	16.99
2J-38	16.50
2J-39	17.99
2J-40	29.50
2J-42	69.95
2J-49	34.00
2J-61	15.99
2J-62	8.99
2K-22	18.99
2K-23	19.95
2K-25	14.99
2K-28	28.99
2K-33A	79.50
2K-39	144.00
2K-41	94.00
2K45	49.50
2K49	53.50
2K52	59.50
2K54	19.50

Type	Price
2K55	29.95
2x2/879	.59
2V3	1.29
3A5	.59
3AP1	5.99
3BP1	3.29
3B22	1.49
3B23	3.99
3B24	2.49
3B24W	4.99
3B25	3.39
3B27	11.69
3B28	3.69
3C21	.94
3C22	64.95
3C23	4.59
3C24	1.69
3C28	4.99
3C30	1.42
3C33	15.95
2C45	7.95
3D23	4.99
3E29	9.99
3EP1	2.99
3FP7	1.99
3GP1	2.89
3HP7	2.99
3J21	79.95
4A-11	.49
4AP-10	3.99
4B22	6.50
4B25/EL6C	8.95
4B28/CE225	2.99
4-125A	18.99
4B36	3.69
4C27	8.95
4C28	33.50
4C35	14.99
4D22	9.95
4D32	19.89
4E27	9.99
4J22	34.50
4J23	34.50
4J24	34.50
4J25	34.50
4J26	59.50
4J27	59.50
4J28	59.50
4J29	59.50
4J30	49.50
4J31	49.50
4J34	49.50
4J36	[illegible]
5AP1	4.99
5BP1	2.99
5BP1A	[illegible]

Type	Price
5BP4	2.99
5CP1	2.99
5CP1A	10.50
5CP7	8.99
5CP11A	15.50
C6J	8.49
5C22	28.99
5D21	7.99
5BP1A	6.99
5FP7	1.99
5HP4	3.99
5HP1	3.99
5JP1	14.50
5JP5	7.49
5RP2	16.50
5J29	9.00
5J30	16.65
5J33	5.90
5LP1	8.25
5NP1	4.99
5R4GY	1.00

Type	Price
259A	6.99
264C	3.44
271A	12.99
274A	1.49
274B2	1.99
282A/B	6.50
286A	7.46
287A	6.61
304TH	10.99
304TL	10.99
307A/RK75	1.99
310A	3.6[illegible]
316A	.46
327A	3.49
329A	4.69
336A	4.99
347A	3.99
350B	3.00
371B	1.00
388A	1.49
393A	4.45
394A	4.99
417A	6.99

Type	Price
725A	6.95
726A	9.59
726B	26.50
726C	26.50
730A	9.99
800	.89
801A	.44
802	2.89
803	2.99
804	8.99
805	4.25
806	10.50
807	1.31
808	2.45
809	3.49
810	9.99
811	3.39
812	2.99
813	10.99
814	2.99
815	2.99
816	1.39
828	9.75

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Type	Price
5R4WGY	2.22
6-4	1.49
6C21	19.99
6J4WA	3.99
7C22	49.50
7C25	89.50
7BP1	6.99
7BP7	6.90
9LP7	5.50
10Y	.31
12X3	1.66
15E	1.09
15R	.39
18C	.19
24R	1.99
25TG	4.44
53A	2.99
89Y	.10
100TH	6.99
100TL	8.99
203	4.95
204A	19.49
205B	.89
207	49.50
211	1.59
215A	3.49
217A	2.49
217C	5.99
221A	2.99
231D	2.39
242C	7.99
249B	2.99
249C	3.99
250R	4.99
250TH	19.50
250TL	21.50
253A	5.99
258B	4.49

Type	Price
434A	3.99
446A	1.49
446B	2.29
WL460A	9.99
WL464A	4.77
GL-471A	2.35
527	23.50
WL-530	19.95
WL-531	4.99
WL-532	.99
GL-559	.99
700A/B/E/D	9.99
701A	4.99
702A	1.99
703A	3.99
704A	1.59
705A	.96
706B	19.95
706C	18.95
707A	3.99
707B	4.59
708A	2.45
709A	1.19
713A	.96
714AY	27.99
715A	2.49
715B	6.99
715C	14.99
717A	.89
718AY/BY/CY/EY	21.99
719A	11.75
720AY/CY/EY/DY	29.75
721A	1.91
721B	8.10
722	1.99
723A/B	9.99
724A/B	1.29

Type	Price
829B	10.49
830B	1.99
832A	8.49
833A	37.49
836	2.99
837	1.99
838	1.99
841	.26
843	.49
845	7.49
849	32.50
851	12.40
860	3.99
861	14.95
864	.69
865	1.19
866A	1.19
869B	15.99
872A	1.26
874	.74
876	.96
878	1.29
884	.99
885	1.49
9-3	.69
902A	3.99
918	2.10
927	1.65
931A	2.99
954	.26
955	.49
956	.59
957	.59
958	.59
959	1.99
991	.33

Type	Price
1500T	84.50
CK1005	.49
CK1006	2.49
1603	2.99
1613	.99
1614	1.99
1616	.99
1622	1.40
1624	1.29
1625	.29
1626	.21
1629	.22
1630	.69
1632	.49
1633	.59
1639	.89
1641	2.49
1642	.29
1644	.69
1806P1	3.99
1851	1.39
1960	.99
2050	1.10
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	.09
2A3	.99
2A4	.99
3B7	.39
3D6	.39
3V4	.73
3Q4	.83
3S4	[illegible]
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	.78
6AN4	1.35
6AQ6	.59
6AR6	1.69

Type	Price
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	.66
7C4	.39
7C5	.79
7F7	.89
7G7	.89
7H7	.69
7N7	.89
7Q7	.99

Type	Price
7Y4	.69
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
12N7	.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
5656	8.25
5670	2.25
5686	1.79
5687	3.4[illegible]
5725	1.99
5751	2.15
5763	1.39
5796	7.99
5814	1.27
5879	1.29
5915	1.09
5963	.99
5964	1.30
8193	.09
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8012	1.94
8013A	4.69
8020	2.50
8025	1.79

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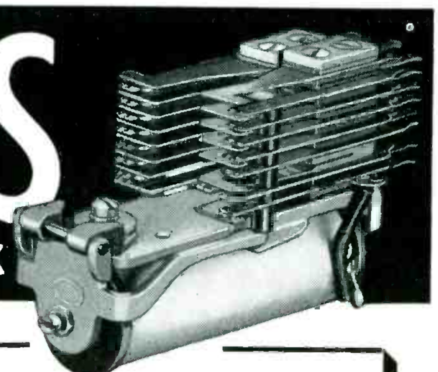

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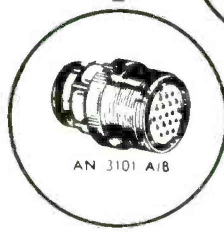

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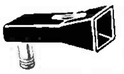
*2J21A..	$2.25	3J31.....	$32.50	700B.....	$8.75
2J22.....	2.50	4J34.....	23.50	700D.....	8.75
2J26.....	2.50	4J42.....	47.50	706A.....	9.75
2J27.....	3.00	5J23.....	34.50	706D.....	14.75
2J29.....	18.50	5J30.....	14.50	706CY....	9.75
2J31.....	13.95	5J33.....	4.75	706EY....	9.75
2J32.....	14.50	QK 59....	39.50	725A*	
2J37.....	9.50	QK 60....	35.00	730A.....	8.75
2J39.....	8.25	QK 61....	50.00		
2J62.....	6.75	QK 62....	54.00	* Write	

X BAND – 1" x ½" WAVEGUIDE



AT-68/UP 3 Cm Horn with type N. feed for receiver measurements, etc. New (as shown) $7.45

ROTARY JOINT (APS-6) Sperry PT #658275, 180 deg. rotation, choke-to-choke. Has "Built-in" Di-Coupler, 20 DB., with "N" Takeoff 22.50

PARABOLOID DISH, 18" diam. Spun Aluminum. 8" Focus. For AN/APS-6 ....$4.95

3 CM. DIPOLE and Feed Assembly. (May be used with above dish.) 8 inches long..............$5.00

FLEXIBLE SECTION 9 in. long Cover-to-Cover..$5.50

3CM. DIPOLE FEED, 15" L. for APS-15 10½" Focus $14.50

MITRED ELBOW. Cast aluminum. 1¼" x ⅝" W.G. W.E. Flanges, "E" Plane..............$3.50

3 CM. ANTENNA ASSEMBLY: Uses 17" paraboloid dish, operating from 24 vdc motor. Beam pattern: 5 deg. in both Azimuth and elevation. Sector Scan: over 160 deg. at 35 scans per minute. Elevation Scan: over 2 deg. Tit: Over 24 deg..............$35.00

Cross-Guide Directional Coupler. UG-40 output flange. Main Guide is 6" Long, with 90 Deg. "E" Plane bend at one end, and is fitted with Std. UG 39/UG 40 flanges. Coupling figure: 20 db Nominal.......$22.50

RG52/U Waveguide in 5' lengths, fitted with UG 39 flanges to UG40. Silver plated.......per length $5.00

Rotating-Joints supplied either with or without deck mountings. With UG40 flanges..........each $17.50

Bulkhead Feed-thru Assembly..............$15.00

Pressure Gauge Section with 15 lb. gauge......$10.00

Directional Coupler, UG-40/U Take off 20db.....$17.50

MAGNET AND STABILIZER CAVITY For 2J41 Magnetron $24.50

90 degree elbows. "E" plane 2½" radius..........$8.50

ADAPTER, waveguide to type "N", UG 81-U, p/o TS 12, TS-13, Etc. $7.50

ADAPTER. UG-163/U round cover to special BTL. Flange for TS-45, etc..............$2.50 ea.

I. F. AMPLIFIER STRIPS

Model 15: 30 Mc Center frequency. Bandwidth 2.5 Mc gain figure: 65 db. Uses 5 stages of 6AC7's. Has D. C. Restorer and Video Detector A.F.C. Strip included. Input impedance: 50 Ohms. Less tubes.$17.50

60 MC. Miniature IF strip, using 6AK5's 60 Mc center Freq. Gain: 95 db at Bandwidth of 2.7 Mc. New Complete with tubes..............$15.00

JAN WAVEGUIDE FLANGES

UG 39/U	$1.10	UG 51/U	$1.65
UG 40/U	$1.25	UG 52/U	$3.40
UG 40A/U	$1.85	UG 52A/U	$3.40

COAXIAL R.F. FILTERS

F-29/SPR-2. Hi-Pass., with 1000 mc Cut-off, Type "N" input and output, 50 Ohms Z..............$9.50

F-41/SPR-1. Hi-Pass, with 300 mc cut-off, Type "N" input and output. 50 Ohms Z (As shown).........$10.50

PULSE TRANSFORMERS

4P37 Primary, 50 Ohms 750V. .001 Duty. Sec. 15KV. 1000 Ohms Impedance. Bifilar 12.6V/2.5A....$32.50

RAYTHEON WX 4298E: Primary 4KV., 1.0 USEC. SEC. 16KV-16 AMP DUTY RATIO: 001 400 CYCLE FIL. TRANS. "BUILT-IN" $42.50

WECO: D-163247 For Modulator of SCR 720....$22.50

GE #K-2449A. Primary: 9.33 KV, 50 ohms Imp. Secondary: 28 KV. 450 ohms. Pulse length: 1.05/5 usec @ 635/120 PPS, PK Power Out: 1.740 KW. Bifilar: 1.5 amps (as shown)..............$62.50

GE #K-2748-A, 0.5 usec @ 2000 Pps. Pk. Pwr. out is 32 KW impedance 40:100 ohm output. Pri. volts 2.3 KV Pk. Sec. volts 11.5 KV Pk. Bifilar rated at 1.3 Amp. Fitted with magnetron well..............$24.50

K-2745 Primary: 3.1/2.8 KV, 50 ohms Z. Secondary: 14/12.6 KV 1025 ohms Z. Pulse Length: 0.25/1.0 usec @ 600/600 PPS. Pk. Power 200/150 KW. Bifilar: 1.3 Amp. Has "built-in" magnetron well.$32.50

K-2461-A. Primary: 3.1/2.6 KV—50 ohms (line). Secondary 14/11.5 KV—1000 ohms Z. Pulse Length: 1 usec @ 600 PPS. Pk. Power Out: 200/130 KW. Bifilar 1.3 Amp. Fitted with magnetron well.........$29.50

K35J45—Pulse Inversion: PRI: 5 KV PK. Pulse Negative. Sec: Pos. Pulse, 4 KV; 1 usec. and .001 DUTY RATIO $6.50

54J318-1—3 wdgs. Ratio: 1:1:1, 1.10 uh. /wdg., 2.5 ohms DCR $3.50

PULSE MODULATORS

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp.) Duty Ratio: .001 max. Pulse duration: 0.5, 1.0, 2.0 microsec. Input voltage: 115 v. 400 to 2400 cps. Uses 715B 1-829B 3-72's, 1-73. New..............Less Cover—$135

ASD Modulator-Units, mfd. by Sperry. Hard tubes pulser delivers Pk. pulse of 144 kw. Similar to Mod 3 unit. Brand new, less tubes..............$85.00

Airborne RF head, model ASD, delivers 50 Kw peak output at 9000 mc. at .001 duty. 1 usec./1000 PPS. Complete with pulser unit and all tubes........$210

3 CM. TEST SETS

TS 12/AP. For standing wave measurement of plumbing, TR/ATR boxes, crystal mixers, antennas, etc. The TS 12 consists of two basic units: Unit 1 is a high gain stable amplifier followed by a 3-inch meter which reads SWR directly. UNIT 2 consists of waveguide accessories, including a slotted line, probes, dummy load, adapters, etc. Either bolometer or crystal input may be used. Both units are portable, self contained. Operates from 115 v. 60-800 cps. New*

TS 13/AP. Signal source 9305-9445 mc, 50 microwatts. Comes with a wavemeter, thermistor-bridge power meter, and calibrated attenuator. Oscillator is a klystron type 723/a-b which may be internally (self-synch) or externally pulsed. Controls are provided for FM operation, variable pulse delay, pulse width and phasing. Operates from 115 v. 60-800 cps. New*

** Price on Request*

—IN STOCK—

AIA	ASH	SO-8
APA-9	BG	SG-1
APA-10	DAS†	SJ-1
APN-3	DBS†	TAJ
APN-7	APT-2	TBK
APN-9*	APT-4	TBL
APS-2	MKIV	SCR520*
APS-3	MKX	SCR521
APS-4	RC145	SCR518
APS-6	RC148	SCR545
ASD	SO-1	SCR584

* COMPONENTS. † LORAN EQUIPMENT

—TEST SETS—

TS-10	TS-12	TS-159
TS-36	TS-56	TS-90
TS-47	TS-34	TS-98

BARGAIN SPECIALS

Barry shock mounts: nos. 2045, C-2060, C-2070, C-2090..............45¢ ea.

Trihedral radar reflector, MK-1, aluminum......$3.50

SPLICER, for 11/16 perforator tape. WEco # X-61859 list 20 SCS #4TW 61859-20. Complete set, with number tape dispenser..............$8.50

SPARES FOR PRC-10

3C1084H-67	3C1084H-71	2Z5822-488
3C1084H-68	3C1084Z-74-3	2Z5822-503
3C1084H-69	2Z9632.611	3DA1-304
3C1084H-70	2Z9631.407	3DA10-543

MN 28Y Control box, unit of MN 26 compass, New.$3.75

Noise filters, Mallory NF1-1, 100 amp/35 vdc.....$1.00

Power supply unit, navy type—EL-2. Input: 115 vac, 60 cy. Output: 135 vdc/10 ma. 90 vdc/5ma; 3 vdc/360 ma. New, complete with spare parts box. To be used with model TBX radio gear..............$9.50

Coaxial switch, 12-position, with type "N" fittings. Type SA-14/SPR-1 ....$17.50

Amplifier, Altec A-127. 18 Watts output with response from 20-20,000 cps. Operates from 115 v. 60 cps. Std. rack panel mtg. Used, excellent..............$103

Pulse analyzer, type APA-6. With 3 in. scope.....$235

BC 602 Control box for SCR 522 (pushbutton)....$3.75

24-volt Transformer. Input 115 v/60 cy. Output 24 v/3A $1.79

Phase-shifter. Helmholtz type: 0-360 deg.........$2.50

Capacitor, oil-filled, 0.25 mfd./25,000 volts dc......$15

Hydrophone, MODEL MI-2. A lattice of 3 crystals in a disk-like structure; 17-37 Kc..............$27.50

AN/CRW-2A Remote control receiver, for operating target planes, etc. New, with soundproof mounting box $34.50

TEL. REPEATER, EE 89, complete with tubes and tech. manual $17.50

TEL. REPEATER, EE 99, with 12 vdc. vibrator power supply (PE 204) $49.50

F.T.&R. 101-A. Two-wire applique, contains equalizing devices, and balancing circuits. Used for adapting 2-wire military circuits to 4-wire systems........$47.50

RADAR TRAINER, Model 15-C. Brand new, complete with pulse generator, power supply, main unit, all cables and instruction book..............$125

UNOERWATER MICROPHONES, Model JR—Consists of a mosaic of 7 crystals. May be used at 17-73 Kc. omnidirectional, 50 ohm output..............$27.50

SA4A/APA-1 Motor Oriven Coaxial Ant. Switch DPDT. Continuous Operation from 24VDC. Completely Enclosed $34.60

MP-22 MAST BASE Mobile Antenna Mount....$4.59

SA-A/APN-1 Altitude Limit Switch for APN-1 Altimeter $7.95

ALTITUDE INDICATOR for APN-1..............$12.50

C-87D Final P.A. Coil for BC610 2-3.5 MC. Variable Link $4.89

RA-74 Power Supply for Super Pro..............$69.50

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For Rural Areas, Hotels, Commercial Steamers, Ball Parks, Etc.

U. S. NAVY type PAE-1 Electric Megaphone equipment is designed for voice reinforcement in much the same manner as, but to a greater degree than, the familiar acoustic megaphone. Consists of Megaphone Unit (which combines a microphone and reproducer in a single assembly). Portable Amplifier which electrically amplifies the output signal of the microphone section of the megaphone and feeds this amplified signal to the reproducer section. Charging Rack for recharging the self-contained storage battery of the portable amplifier. BRAND NEW.............. $129.50

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	Price
BDAR83	14	...	375	.150	$6.50
35X-059	19	3.8	405	.095	4.35
POSX-15	14	2.8	220	.08	8.95
DM33A	28	7	540	.250	3.95
23350	27	1.75	285	.075	3.95
B-19	12	9.4	275	.110	6.95
			500	.050	
DA-3A*	28	10	300	.260	3.95
			150	.010	
			14.5	5.	
PE 73CM	28	19	1000	.350	10.50
BD 69‡	14	2.8	220	.08	8.95
DAG-33A	18	3.2	450	.06	2.50
DM25†	12	2.3	250	.05	6.95
BDAR 93	28	3.25	375	.150	6.95

‡Less filter *Replacement for PE 94.
†Used, Excellent.

PE 94–, Brand New.............. 5.95

INVERTERS

800-1B Input 24 vdc, 62 A. Output: 115 V, 800 cy. 7A. 1 phase. Used, excellent..............$18.75

PE-218H: Input: 25/38 vdc, 92 amp. Output 115V 300/500 cy 1500 Volt-ampere. NEW..............$32.50

PE206: Input: 28 vdc, 36 amps. Output: 80 V 800 cy. 500 volt-amp. Dim. 13 x 5½ x 10½. New....$22.50

AN3187-1, Input: 13.75 V; 18.4A. Output: 115 V/400~, 3φ. 0.95 PF. New..............$59

PU 7/AP. Input: 28 vdc/160 A. Output: 115 VAC, 400~, 1φ. 500 VA., 21.6 Amp. Volt, and Freq. Reg. Used, Exec. $75

TS-56A/AP TEST EQUIPMENT

Slotted line test equipment designed for operation over a frequency of 500-675 MC. Has impedance of 51 ohms. Ideal test set for matching antennas, measurement of characteristics of transmission line. With instructions manual. New. Shipping wt.: 41 lbs.............. $120.00

TEST OSCILLATOR TS-47/APR, 40-2000 + Mc. Fundamental coverage 40-500 Mc in two ranges. Harmonics above 2000 Mc. Provides a calibrated (dial) accuracy ± 0.7 per cent) H.F. source for testing receiving equipment. Output 3MW or more up to 400 Mc. less on harmonics. C.W., mod. pulse or sine wave output. Operates on 115/230 60 Cy. or batteries Part of APR countermeasures equipment. New $165.00

VHF ANTENNA

Sig. Corps. AN154. 150-200 mc. Consists of 3 vertical dipoles working against a mesh reflector, 90 in. x 40 in. Spacing between elements is ½ wavelength. Unit comes complete with portable carrying chest and 1/12 HP lobing motor - (synchronous, 115 vac 60 cy.). Antenna folds up to 46 in. sq. x 18 in. height. Hhpg. wt. aprox. 200# (as shown)........ $22.50

400 CYCLE TRANSFORMERS

(All Primaries 115V. 400 Cycles)

KS13101	6.3V/15A, 6.3V/0.9A, 6.3V/0.4A, 6.3V/0.2A..............	$3.85
KS13104	1450VCT/0.283A, 1050VCT/0.217A..	7.50
KS9615	6.3V/4A, 3V/1A..............	1.57
KS9608	1233/.35MA, 1140VCT/.07A..............	5.79
302433A	6.3V/9.1A, 6.3VCT/6.5A, 2.5V/3.5A, 2.5/3.5A..............	4.85
KS 9445	592VCT/118MA, 6.3V/8.1A, 5V/2A..	5.39
KS 9685	6.4/7.5A, 6.4V/3.8A, 6.4/2.5A..............	4.79
	ALL CT	
70G30G1	600VCT/36MA..............	2.65
M-7474318	2100V/.027A..............	4.95
352-7069	2-2.5V Wdgs at 2.5A, Each Lo-Cap., 22Kv Test..............	5.95
352-7096	2.5V/1.79A, 5V/3A, 6.5V/6A, 6.5V/1.2A, D/O BC800..............	4.95
352-7099	360VCT/20MA, 1500V/1MA, 2.5V/1.75A, 6.3V/2.5A, 6.3V/.6A, P/O BC-929..............	6.45
3 D163253	5200V/.002A, 2.5V/5A..............	5.35
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778 Bendix
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10285 Leland
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10486 Leland
Output: 115 VAC; 400 cycles; 3-phase; 175 VA; .80 pf. Input: 27.5 DC; 12.5 amps; cont. duty. **$70.00**

10563 Leland
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PE109 Leland
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MG153 Holtzer-Cabot
Input: 24 VDC; 52 amps. Output: 115 volts—400 cycles, 3-phase, 750 VA. Voltage and frequency regulated. **$95.00**

DMF2506M Continental Electric
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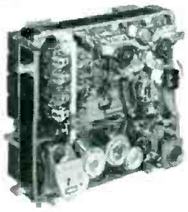

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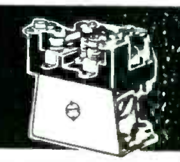

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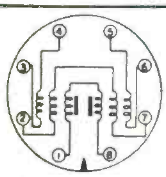

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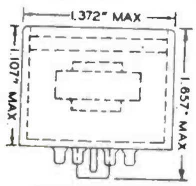

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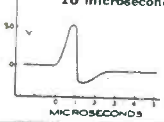
Rise time, microseconds .03
Drop in 1 microsecond 20%
2 microsecond 40%
5 microsecond 55%
10 microsecond 75%



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Index to electronics

VOLUME XXVIII

January to December Issue Inclusive 1955

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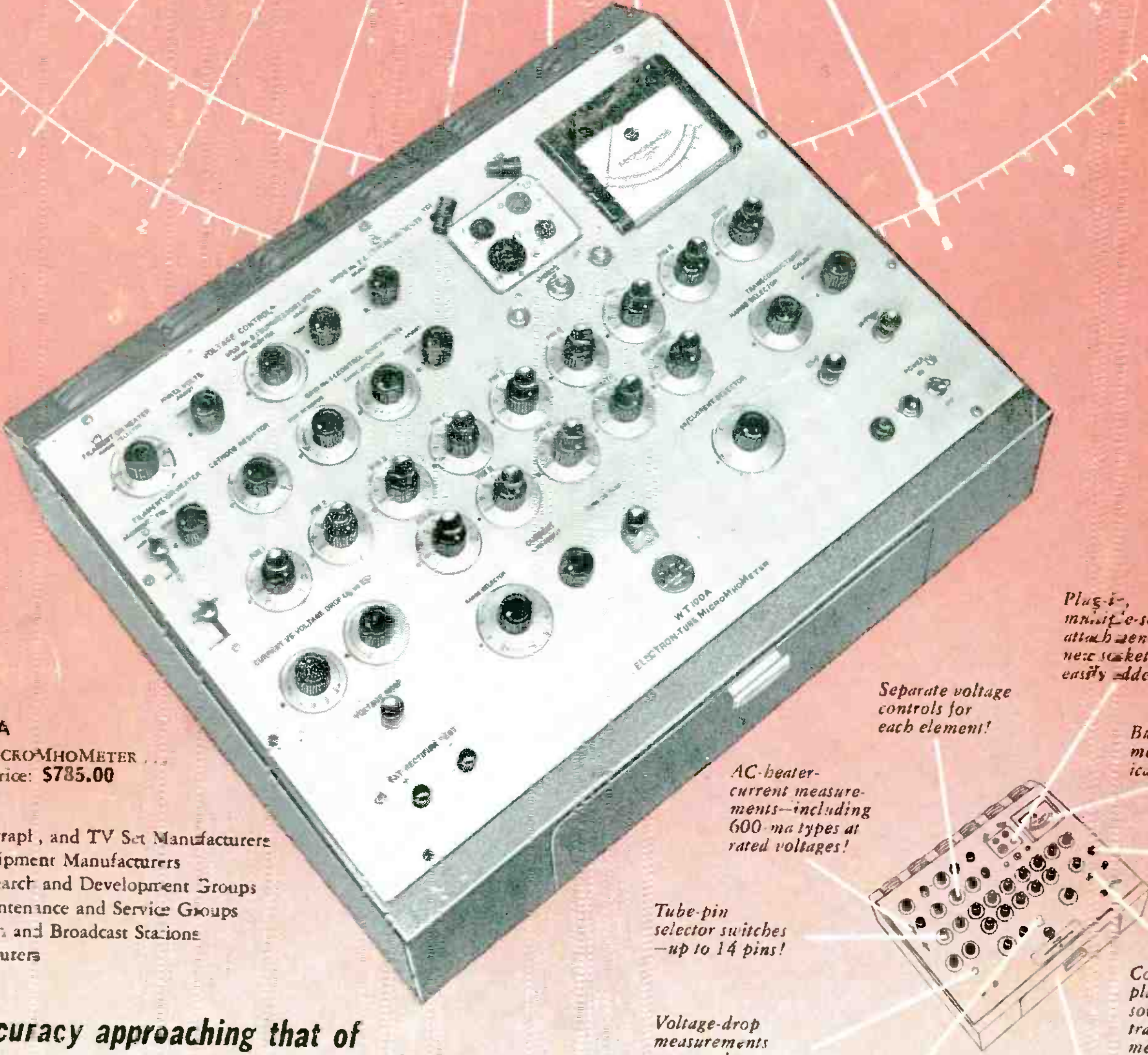

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