electronics

JANUARY • 1954

PRICE 75 CENTS

A McGRAW-HILL PUBLICATION

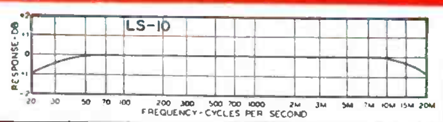
TESTING MAGNETIC DECISION ELEMENTS

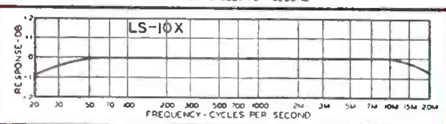
FOR Higher Fidelity*

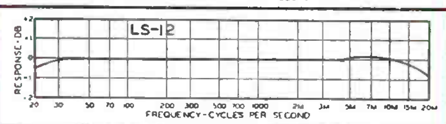
THE Linear Standard SERIES

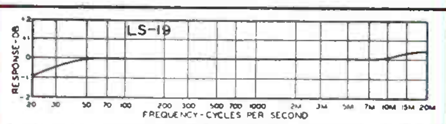
The ever increasing use of wide range equipment for broadcast service has reached the point where the major limiting factor is the frequency range of the transformers employed. UTC Linear Standard components represent the closest approach to the ideal transformer from the standpoint of uniform frequency response, low wave form distortion, high efficiency, thorough shielding, and dependability. Typical LS units are described below.

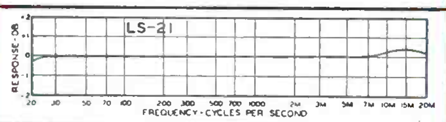
Case Size	LS-1	LS-2
Length	3⅛″	4 7/16″
Width	2⅝″	3½″
Height	3¼″	4 3/16″

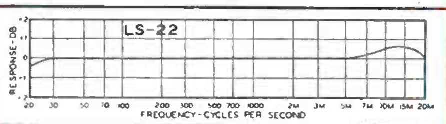


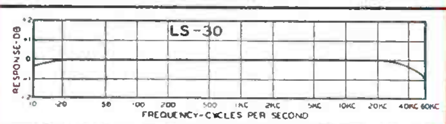


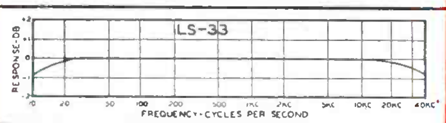


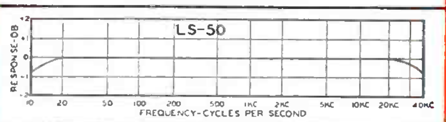


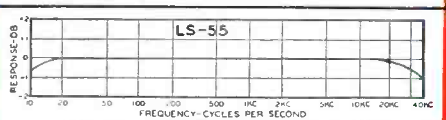


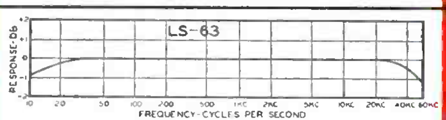


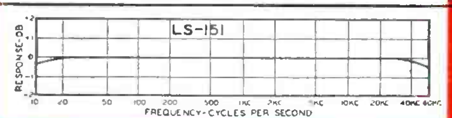












INPUT TRANSFORMERS

Type No.	Application	Primary Impedance	Secondary Impedance	± 1 db from	Max.† Level	Relative* hum	Unbal. DC in prim'y	Case No.	List Price
LS-10	Low impedance mike, pickup, or multiple line to grid	50, 125/150, 200, 250, 333, 500/600 ohms	60,000 ohms in two sections	20-20,000	+10 DB	−74 DB	.5 MA	LS-1	$25.00
LS-10X	As above	As above	50,000 ohms	20-20,000	+10 DB	−92 DB-Q	.5 MA	LS-1	35.00
LS-12	Low impedance mike, pickup, or multiple line to push pull grids	50, 125/150, 200, 250, 333, 500/600 ohms	120,000 ohms overall, in two sections	20-20,000	+10 DB	−74 DB	.5 MA	LS-1	28.00
LS-12X	As above	As above	80,000 ohms overall, split	20-20,000	+10 DB	−92 DB-Q	.5 MA	LS-1	35.00
LS-15X	Three isolated lines or pads to one or two grids	30, 50, 200, 250 ohms each primary	60,000 ohms overall, in two sections	20-20,000	+10 DB	−92 DB-Q	.5 MA	LS-1	37.00

INTERSTAGE AND MATCHING TRANSFORMERS

Type No.	Application	Primary Impedance	Secondary Impedance	Response	Max.† Level	Relative* hum	Unbal. DC in prim'y	Case No.	List Price
LS-19	Single plate to push pull grids like 2A3, 6L6, 300A. Split secondary	15,000 ohms	95,000 ohms; 1.25:1 each side	± 1 db 20-20,000	+12 DB	−50 DB	0 MA	LS-1	$26.00
LS-21	Single plate to push pull grids. Split pri. and sec.	15,000 ohms	135,000 ohms; 3:1 overall	± 1 db 20-20,000	+10 DB	−74 DB	0 MA	LS-1	26.00
LS-25	Push pull plates to push pull grids. Medium level. Split primary and sec.	30,000 ohms plate to plate	50,000 ohms; turn ratio 1.3:1 overall	± 1 db 20-20,000	+15 DB	−74 DB	1 MA	LS-1	32.00
LS-30	Mixing, low impedance mike, pickup, or multiple line to multiple line	50, 125/150, 200, 250, 333, 500/600 ohms	50, 125/150, 200, 250, 333, 500/600 ohms	± 1 db 20-20,000	+15 DB	−74 DB	.5 MA	LS-1	26.00
LS-33	High level line matching	1.2, 2.5, 5, 7.5 10, 15, 20, 30, 50 125, 200, 250, 333, 500/600	50, 125, 200, 250, 333, 500/600 ohms	± .2 db 20-20,000	15 watts			LS-2	30.00

OUTPUT TRANSFORMERS

Type No.	Application	Primary Impedance	Secondary Impedance	Response	Max.† Level	Relative* hum	Unbal. DC in prim'y	Case No.	List Price
LS-50	Single plate to multiple line	15,000 ohms	50, 125/150, 200, 250, 333, 500/600	± 1 db 20-20,000	+15 DB	−74 DB	0 MA	LS-1	$26.00
LS-52	Push pull 245, 250, 6V6 or 245 A prime	8,000 ohms	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	± .2 db 25-20,000	15 watts			LS-2	35.00
LS-55	Push pull 2A3's, 6A5G's, 300A's, 275A's, 6A3's, 6L6's, 6AS7G	5,000 ohms plate to plate and 3,000 ohms plate to plate	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	± .2 db 25-20,000	20 watts			LS-2	35.00
LS-63	Push pull 6F6, class B 46's, 6AS7G, 807-TR, 1614-TR	10,000 ohms plate to plate and 6,000 ohms plate to plate	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	± .2 db 25-20,000	15 watts			LS-2	25.00
LS-151	Bridging from 50 to 500 ohm line to line	16,000 ohms, bridging	50, 125/150, 200, 250, 333, 500/600	± 1 db 15-30,000	+18 DB	−74 DB	1 MA	LS-1	27.00

The values of unbalanced DC shown will effect approximately 1.5 DB loss at 30 cycles.
* Comparison of hum balanced unit with shielding to normal uncased type. Q Multiple alloy magnetic shield.
† 6 MW as ODB reference.

* **UTC LINEAR STANDARD** transformers are the **ONLY** audio units with a **GUARANTEED** uniform response... ± 1 DP from 20 to 20,000 cycles.

United Transformer Co.

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electronics

JANUARY • 1954
A McGRAW-HILL PUBLICATION

TESTING MAGNETIC DECISION ELEMENTS—Production setup for testing three types of basic potted plug-in elements made by The Minnesota Electronics Corp., St. Paul, for building entire arithmetic, program, control and memory sections of any digital computer (see p 200)

January, 1954 ELECTRONICS Vol. 27, No. 1
Member ABC and ABP

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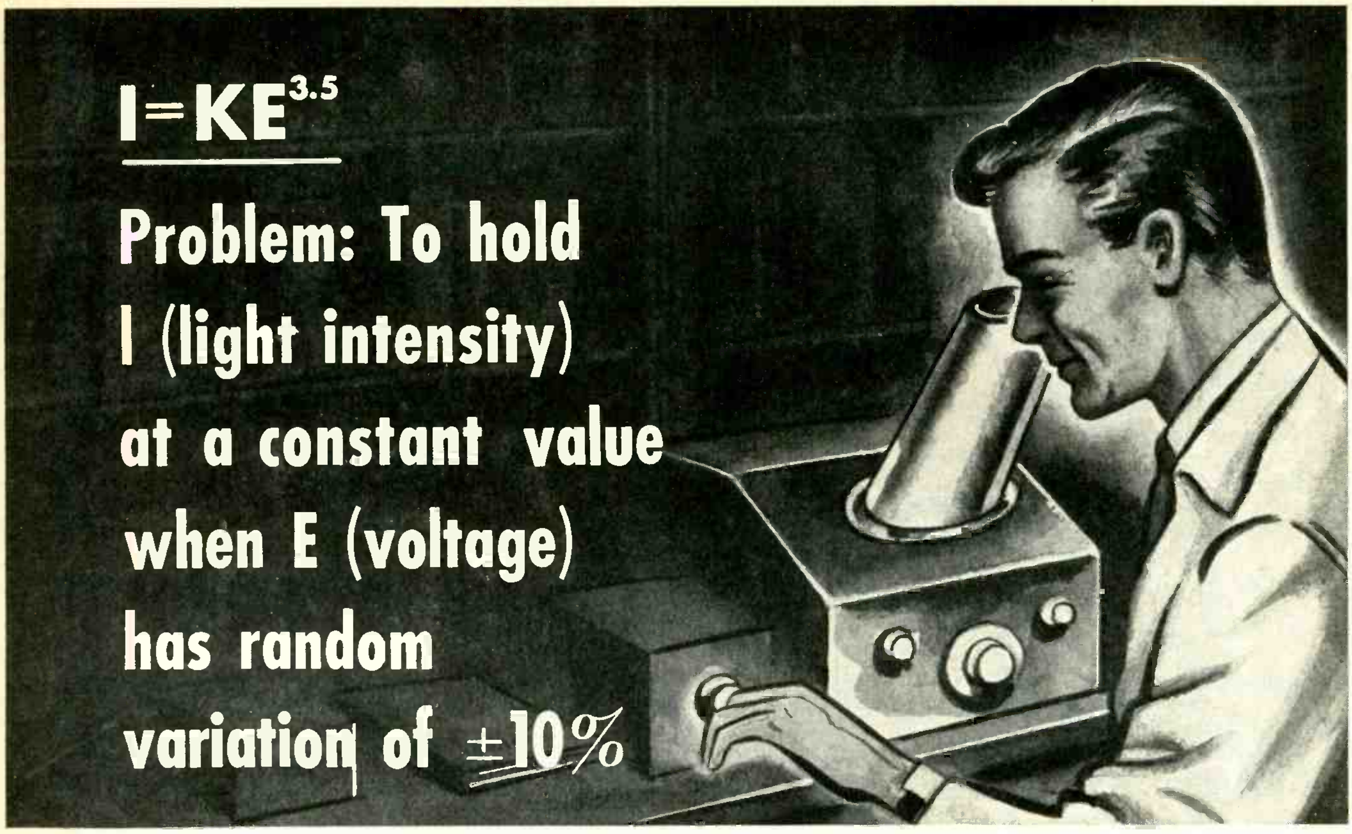

There is obviously no solution to the problem as stated. It follows, then, that where voltage is as critical as in the above formula, untold man-hours of research, test, design, or production may be completely wasted unless E can be accurately controlled. Whether E or its equivalent in any formula is AC (60-cycle or 400-cycle) or DC, Sorensen electronic regulating equipment is designed to make the results of your work more accurate and your time more fruitful. Instruments are available from stock to fit a very large variety of applications.

AC REGULATORS — Capacities from 150VA to 15KVA, regulation accuracy ±0.1% with good waveform. A precision model regulates to ±0.01% and has a capacity of 1000VA.

DC POWER SOURCES — The well-known Sorensen NOBATRONS* are available in many different models, providing 6 to 200 volts DC at 5 to 350 amperes. This line includes dual supplies and the highly versatile RANGERS (wide-range-variable DC sources). Regulation accuracy is ±0.25%. A full line of B-supplies provide high-voltage, low-current DC regulated ±0.5%.

MAGNETIC AMPLIFIER POWER SUPPLIES — These instruments provide regulated DC power at heavy currents. Since they are tubeless, maintenance is at a minimum.

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Literature describing the Sorensen line of electronic power regulating equipment is yours for the asking. Write Sorensen & Co., Inc., 375 Fairfield Avenue, Stamford, Conn. In Europe, write directly to Sorensen A. G., Gartenstrasse 26, Zurich 2, Switzerland.

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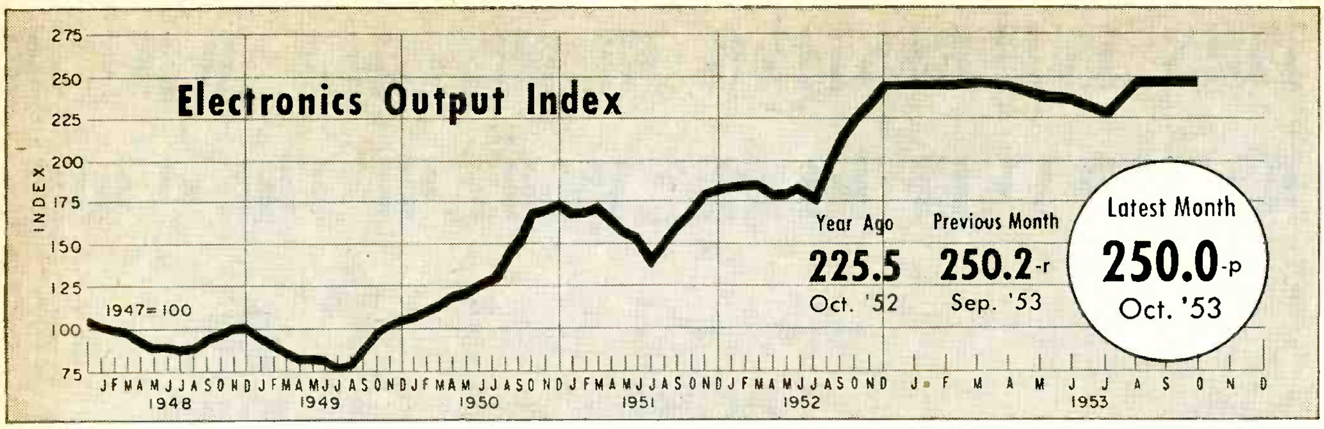

FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Year Ago Oct. '52	Previous Month Sept. '53	Latest Month Oct. '53
Television sets	724,117	770,085	680,433
Home sets	314,459	529,427	370,178
Clock Radios	180,841	182,417	189,230
Portable sets	113,552	147,355	135,009
Auto sets	163,494	357,326	358,076

RECEIVER SALES

(Source: RETMA)	Oct. '52	Sept. '53	Oct. '53
Television sets, units	847,219	753,953	621,768
Radio sets (except auto)	580,077	650,898	385,229

RECEIVING TUBE SALES

(Source: RETMA)	Oct. '52	Sept. '53	Oct. '53
Receiv. tubes, total units	41,880,318	38,929,539	34,928,108
Receiving tubes, new sets	29,132,068	25,277,061	23,028,120
Rec. tubes, replacement	8,791,404	10,923,386	9,509,908
Receiving tubes, gov't.	3,105,005	720,081	439,691
Receiving tubes, export	851,841	2,009,011	1,950,389
Picture tubes, to mfrs.	862,431	685,666	719,055

SEMICONDUCTOR SALES

(Source: RETMA)	Oct. '52	Sept. '53	Oct. '53
Germanium Diodes	......	870,555	772,381

INDUSTRIAL TUBE SALES

	Quarterly Figures		
(Source: NEMA)	Year Ago 2nd '52	Previous Quarter 1st '53	Latest Quarter 2nd '53
Vacuum (non-receiving)	$12,110,000	$11,340,000	$10,400,000
Gas or vapor	$3,150,000	$3,140,000	$3,300,000
Phototubes	$480,000	$930,000	$700,000
Magnetrons and velocity modulation tubes	$9,830,000	$10,070,000	$10,500,000
Gaps and T/R boxes	$2,140,000	$2,050,000	$1,700,000

TV AUDIENCE

(Source: NBC Research Dept.)	Year Ago Nov. '52	Previous Month Oct. '53	Latest Month Nov. '53
Sets in Use—total	19,751,200	25,690,000	26,364,000

BROADCAST STATIONS

(Source: FCC)	Nov. '52	Oct. '53	Nov. '53
TV Stations on Air	116	315	334
TV Stns CPs—not on air	114	230	216
TV Stns—Applications	836	424	236
AM Stations on Air	2,374	2,497	2,509
AM Stns CPs—not on air	139	106	113
AM Stns—Applications	250	187	185
FM Stations on Air	626	566	561
FM Stns CPs—not on air	14	20	20
FM Stns—Applications	9	5	5

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Oct. '52	Sept. '53	Oct. '53
Aeronautical	33,630	42,427	42,974
Marine	37,914	42,931	43,292
Police, fire, etc.	11,772	14,094	14,315
Industrial	15,090	18,868	19,287
Land Transportation	5,346	6,201	6,287
Amateur	116,102	113,909	114,275
Citizens Radio	1,788	3,987	4,026
Disaster	80	251	254
Experimental	519	476	480
Common carrier	1,032	1,327	1,374

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Sept. '52	Aug. '53	Sept. '53
Prod. workers, comm. equip.	367,300	401,600-r	408,200
Av. wkly. earnings, comm.	$67.60	$68.06-r	$68.38
Av. wkly. earnings, radio	$63.46	$65.69	$66.17
Av. wkly. hours, comm.	41.7	41.0	40.7
Av. wkly. hours, radio	41.1	40.3	40.1

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Nov. '52	Oct. '53	Nov. '53
Radio—TV & Electronics	321.9	272.1	261.8
Radio Broadcasters	300.3	272.2	261.1

p—provisional; r—revised

FIGURES OF THE YEAR

	1952 Total	TOTALS FOR THE FIRST TEN MONTHS 1952	1953	Percent Change
Television set production	6,096,279	4,394,708	6,204,803	+41.2
Radio set production	10,934,872	7,461,881	11,201,656	+50.1
Television set sales	6,144,990	4,291,893	4,922,128	+14.7
Radio set sales (except auto)	6,878,547	4,877,059	4,911,415	+07.0
Receiving tube sales	368,519,243	287,569,947	382,080,558	+32.8
Cathode-ray tube sales	6,120,292	3,982,763	6,647,857	+66.9

INDUSTRY REPORT

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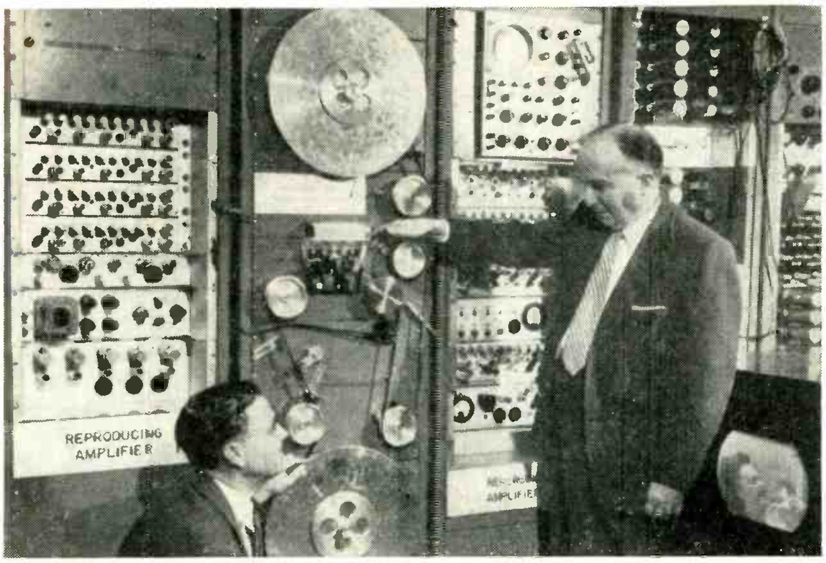


VIDEO TAPE RECORDING equipment demonstrated by RCA engineers W. D. Houghton and H. F. Olson handles b-w and color experimentally as . . .

Electronic Movies Forge Ahead

Sarnoff confident video tape development will be commercial within two years time

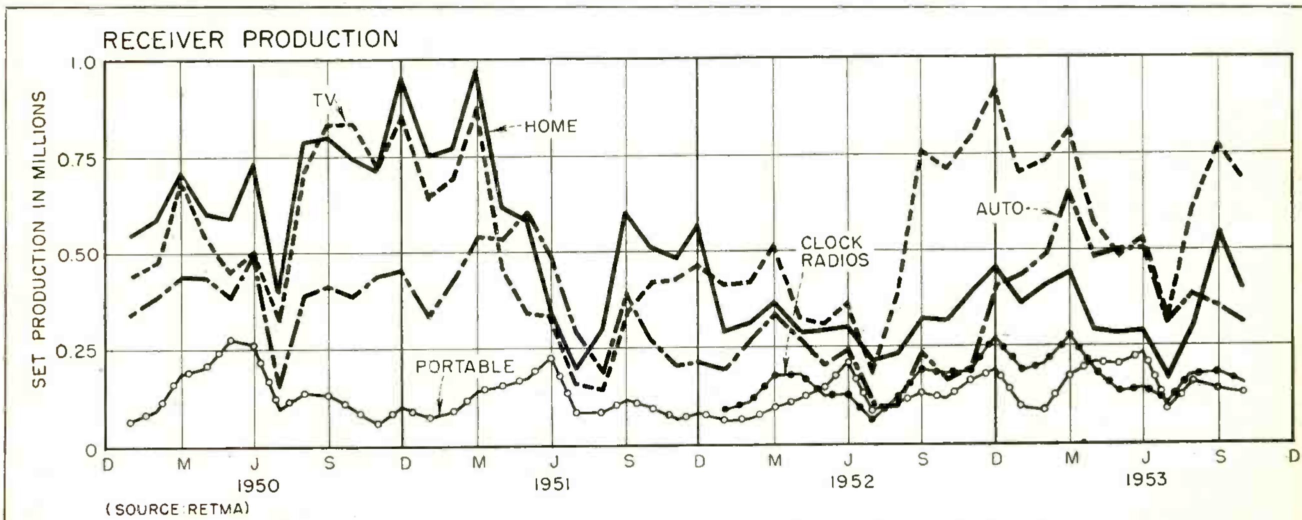
MAGNETIC-TAPE recording of color television pictures recently demonstrated by RCA at Princeton Lab may prove the key to commercial colorcasts in the near future, according to engineers who viewed it.

The test program originated by NBC in New York City was sent over a 45-mile microwave circuit to Princeton where it was viewed and recorded simultaneously. The recording was immediately played back through an adjacent receiver so that direct comparison was possible. Later, the complete recording was played back. Viewers found it good.

▶**How It Works**—In principle, video recording is the same as that for sound. However, audio signals range from 20 to 20,000 cycles, whereas picture signals extend to about 4,000,000 cycles. To accommodate the higher frequencies, it is at present necessary to speed up the tape to 30 feet a second (as compared with audio's 15 inches a second). The recording and reproducing heads must be specially designed and made. The tape transport mechanism must move at extremely constant speed.

Rebroadcasts over a television transmitter requires relatively simple additional equipment. En-

***ELECTRONIGRAPHS**—A Year-End Glance at Electronics Industry Figures*



More charts following

gineers know how to do it and foresee no difficulties.

For the demonstration, five parallel channels were magnetically recorded on a single half-inch plastic tape coated with a special iron rust. There was a channel for each primary color (red, green and blue), for the synchronizing signal and for the sound.

Each channel can handle up to 3,000,000 cycles. Black-and-white television was reproduced with two channels on a quarter-inch tape.

▶ **What It Saves**—Tape itself costs more than equivalent film for any given length show. However, film processing (unnecessary with tape) bring the costs about level. But tape can be magnetically erased and reused—perhaps as much as 25 times. Over the long run, then, use of tape becomes cheaper. RCA's E. W. Engstrom foresees the day when tape for a monochrome show will cost less than 20 percent that of film, while color tape expense may be less than 10 percent of film.

For the future, Engstrom hopes to reduce tape travel from 30 to 20 feet a second. Present reels are 17 inches and contain 5 minutes of program. At the slower speed, a 15-minute program can be made to fit a 19-inch reel.

Color TV Timetable

As predicted, color decision by FCC made Dec. 17, will become legal around third week in January . . . 30 days after publication in official Federal Register . . .

• • •

Networking full color to 13 cities is guaranteed to NBC by AT&T for Jan. 1 Tournament of Roses . . . Pasadena will be linked to Washington, Wilmington and Baltimore as well as 10 other big cities . . .

• • •

DuMont has just delivered color slide scanner to CBS but is mum about adapting its continuous film device to color . . .

RCA held color-tv seminar in Camden for engineers and consultants of their transmitter customers . . .

GE plans limited production of planar shadow-mask tube in first quarter of '54 . . .

• • •

Thomas Electronics in Passaic, N. J. announced signing with Chromatic to make Lawrence tube . . . radiation from this type is now claimed well below FCC specs.

• • •

Network engineers point to 920-kc beat in picture caused in intercarrier monochome receivers by strong 3.58-mc color subcarrier versus 4.5-mc sound . . . sets with sound traps ahead of video detector are apparently not affected.

Radio-TV Makers Eye Last Quarter

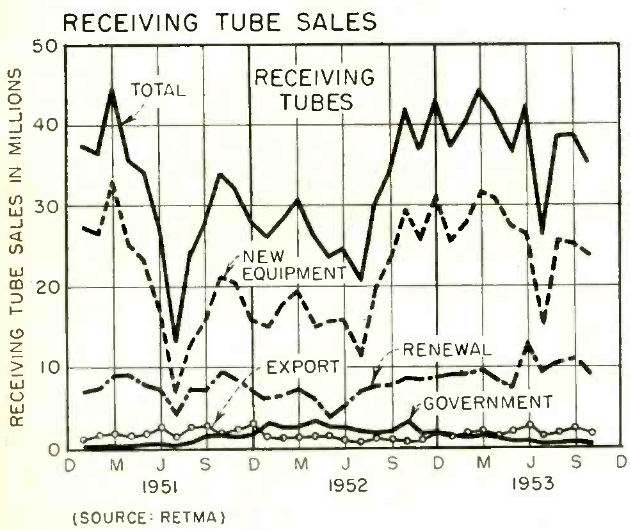
Proportion of total sales volume in last 3 months of 1953 may be lower than in 1952

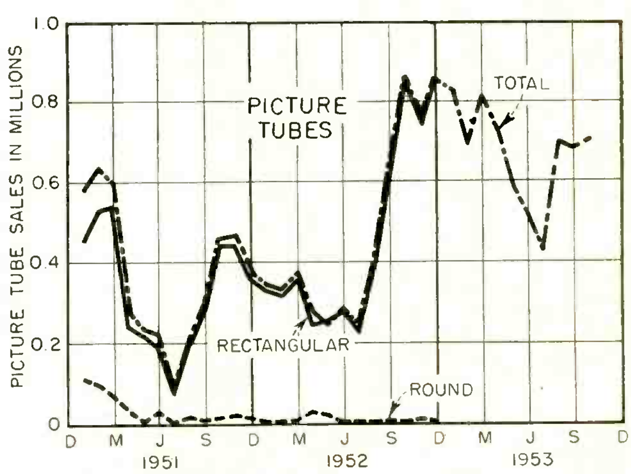
RADIO and tv sales for 1953's last months will have to really zoom to equal 1952's fourth quarter record. In that year, the last three months accounted for over 43 percent of the total year's sales.

In 1951 and 1950 the proportion was about 35 percent. Radio sales also hit their peak in these months,

(Continued on page 8)

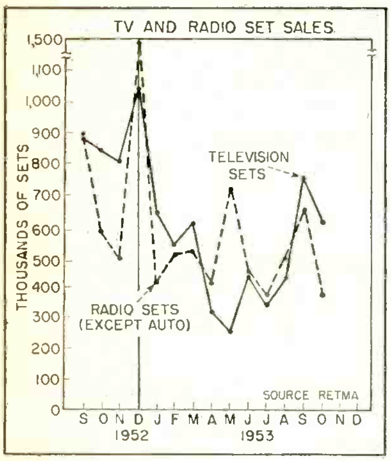
ELECTRONIGRAPHS Continued





More charts following

Want more information? Use post card on last page.



as shown in the chart, although summer percentages are higher than for tv.

▶ **Goals**—Radio and tv final sales figures for November and December will have to be even higher than 1952's record to keep the total fourth quarter sales equal to its total in 1952. October's record shows that tv retail sales were 225,000 units below those of 1952 and radio sets sold dropped by nearly 195,000. To maintain 1952's last quarter sales percentage, November and December figures will have to account for sales of over 2.6 million sets. To equal 1952's sales in units alone will take over 2 million sets. Radio also has a hard row to hoe to keep up with 1952 sales. Over 2.1 million radios were sold in 1952's last two months.

▶ **Outlook**—Despite the seemingly unbelievable rate at which tv and radio sets must move in the final months of 1953 and various let-up signs that appeared, some set manufacturers find that sales in the last two months are passing 1952's fast pace. Emerson reports its distributor sales to dealers during the week ending December 4, 1953 were the highest in the past three years, topping the previous high week in the period by 11 percent. GE also reports that radio and tv set sales to dealers from Nov. 9 through Nov. 24 exceed by 25 percent those of any other two-week period in its history.

Citizens Radio Gets Transceiver

FCC type-approved unit produces 0.5 watt at 465 mc from batteries or a-c power pack

RADIO COMMUNICATION for the average citizen became a reality last month when Stewart Warner announced the "Portafone." The transceiver is similar in size and shape to a telephone handset and operates within the Citizens Band, where no operators' licenses are required.

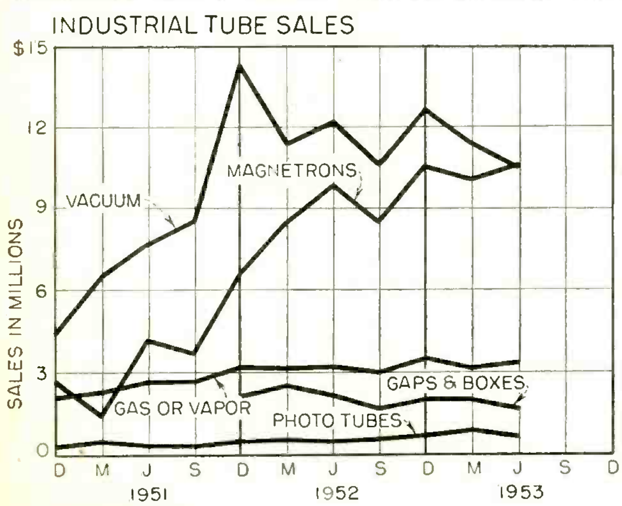
Since the new transceiver is FCC type approved (for class-B service), obtaining the required station license becomes a mere formality. Frequency tolerance is better than 0.5 percent at 465 mc for temperatures from zero to 25 deg F and a wide range of battery voltages and humidity values.

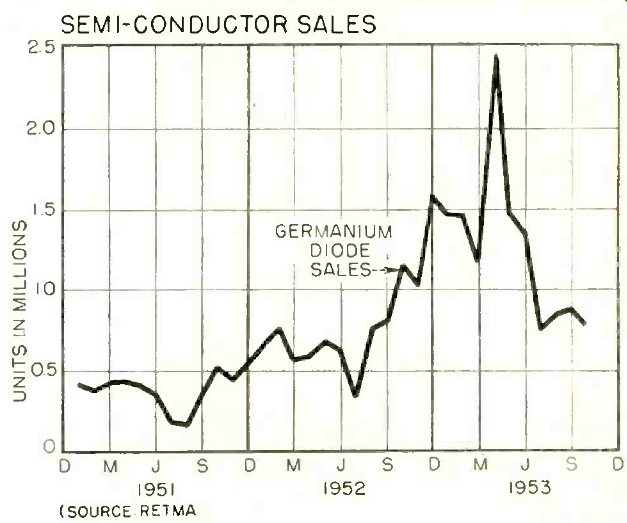
Receiver portion of the set is a two-tube superregenerative circuit having a sensitivity of 12 microvolts and an output of about 15 milliwatts to the earpiece. Power for the handset can be obtained from port-

Power pack setup for fixed operation

(Continued on page 10)

ELECTRONIGRAPHS Continued



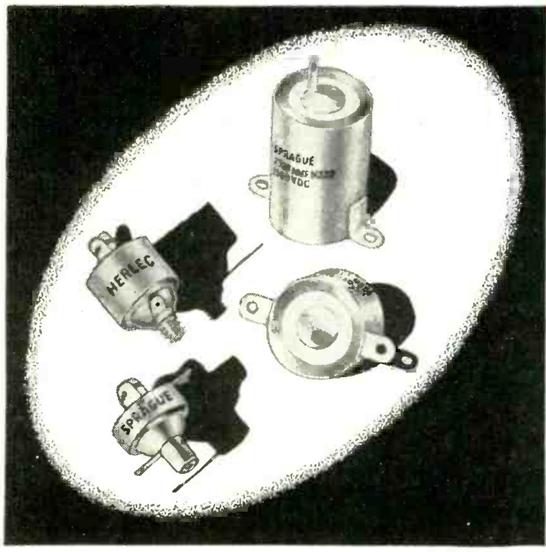


More charts following

HERMETICALLY SEALED METAL-ENCASED

PRECISION CERAMIC CAPACITORS

with HIGH STABILITY for critical circuits



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

IF YOUR problem is one of circuit stability in precision oscillators or of close capacitance tolerances in electronic instrumentation, have you investigated the advantages of Sprague-Herlec Precision Ceramic Capacitors?

These unique capacitors offer not only top capacitance and temperature stability but stability with applied voltage, uniform retrace characteristics, and high "Q". They are available in capacitance tolerances as close as ±1% and temperature coefficient tolerances as close as ±10 ppm/°C in regular production quantities.

Mechanically, they are small in size, sealed against atmospheric humidity, and resistant to vibration and shock. Standard operating temperature range is from −55°C to +85°C.

Sprague-Herlec Precision Ceramics are available in all standard temperature coefficients from P100 to N750, and can also be manufactured to any exact intermediate coefficient required for balancing other circuit constants. When used in combination with Sprague Durameg® Accurate Wire-Wound Resistors, it is possible to achieve stability heretofore impracticable in mass-produced electronic equipment. Sprague can furnish you either these R-C network components or complete network subassemblies to meet your tolerance requirements.

For complete details on Sprague-Herlec Precision Ceramic Capacitors, write for Engineering Bulletins 603-B and 607-A to Sprague Electric Co., 35 Marshall Street, North Adams, Mass. or Herlec* Corporation, Grafton, Wisconsin.

*THE HERLEC CORP. IS A WHOLLY-OWNED SUBSIDIARY OF THE SPRAGUE ELECTRIC CO.

SPRAGUE WORLD'S LARGEST CAPACITOR MANUFACTURER

EXPORT FOR THE AMERICAS: SPRAGUE ELECTRIC INTERNATIONAL LTD., NORTH ADAMS, MASS. CABLE: SPREXINT able battery packs, vibrator packs or a-c supplies. Cost for a pair of units complete with batteries is a little over two hundred dollars.

Electronics Industry Looks At TV For '54

ESTIMATES of the volume of tv sets, both monochrome and color, that would be produced and sold by the set industry in 1954 were made by RETMA members representing three segments of the industry.

The radio-tv industry committee of the association made estimates of black and white set production that averaged 4,860,000. Black and white sales estimates ranged from 3.5 million to 6,360,000 for an average of 4.9 million sets. Color set production estimates averaged 192,600 with a range of 50,000 to 650,000. Radio set production was expected to reach 10,390,000.

RETMA's sales managers committee saw 5 million black-and-white tv set sales being made in 1954 and color output of 120.000

The tube division of RETMA was the most optimistic of the three groups in its estimates for 1954. Black-and-white set production estimates averaged 5.1 million with a range of from 4 million to 10 million sets. Color set estimates ranged from 30,000 to 400,000 for an average of 171,000.

Electroplated Transistors Announced

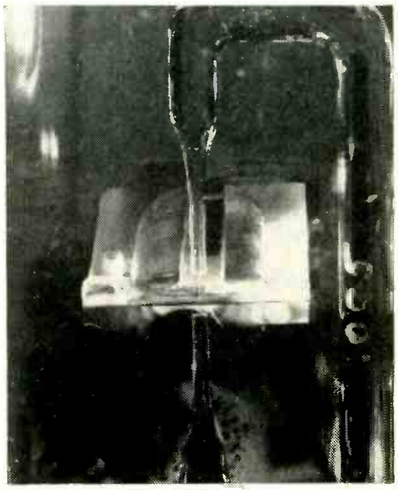
New manufacturing process yields high-frequency units with reproducible characteristics

STILL another method for manufacturing transistors is that of an electroplating process developed by Philco engineers. The technique is capable of producing transistors with consistent characteristics superior to those obtained in units made by other methods.

▶ **Polarized Jets**—The Philco transistors are formed electrochemically. Two tiny jets of indium sulphate are directed onto opposite sides of a thin strip of germanium. The streams are connected to one terminal of a d-c electroplating source and the germanium to the other.

Initially the polarity of the source is fixed so germanium is forced into solution and washed away, leaving depressions on opposite sides of the germanium strip. When enough germanium is eaten away to leave a thickness of 200 millionths of an inch, the polarity of the voltage source is reversed. This causes metallic indium to be plated onto the germanium.

The indium deposits formed become emitter and collector of a junction transistor by virtue of an effect which causes the germanium near the surface of the deposited indium to take on an impurity character opposite to that of the germanium base. Thus the name, surface barrier transistor.

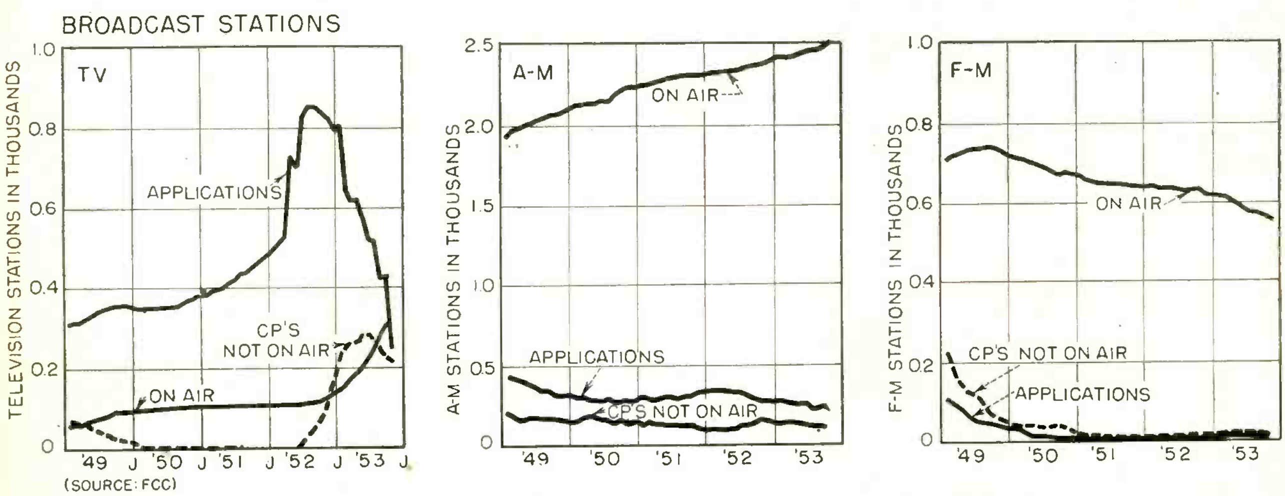


Closeup of surface barrier transistor process shows thin stream of solution

▶ **High Frequencies**—The extreme close spacing obtainable results in extension of useful frequency range from 10 to 100 times that obtainable with junction transistors made by processes currently in use. The technique used to determine the exact moment when the desired base thickness is reached is accurate to 0.00001 inch. According to Philco engineers, the process is

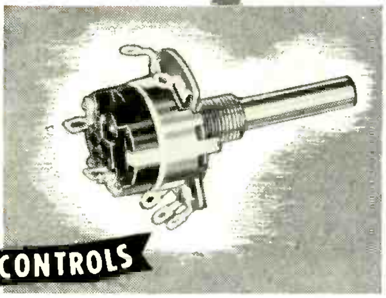
(Continued on page 14)

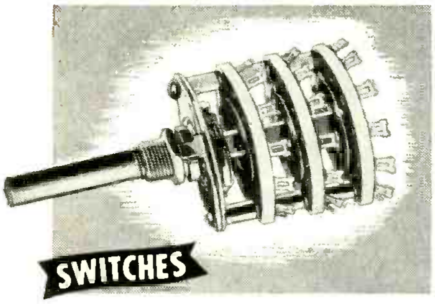
ELECTRONIGRAPHS Continued

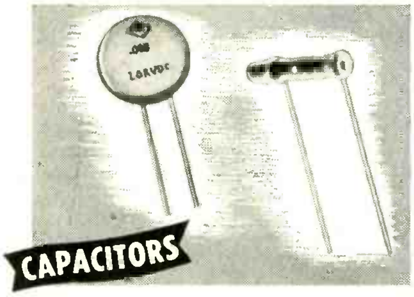


More charts following

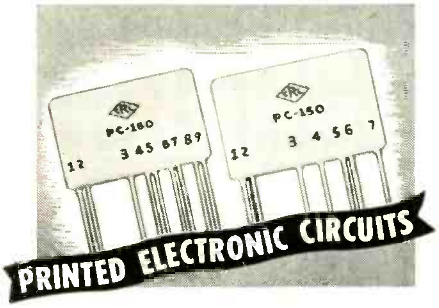
To gain the most in *performance*

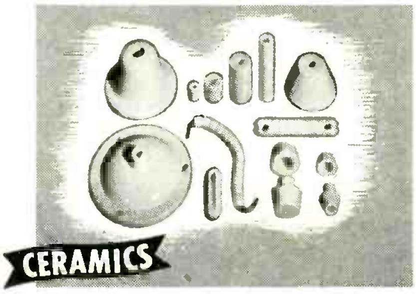






...you're invited to concentrate your 5 major electronic component problems with the industry's most experienced and No. 1 electronic component source

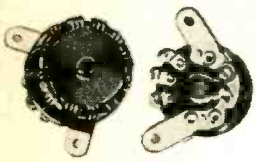


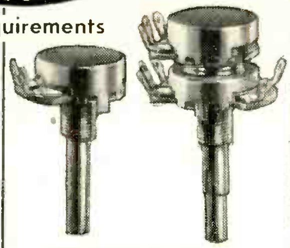


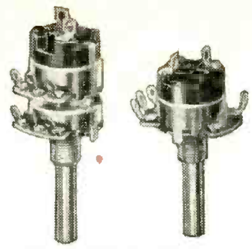
see next 2 pages for details

Want more information? Use post card on last page.

1 VARIABLE RESISTORS
– to meet your requirements

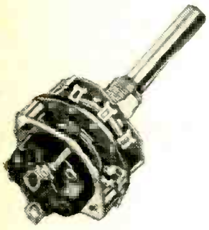

Model 1 Radiohm®
Miniature

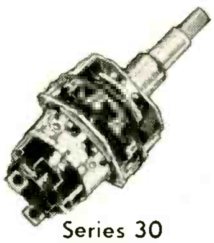

Model 2 Radiohm

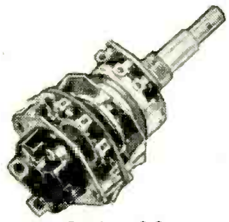

Model 2 Radiohm
(including JAN types)

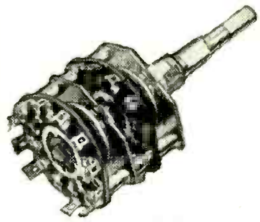

Wirewound Radiohm
Three watts

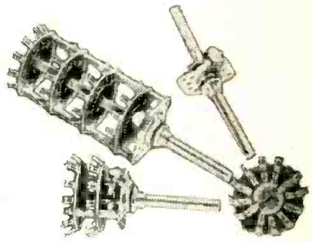

Model 2 EXPRESS (†)
for immediate
production needs

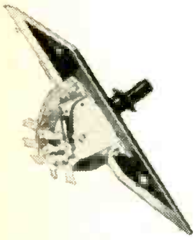

Series 20 Miniature
with a. c. line switch

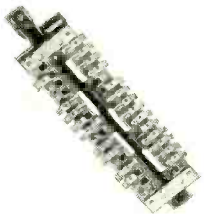

Series 30
Dual Concentric
Switch and Control


Series 30
Dual Concentric
Control and Switch


Series 30
Dual Concentric
Dual Switch

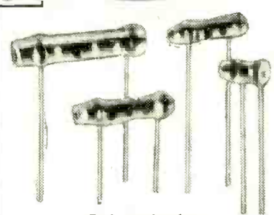

Standard Phenolic

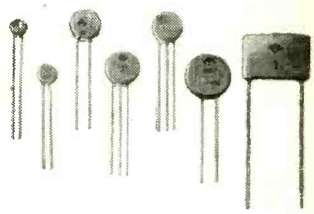

Lever Switch

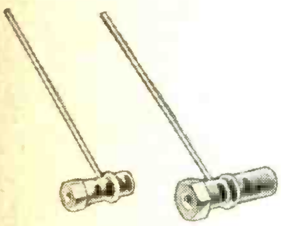

Slide Switch

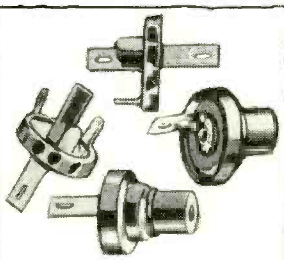

Industrial Switch Kit

3 CAPACITORS

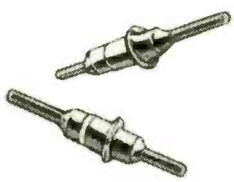

BC Tubular

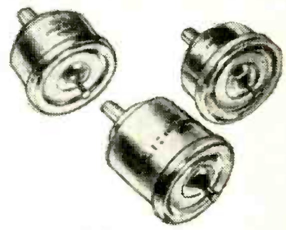

BC Discs

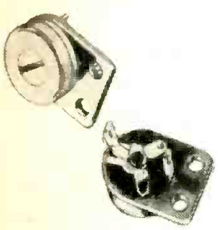

Stand-off


Button-Style


Feed-Thru HI-KAPS®

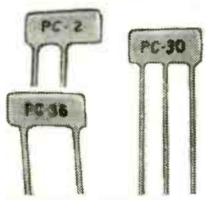

Miniature
Feed-Thru HI-KAPS®


High Accuracy
Capacitors

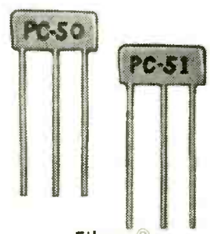

Ceramic Trimmers

4 PRINTED ELECTRONIC CIRCUITS

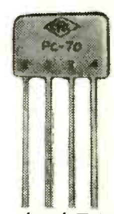
Ceramic Min-Kaps®



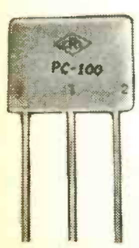
Miniature Resistor and
Resistor-Capacitor Units



Filpec®
(balanced load
diode filter)

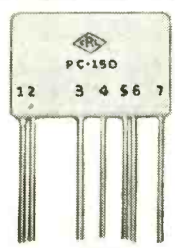


Standard Triode
Couplate®

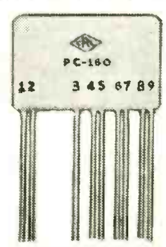


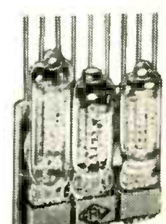
Vertical Integrator

Special Plates
to suit manufacturer's
requirements



Audet®
Audio-detector plate


Pendet (†)
(Pentode detector
coupler)


Model II Ampec®
Standard 3-stage
amplifier

readily adaptable to production, but no statement was made as to when units would be available on a large scale for commercial application by electronic manufacturers.

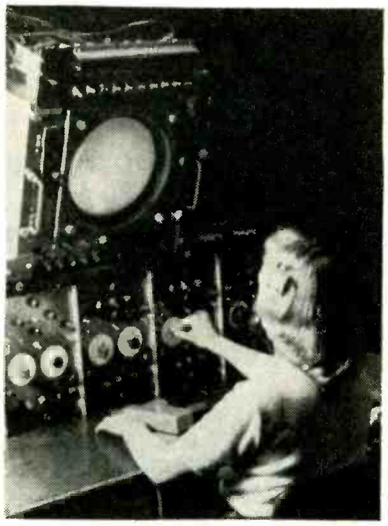
The preliminary planning and experimental work which led to the development of the process was sponsored partly by the Navy Bureau of Ships.

Volscan System Shown by Air Force

Computers channel airplanes into nonconflicting landing sequence

INSTRUMENT LANDINGS in low-visibility weather are commonplace today. However, many serious, and sometimes disastrous, delays occur because of the lack of means for channeling large numbers of aircraft into position for blind landing approaches.

The Air Force Cambridge Research Center has unveiled a new system, called VOLSCAN, which fills in the missing link between radio navigation aids and blind landing systems.



Nerve center of volscan is ppi radar

▶ **How it Works**—A pilot approaching his destination radios from about 40 miles out, telling the volscan operator of his intentions to land. She picks him up on a radar ppi scope and sets automatic tracking equipment in motion. The automatic tracking equipment also feeds information into computers that predict the exact moment when that aircraft would reach the threshold of the instrument landing system if he took the most direct route.

The computer consults its memory system to see if that time is reserved for a plane having called in previously. If not, the pilot is given a direct course to fly and continues his approach and landing.

If, however, another plane is scheduled to land at the time indicated by the computer, a slight course change is sent to the pilot which causes his arrival to be delayed until an unoccupied time interval presents itself—30 seconds later if no other plane has that interval reserved.

▶ **Cost**—Using volscan, up to 120 arrivals and departures can be handled each hour. The equipment is complex and somewhat expensive, but the Air Force points out a single B-36 saved by volscan would pay for installations at 40 air bases. A recent crash of six jets in Japan, which might have been prevented by volscan, cost the government approximately $5,400,000, enough to equip every major U. S. base with volscan.

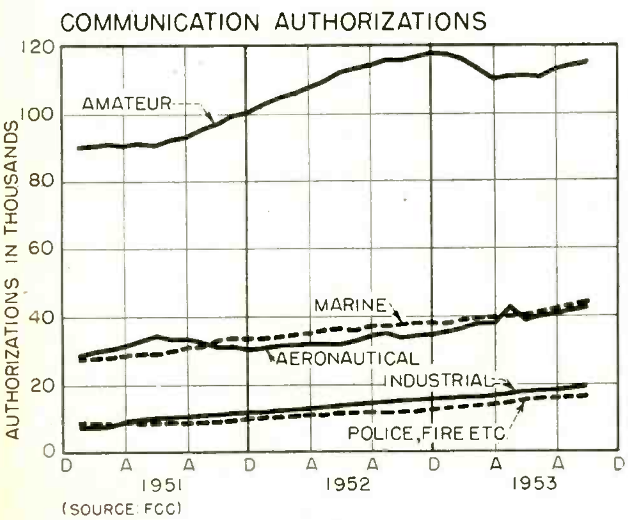
TV Makers and Stations Get Set For Color

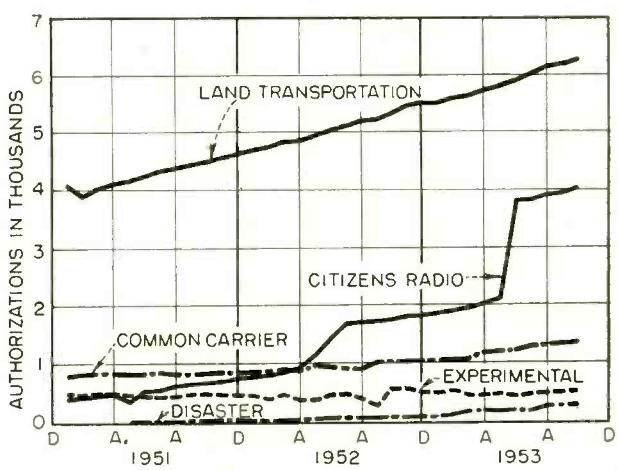
Industry varies in stages of equipment readiness with broadcasters slightly behind

RECEIVER manufacturers and tv broadcasters have moved ahead at varying speeds in getting ready for the advent of color television. All major tv set manufacturers have color tv production equipment on hand in some degree and some are

(Continued on page 16)

ELECTRONIGRAPHS Continued





More charts following

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

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

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

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

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

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

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

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

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

THE BARRY CORP.

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SALES REPRESENTATIVES IN

Atlanta Baltimore Chicago Cleveland Dallas Dayton Detroit Los Angeles Minneapolis New York Philadelphia Phoenix Rochester St. Louis San Francisco Seattle Toronto Washington using their first few costly samples for demonstration promotions. Raytheon has just announced plans to have four color sets in operation for the colorcast of the Tournament of Roses parade in Pasadena, Calif.

▶ **Broadcasters**—As a whole, the broadcasting fraternity is lagging behind receiver manufacturers in jumping on the color band wagon. Status of color in tv broadcasting is indicated by the fact that only two of the major tv networks have regular color studios completely equipped. NBC has three studios ready for colorcasting and CBS has two. DuMont has its experimental set up for use and ABC has not as yet announced its color studio plans.

Despite the lag in color studio readiness, a number of individual stations are set for broadcasting network tv programs in color. It is expected that 20 stations will carry the Tournament of Roses parade in color on New Year's day. AT&T is reported to be set to deliver the parade colorcast to 13 cities and stations.

▶ **Future**—Number of color equipped tv stations is expected to increase much faster in the next few months. It is estimated that about 100 tv stations will be equipped by the end of April for network color programs.

How Electronics Plants Grew In 1953

Tube plants, parts facilities, receiver and instrument expansions led the parade

OVER $150 million was spent for new plants and equipment during 1953, it is estimated. How this money was spent is seen in an analysis of plant expansions announced by major manufacturers in the field.

▶ **Tubes**—Plant and facility expansions by tube manufacturers led all other segments of the industry in growth in 1953. Eleven tube manufacturers announced major expansions during the year which added over two-million sq ft of space for manufacturing. Most expansions were for picture tube production although receiving and industrial tube expansion was also important. Companies with top tube expansions included GE, Raytheon, Sylvania and Westinghouse. Glass tube envelope manufacturers also made substantial plant expansions during the year.

▶ **Parts**—One noticeable expansion move was that of capacitor manufacturers who announced plant extensions in North Carolina. Four major manufacturers, Cornell Dubilier, IRC, Pyramid and Sprague all expanded plants there in 1953.

▶ **Sets & Labs**—Ten major tv set manufacturers expanded facilities during 1953 with expenditures totaling over $10 million. Largest single plant expansion was made by Sylvania with a 416,000 sq ft plant in New York. Zenith and Motorola both set $3 million expansions for the year.

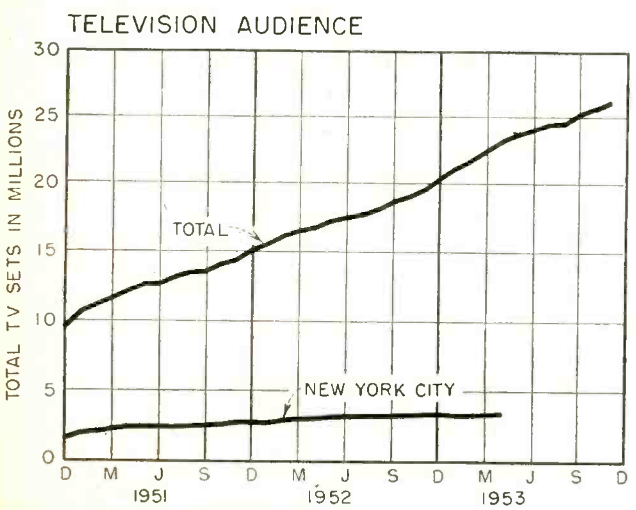
Ten instrument manufacturers also made major expansions during 1953, mostly in California. Floor space added by major firms in the field totaled over 500,000 sq ft.

More than ten companies expanded laboratory research facilities during the year. Some of the companies were not primarily in the electronics field but expansions were made specifically for electronics research. Several new firms were formed during the year for electronics research only. Some non-profit and independent research companies were among the leaders in growth.

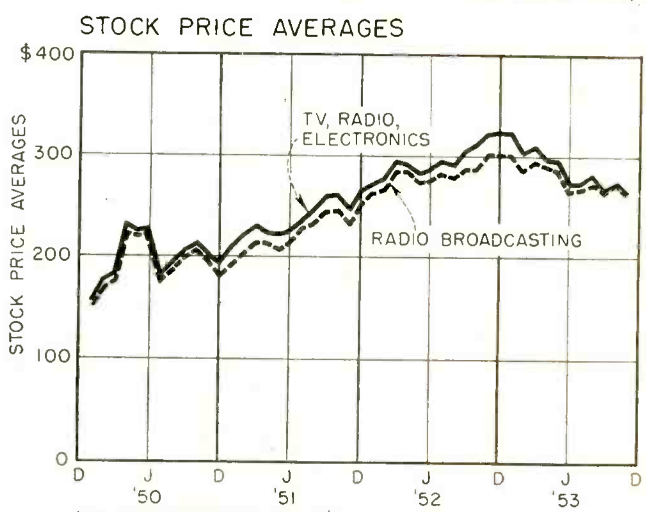
▶ **From Other Fields**—A number of companies not previously associated with the electronics industry

(Continued on page 18)

ELECTRONIGRAPHS Continued

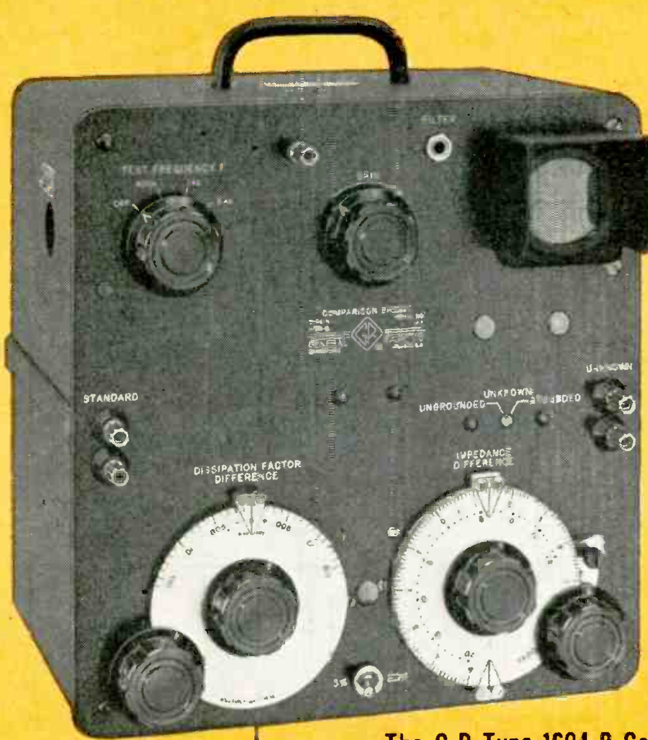


(SOURCE: NBC RESEARCH DEPT.)



(SOURCE: STANDARD AND POOR'S)

More charts following



SPEED Production Testing

of Resistors — Inductors Capacitors — Impedances

The G-R Type 1604-B Comparison Bridge

is a direct-reading instrument which makes possible the rapid measurement of impedance and dissipation factor of R-L-C components, rheostats, capacitance trimmers and other impedances. Basic measurement accuracy is *one-tenth of one percent* . . . more than required for most measurements.

This Versatile Instrument is Useful for Many Other Types of Work

Checking tracking of condensers and potentiometers to very close tolerances — locating the position at which windings are to be center-tapped — measuring small capacitors in the 1 $\mu\mu$f range — adjusting one component to the value of another, rapidly and reliably

In any laboratory or shop, the Comparison Bridge will prove invaluable for checking, selecting and pairing components within given tolerances – the approach to balance is continuously and instantly indicated.

FEATURES

★ Instrument is completely self-contained and ready for operation — includes internal oscillator, bridge circuit and high-gain non-linear amplifier terminated in a cathode-ray-tube detector.

★ Three Measuring Frequencies — 400 c, 1 kc or 5 kc, selected by panel switch.

★ Two IMPEDANCE DIFFERENCE Dial Ranges — 0 to ±5% range for accurate measurements; 0 to ±20% for determining whether components are within the common 20% tolerances.

★ Accuracy and Range of Impedance Measurements

The range over which the basic ±.01% accuracy applies for resistors, inductors and capacitors is given below. At the more extreme values of impedance, measurements are less accurate.

Frequency	Resistance	Inductance	Capacitance
400 c	2Ω to 20 MΩ	2 mh to 1500 h	100 μf to 50 $\mu\mu$f
1 kc	2Ω to 20 MΩ	1 mh to 250 h	30 μf to 50 $\mu\mu$f
5 kc	4Ω to 2 MΩ	200 μh to 10 h	2 μf to 50 $\mu\mu$f

On the 20% deviation range, accuracy is ±0.5% over the same impedance range.

★ DISSIPATION FACTOR RANGE and Accuracy

Frequency	Range	Accuracy
400 c	±.006	±(0.0002 + 2% impedance diff.)
1 kc	±.015	±(0.0005 + 2% impedance diff.)
5 kc	±.075	±(0.0025 + 2% impedance diff.)

★ CRO visual Detector — horizontal band of light is used as the indicator — highly non-linear detector amplifier keeps indication on scope over wide ranges of unbalance — continual resetting of gain control is eliminated.

★ Zero Adjustment — adjustable index mark on scope can be offset and locked to compensate for deviation of the standard from the desired nominal value — permits use of any component as a standard of comparison.

★ Anyone can be taught to operate the instrument in a very short time.

★ Measurements can be made with unknown grounded or ungrounded, as desired.

★ Dimensions—12" x 14¼" x 10"; Net Weight is 22½ lbs.

1604-B Comparison Bridge $390.00

HIGH-SPEED SORTING with the COMPARISON BRIDGE

Both dials are set to zero, and the cathode-ray-tube adjustable indicator is offset to the desired tolerance to give a visual "go, no-go" indication. As rapidly as each component is plugged into the unknown terminals . . . a few seconds at most . . . the detector indicates whether the unit is acceptable.

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.

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Admittance Meters ☆ Coaxial Elements ☆ Decade Capacitors ☆ Decade Inductors ☆ Decade Resistors ☆ Distortion Meters ☆ Frequency Meters ☆ Frequency Standards ☆ Impedance Bridges ☆ Modulation Meters ☆ Oscillators Variacs ☆ Light Meters ☆ Megohmmeters ☆ Motor Controls Noise Meters ☆ Null Detectors ☆ Precision Capacitors Pulse Generators ☆ Signal Generators ☆ Vibration Meters ☆ Stroboscopes ☆ Wave Filters U-H-F Measuring Equipment ☆ V-T Voltmeters ☆ Wave Analyzers ☆ Polariscopes entered the field during 1953. More than 15 companies in fields as widely diversified as safety matches and textiles acquired interests in electronics. Reason given by most outside firms is that they feel electronics is a growth industry and they want to share in it to stabilize the cycles of their main business.

Eight Stations Acquire TV Network Service

WITH the addition of eight stations during the past month, network television service is now available to 233 stations in 145 cities.

The recently connected stations include: WCIA-TV, Champaign, Ill.; KGTV, Des Moines, Ia.; WIBW-TV, Topeka, Kan.; WNOW-TV, York, Pa.; WKJG, Ft. Wayne, Ind.; KFOR-TV, Lincoln, Neb.; WWOR-TV, Worchester, Mass.; and WTOV-TV, Norfolk, Va.

▶ **Radio Relay**—Network television facilities were also augmented this past month when an eleven-station microwave system covering the 298 miles between Atlanta, Ga. and Jacksonville, Fla. was placed in operation.

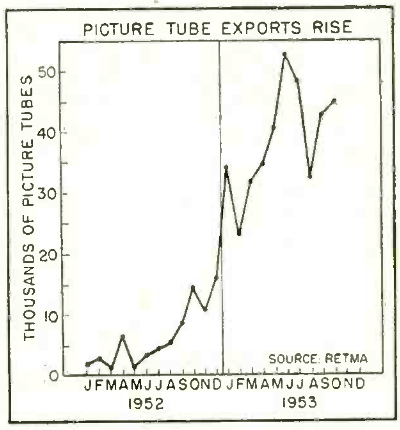
The telephone company also announced plans to add two television channels, one westbound and one eastbound, on their Albany to Buffalo, N. Y. radio relay system.

Cathode-Ray Tube Exports Boom

Volume to foreign markets five times '52 exports and is seen going higher in 1954

GROWTH of the electronics industry abroad, particularly television, is mirrored in the greatly increased cathode-ray tube export sales made by U. S. tube manufacturers. For the first ten months of 1953, volume of all types of c-r tubes sold abroad totaled 382,025 units valued at $8.1 million compared to 83,372 units valued at $1.6 million sold for export in all of 1952.

▶ **Size**—Over 46.9 percent of all picture tube export shipments in the first ten months of 1953 were in the 16 through 18-inch sizes. This size group led in sales until October, 1953 when the 19 to 21-inch group took the lead and accounted for 48.9 percent of total unit sales and more than 57 percent of total export dollar value in the first ten months of 1953. In 1952, the percentage for the 16 and 17-inch sizes was approximately 54 percent while 18-inch and larger size tubes accounted for about 30 percent. Thus, the trend to larger size screens is moving upward fast in export markets as it has in the U. S. since tv's introduction.

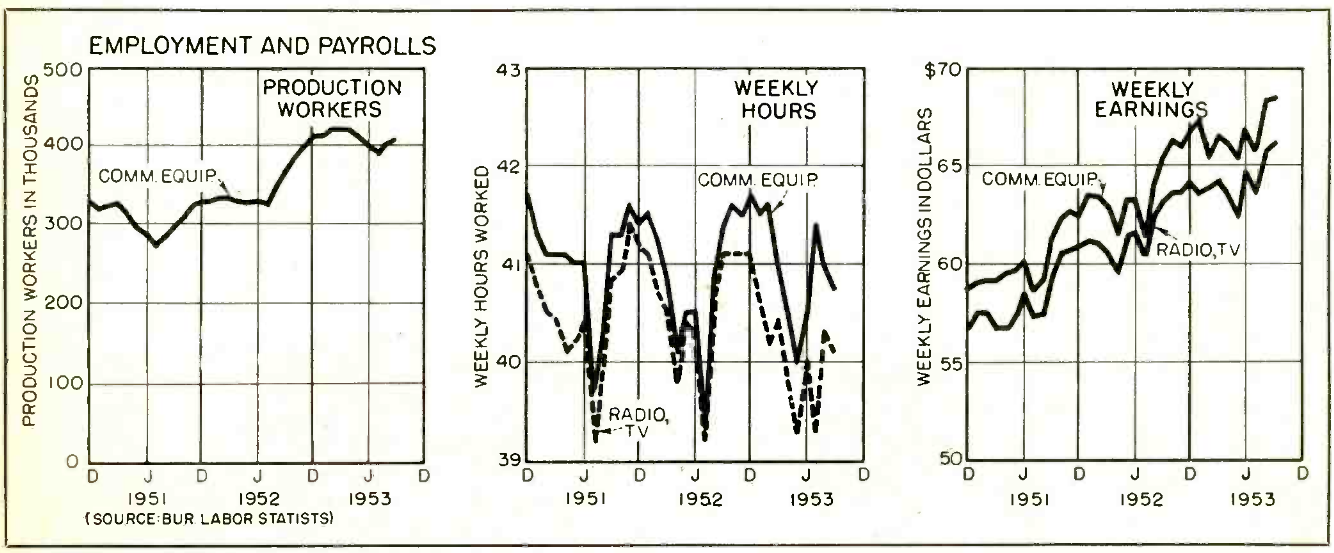


▶ **Future**—Picture-tube manufacturers here expect the export market to keep growing with the development of foreign television. But they also expect greater foreign competition. According to E. A. Marx of DuMont, who recently returned from Europe, there are three large c-r tube manufacturers in France and the number may increase considerably in the near future.

Some c-r tubes are being made in Italy but most glass blanks are being imported from the U. S. or Holland. In Germany, one of the largest radio manufacturers in Europe has concluded contracts with U. S. c-r tube manufacturers so that further activity can also be expected from that country.

(Continued on page 20)

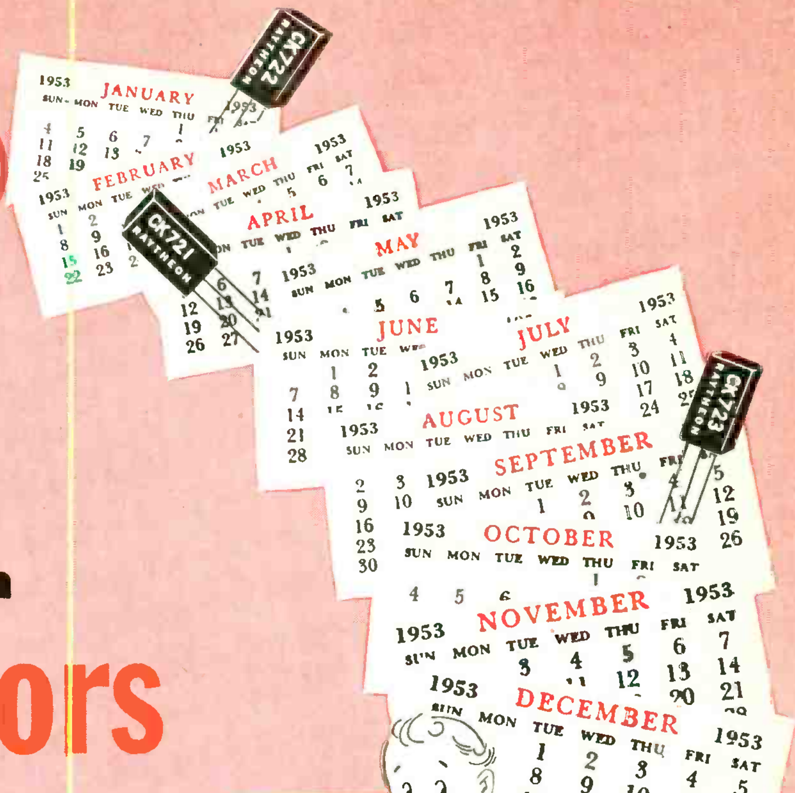
ELECTRONIGRAPHS



RAYTHEON

presents the

FIRST ANNUAL REPORT on transistors



Hundreds of thousands of RAYTHEON *Junction Transistors are now in actual commercial use . . . several times more than all other makes combined! Furthermore, one year's field experience has demonstrated that the moisture resistance of Raytheon's specially developed glass-plastic package is completely satisfactory!*

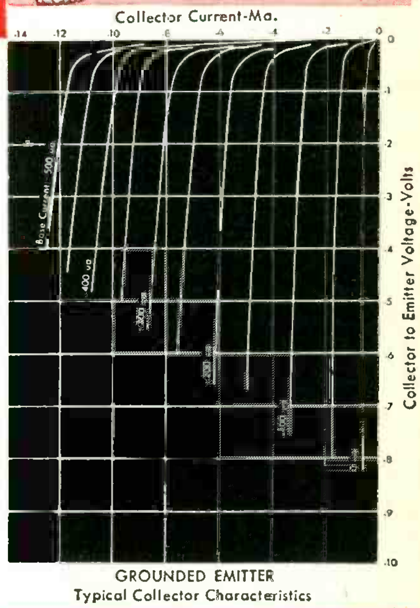
For critical applications, the new CK727 Raytheon junction transistor offers the low average noise factor of only 15 db. plus all the desirable performance characteristics of the popular and highly successful CK721.

For complete characteristics on CK727, get in touch with our nearest office.

AVERAGE CHARACTERISTICS AT 30°C

	CK721	CK722	CK723	CK727
Collector Voltage (volts)	–6	–6	–6	–1.5
Collector Current (ma.)	–2	–2	–2	–0.5
Alpha	.975	.90	.90	.975
Cut-off Current (approx.) (μa)	10	25	10	5
Noise Factor (Max.) (db.)*	30	—	30	18
Collector Resistance (meg.)	0.7	0.5	0.5	1.0
Base Resistance (ohms)	350	150	150	800

*Common emitter circuit with R_{in}=1000 ohms; R_{out}=20000 ohms.



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Want more information? Use post card on last page

Hearing Aid Companies Set For Big Year

Transitorized aids gain in sales and may represent the bulk of output in 1954

JANUARY, 1954 marks the first anniversary of the commercial debut of transistors in the hearing aid industry.

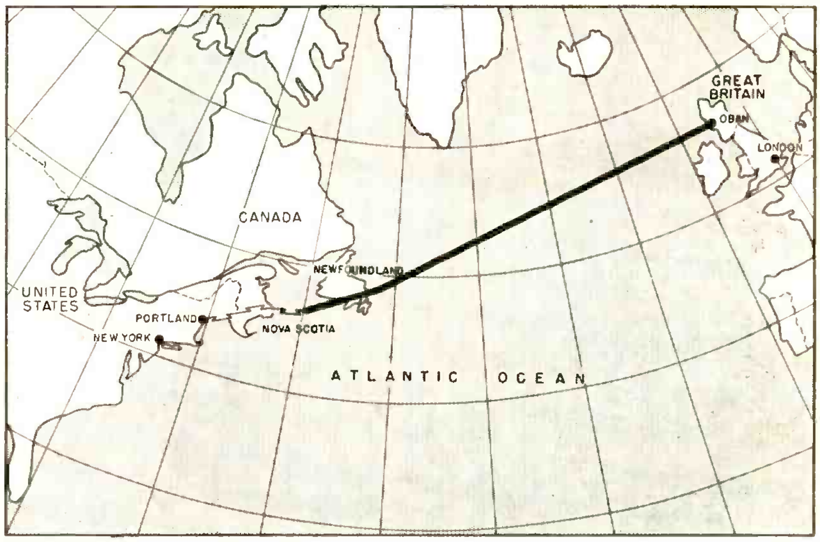
▶ **Sales**—According to the American Hearing Aid Association, between 130,000 and 150,000 hearing aids were produced in 1953 and about 50 percent of them were transistorized. In 1954, manufacturers expect an even larger percentage of production to be of the transistor type. However, tube aids are not expected to drop completely out of the picture, because certain types of deafness, according to the manufacturers, are better handled by the tube-type aid.

▶ **Companies**—About 35 manufacturers are in the field and it is estimated that 15 of them are producing transistor-type hearing aids. Six companies are estimated to do 85 percent of the total business. They are Acousticon, Audovox, Bell, Maico, Radio Ear and Sonotone.

These companies sell to about 1,500 full-time hearing aid dealers and there are another 1,500 dealers who sell aids on a part-time basis or along with other products.

▶ **Future**—The hearing aid industry expects sales of all aids to increase 15 to 20 percent in 1954. With transistor aids selling retail about 45 percent higher than tube types, dollar volume in sales is expected to be much more substantial.

Manufacturers are quick to point out that the increase in sales dollar volume is not directly transferred into larger profits. They estimate that the cost of manufacture for transistorized aids is about 85 percent higher than that of the tube types. Some allied components, they say, are as much as seven times more expensive.



VACUUM TUBES will be put to work at three-mile depths, when . . .

Telephone Cable Spans Atlantic

Work starts immediately on $35 million coaxial cable linking New York and London

RESULTS of a 25-year development project will assist AT & T and British Post Office engineers in fabricating and laying a 2,000-mile coaxial telephone cable across the North Atlantic. The project. which will cost $35-million and take three years to complete, is a joint undertaking of AT & T, the British Post Office and the Canadian Overseas Telecommunication Corp.

The cable will handle 36 simultaneous conversations and triple existing radiotelephone circuit capacity. Although adequate for radio program use, the cable's bandwidth will be too narrow for television.

▶ **Route**—The complete route from New York to London will include: land line to Portland, Me.; microwave radio relay to Nova Scotia; underwater cable to Newfoundland; deep-sea cable to Oban, Scotland and thence to London by British land-line circuits.

▶ **Design**—Core of the cable will be a ⅝-in. flexible copper tube surrounded with polyethylene dielectric and a flexible copper outer conductor. Additional protection will be afforded by a wrapping of copper foil and a heavy outer coating of jute and armoring wire. Overall outside diameter will be 1¼ in.

▶ **Repeaters**—The deep-sea cable will have over 100 vacuum-tube repeater amplifiers. Each repeater will contain three tubes and will be housed in a flexible copper tube 7 ft long and 1½ in. in diameter. Power for the amplifiers will be carried over coaxial conructors.

Kaiser-Sanders Relationship Clarified

CLARIFICATION of the business relationship between Sanders Associates of Nashua, N. H. and Kaiser Manufacturing Corp. came last month when Sanders stated that it "is not and never has been either financially or corporate wise affiliated with any organization, company, or corporation. The company is an independent entity and has no control whatever from outside interests."

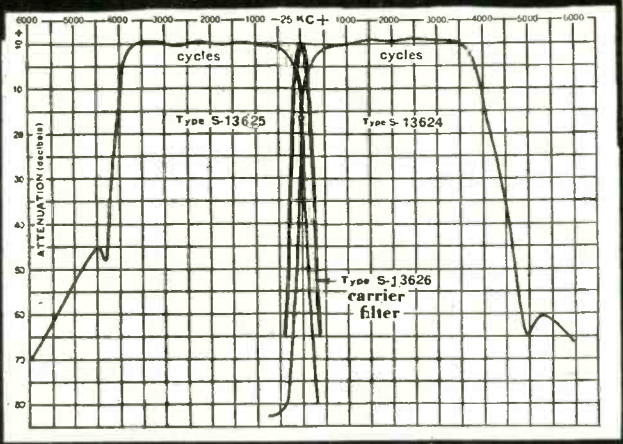
Confusion arose when Kaiser designated the division it formed in Nashua, N. H. in 1952 as the Kaiser-Sanders Electronics Division of Kaiser Manufacturing

(Continued on page 22)

RIGHT ON TOP

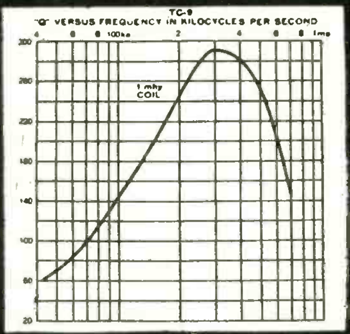
Burnell records a few of it's most recent engineering achievements in Toroids and Filter Networks.

SIDE BAND FILTERS



Our most recent engineering achievement in communications filters has already stirred the interest of the leading receiver manufacturers in the country.

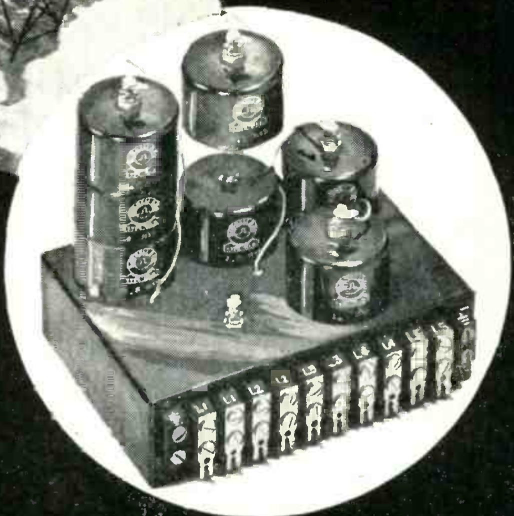
Our new side band filters which eliminate, for most applications, the necessity for expensive crystal filters are expected to accelerate the advancement of single side band communications.



SUB MINIATURE TOROIDS

Toroids for intermediate frequencies of 100KC to 1 megacycle. A wide variety of coils ranging in size from 1/2 inch provides high Q in the frequency range between audio and RF.

The tiny toroid about the size of a dime has been welcomed by designers of sub miniature electronic equipment for the transistor, guided missile and printed circuit field.



PLUG IN DECADES

An entirely new development in inductance decades eliminating disadvantages of switch boxes. Inductance units plugged together in various combinations providing decade steps of inductance with minimum number of units required.

MINIATURE TELEMETERING FILTERS

In recognizing the need for miniaturization of the presently bulky telemetering equipment, our engineering staff has succeeded in reducing the size of telemetering filters to as little as 25 to 50% of the original volume.

BURNELL & COMPANY is very pleased to announce that it now has available a 12 page catalog which includes valuable and complete information on toroids, high quality coils and various audio filter networks.

The catalog includes complete descriptions, attenuation and Q curves that will prove valuable for equipment design engineers.

Write for Catalog 101-A.

Burnell & Company
YONKERS 2, NEW YORK
CABLE ADDRESS "BURNELL"

Exclusive Manufacturers of Communications Network Components

Corp. According to Sanders, this was done because of the proximity of operations, and intent to utilize the electronic research engineering services of Sanders Associates. Sanders accepted subcontracts for electronic research from the Kaiser organization and this has been the only relationship between the two organizations.

According to Sanders, with the merger of the Willys and Kaiser organizations, the name Kaiser-Sanders Division was replaced by Kaiser Electronics Division, Willys Motors, Inc.

Broadcasters Hit Record Billings

Sales set record highs with tv up and radio down slightly; FCC sets new limitations

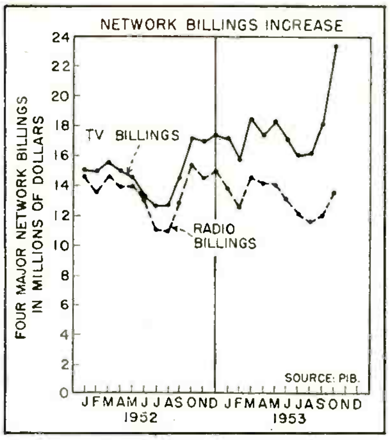
GROSS time charges for the four major tv and radio networks during the first ten months of 1953 reached a total of $311.4 million for the highest combined billings on record for any previous year.

In 1952 the total for the whole year for radio and tv nets was $302.6 million. Network tv billings were largely responsible for the rise with a billing total of $178.9 million as against $146.2 million in 1952. Network radio lagged slightly with charges $1.5 million under last year's ten months total of $134 million.

October tv billings were largely responsible for the new record. They reached $23.4 million for the best single month volume by about $5 million that network tv ever experienced.

▶ **Nets**—According to Publisher's Information Bureau figures, which are guides to trends in network sales, all four of the major tv networks had higher sales in the first ten months of 1953. CBS led in the period in tv gross billings with $77.3 million. NBC followed with $76.9 million in tv for the period. But it led in October sales by almost $1 million to set a new record in monthly billings. ABC and DuMont followed in 10 months tv billings with $16.0 million and $8.5 million respectively.

In radio, through October, individual network sales showed diverging trends. ABC and NBC showed increased billings over the first ten months of 1952 while CBS and MBS dropped slightly. Gross time charges for the four radio networks during the period were: ABC, $24.1 million; CBS, $51.4 million; Mutual, $18.9 million and NBC, $38.0 million.



▶ **FCC**—As network broadcasters glowed over their new sales records, FCC issued a new limitation on station ownership. CBS was the only network affected by the ruling because it has interests in 8 radio stations, 5 tv stations and 3 tv cps.

The commission set a limitation for any one owner of having an interest in more than 7 a-m stations; 7 commercial f-m stations and 5 commercial tv stations because a holder of small interest "may exert a considerable influence on the station's operations and because of the difficulty of determining from the face of the application what the extent of the influence will be." Heretofore there has been no limitation on a-m station ownership; commercial f-m ownership was limited to 6 stations and tv remained at 5 outlets.

Metal Detector Sales Progress

Business in electronic prospecting, treasure finding, industrial units totals over $16 million

OVERLOOKED by all but a few in the electronic field is the business of detecting and locating concealed, imbedded, buried or otherwise invisible metal objects. One widely publicized use, for frisking visitors to prisons, is peanuts dollarwise compared to sales in the four major categories—pipeline locators, treasure finders, industrial tramp metal detectors and medical units.

▶ **Buried Pipes and Treasure**—Approximately 100,000 portable battery-operated electronic metal detectors have been sold in the past 25 years, at an average price of $150 each. Sales breakdown is roughly 50,000 to public utilities for locating buried pipes and cables, 15,000 to prospectors for finding metallic ore bodies and 35,000 to individuals seeking their fortune in buried treasure. Prices of units range from $75 to $425, depending on sensitivity, depth penetration and width of coverage pattern.

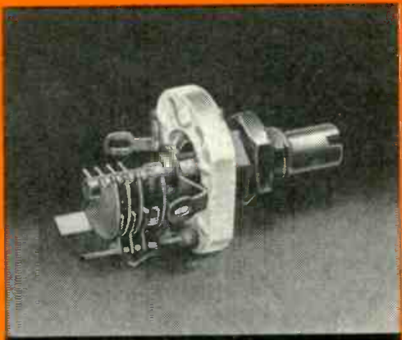
Units that will locate sunken outboard engines, pirate treasure or other metal objects dropped in water are in demand, but so far only custom-built waterproof units have been available. One manufacturer reports, however, that a waterproof unit is in the works.

The SCR-625 metallic mine detector of World War II made a sizeable dent in the post-war market for commercial buried-metal locators, but has now just about vanished from the surplus market. Only an estimated 300 units remain in trade channels throughout the country. Current price is around $100 as compared to $65 a year ago, with likelihood of higher prices as the supply dwindles.

▶ **Tramp Metal**—Industrial plants have about 900 installations costing an average of $1,200 each for find-

(Continued on page 24)

To help you meet the Tolerance Squeeze



Miniature "MAC" Variable Capacitor

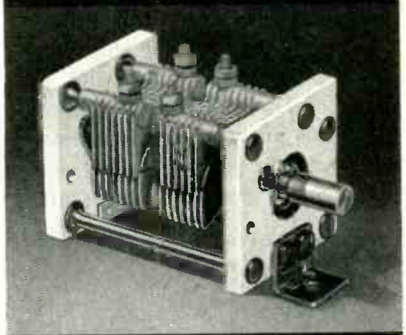
QUALITY CAPACITORS BUILT BY HAMMARLUND

Performance requirements for electronic products—commercial, industrial and military—are becoming more difficult to meet. Specifications call for the finest quality components available to fulfill exacting equipment tolerances.

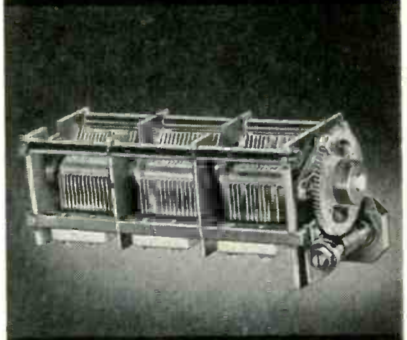
Hammarlund variable capacitors have been designed and built for more than 25 years to meet the most demanding of requirements. Check the general characteristics of these outstanding variables:

- **Rotor and stator plates of brass stock soldered, not staked, to their supports to permanently insure perfect contact and prevent loosening of plates.**
- **Stator supports soldered into eyelets assembled to steatite insulators.**
- **Terminals hot-tinned for ease in soldering.**
- **Insulators of low-loss steatite, impregnated with DC 200 silicone fluid to prevent absorption of moisture.**
- **Rotor and stator assemblies nickel or silver-plated.**
- **Rotor contact springs of beryllium copper or phosphor bronze, and nickel or silver-plated.**
- **Precision soldering fixtures and assembly jigs used in fabricating to assure absolute uniformity of plate spacing.**

These are basic reasons why Hammarlund capacitors should be used where highest dependability is required. Convince yourself in your engineering models and you will specify them for production.

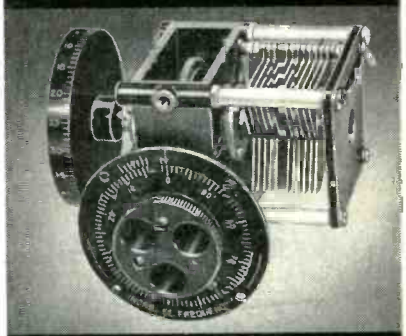


"VU" Capacitor For Up to 500 Mc



Special 3-Gang Precision Capacitor

For detailed information on Hammarlund variable capacitors write for this latest catalog. It includes complete drawings and specifications on all standard units. Ask for bulletin C20.



Precision Frequency Meter Capacitor

HAMMARLUND

THE HAMMARLUND MANUFACTURING COMPANY, INC.
Main Plant and Offices: 460 W. 34th ST., N. Y. 1, N. Y.
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ing stray metal. Most are in food and confectionery plants. The next three markets are the plastics molding industry, rock and ore crushing, and the tobacco industry.

Prices range from $450 to $2,200 per unit, plus relatively low installation costs. The under-$500 units are useful for packaged-product lines since wrapped or boxed candies, cereals and other foodstuffs on conveyor belts can go through relatively small search coils.

Electric solenoids or air cylinders are used to push metal-bearing packages off the line.

Food processors buy metal detectors primarily to protect their reputation and business, and secondarily to avert lawsuits. Detector units find way more metal than is indicated by customer complaints.

▶ **Medical Units**—Pinpointing the location of metal in the human body calls for specialized equipment that can be used during surgery to supplement preliminary x-ray findings. Since publication of first details of a successful instrument for this purpose (ELECTRONICS, p 114, May 1943), approximately 1,000 of the instruments have been sold by one company at an average price of around $700. Biggest customer is the military, though many hospitals have units on hand for emergencies.

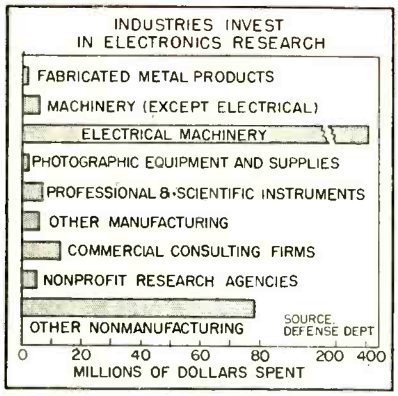
Navy Clarifies U.S. Manufacturing Specs

ELECTRONIC manufacturers who have done business with the U. S. government and experienced difficulty in interpreting U. S. manufacturing specifications can now obtain a guide for understanding them.

Written especially for commercial firms by Navy's Bureau of Ships, the guide covers both federal and military specs. It is being published in three sections covering specifications, qualified products lists and standards and is expected to be helpful to all manufacturers engaged in government business.

Electronics Research Enters Other Fields

Companies in sixteen other industries list electronics as major research specialty



TOTAL of 277 companies in 16 industry classifications, ranging from the chemical field to machinery manufacturing, spent $531 million mainly on electronics research, according to a survey of 1,953 firms made by the Department of Labor in 1951. A total of 144 of the companies that listed electronics as the main research specialty were in the electrical machinery classification, under which electronics firms are included. But of those outside the electronics field, 133 companies still listed electronics as their main research specialty.

▶ **Breakdown**—As shown in the chart, substantial money was spent by companies in other industries for electronics research. Two chemical manufacturers, two in aircraft, two glass companies and one in metals spent the bulk of $13.7 million on electronics research. Four firms in the fabricated metal products field spent $597,000 mainly on electronics and seven machinery manufacturers spent over $2.9 million. Five photographic equipment companies spent nearly $1.0 million during the year and 42 other scientific instrument firms spent $6.3 million. Eight companies in other manufacturing lines spent $5.6 million bringing the total for all manufacturing to $435.0 million.

Non-manufacturing firms spent nearly $96.5 million on research in electronics. A total of $12.6 million was spent by commercial consulting firms in the field and three nonprofit research agencies spent over $5.4 million. Eleven other nonmanufacturing companies spent $78.6 million on research that was largely in the electronics field.

Financial Roundup

DESPITE the decline in electronic stock prices that has been evident since the beginning of 1953, electronic manufacturers continued to report healthy profits in 1953. For the first nine months of the year, net profits for twelve companies were as follows:

Company	1953	1952
Circle Wire	$1,529,679	$1,644,135
IT&T	14,926,304	15,324,144
W. L. Maxson (12m)	1,085,000	526,000
Philco	15,418,000	6,037,000
Reliance Electric (12m)	1,832,778	1,816,140
Sangamo	1,633,077	1,427,745
Servomechanisms	276,613	243,556
Standard Coil	3,306,963	1,963,945
TelAutograph	203,791	154,686
Thompson Products	7,463,109	6,101,678
Tung-Sol	1,423,284	1,288,324
Weston Instrument	825,395	810,080

American Car & Foundry, which entered the electronics field in 1953 with an investment in Avion Instrument, reported net profits for the first nine months of $1,954,660 compared to $4,225,302 during the same period in 1952. Burroughs Corp., which became more active in the electronic computer field in 1953, reported net profits for the first nine months of $5,310,105 compared to $5,764,172 in the first three quarters of 1952.

▶ **Securities**—General Precision Equipment offered 108,167 shares of $2.90 cumulative convertible preferred stock, without par value, at a rate of one preferred for six common. Proceeds will be used for expansion through the acquisition of companies, to repay bank loans and to increase general corporate funds.

Laboratory of Electronic Engineering of Washington D. C. filed with SEC covering 17,523 shares of

(Continued on page 26)

ELECTRONIC TEST INSTRUMENTS

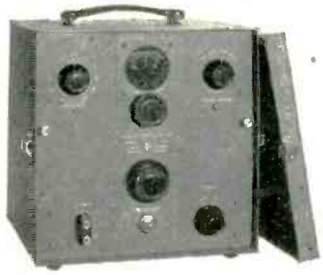
TEST VOLTAGE PROBLEMS 1/100 cps to 10 mc?

Hewlett-Packard has 17 different oscillator models. Some are highly specialized, others are all-purpose instruments. Almost certainly, there's a model to meet your exact requirements. All are precision instruments of highest quality. All embody the famous RC circuit pioneered by *-hp-*. Check the table below for the oscillator that can help you most. Then write us for complete operating and application details.

-hp- 200CD AUDIO OSCILLATOR

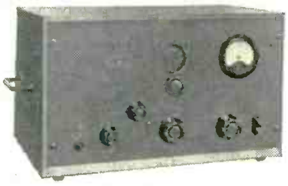
World standard for electronic or electrical measurements, now redesigned with wider range, lighter weight, smaller size. Use for any lab, field or production problem in sub-audio, audio, telephony, carrier, supersonic, telemetering or rf measurement fields. Highest stability, low distortion, constant output, no zero set while operating. With carrying strap for bench or portable use; or for rack mounting.

Instrument	Primary Uses	Frequency range	Output	Price
-hp- 200AB	Audio tests	20 cps to 40 kc	1 watt/24.5v	$120.00
-hp- 200CD	Audio and ultrasonic tests	5 cps to 600 kc	160 mw/20v open circuit	150.00
-hp- 200H	Carrier current, telephone tests	60 cps to 600 kc	10 mw/1v	350.00
-hp- 200I	Interpolation, frequency measurements	6 cps to 6 kc	100 mw/10v	225.00
-hp- 201B	High quality audio tests	20 cps to 20 kc	3w/42.5v	250.00
-hp- 202A	Low frequency measurements	.01 cps to 1 kc	20 mw/10v	450.00
-hp- 202B	Low frequency measurements	½ cps to 50 kc	100 mw/10v	350.00
-hp- 202D	Low frequency measurements	2 cps to 70 kc	100 mw/10v	275.00
-hp- 204A	Portable, battery operated	2 cps to 20 kc	2.5 mw/5v	175.00
-hp- 205A	High power audio tests	20 cps to 20 kc	5 watts	390.00
-hp- 205AG	High power tests, gain measurements	20 cps to 20 kc	5 watts	425.00
-hp- 205AH	High power supersonic tests	1 kc to 100 kc	5 watts	550.00
-hp- 206A	High quality, high accuracy audio tests	20 cps to 20 kc	+15 dbm	550.00
-hp- 230A	Carrier test oscillator	35 cps to 35 kc	+14 dbm/600 ohms	275.00
-hp- 233A	Carrier test oscillator	50 cps to 500 kc	3w/600 ohms	475.00
-hp- 234A	Carrier test oscillator	160 cps to 160 kc	+14 dbm/600 ohms	300.00
-hp- 650A	Wide range video tests	10 cps to 10 mc	15 mw/3v	475.00



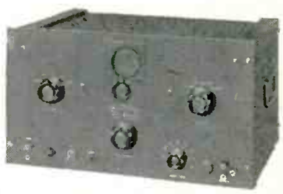
-hp- 204A Battery-Operated Oscillator

Precision instrument for measurements 2 cps to 20 kc where ac power is not available. Compact, light weight, weather-proofed—extra rugged construction for field duty. Frequencies set and read directly on large dial. Particularly useful for telephone or remote broadcast line checks, strain gauge applications, telemetering and geophysical measurements. Provides completely hum-free signal. Operates from flashlight and 45-volt batteries. Output stable and constant throughout range.



-hp- 650A Resistance-Tuned Oscillator

Highly stable, wide band (10 cps to 10 mc) oscillator particularly useful for testing television amplifiers, receiver alignment, bridge or carrier circuits, wide band systems; determining tuned circuit response. Operates independently of line or tube changes, requires no zero setting. Output flat within 1 db throughout range, monitored with VTVM. 60 db attenuator adjusts in 10 db steps.



-hp- 202A Low Frequency Function Generator

Compact, convenient, all-purpose source of transient-free voltages between 1/100 cps and 1 kc. Provides distortion-free signals for vibration studies, servo applications, medical and geophysical work and other subsonic problems. Generates sine, square or triangular waves. Output 10 v RMS, balanced or single ended, 1% distortion, constant within 0.2 db.

Data subject to change without notice. Prices f.o.b. factory

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class A common stock to be offered at par ($10 per share). Proceeds are to be used for working capital.

Power Condenser And Electronic Corp. filed with SEC covering 47,000 shares of common (par $1), the proceeds of which are to be used to finance the corporations research program and for laboratory equipment.

Trad Television filed with SEC covering 2,400,000 shares of common stock (par 1 cent), to be offered at 12.5 cents a share. Proceeds are for working capital.

CAA Ponders Dropping Older Radio Ranges

ON THE BEAM, to those who fly planes, refers to the characteristics of the four-course radio range. Interlocked Morse characters A (dot-dash) and N (dash-dot), audible on either side of a center line, merge into a continuous dash when aircraft are on the beam, flying squarely towards the transmitter.

▶ **More Courses**—Besides operating 335 of these low-frequency ranges, Civil Aeronautics Administration has 369 of a newer vhf type known as very high-frequency omnidirectional range (VOR). Although a VOR does not, in practice, supply 360 beams, it does provide about 90 as compared with the radio-range's four. There are other advantages.

CAA now proposes to shut down 64 of the older ranges, in accordance with a modernization program begun in 1948. Pointing out that about 19,000 vhf receivers have been produced and more than 1,700 have been installed in the scheduled air-carrier fleet, F. B. Lee, Administrator of Civil Aeronautics, believes some of the older ranges can be abandoned.

"Since this means that more than half the 32,000 civil aircraft equipped with two-way radio are potentially capable of performing instrument flight by means of vhf facilities," said Mr. Lee, "conditions are appropriate to accelerate our decommissioning program without endangering safety."

MEETINGS

JAN. 18–22, 1954: Winter Meeting of AIEE, Hotel Statler, New York, N. Y.

JAN. 26, 27, 1954: AIEE Scintillation Counters Conference, Washington, D. C.

JAN. 1954: Conference on Radio Astronomy, Carnegie Institute of Washington, California Institute of Technology and National Science Foundation, Washington, D. C.

FEB. 4–6, 1954: Sixth Annual IRE Conference And Electronics Show, Hotel Tulsa, Tulsa, Oklahoma.

FEB. 4–6: West Coast Audio Fair, Los Angeles, Calif.

FEB. 11-12, 1954: Joint IRE, AIEE, ACM West Coast Computer Conference, Ambassador Hotel, Los Angeles, Calif.

FEB. 18–19: IRE, AIEE Conference on Transistor Circuits, Philadelphia, Pa.

MAR. 22–25: IRE National Convention, Waldorf-Astoria Hotel and Kingsbridge Armory, New York, N. Y.

APRIL 22–23, 1954: AIEE Conference On Feedback Control, Claridge Hotel, Atlantic City, N. J.

APRIL 24, 1954: Eighth Annual Spring Technical Conference, Cincinnati IRE, Cincinnati.

APRIL 27–29: AIEE Electronic Components Conference, Washington, D. C.

MAY 4–6: The 1954 Electronic Components Symposium, Department of Interior auditorium, Washington, D. C.

MAY 5–7: 1954: Third International Aviation Trade Show, 71st. Regiment Armory, New York, N. Y.

MAY 7–8: New England Radio Engineering Meeting, IRE, Sheraton Plaza Hotel, Boston, Mass.

MAY 17–20: 1954 Electronic Parts show, Conrad Hilton Hotel, Chicago, Ill.

MAY 24–26, 1954: AIEE Conference On Telemetering, Morrison Hotel, Chicago, Ill.

MAY 25–27: Eighth NARTB Broadcast Engineering Conference, Palmer House, Chicago, Ill.

JULY 6–9, 1954: International Conference On Electron Microscopy, Joint Commission on Electron Microscopy of International Council of Scientific Unions, London, England.

JULY 8–12: British IRE 1954 Convention, Christ Church, Oxford, England.

AUG. 24–SEPT. 4: National Radio Show of Great Britain, Earls Court, London, England.

AUG. 26–28: 1954 Western Electronic Show & Convention, Los Angeles, Calif.

SEPT. 1–16: Golden Jubilee Meeting of the International Electrotechnical Commission, University of Pennsylvania, Philadelphia, Pa.

SEPT. 13–24: 1954: First International Instrument Congress And Exposition, Commercial Museum and Convention Hall, Philadelphia, Pa.

SEPT. 1954: International Scientific Radio Union, Amsterdam, Netherlands.

SEPT. 30–OCT. 2, 1954: Second Annual International Sight and Sound Exposition, Palmer House Hotel, Chicago, Ill.

Industry Shorts

▶ **Petition** of manufacturer's committee to FCC asks for reassignment of 40 Citizens Radio frequencies to a proposed Manufacturers Radio Service. They also ask for point-to-point authorizations to link separated operating centers. Fifty-six large companies support the petition.

▶ **Tele-meter** pay-to-see tv made its commercial debut in Palm Springs, Calif. to 70 customers who paid $21.75 for meter installation and $1.35 to see a first-run movie.

▶ **Intermetall** Desellschaft of Dusseldorf, Germany plans a U. S. affiliate in New York City to sell transistors and crystal products.

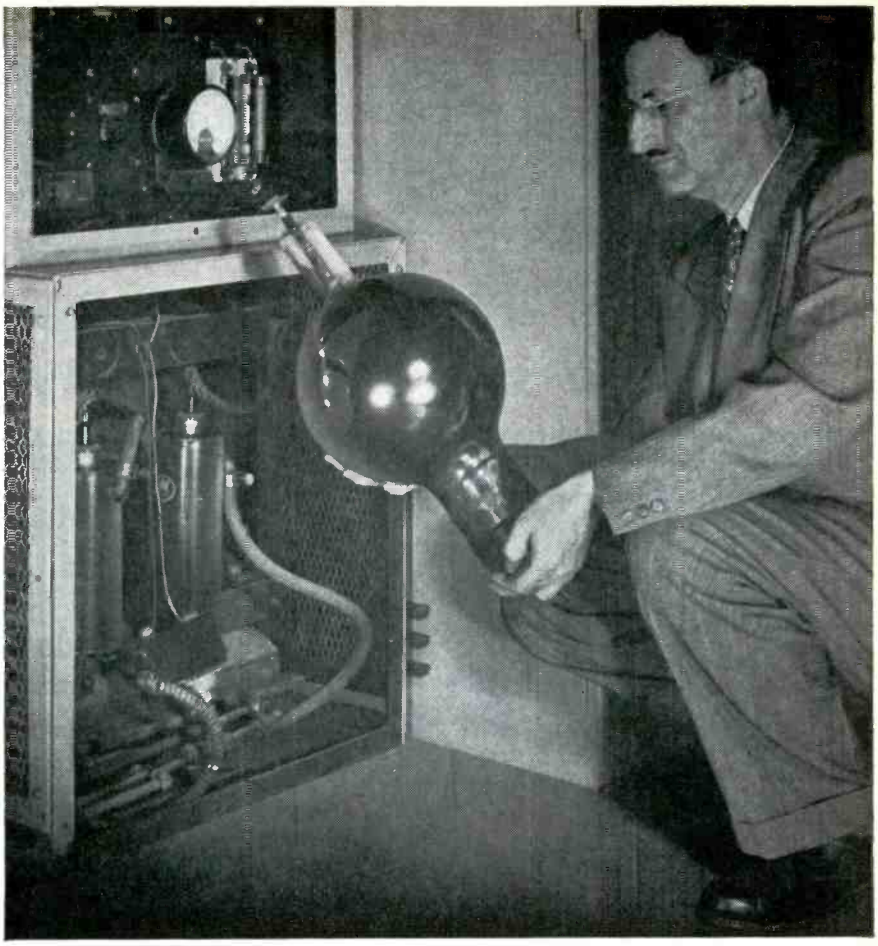
▶ **Navy** will shortly release tool drawings for modular design of electronic equipment developed under Project Tinkertoy, through OTS, Dept. of Commerce. Industry can use it without license.

▶ **Aircraft** factories have appealed to FCC for more frequencies for use by vehicles feeding parts to airplane production lines.

▶ **Sales** of GE diamond styli increased 400 percent during the first nine months of 1953 compared to the same period in 1952.

▶ **Survey** of 545 Sarkes-Tarzian employees reveals that although over 85 percent would be willing to pay $500 for a color tv set, a larger percentage would wait two years for the price to come down to $300.

Westinghouse Ignitron Gives 16 Years' Trouble-Free Service



In the Westinghouse plant in Elmira, N. Y., Donald E. Marshall, Section Manager of Gas and Industrial Tube Development, holds a KU-671 Ignitron retired after more than 32,000 hours service.

This rugged old Westinghouse Ignitron was finally retired after 16 years' service only because re-design of resistance welding equipment made a modern Westinghouse Ignitron simpler to use; it is still operable. An exclusive Westinghouse design, the KU-671 was developed in 1937 a few years after Westinghouse engineers first invented the Ignitron —it was the first Ignitron type to be sealed, its predecessors being continuously pumped while in service. (Even some of those earlier Westinghouse tubes are still in active service—pumps and all!)

To an electronic equipment designer such performance means two things:

First, a Westinghouse Ignitron designed into a circuit means reliability and long service without repair, replacement, or down-time due to failure—just as when Westinghouse invented and developed the tube.

Second, the wide variety of modern metal-encased Ignitrons by Westinghouse offers designers of resistance welding and power rectification equipment and inverters possibilities not yet fully explored.

Since the first Ignitron, Westinghouse continued to forge ahead and adapt its Ignitrons to new, more difficult and more exacting applications. Through continuing research and development, Westinghouse has maintained leadership through the years.

For the latest application data, or for design aids or suggestions, write to Department A-1014 at the address below, or call your nearest Westinghouse Electronic Tube sales office.

ET-95050

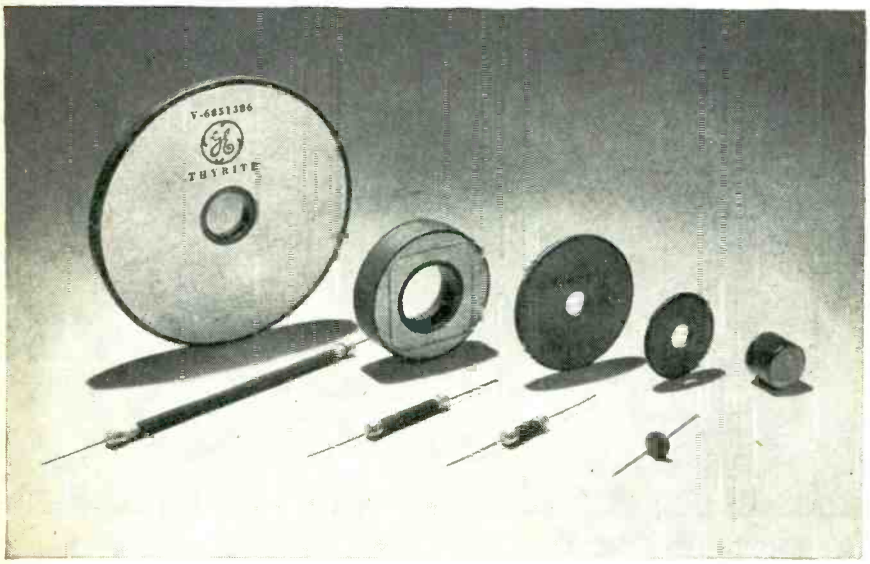
YOU CAN BE SURE...IF IT'S Westinghouse

RELIATRON TUBES TM

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, N. Y.

DESIGNER'S

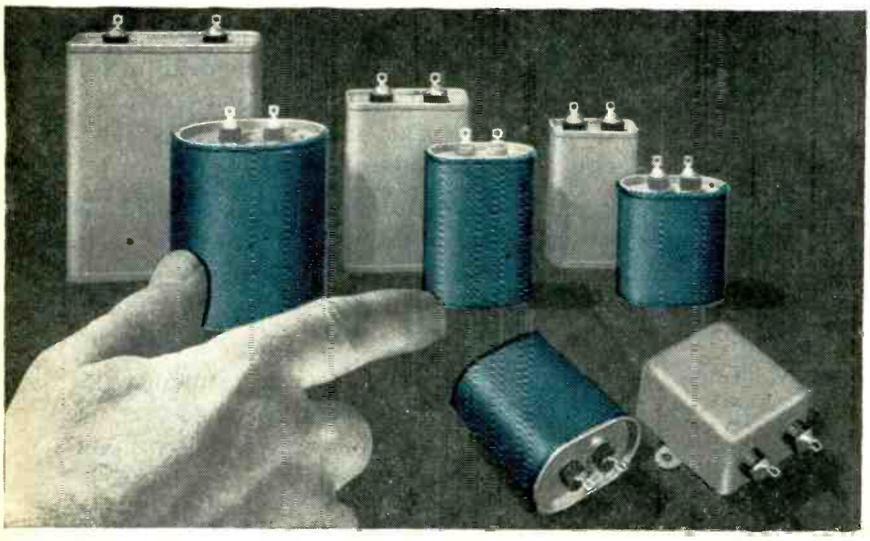
Thyrite* resistance material offers new answer to many circuit problems



Here's a silicon-carbide ceramic material, dense and mechanically strong, having non-linear resistance in which I varies as E^n—the current varies as a power of the applied voltage. General Electric Thyrite resistance characteristic is stable and substantially independent of polarity or frequency. Because of this notable electrical property, it has solved many important circuit problems in electronic applications. Available in disk-type, rod-type, or miniature resistors, Thyrite material can also be successfully molded to meet your special needs. Unaffected by pressure or vibration, it can operate in temperatures up to 150 C. Its special coating compound minimizes the effect of humidity. See Bulletin GEA-4138.

*Reg. Trade-mark of the General Electric Company.

Drawn-oval capacitors reduce size, weight, and cost of your equipment



This full line of General Electric paper-dielectric capacitors features size and weight reductions up to 30 percent! They are also mechanically stronger than conventional types because of their drawn-steel containers with cover attached by double-rolled seam. You get space and cost savings plus improved reliability. Moreover, shipments arrive faster. Sturdy brackets offer versatility of mounting. Dual-rated (both a-c and d-c), these versatile capacitors are designed to replace styles CP 53 and CP 70, in ratings from 1 to 10 muf, 600 to 1500 volts d-c and 330 to 660 volts a-c. For more information check Bulletin GEA-5777.

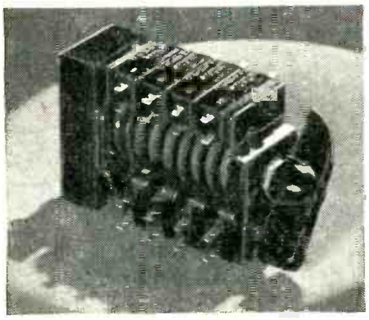
GENERAL ELECTRIC

DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS

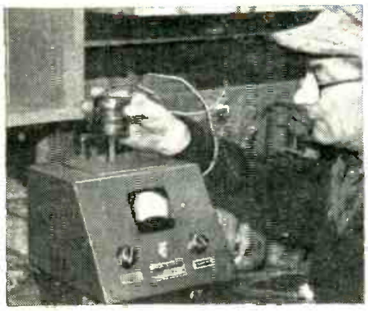
Withstands vibration

Now the improved General Electric hermetically sealed relay withstands vibration forces of 10g from 10 to 500 cycles per second, offers extra protection against permanent breakdown due to voltage surges. Coil ratings up to 10,000 ohms. Contact configurations available include 4-pole double-throw and 6-pole single throw. See Bulletin GEA-5729.



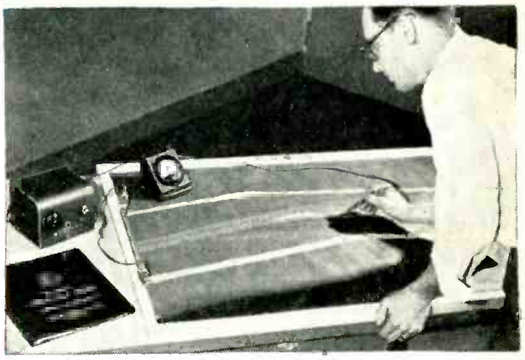
Controls 20 circuits

Compact, lightweight and easy to mount, these G-E cam-operated selector switches help solve many intricate circuit-combination or sequencing problems . . . control from one to 20 circuits, in any operating sequence within the limits of 12 positions . . . operate at altitudes up to 50,000 feet, and in temperatures from 200 F to −70 F. Check Bulletin GEA-4493.



Quickly locates shorts

Minimize the hazards of short circuits quickly, easily with General Electric low-voltage coil testers. These portable units are designed to test coils before assembly in relays, radios, small transformers and instruments. They maintain accurate on-the-spot service for long use. Can also be used to detect open circuits. See Bulletin GEC-964.



G-E analog plotter helps solve complex field problems — fast

Now you can simplify and speed up those complex field studies by using General Electric's analog field plotter. By means of electric current flow patterns set up in a sheet of thin conducting paper, over-all operation of plotting in two dimensional fields is greatly simplified. Problems in electrostatics, electromagnetics, and many other fields are rapidly solved with this sensitive, versatile plotting board and the complete package of components necessary for making field studies. It needs only low-voltage d-c supply, which eliminates shock hazard, and is not affected by line-voltage variations. Explanation and instructions are covered in a 50-page manual accompanying the plotter. For full details, see Bulletin GEC-851.

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Insulation testers
Vacuum-tube voltmeter
Photoelectric recorder
Demagnetizers

General Electric Company, Apparatus Sales Division
Section A667-27, Schenectady 5, New York

Please send me the following bulletins:

√ for reference only   X for planning an immediate project

☐ GEA-4138 Thyrite Resistance Material
☐ GEA-4493 Selector Switches
☐ GEA-5729 Hermetically Sealed Relays
☐ GEA-5777 Drawn-oval Capacitors
☐ GEC-851 Analog Field Plotter
☐ GEC-964 Low-voltage Coil Tester

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Company__________

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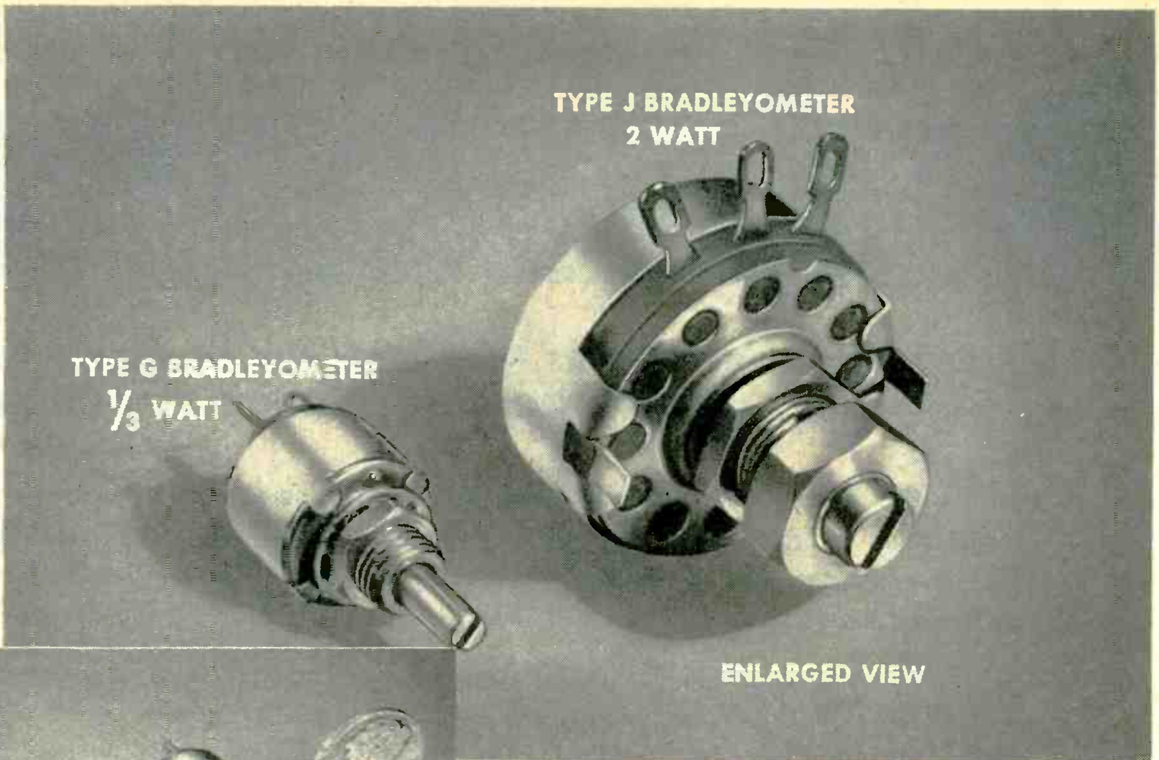
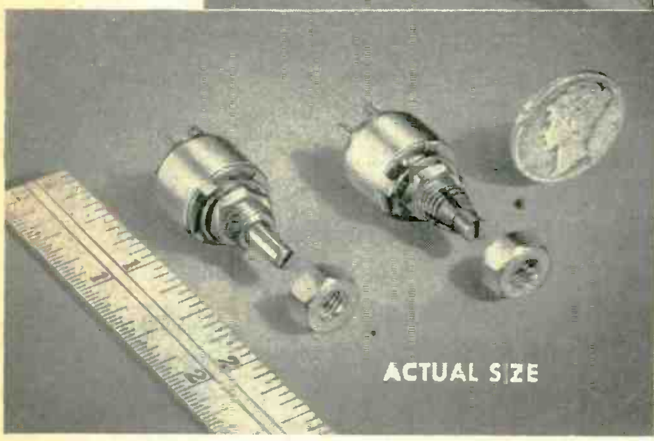
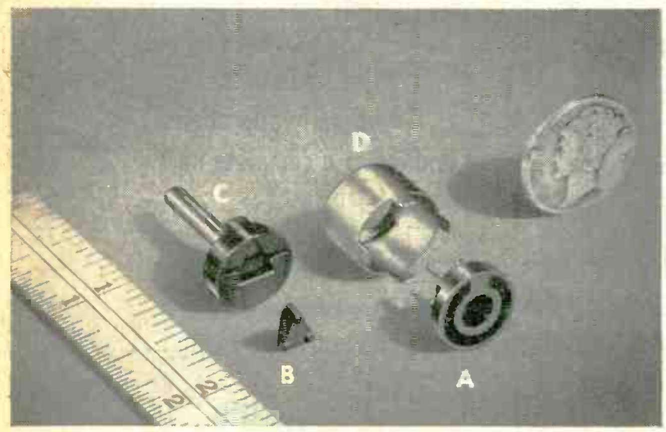




Type G Bradleyometers Made with two types of bushings . . . the standard bushing and straight shaft for knob control, and the split bushing with lock nut and slotted shaft for shaft lock applications. Metal parts are all of corrosion resistant materials.



Type G Bradleyometer Component Parts

A—Resistor element—molded in one piece with resistor and terminals. No rivets or welds—no maintenance problems.
B—Carbon brush—which fits into triangular opening in rotor and makes contact with resistor ring at any point.
C—Rotor and shaft — showing triangular opening or recess for holding the brush; a spring keeps brush firmly against the resistor element.
D—Metal case made of corrosion resistant metal. Diameter—½ inch.

SMALLEST MOLDED ADJUSTABLE RESISTOR

• ONLY ½″ DIAMETER •

for Rheostat or Potentiometer Service

The Type J Bradleyometer has long been recognized as the top quality, 2-watt, adjustable resistor for electronic applications. Since it has a solid MOLDED composition resistor . . . and is not a paint or spray type unit . . . its characteristics remain permanent even after long use.

The new, Type G Bradleyometer . . . only ½ inch in diameter and rated at ⅓ watt . . . offers the same advantages of construction and noiseless performance as the bigger, Type J unit. Its solid MOLDED resistor element can be made to satisfy any resistance-rotation curve. The carbon contact brush assures quiet operation, even improving with long service.

Maximum or total resistance values range from 100 ohms to 5 megohms. Maximum continuous power for the entire element in circuit is 0.33 watt. Maximum continuous volts—350 RMS. Maximum current—0.1 ampere.

Samples can be supplied for qualification tests.

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

ALLEN-BRADLEY

FIXED & ADJUSTABLE RADIO RESISTORS

QUALITY

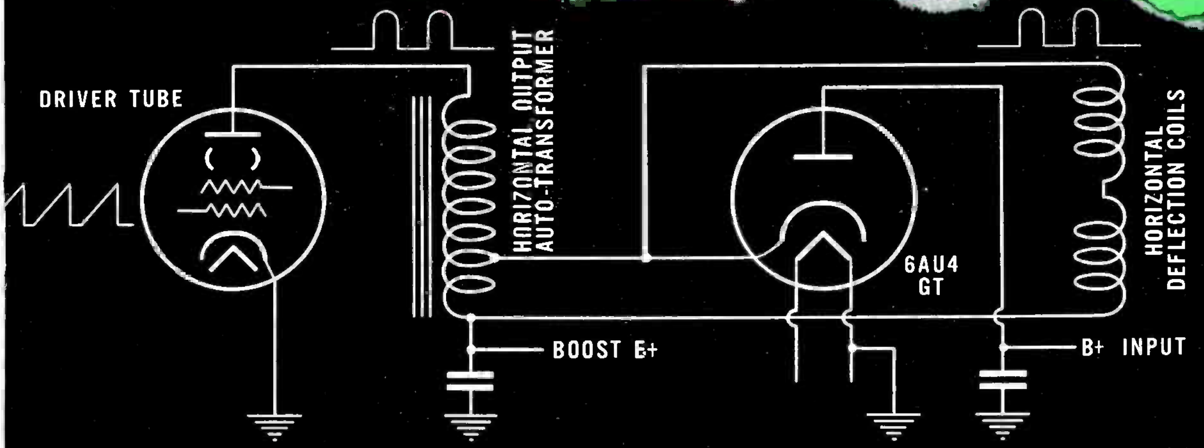
Sold exclusively to manufacturers of radio and electronic equipment

TUNG-SOL®

DAMPER DIODE

6AU4 GT

for TV use with picture tubes having 90° deflection



see other side for additional information →

6AU4 GT

DAMPER DIODE

A Tung-Sol Designed and Developed Tube

HERE is an entirely new Damper Diode designed to keep pace with the development of the large screen 90° deflection picture tube. Wider deflection angles and the increased second anode voltage so necessary to maintain picture brightness require higher deflection power and increased circuit efficiency. The 175 ma. rating of type 6AU4GT is more than adequate—with ample safety factor—for these new designs. "Stretching" the ratings of tubes designed for 70° deflection service is not sound engineering and invariably leads to production troubles and jeopardizes the service life in the field. This new tube is the answer.

The 6AU4GT retains the many features which have established the 6AX4GT as a favorite for the 70° deflection designs. Insulation between heater and cathode designed to withstand the full pulse plate-to-cathode voltage eliminates the need for separate power transformer windings insulated for high voltage. Improvements in the heater—cathode insulation have decreased the warm-up time and resulted in improved reliability. The 6AU4GT is produced under the same careful manufacturing techniques and the thorough quality control which the industry has come to expect from the Tung-Sol organization.

DIRECT INTERELECTRODE CAPACITANCES

Heater to Cathode: (H to K)	4.0	μμf
Plate to cathode and heater: P to (H+K)	8.5	μμf
Cathode to plate and heater: K to (P+H)	11.5	μμf

RATINGS [A]

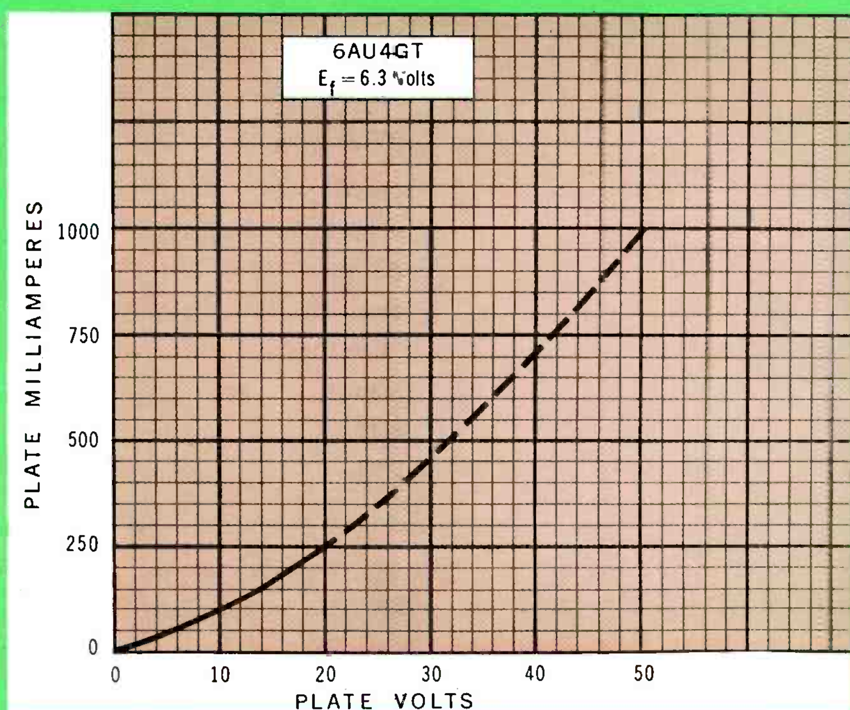
Interpreted according to RTMA Standard M8-210

DAMPER DIODE [B]

Heater voltage	6.3	VOLTS
Maximum heater cathode voltage:		
Heater negative with respect to cathode		
DC	900	VOLTS
Total DC and peak (absolute maximum)	4 500	VOLTS
Heater positive with respect to cathode		
DC	100	VOLTS
Total DC and peak	300	VOLTS
Maximum peak inverse plate voltage (absolute maximum)	4 500	VOLTS
Maximum DC plate current	175	MA.
Maximum steady state peak plate current	1 050	MA.
Maximum plate dissipation	6.0	WATTS
Average tube voltage drop (with tube conducting 350 MA.)	25	VOLTS

A All values are evaluated on the design center system except where absolute maximum is stated.

B For installation in a 525-line, 30-frame system as described in "STANDARDS OF GOOD ENGINEERING PRACTICE FOR TELEVISION BROADCASTING STATIONS: FEDERAL COMMUNICATIONS COMMISSION." The duty cycle of the horizontal voltage pulse, not to exceed 15% of scanning cycle.



The TUNG-SOL engineering which has produced the 6AU4GT is constantly at work on a multitude of special electron tube developments for industry. Many exceptionally efficient general and special purpose tubes have resulted. Information about these and other types is available on request to TUNG-SOL Commercial Engineering Department.

TUNG-SOL ELECTRON TUBES

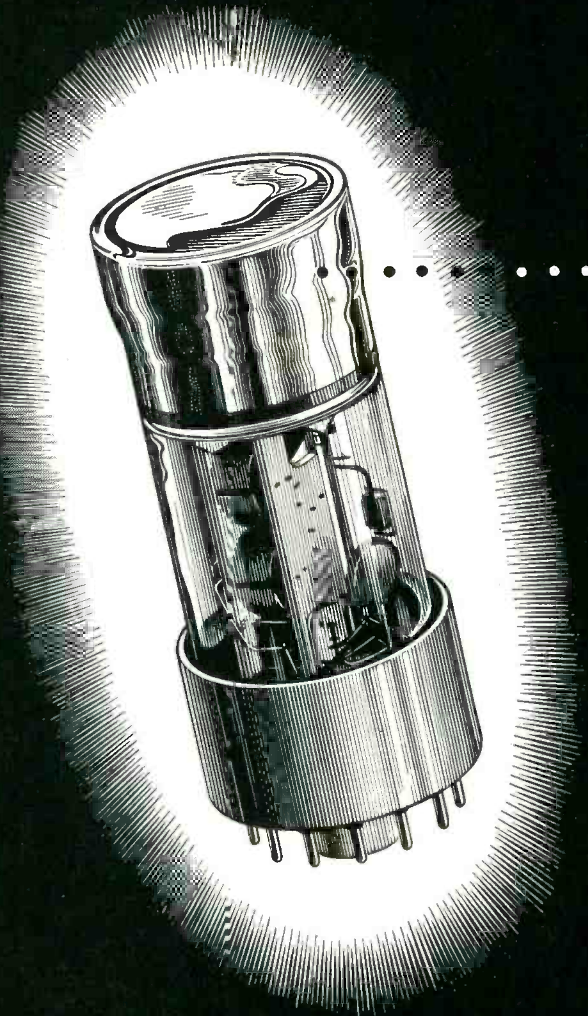
TUNG-SOL ELECTRIC INC., Newark 4, New Jersey

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

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

JANUARY, 1954

Want more information? Use post card on last page.



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- Guaranteed Minimum Specifications
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- Stability
- High Cathode Sensitivity

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Whether your needs are for high average output current, good resolution, high signal-to-noise ratio, very high amplification, or any combination of these—you'll find them all in the Du Mont Multiplier Phototube.

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OSCILLOGRAPH-RECORD CAMERA

• Continuous motion recording over the entire range of laboratory applications, including the most highly specialized investigations • Film speeds from 1 to 10,800 inches per minute. Film motion either horizontal or vertical • Overall accuracy of film speed guaranteed within 2% at proper line frequency • Friction film drive for simple loading. Permits use of perforated or unperforated film or paper • Single-frame recording of any phenomenon, including high-speed, single transients. Coated f/1.5 lens enables recording of spot-writing rates up to 35 inches/μsec from cathode-ray tube operated at 12,000 volts • Built-in timing lamp • Built-in illuminated data card • Simultaneous viewing and recording • Mounts quickly and easily on any standard 5-inch cathode-ray oscillograph • Delivery FROM STOCK.

(For 60-cycle power) PRICE $875

SPECIFICATIONS

Optical System: Wollensak f/1.5 coated Raptar lens. Image reduction ratio 4.5.

Shutter: Permits "Time" and "Bulb." *Provision for remote operation.*

Writing-rate Capability: 35 in./μsec with Type P11 screen at 12,000 volts.

Film Speed: Variable in steps of: 0.8; 1.6; 2.5; 4.9; 7.4; 14.8; 22.2; 44.4; 66.6; 133.3; 200; 400; 600; 1200; 1800; and 3600 in/min with rolls up to 400 feet in length. Also 5400 and 10,800 in/min wth film strips up to 10 feet in length. Accuracy of film speed within 2% at proper Line frequency.

Recording Material: Perforated or unperforated 35 mm film or recording paper in lengths up to 400 ft.

DU MONT

WRITE *for "Techniques of Photo-Recording," a 36-page handbook on cathode-ray photography.*

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Seven years a SELETRON CUSTOMER!

RICHARDSON-ALLEN CORPORATION
RECTIFIER SPECIALISTS
FIFTEENTH AVENUE
COLLEGE POINT, LONG ISLAND
NEW YORK

October 19, 1953.

Mr. Julian Loebenstein, Sales Manager
Seletron and Germanium Division,
Radio Receptor Company, Inc.,
251 West 19th Street,
New York 11, N. Y.

Dear Mr. Loebenstein:

We are planning a considerably expanded production for the new year and would like to know whether we can depend upon you for much heavier deliveries of the rectifiers we shall need.

Naturally we guard our reputation as manufacturers of power supplies carefully and, therefore, all components used must rank tops in their class -- with special attention to the rectifier stacks since the performance of our equipment depends so largely on them.

For the past seven years your Seletron selenium rectifiers have done a splendid job for us in applications for low voltage electroplating, and for power supplies of 110/220 volts. Both types of use involve individual jobs running into many kilowatts.

We are very greatly pleased with both your product and service which have helped result in repeated reorders from our customers and, therefore, want to be able to count on you to take care of our growing business.

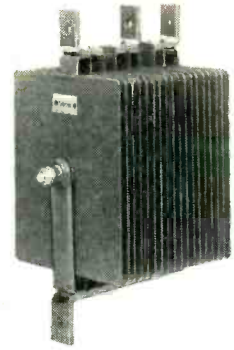
Sincerely yours,

RICHARDSON-ALLEN CORPORATION

Harry Walker

Harry Walker,
Vice President.

HW:lk



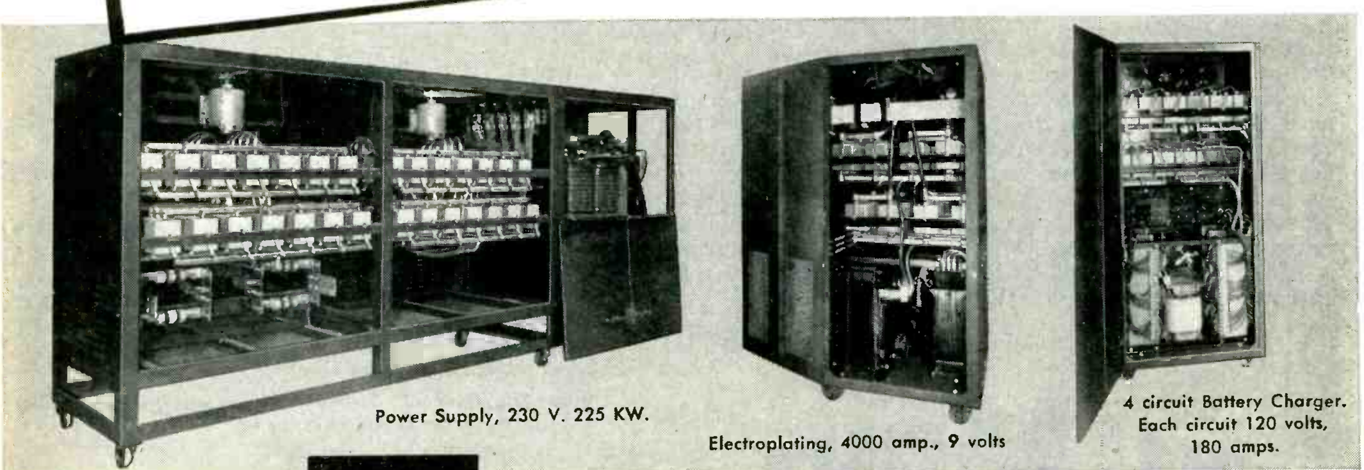
Seletron

SELENIUM RECTIFIERS

When the problem is industrial rectification, a great number of rectification specialists such as Richardson-Allen Corporation look to SELETRON to do a lasting, dependable job. Need we amplify? The record speaks for itself.

SELETRON Selenium Rectifiers are available up the line from miniatures for Radio and TV and other electronic circuits, all the way to large power stacks required by heavy industry.

Do *you* need information on a problem in a rectification? We'll gladly help without obligation if you drop us a note today... and study our catalog in Sweet's Product Design File. *We also manufacture germanium diodes and transistors.*



Power Supply, 230 V. 225 KW.

Electroplating, 4000 amp., 9 volts

4 circuit Battery Charger. Each circuit 120 volts, 180 amps.

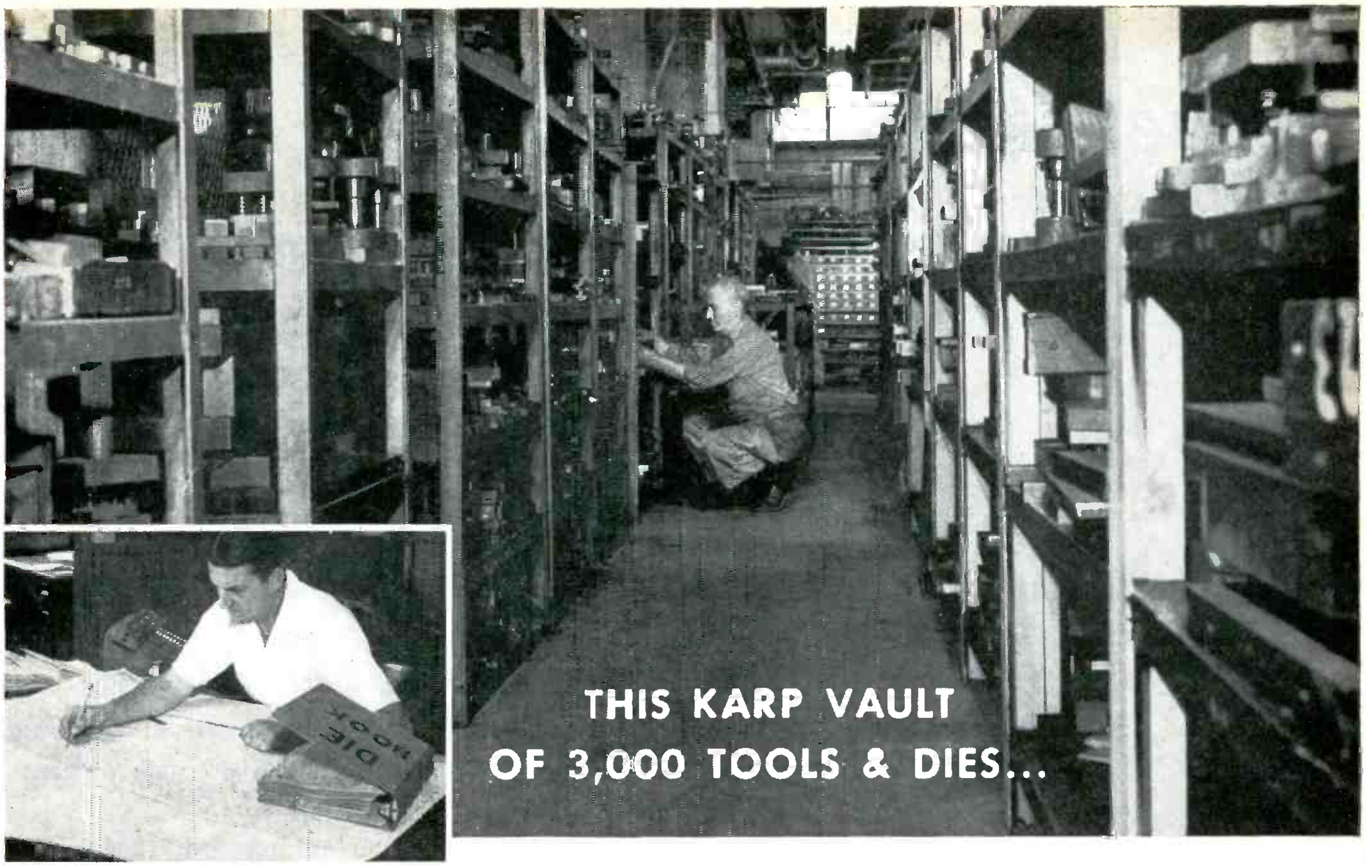
Seletron and Germanium Division

RRR

RADIO RECEPTOR COMPANY, Inc.

In Radio & Electronics since 1922

SALES OFFICE: 251 WEST 19th STREET, NEW YORK 11 • FACTORIES IN BROOKLYN, N. Y.



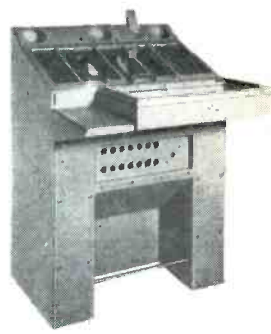
Can Save You the Total Tooling Cost for Your Cabinet, Enclosure or Chassis

No Other Sheet Metal Fabricator Offers This Plus—During our business life beginning in 1925 we have invested in and accumulated thousands of the tools and dies used to produce sheet metal cabinets, chassis, housings and enclosures.

These Dies are Available to All Karp Customers—All of these Karp-owned dies are carefully recorded in our die books and catalogued in our die vaults. When our Engineering Department estimates your inquiry or methodizes your job—from your sketch, sample or drawings—they specify use of these stock tools and dies where possible. Since our selection is so large, we are usually able to eliminate tooling costs entirely, a substantial saving for you.

Read "American Machinist's" 16-Page Article on Karp—This McGraw-Hill metal-working magazine, in its issue for December 7, 1953, described and illustrated the methods, facilities and skills which have made Karp the electronics industry's leading sheet metal fabricator. We will be glad to send you a reprint. It will convince you, we are sure, to consider Karp for your next job, whether it involves small quantities or large. Write for that reprint today.

***KARP METAL PRODUCTS CO.**, Division of H & B American Machine Co.*
215 63RD STREET · BROOKLYN 20, N. Y.



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ENCLOSURES REFLECT THE SKILLS WITHIN

FACILITIES FOR ENGINEERED SHEET METAL FABRICATIONS: in aluminum or steel • long run or short • spot, arc, gas or heliarc welding • any type finish

- Modern plant—3 city blocks long
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- Complete sub-assembly facilities

Want more information? Use post card on last page.

Come Again

Radio - Electronic Men!

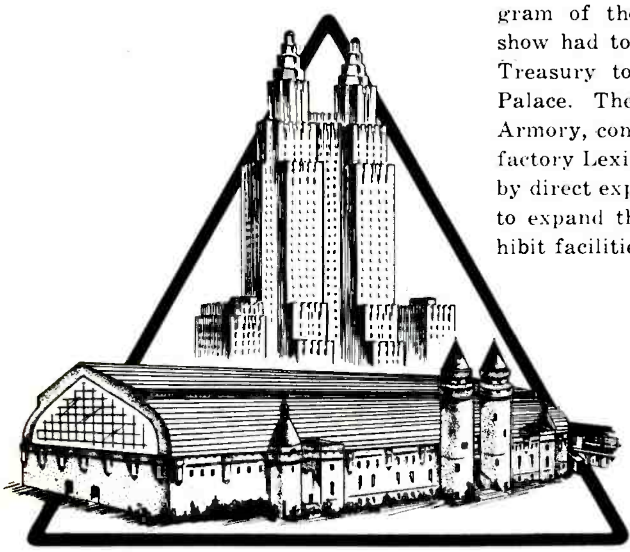
Just as you have been coming since 1945 to the IRE National Convention and Radio Engineering Show — coming by the thousands, 35,642 in '53 — so come again to see and hear all that is new in the engineering advances of your industry.

▲ Fifty-four in '54! — 243 scientific and engineering papers will be presented, skillfully grouped by related interests into 54 technical sessions. More than half these sessions are organized by IRE Professional Groups, thus making the IRE National a federation of 21 conferences in one. The whole provides a practical summary of radio-electronic progress.

▲ 600 Exhibitors "spotlight the new!" — A mile and a half of exhibits line the avenues of this show, intriguingly named for the elements of radio — such as "Instruments," "Components," "Airborne," "Radar," "Transistor," "Audio," "Microwave," etc., filling the four acres of the great Kingsbridge Armory to capacity. An expanding radio industry shows why it is growing by proving how engineering research pays out in new products. The exhibits themselves are an education, condensed to one place — reviewed in four days.

▲ Kingsbridge is the solution! Only the combined facilities of the Waldorf-Astoria Hotel, plus the three great halls in the Kingsbridge Armory, seating 906, 720, and 500 respectively, are able to keep pace with the increased technical papers program of the IRE Convention. The show had to move because the U. S. Treasury took over Grand Central Palace. The immense Kingsbridge Armory, connected to the very satisfactory Lexington Avenue Hotel area by direct express subway, serves well to expand the already outgrown exhibit facilities of the Palace and provide space for 200 new firms to exhibit, as well as seat greater audiences at the high-interest sessions. In addition to the subways, free busses leave the Waldorf every ten minutes in which you may travel in the congenial company of fellow engineers, direct to Kingsbridge.

▲ Admission by registration only! Registration serves for the four day period. It is $1. for IRE members, $3. for non-members, covering sessions and exhibits. Social events priced separately.



Waldorf-Astoria and Kingsbridge Armory

March 22-25, 1954

The IRE National Convention
and
Radio Engineering Show

THE INSTITUTE OF RADIO ENGINEERS
1 East 79th Street, New York City

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From .5 AMP to 3 AMP
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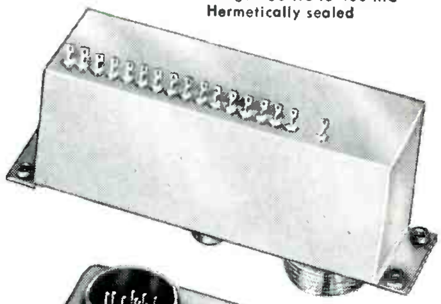
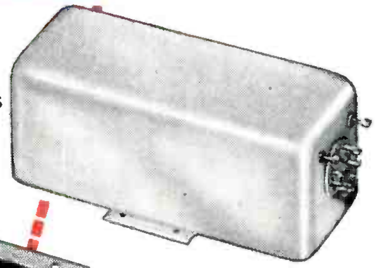
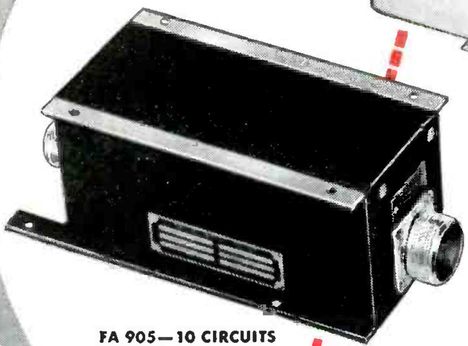
Range 150 KC to 400 MC
Hermetically sealed



FA 782—12 CIRCUITS
From .1 AMP to 15 AMP
28 VDC to 115 VAC, 400 CPS
Range 150 KC to 150 MC
Hermetically sealed





FA 905—10 CIRCUITS
From 4 MA to 5 AMPS
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Range 150 KC to 400 MC
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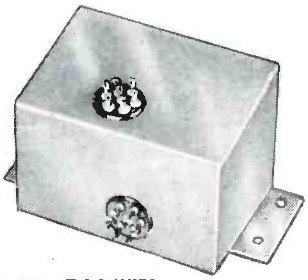
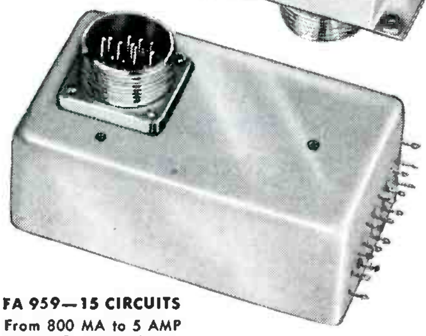


FA 512—7 CIRCUITS
From 100 MA to 5 AMP
100 VDC to 115 VAC
Hermetically sealed



FA 959—15 CIRCUITS
From 800 MA to 5 AMP
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Representative multi-section, high attenuation, hermetically sealed R.F. Interference Filters for space saving, simple installation and light weight applications.

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Our complete engineering and manufacturing organization is devoted exclusively to the research, design and production of RF interference filters to make YOUR products noise-free.

The Filtron Company is a complete engineering and manufacturing organization that pioneered the development of special filter types: subminiatures, high attenuation, completely hermetically sealed, high altitude, high temperature and wide-band multi-section units. Today we are producing more filters than ever before.

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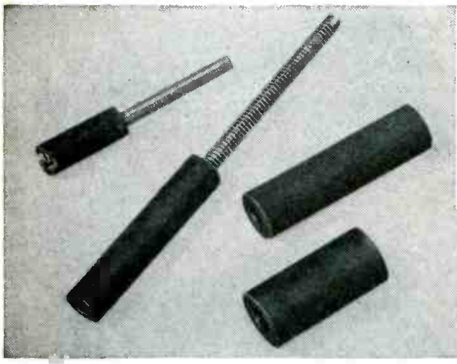
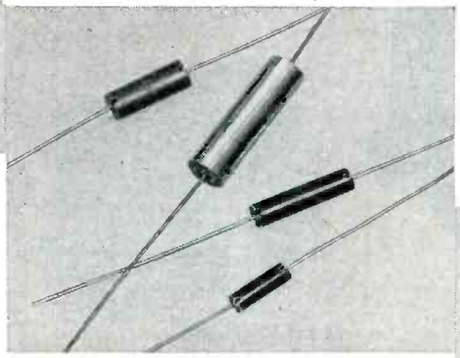
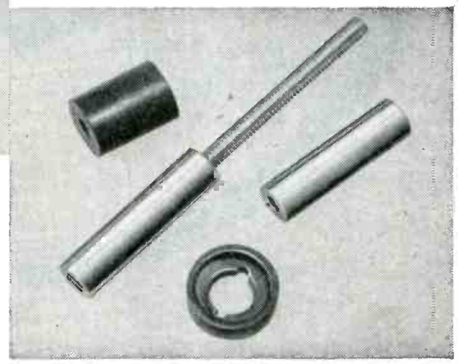


FERRICORES



MOLDED COIL FORMS



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Through years of continued engineering and research Moldite has produced cores of guaranteed dependability, economy, quality and uniformity. Our customers' smooth running production lines tell the story best.

Specify a Moldite core specially designed and precision made for you, with absolute uniformity from first to last.

FERRITE CORES
MOLDED COIL FORMS
(iron and phenolic)
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Samples promptly submitted upon request for design, pre-production, and test purposes

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

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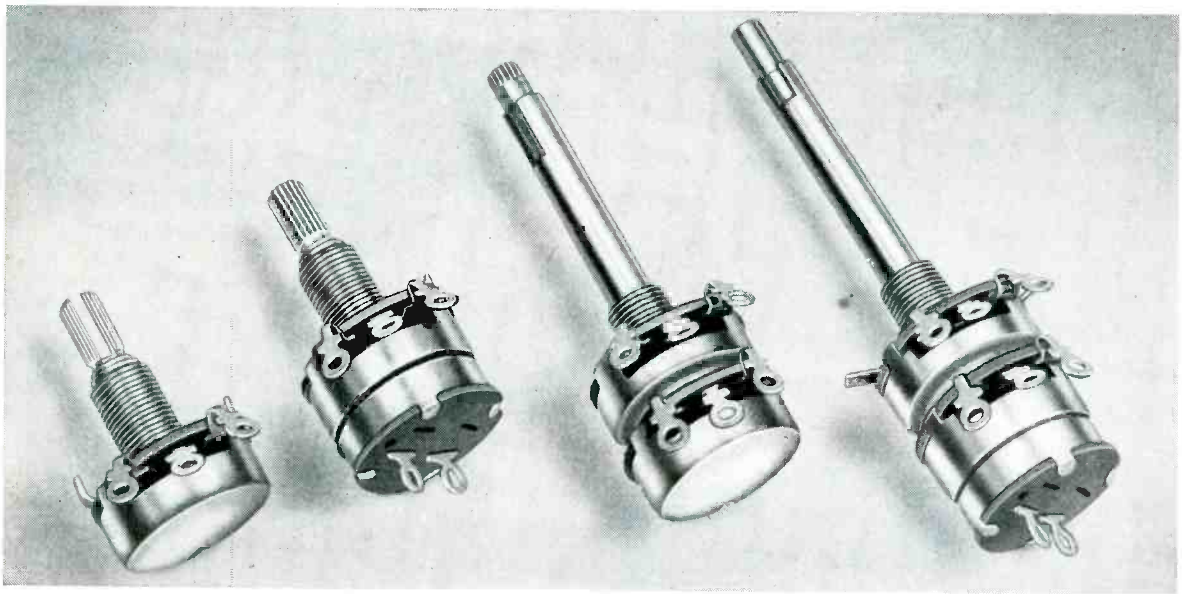
Stable, Low-Noise Carbon Controls in ANY Combination You Want



You don't have to compromise with quality to get the carbon controls your application requires. For Mallory Controls are available in a complete range of constructions, including single, dual concentric and dual tandem types . . . with or without switch.

Their noise level is unusually low, resistance values are unusually stable, and humidity drift is held to 10% . . . thanks to carbon elements with a high degree of surface smoothness and unusual density. Switches are built for long, trouble-free service, with special silver contactors and heavy gauge terminals.

Mallory Controls are built with ample ruggedness to stand any production line handling.

Expect more . . .
Get more
from MALLORY

They incorporate such mechanical features as welded assembly, vibration-proof clinched terminals, and heavy gauge fastenings.

Write today for the new catalog that describes all Mallory fixed and variable resistors . . . including both carbon and wire-wound types.

CUSTOM-BUILT CONTROLS

The control illustrated is typical of the many special types which Mallory manufactures. Designed for service adjustments in television receivers, it is a tab-mounted, bushingless model with a phenolic shaft . . . for especially economical mounting.

We'll be glad to consult with you on any special adaptations to fit your individual resistor requirements . . . also, to analyze your circuits for opportunities for resistor cost reduction.

Parts distributors in all major cities stock Mallory standard components for your convenience.

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
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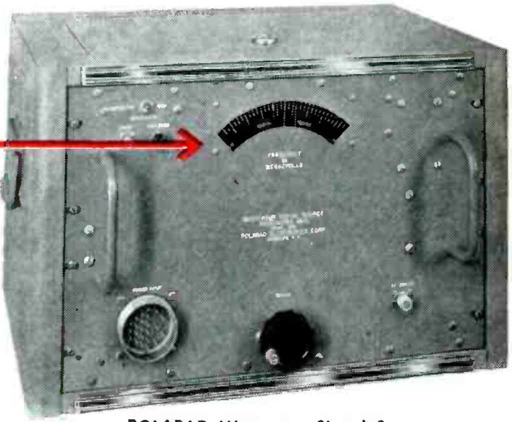
BROADBAND MICROWAVE POWER SIGNALS

as fast as you can turn the dial



POLARAD Microwave Signal Source

Make microwave measurements rapidly.

No mode charts or slide rule interpolations.

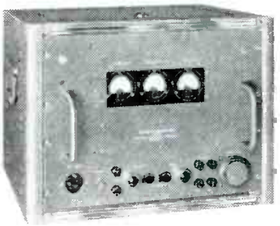
Turn only one dial and read the frequency *directly* on the dial with assured power output throughout the entire range.

Polarad's automatic tracking mechanism corrects reflector voltages for you as the klystron cavity is being tuned. Frequency accuracy is within 1%.

There are 5 models available, covering the range – 650 to 10,750 mc . . . each has approximately a 2:1 frequency range with continuous tuning . . . power output: 10 to 100 mw . . . external modulation: square wave or fm . . . temperature compensated klystron tube. *Immediate delivery on all models.*

Polarad Microwave Signal Sources save engineering man hours in the laboratory and in the factory.

Unusual economy and accuracy in making antenna and transmission loss measurements and standing wave determinations in the laboratory–excellent for microwave component testing in the factory. Write for a complete catalog and data today.



Model KX, Klystron Power Supply, especially designed for Polarad Signal Sources. Works with all 5 models. Has special 1000 cps square wave output for modulating purposes.

MINIMUM POWER AVAILABLE FROM POLARAD SIGNAL SOURCES IN THE RANGE OF 650 TO 10,750 MC

		MODEL SSR	MODEL SSL	MODEL SSS	MODEL SSM	MODEL SSX
FREQUENCY RANGE		650-1300MC	1050-2350MC	2200-4550MC	4350-8250MC	8000-10,750MC
MINIMUM POWER AVAILABLE (mw)	Low Range	150	80	15	10	13
	Middle Range	400	150	60	70	30
	High Range	100	100	40	15	10

Signal Sources in the range 10,750 to 50,000 mc available on special order.

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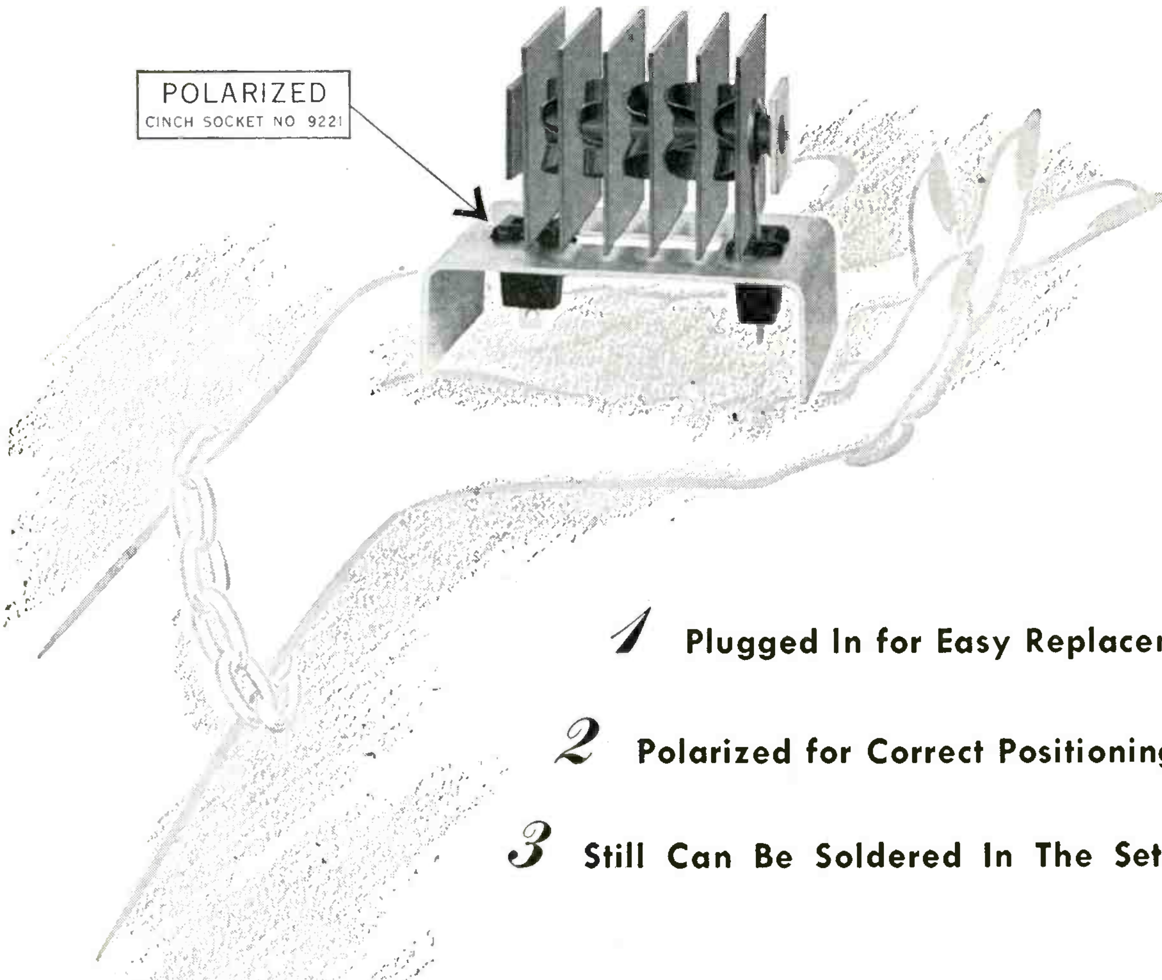
Plug-In

Selenium Rectifiers



1 **Plugged In for Easy Replacement**

2 **Polarized for Correct Positioning**

3 **Still Can Be Soldered In The Set**

Available In All Sizes.

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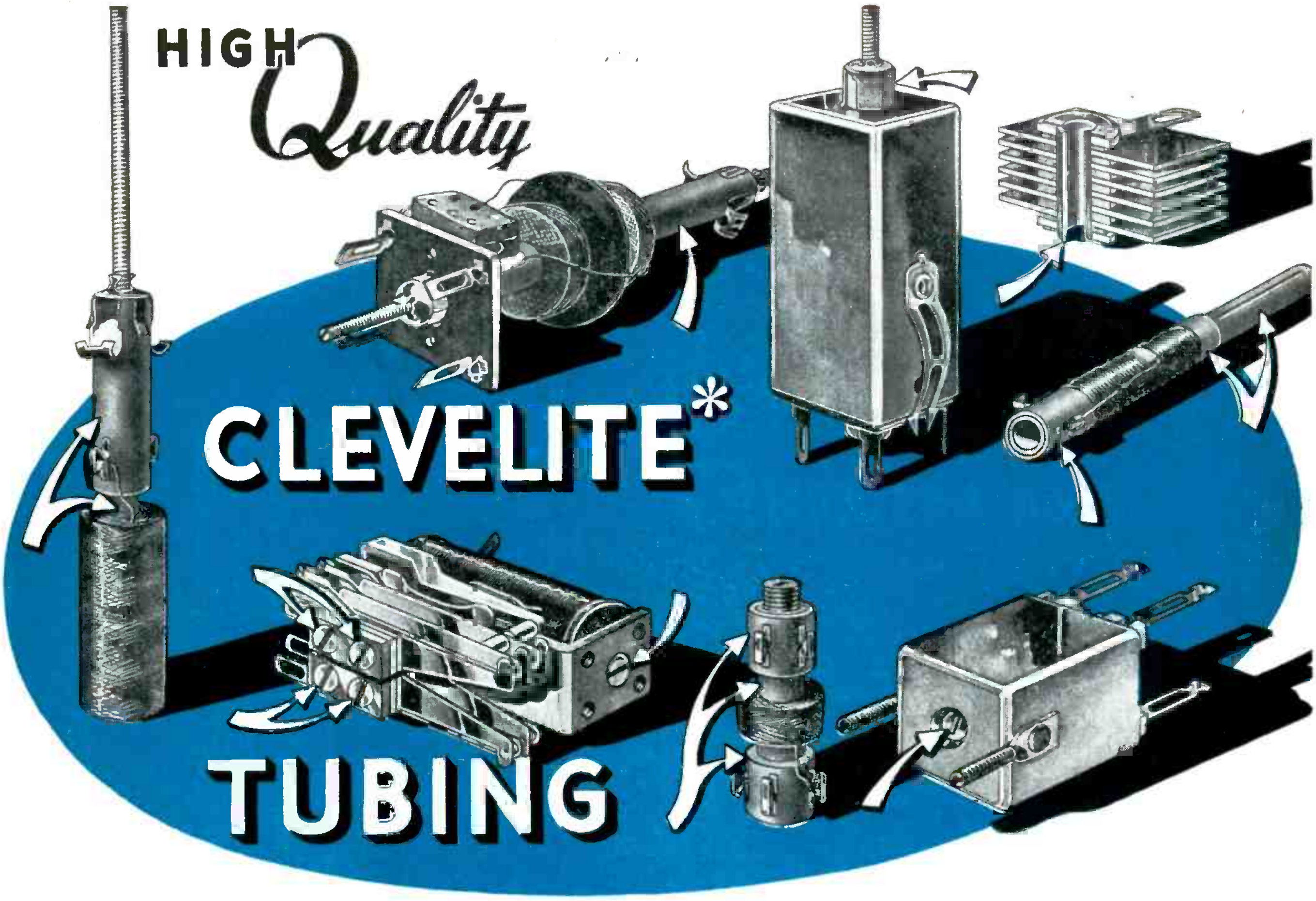

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ITS CHARACTERISTICS INCLUDE:

High Dielectric Strength . . .

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Low Loss and Good Machinability.

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CLEVELITE is known for its dependability—uniformity—and ability to meet required tolerances, which are particularly important in coil forms, collars, bushings, spacers, tubes and many other products. Available in diameters, wall thickness and lengths as desired.

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It is true that tubing of other materials costs you far more than STONIZED Spiral Phenolic Tubes. Upon close examination of your specifications, you may find that the very characteristics for which you bought your present tubing are present in our STONIZED tubes.

These paper-base phenolic tubes with high dielectric strength, low moisture absorption, and good dimensional stability are available in various grades which can be punched, notched, slotted, printed or have specially formed ends.

STONIZED Spiral Phenolic Tubes can be furnished in various wall thicknesses and lengths with inside diameters as low as $^1/_{16}$"

Our quality controlled manufacturing process enables us to furnish you with a custom-made product at a mass production price.

A phone call or letter to us today may mean a considerable saving to you.

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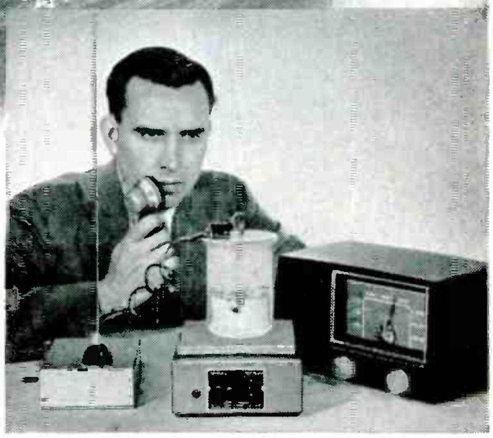
TESTS PROVE EFFICIENT OPERATION —BELOW ZERO AND AT 100°C!



VACUUM
JUNCTION TRANSISTORS

WELL deserved recognition has been given General Electric's new vacuum sealed junction transistors throughout the entire engineering world. For here is a product with performance characteristics *second to none.* Designed for mass production at *low cost,* new G-E transistors ideally answer the needs of multiple commercial and military applications. Include this *tested and proved superior* product in your design plans now!

For complete specifications and additional information write today! *General Electric Company, Section 414, Electronics Park, Syracuse, New York.*

● To demonstrate positive elimination of temperature and humidity restrictions this transistor was operated as the heart of a miniature radio transmitter while frozen in a cake of ice which was then melted and converted into boiling water. Above J. H. Sweeney, Manager of Marketing, G-E Germanium Products, demonstrates the unique system.

DESIGN FEATURES:

VACUUM SEALED JUNCTION... contaminating gases permanently eliminated!

WELDED SEAM CONSTRUCTION... free from solder-flux contamination.

HIGH POWER OUTPUT... case design makes possible a collector dissipation of 150 MW.

HIGH FREQUENCY PERFORMANCE... specifications cover operation at audio and supersonic frequencies.

HERMETIC SEAL... unaffected by moisture.

HIGH TEMPERATURE OPERATION... rated for a maximum junction temperature of 100°C.

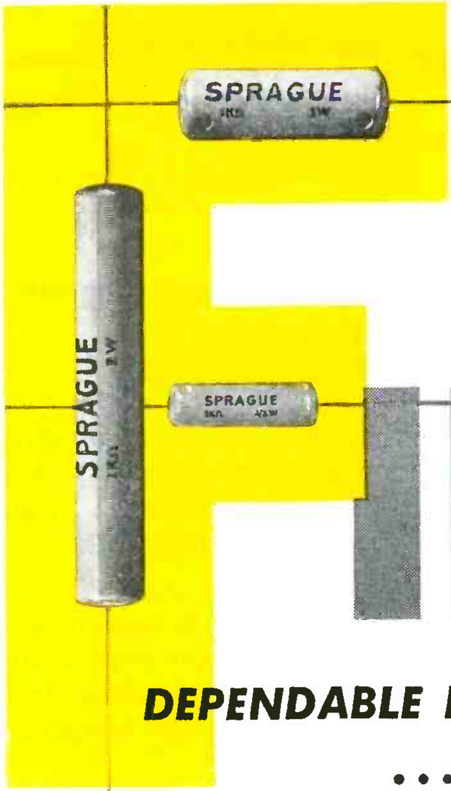
LONG LIFE... stable performance throughout the life of your equipment.

SMALL SIZE... extremely compact design provides added flexibility for all applications.

NEWS FROM OUR ADVANCED DEVELOPMENT LABORATORIES

● Silicon junction rectifiers are capable of operating at relatively high temperatures. Heretofore, this advantage has been offset by high forward resistance compared to germanium. General Electric laboratories have recently succeeded in making 1 mm² silicon junctions having a forward resistance of only 1 ohm at 1.5 amperes.

GENERAL ELECTRIC



MOLDED JACKET IS

MOISTURE-RESISTANT

VAPOR-RESISTANT

AND INERT TO FILM!

FILMITE® "B"

DEPENDABLE BORO-CARBON RESISTORS ...IN ½, 1, AND 2 WATT RATINGS

Now for the first time you can obtain a superior yet relatively low cost film-type resistor for military electronic gear—resistors that not only meet the severe performance requirements of Military Specification MIL-R-10509A, but are capable of full voltage dissipation at 70°C ambient!

Sprague Type 4E, 5E, and 6E Filmite B resistors are housed in a dense molded jacket which not only provides unexcelled physical protection for the film resistance element but serves as a barrier to moisture and vapor, the twin enemies of all film-type resistors.

Boro-carbon films are unusually sensitive to moisture. Protection against moisture in any form is a primary requirement for successful long term stability of resistance. The low-loss phenolic housings on molded Filmite resistors not only shed water but are vapor resistant and inert to the film material. There is minimum possibility of field failure through electrolytic action and penetration of moisture or vapor through the dense molded jacket.

Other features of molded Filmite B resistors are special low-contact-resistance, low noise end terminations held rigidly in place on special ceramic cores, extremely low temperature and voltage coefficients of resistance, and excellent load-life and high frequency characteristics.

For complete engineering data, write for Engineering Bulletin No. 130 to:

SPRAGUE ELECTRIC COMPANY

35 Marshall Street, North Adams, Mass.

SPRAGUE TYPE NO.	WATTAGE RATING	DIMENSIONS (INCHES) L	D	RESISTANCE (OHMS) Min.	Max.	VOLTAGE (Max.)
4E	½	¾	¼	100	1 Meg.	350
5E	1	1 1/16	⅜	100	2 Meg.	500
6E	2	2 3/16	⅜	200	10 Meg.	750

Standard Resistance Tolerances: 1 2 and 5%

SPRAGUE

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

NORTH ADAMS, MASSACHUSETTS

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

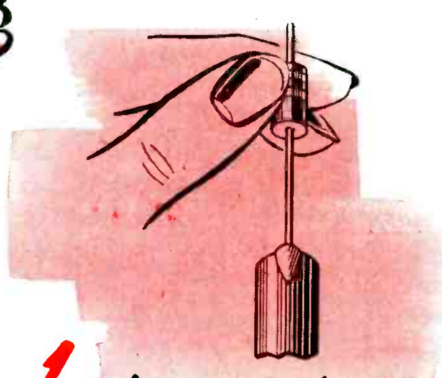
"Drop that Soldering

Revolutionary new method wraps connections so tightly that soldering is unnecessary

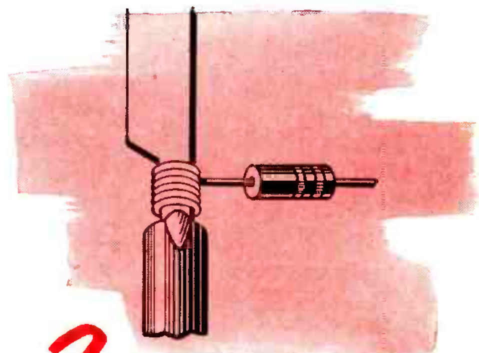
Here is a method that produces electrical connections more reliable than the most skillfully soldered connections . . . in a fraction of the time . . . at a fraction of the cost. Operator training takes only minutes instead of days.

By replacing hand operations with pneumatic or electric Wire-Wrap Tools, you get consistently uniform connections all through the day. Rejects are greatly reduced . . . inspection becomes simple . . . production costs are cut.

Investigate this revolutionary new process—write for Bulletin No. 11, today.



1 INSERT WIRE



2 ZIP... AND

Wire-Wrap Tools

are now available from Keller—
the original manufacturer

KELLER TOOLS

Iron, Sister!!...

THIS **NEW**

Wire-Wrap Tool

MAKES SOLDERLESS CONNECTIONS

...in half the time!

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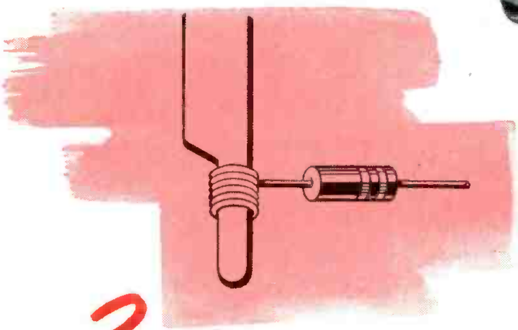

3 IT'S FASTENED

KELLER
Wire-Wrap
TOOLS
Wire-Wrap Division

KELLER TOOL CO.
Grand Haven, Michigan

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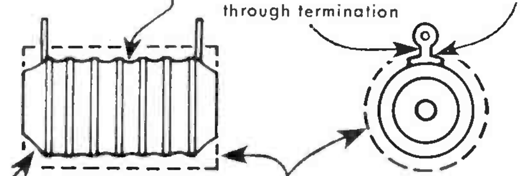
WHAT ABOUT
Encapsulated
PRECISION WIREWOUND RESISTORS?

Engineers, buyers, and purchasing agents during the past year have had thrust upon them something new to consider in the precision wirewound resistor field. Verbally and through the medium of advertising it has been relentlessly stated that encapsulated resistors exceed and surpass MIL-R-93A and JAN-R-93 specifications, but frequently without proof of performance. Quite to the contrary, there have been production difficulties, overnight changes in encapsulating materials, and reluctance to reveal just what these encapsulation materials were. As evidenced by previous messages in this series, Shallcross believes it better to reveal than conceal!

The bobbins and the coating in Shallcross "P" type wirewound encapsulated resistors are the same mineral filled, pigmented epoxy resin. The material is "hot" curing, which simply means that it cures at a much higher temperature than "cold" resin. Some "cold" resin resistors now on the market have one major failing, they become deformed after temperature cycling. Shallcross encapsulated resistors remain unaffected.

The efficient Shallcross encapsulation results in a sealed resistor with a physical configuration (see sketch) providing maximum winding area and leakage paths, minimum size and weight, and aesthetically, retention of the visual identity of a precision wirewound resistor. The seal of Shallcross "P" type resistors cannot be broken by flexure of the lugs. The lugs are designed so that excessive flexure will result in bending of the lug *outside* of the encapsulation.

Shallcross "P" type encapsulated resistors pass military qualification approval tests easily and are the only resistors to date to pass the more stringent qualification approval tests of a leading eastern manufacturer of electronic equipment. This test requires 24 temperature cycles from −65°C to



+100°C as compared with only 5 cycles from −55°C to +85°C required by MIL-R-93A. In qualification approval tests more rigid than MIL-R-93A, another leading eastern airborne electronic manufacturer reports that Shallcross "P" type resistors passed all tests without failure. Three other manufacturers tested had from one to nine failures in each test.

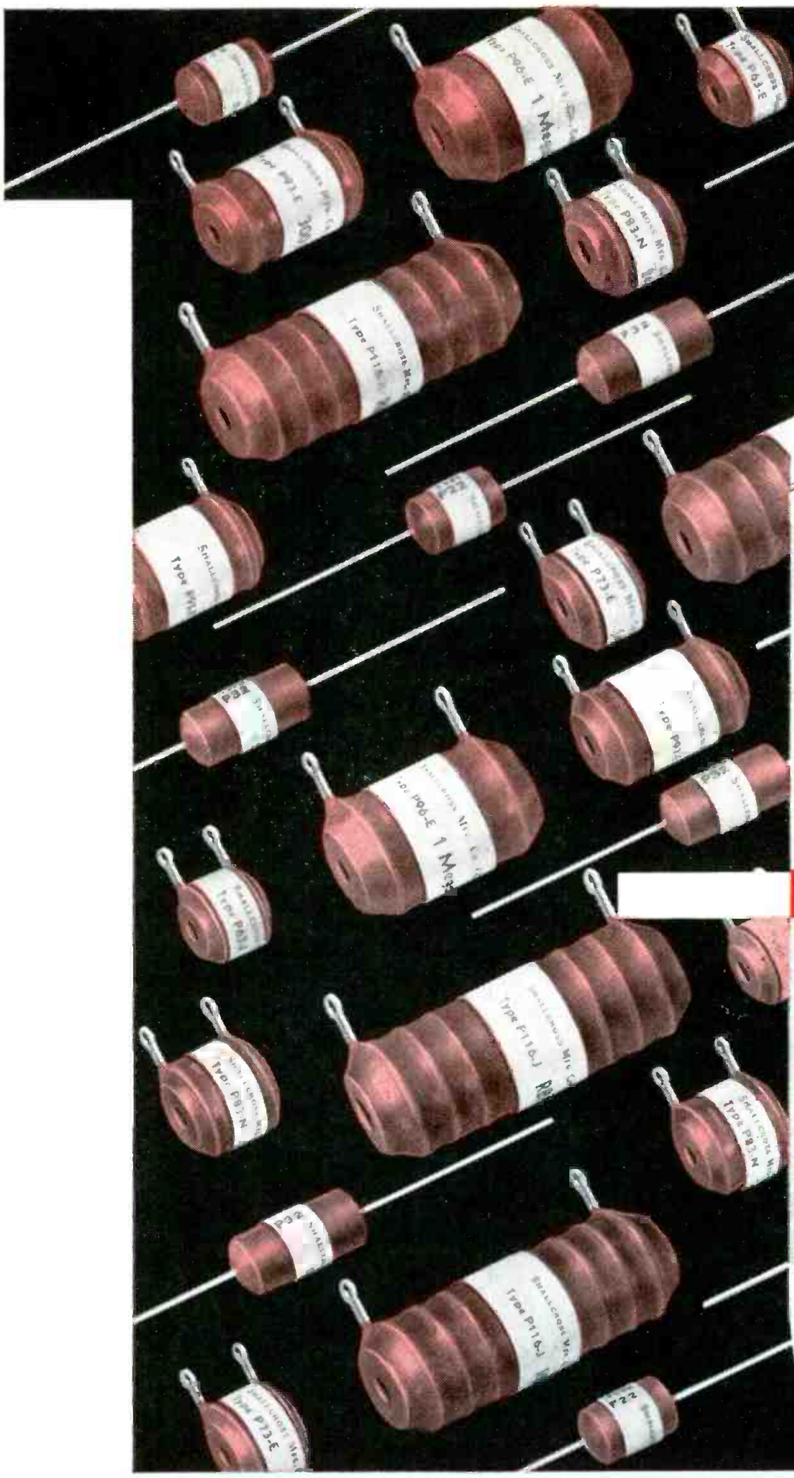
The "P" type sealed resistors are unquestionably the most outstanding development in sealed precision wirewound resistors since Shallcross patented the sealed-in steatite "1100" series in 1945. Both the old "1100" series and the new lower cost "P" types pass the immersion cycling tests of JAN-R-93, Characteristic A.

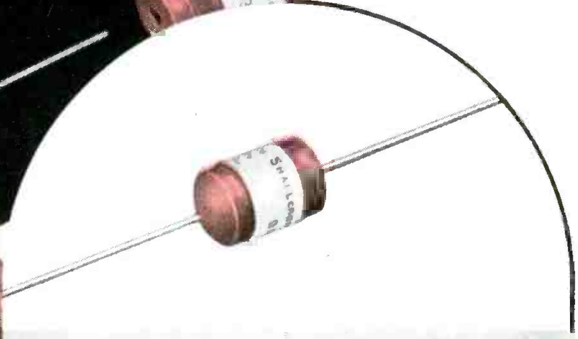
Test data, available styles and ratings for Shallcross "P" type resistors are yours for the asking. Write for Engineering Bulletin L-30.

1929 Our twenty-fifth year 1954

SHALLCROSS MANUFACTURING COMPANY • 522 PUSEY AVENUE, COLLINGDALE, PA.

The fifth of a series to promote a better understanding of the performance characteristics of precision wire-wound resistors.



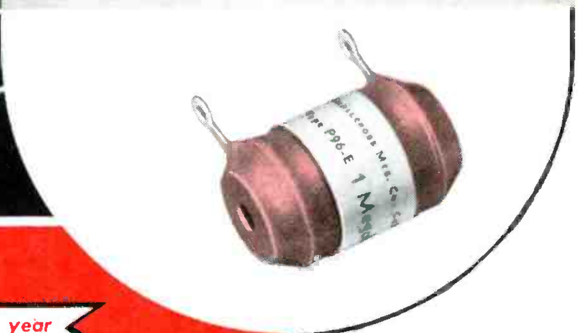


AXIAL LEAD ENCAPSULATED RESISTORS

Ideal where space and weight are at a premium, these resistors have securely anchored leads that cannot break the seal. Available in five sizes, including several that conform to MIL-R-93A style RB52.

LUG TYPE ENCAPSULATED RESISTORS

Available in all MIL-R-93A styles with commercial ratings to 3.5 watts, Shallcross "P" type resistors are suitable for 125°C operation.



Our twenty-fifth year

Shallcross

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by

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with new features for greater accuracy and time-saving facility in all testing

• Provides accurate meter measurement of leakage resistance as high as 5 megohms between tube elements.

• Permits high transconductance measurements, with ranges 3000/6000/12000/24000 micromhos.

• Multiple switching protects against early obsolescence, allows making any combination of tube connections.

• Element switching permits checking and comparing individual sections of twin-section tubes without changing selector switch.

• Only *one* socket for each type tube base eliminates plugging tubes into wrong sockets.

• Sockets for all type bases . . . including acorn and 7 and 8 pin subminiatures.

• 19 filament voltage settings—.65 to 115 volts. 5 plate voltages — 20 to 177 volts. A 45-volt source for testing subminiature types.

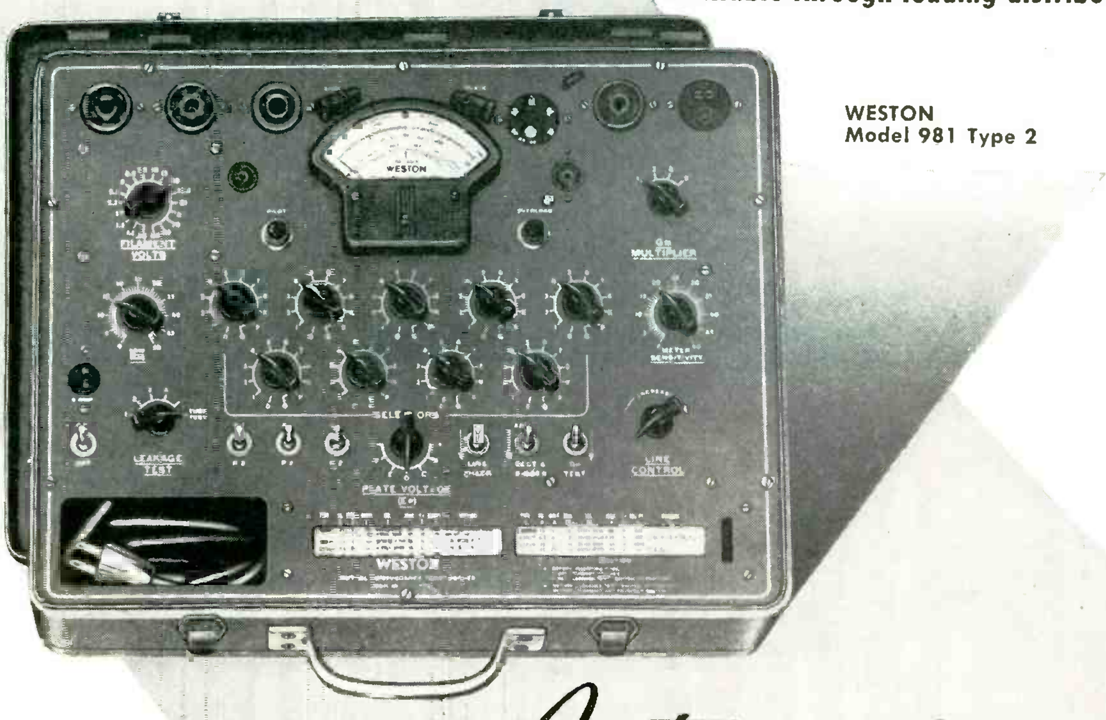
• Grid bias, plate voltage and meter sensitivity adjustable.

• Large, readable fan-shaped meter . . . new roll chart with complete, up-to-date data on all tubes.

Complete data on the new Model 981 Type 2 available in bulletin form. Write . . . WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

5539

Available through leading distributors



WESTON
Model 981 Type 2

WESTON *Instruments*

NON-STOP ORDER AND DELIVERY SERVICE • SPECIFIC TUBE DESIGN SERVICE • SPECIFIC TUBE APPLICATION SERVICE
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Now for TV-transmitter builders, a cost-saving G-E SERVICE....

HIGH-GAIN U-H-F TUBES FOR EVERY STAGE, DRIVE TO FINAL!

G-E SERVICE—specific tube design service—helps you build real economy into your new transmitters . . . because G-E high-gain power tubes mean *fewer intermediate stages.* With their low drive requirements, these advanced u-h-f types reduce circuitry—save tubes and components—so keep down the cost of your equipment. Lower power bills, less maintenance, are plusses you can offer cost-conscious station operators.

G-E SERVICE brings you a complete line of up-to-900-mc high-gain tubes, 250 w to 12 kw. *Service at your door!* G-E engineers will be glad to work side-by-side with your designers on tube applications. You may draw freely on their specialized knowledge and experience. Wire or write *General Electric Company, Tube Department, Schenectady 5, New York.*

LOW DRIVE, HIGH GAIN.....SEE FIGURES BELOW!
YOU CUT DOWN ON INTERMEDIATE TUBE STAGES, REDUCE USERS' POWER BILLS.

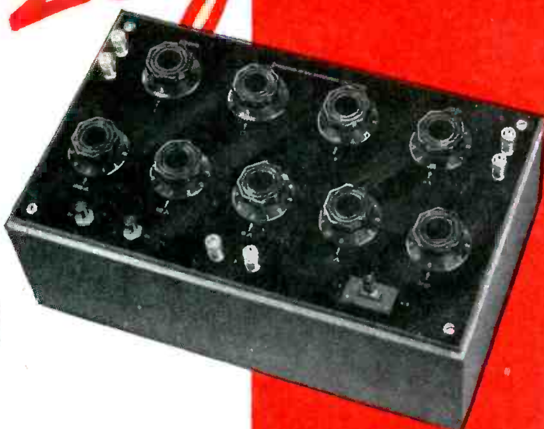
GL-6283 TETRODE	GL-6019 TETRODE	GL-6183 TETRODE	GL-6182 TETRODE	GL-6237 THROUGH GL-6242 KLYSTRONS
250 W OUTPUT	1 KW OUTPUT	1 KW OUTPUT	5 KW OUTPUT	12 KW OUTPUT
35 W DRIVE	100 W DRIVE	100 W DRIVE	300 W DRIVE	60 W DRIVE
POWER GAIN 7.1	POWER GAIN 10	POWER GAIN 10	POWER GAIN 16.6	POWER GAIN 200

10 TUBES
250 w to 12 kw
(Approx power output, typical operation, broadband TV service, sync-level conditions.)

GENERAL ELECTRIC

163-1A1

"We have used D-H MANGANIN for 25 years..."



DOUBLE-PURPOSE BRIDGE. This Shallcross Model 6320 Wheatstone Limit Bridge can be used both for exact resistance readings and, in production, for rapid checks on percent deviation from an accepted standard. Overall range extends from 0.1 ohms to 111,110,000 ohms. All resistors are D-H Manganin.

Says **SHALLCROSS MANUFACTURING COMPANY,** Collingdale, Pa.: "For 25 years we have been using Driver-Harris Manganin wire in the construction of Wheatstone and other precision bridges. In addition, D-H Manganin alloy has been used in many special standards for research and development laboratories. We feel that the quality of our products and the reputation of our instruments have been greatly enhanced by its use."

Behind statements like these stand Driver-Harris production and drawing techniques, which provide Manganin of such fixed stability that maximum change in resistance between 15°C and 35°C is only about 15 parts per million per degree centigrade—and frequently *less than one-third this* amount. Equally good electrical characteristics are available for ammeter shunt stock operating between 40°C and 60°C.

The experience of Shallcross reflects the experience of a host of manufacturers throughout the country; reflects what *you* can expect from Driver-Harris products, whether Manganin or any of the numerous alloys developed by Driver-Harris for application in the electrical and electronic fields.

Whatever your alloy problem, therefore, let us have your specifications. We'll gladly put at your disposal the skills acquired from 50 years of alloy manufacturing experience . . . make recommendations based on your specific needs.

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

*Sole producers of world-famous Nichrome**

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

Driver-Harris Company

HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco

In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario.

MAKERS OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE, AND ELECTRONIC ALLOYS IN THE WORLD

Heldor

is *Still* your

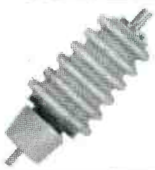
BEST BUY for

PROVEN quality-control volume production methods enable Heldor to deliver cans, terminals and assembled components — made to meet MIL-T-27 or commercial specifications — at definite savings . . . in money, time and responsibility.

With a record of past performances second to none, Heldor offers you comparable savings on your requirements. Get the facts by sending your specifications or prints for an "eye-opening" quotation. Do it now.

● CANS and COVERS

● HERMETIC SEAL BUSHINGS



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HELDOR MANUFACTURING CORPORATION

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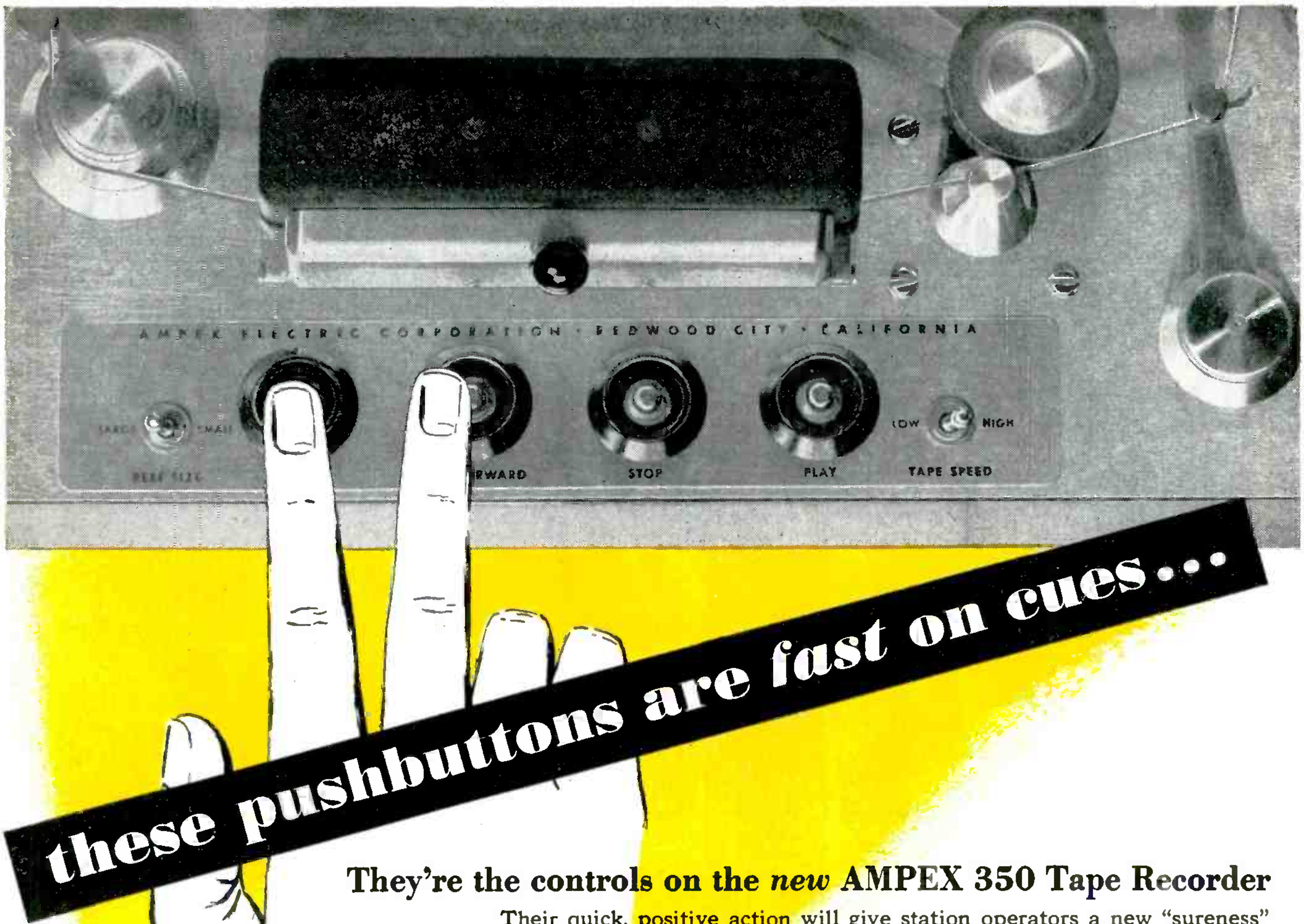
HELDOR BUSHING & TERMINAL CO., INC.

238 Lewis Street • Paterson, N. J.

Heldor

Want more information? Use post card on last page.



They're the controls on the *new* AMPEX 350 Tape Recorder

Their quick, positive action will give station operators a new "sureness" with tape. Cueing is exact; editing is faster; fumbling is out. Remote control is available too. Responsiveness has always been a part of the *Ampex Standard of* ***Excellence*** — but now it is better than ever, making the AMPEX 350 truly the NEWEST OF THE BEST.

- **STARTING WITH A SPLIT SYLLABLE**

From pressing of the start button to stable tape motion takes 1/10th second. Tape can be backed off from starting cues as little as one to two inches. Precise starts become routine. Reliability is supreme.

- **STOPPING WITHIN TWO INCHES**

Even at 15 inches per second, the tape stops within less than two inches after the button is pressed. Band type brakes give positive stops; no drift or tape spillage can occur.

- **EASIER CUEING AND EDITING**

The Model 350 can be shuttled rapidly between fast forward and rewind without stopping. Cues for starting, editing or dubbing are speedily located. And for convenient editing, the capstan drives on the "pull side" of the heads.

- **ADJUSTMENT FOR REEL SIZES**

A new switch selects proper tape tension either for 10½-inch NARTB reels or for 5 or 7-inch plastic RMA reels. Proper tension means longer tape life, more accurate timing and truer performance.

AMPEX MODEL 350
The new slant puts all controls within easy reach of any operator, tall or short.

Recorders from $975; Model 350 from $1095; Reproducers from $495. For further information write today to Dept. E-1279-A

IF YOU PLAN FOR TOMORROW, BUY AN AMPEX TODAY

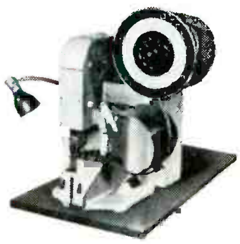
AMPEX
CORPORATION

934 CHARTER STREET, REDWOOD CITY, CALIFORNIA
Distributors in principal cities; distribution in Canada by Canadian General Electric Company

A NEW TERMINATION TECHNIQUE FOR . . .

- BUSINESS MACHINES
- COMPUTERS
- CONNECTOR PLUGS
- MULTI-CIRCUIT COMPONENTS
- SIGNAL APPARATUS
- PRINTED CIRCUITS

AMP ROUND* TAPER



Here at last is a connector which combines miniature size and self-locking action! To make electrical connections, simply press AMP Taper Pins into mating receptacles. The pins are almost as small as the wire itself, yet when securely inserted will maintain their connection even up to the point of wire failure. Salt spray and vibration tests show initial contact resistances of only 0:5 to 1.0 milliohms increasing to a maximum of 2.63 milliohms after 160 hours of cycling.

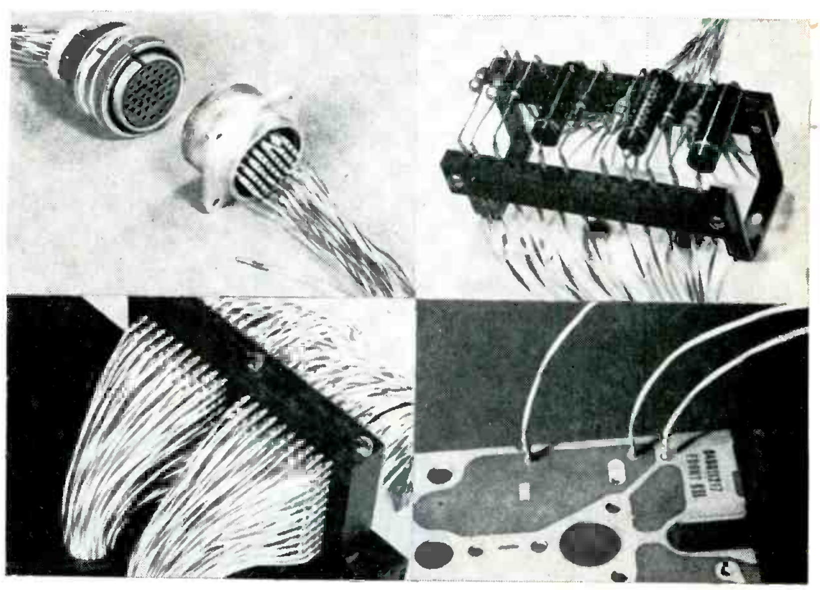
New applications are being found every day for these versatile connectors—over a billion pins are in the field in computers and associated business machines alone!

Uses include termination of printed circuits, speaker disconnects, UHF antennae filters and tuners, Germanium diodes and TV high voltage fuses etc. Extraordinary security under vibration makes them excellent for attaching wires to crowded multiple contact "AN" connectors in aircraft. Write for "TAPER TECHNIQUE" Folder.

***For relays, switches, multi-circuit components, and other applications where a flat tab is more adaptable, see AMP Taper Tab Receptacles.**

AMP Taper pins, rolled from strip stock to very close tolerances, are wound on reels ready for use in AMP Automatic Wire Terminators. Pins can be applied as fast as operator can insert wire with speeds reported as high as 4,000 per hour! Spring type installation tool will seat pins firmly in mating receptacles.

Photo courtesy Remington Rand, Inc. →



AMP Trade Mark Reg. U.S. Pat. Off.

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AIRCRAFT-MARINE PRODUCTS, INC.
ELECTRONICS DIVISION
2100 Paxton Street, Harrisburg, Pa.

Aircraft-Marine Products of Canada, Ltd.
1764 Avenue Rd., Toronto 12, Ontario, Canada

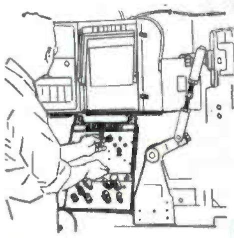
Want more information? Use post card on last page.

Are you designing any electronic equipment that should have —

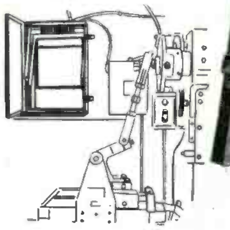
❶ Easy installation and maintenance by non-technical personnel?

❷ Widest possible use by being instantly interchangeable between machines?

See how easily these features were built into this electronic punch press protection equipment with the Alden Serve-A-Unit Kit.

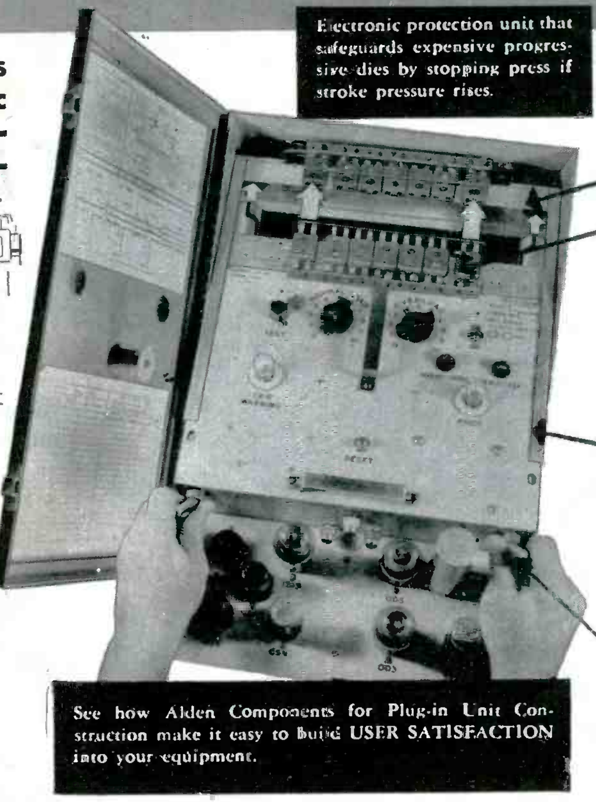


❶ In 30 seconds, user's own personnel can install plug-in protection unit . . . replace with spare . . . or shift it to another machine.



❷ With plug-in receptacle for electronic protection unit installed at each press, 8 actual electronic units are enough to serve the requirements of 14 presses, because all presses are not simultaneously active, and each electronic unit can instantly be moved anywhere to cover the active presses . . . or replace an inoperable unit.

Inoperable unit easily shipable air express for factory servicing.

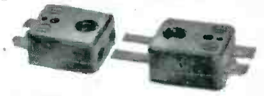


Electronic protection unit that safeguards expensive progressive dies by stopping press if stroke pressure rises.

See how Alden Components for Plug-in Unit Construction make it easy to build USER SATISFACTION into your equipment.

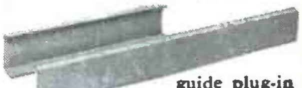
(A) ALDEN LOCK FRAME mounts mating Alden Back Connectors and engages pilot heads of Alden Serve-A-Unit Locks.

(B) ALDEN SLIDE-IN BACK CONNECTORS



spread all leads out accessibly at central check point, color coded and symboled for easy identification and first-level service checks by user's personnel.

(C) ALDEN SIDE RAILS

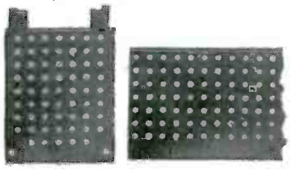


guide plug-in unit into position until pilot heads of Serve-A-Unit Locks take over.

(D) ALDEN SERVE-A-UNIT LOCKS pilot, draw in, lock and eject complete plug-in unit with a half turn of the wrist.

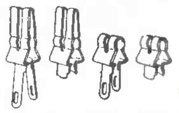
WITH ALDEN COMPONENTS, YOUR CIRCUITRY EASILY BECOMES PLUG-IN UNITS

Design your circuitry as compact vertical planes — **It's as simple as this —**



ALDEN PREPUNCHED TERMINAL MOUNTING CARDS cut to proper sizes for 7-pin, 9-pin, 11-pin and 20-pin packages. Or in 3' strips for chassis — cut it off as you require.

\+

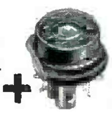


ALDEN MINIATURE STAKING TERMINALS Lay out in any pattern on Terminal Mounting Cards; ratchet slots hold elements for soldering without pliering or wrap-around.

\+

ALDEN JUMPER STRIP stakes right under Terminals providing common circuit without soldering.

\+



ALDEN CARD-MTG. TUBE SOCKETS for min. 7-pin, 9-pin and octal tubes.

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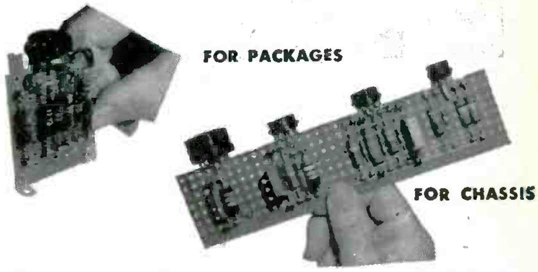
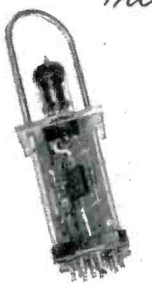


FOR PACKAGES

FOR CHASSIS

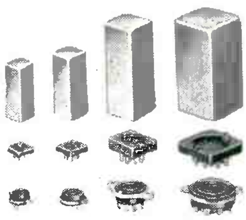
These vertical planes fit beautifully into plug-ins — **It's as simple as this —**



ALDEN PLUG-IN PACKAGE

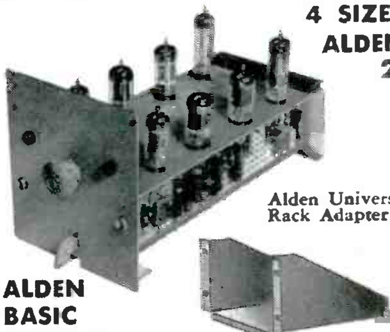
4 SIZES OF PLUG-IN PACKAGES

Alden standard Bases, Lids, Handles, Cans, Sockets for 7, 9, 11 and 20-pin packages house Terminal Card Circuitry with tremendous flexibility for endless variety of open and shielded packages . . . making it easy and inexpensive to give your equipment reliability in service with instantly replaceable plug-ins for all sub-units.



7-pin 9-pin 11-pin 20-pin

Package components and matching sockets.

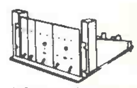


ALDEN BASIC CHASSIS

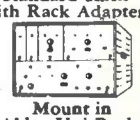
Alden Universal Rack Adapter

4 SIZES OF ALDEN BASIC CHASSIS 2", 4", 8", 17"

Your circuitry on Terminal Card strips snaps right into Alden Basic Chassis. Vertical mounting and hinged front panel give beautiful accessibility and space saving. Chasses can be plugged interchangeably into Standard Racks, Alden Uni-Racks, Alden Portable Cases. Alden Rack Adapter mates Standard Rack to Chassis.



Plugged into Standard Rack with Rack Adapter



Mount in Alden Uni-Racks

Plugged into Portable Cases

-and assign to each unit a tiny tell-tale to spot trouble instantly **It's as simple as this —**

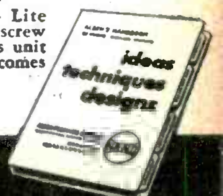
See how compact front panel easily mounts six tiny Alden Sensing Elements — specifically designed to lick the problem of having only a small amount of space. Assembled by simplest methods.

ALDEN MINI-TEST POINT JACK For checking critical voltages from front of panel.

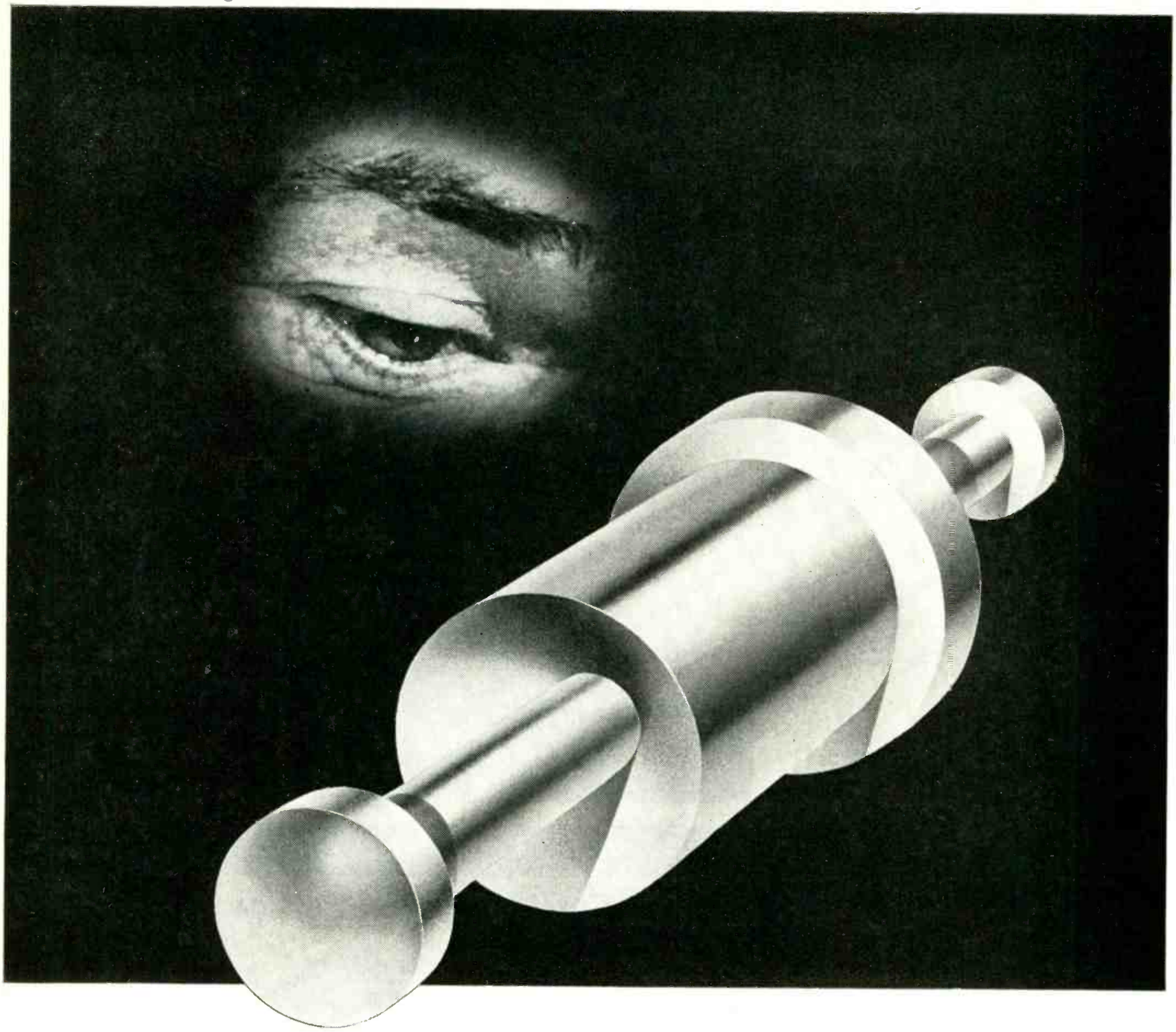
ALDEN "PAN-i-LITE" Miniature indicator light with unbreakable 1-piece light-lens unit replaceable from front.

ALDEN "FUSE-LITE" Fuse blows — Lite glows. Simply unscrew 1-piece light-lens unit and blown fuse comes out with it.

GET THE COMPLETE STORY — REQUEST "ALDEN HANDBOOK" — SENT FREE



ALDEN PRODUCTS COMPANY 127 North Main Street, Brockton, Mass.



The "skin" we love to watch

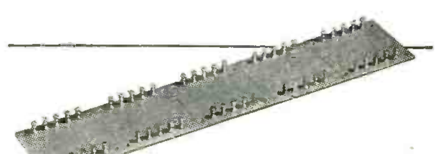
The "skin," or plated coating, on CTC terminals gets extremely close scrutiny from our quality control engineers. And we take pleasure in this careful watching because —

We know, as a result, that you can depend on CTC terminals for electroplated coatings of guaranteed minimum thickness — whether to government specifications or your own.

Our "watching" of these coatings includes periodic bend tests for adhesion, and periodic microscopic inspection of cross sections for coating thickness. These are but two of many examples of quality control that enable us to offer customers *guaranteed* electronic components . . . custom or standard.

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.



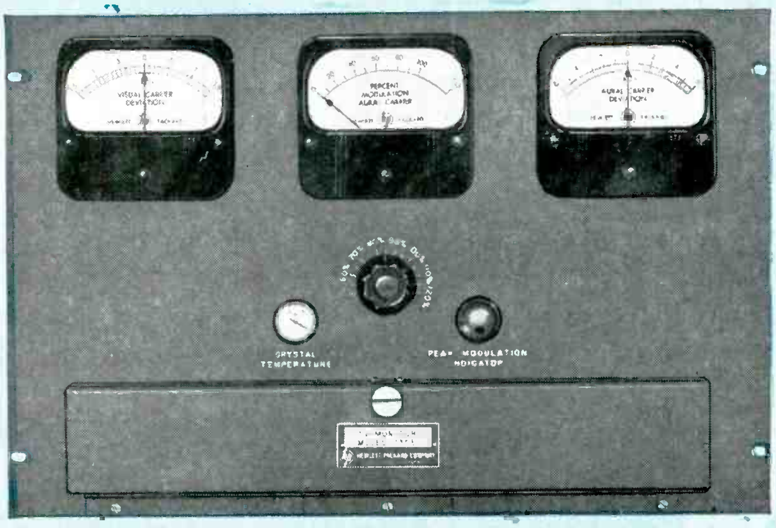
Standard CTC Terminal Boards as well as those made to your own specifications by CTC are available. Standard in cotton fabric phenolic, nylon phenolic or grade L-5 silicone impregnated ceramic. Custom made in cloth, paper phenolic, melamine, or silicone fibreglas laminates, imprinted as required and lacquered or varnished to specifications MIL-V-173 and JAN-T-152.

CTC

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components, custom or standard

ELECTRONIC TEST INSTRUMENTS



TV MONITOR

MODEL 335E

All channels 2 to 83

Exceeds F. C. C. requirements

12¼" high; rack mounted

High stability, accuracy, long-term dependability

Monitors visual, aural frequencies; percentage aural modulation

New! Small, low-cost monitor for all TV channels gives continuous, precise indication without adjustment

The unusually compact, low-cost Model 335E occupies just 12¼" of a standard relay rack. Yet it accurately and continuously performs all VHF and UHF television monitoring functions including visual and aural carrier frequency and aural carrier percentage modulation measurement.

Carefully engineered crystal reference oscillators provide accuracy in excess of F. C. C. requirements for all channels. Because discriminator accuracy does not depend on a tuned circuit, no time-consuming adjustments are required during operation. It is never necessary to reset carrier level or realign circuits. Proper operation of the monitor can be checked conveniently by controls located behind the front panel cover.

Trouble-Free Dependability

The monitor is specifically designed to operate at full accuracy over long periods of time without maintenance. Highest quality components and construction are used throughout. A new chassis design increases accessibility of components and makes possible cool operation through forced ventilation. Extra features include provision for remote indicating meters, remote peak modulation indicator lamp, and a demodulated signal for aural monitoring.

The instrument also includes a front-panel crystal temperature indicator and illuminated meter faces. It fits a standard relay rack, and can be color finished to match your transmitter installation.

SPECIFICATIONS

AURAL FREQUENCY MONITOR

Deviation Meter Range: +6 kc to −6 kc.
Accuracy: Better than ±1,000 cps for at least 10 days.

AURAL MODULATION METER

Modulation Range: Meter reads full scale on 33.3 kc swing. Calibrated to 100% at 25 kc swing; 133% at 33.3 kc swing.
Accuracy: Within 5% of mod. full scale.
Meter Characteristics: Meter damped in accordance F.C.C. requirements. Reads peak value of modulation peak of duration between 40 and 90 milliseconds. Meter returns from full reading to 10% of full value within 500 to 800 msec.
Frequency Response: Flat within ± ½ db, 50 to 15,000 cps.

MODULATION PEAK INDICATOR

Peak Flash Range: From 50% to 120% modulation (25 kc = 100%).

VIDEO FREQUENCY MONITOR

Deviation Meter Range: +1.5 to −1.5 kc.
Accuracy: Better than ±500 cps for at least 10 days.

AUDIO OUTPUT

Frequency Range: 50 to 15,000 cps. Response flat within ± ½ db. Standard 75 μsec de-emphasis circuit.
Distortion: Less than 0.25% at 100% modulation.
Output Voltage: 10 volts into 20,000 ohms at 100% modulation (low frequencies).
Monitoring Output: 1 milliwatt into 600 ohms, balanced, at 100% modulation (low frequencies).
Residual Noise: At least 70 db below output level corresponding to 100% modulation (low frequencies).

GENERAL

Frequency Range: Channels 2 to 83 inclusive, including offset channels.
R. F. Power Required: Approx. 1 watt.
External Meter Indication: Available for aural carrier deviation, video carrier deviation, aural modulation percentage and peak indication.
Size: 12¼" x 19" x 13". Rack mounting.
Power: 115 volts, 50/60 cps, 180 watts.
Price: $1,950.00 f.o.b. factory.

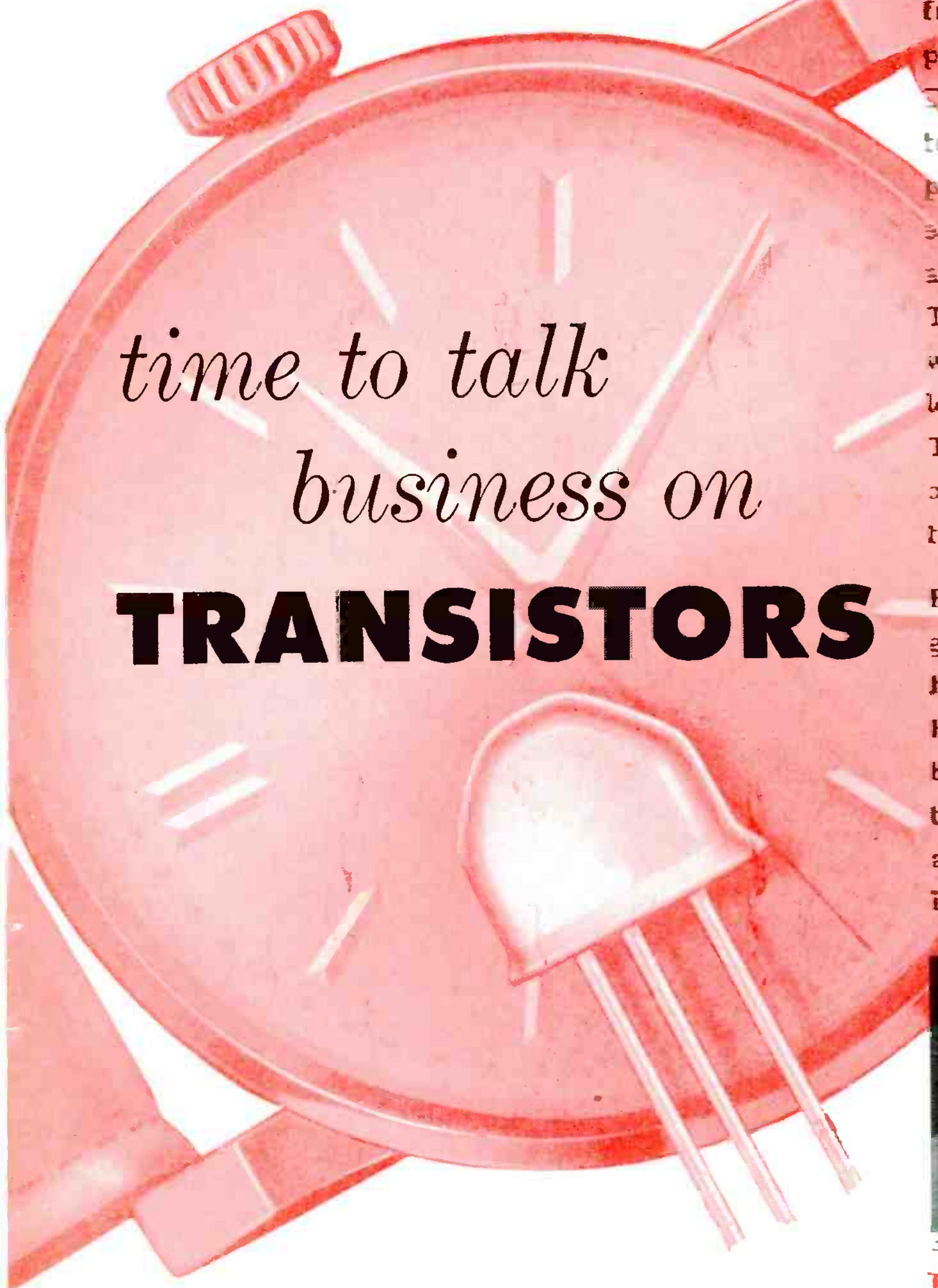
Data subject to change without notice

HEWLETT-PACKARD CO.
2757A Page Mill Road, Palo Alto, California, U. S. A.
SALES AND ENGINEERING REPRESENTATIVES IN PRINCIPAL CITIES

Instruments for Complete Coverage

Want more information? Use post card on last page.

If you are in Electronics you are going to need Transistors.
The time to investigate is NOW!

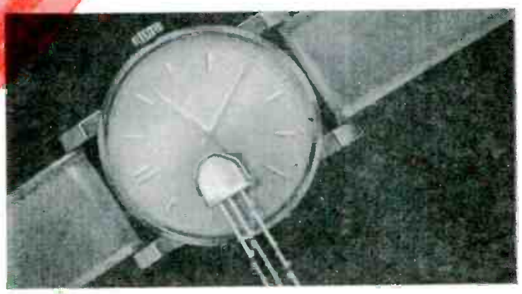


time to talk business on TRANSISTORS

From now on the use of Transistors is going to spread rapidly. Their advantages in simplifying design are unique. Their potential applications are endless.

Whenever you think of vacuum tubes, from now on you should consider the possibility of substituting Transistors. True, the characteristics of the Transistor do not lend themselves to direct replacement of tubes in existing circuitry; each new application must be designed around the Transistor. What makes the Transistor so overwhelmingly worth while is its small size and light weight, long life and low cost. In addition, the Transistor's versatility of function opens up a broad new field of applications never before possible.

By consulting with Hydro-Aire now you get a head start in exploring the possibilities that Transistors hold for you. Hydro-Aire's specialized research know-how and experience in such important techniques as true hermetic sealing are at your disposal. Our engineers are waiting to consult with you—now.*



Actual size

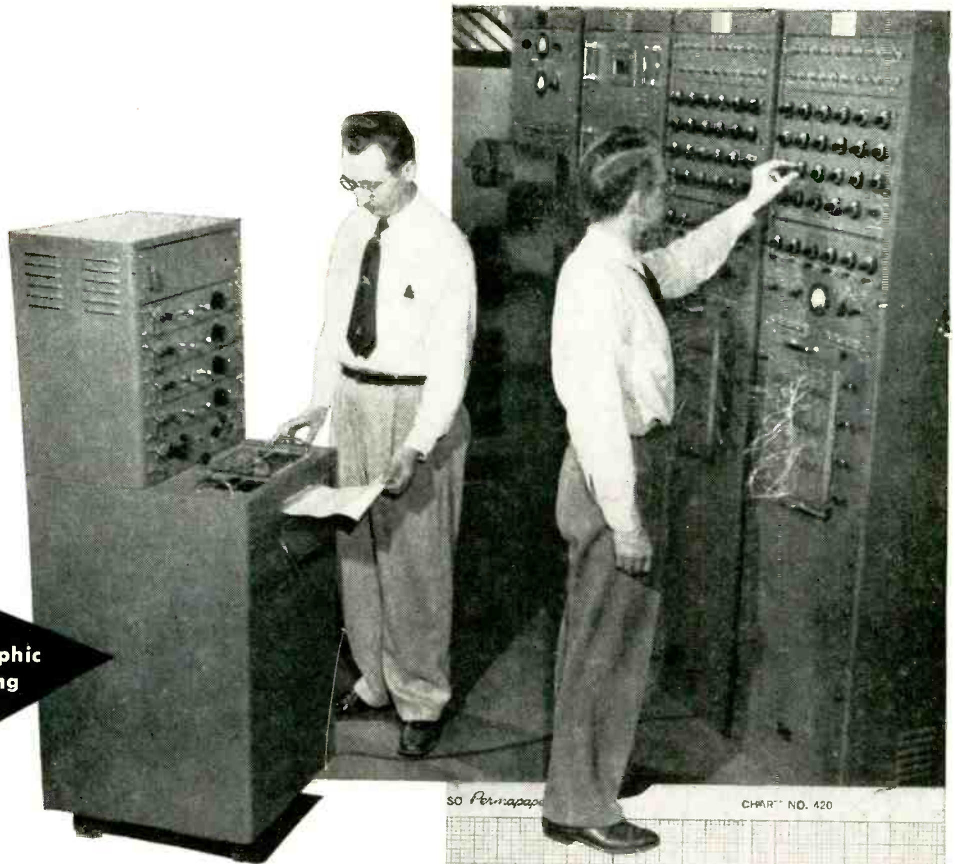
* *Please address your inquiries:* CHIEF CONSULTING ENGINEER, Transistor Development and Application Division, Hydro-Aire, Inc., 3000 Winona Avenue, Burbank, Calif.

HYDRO-AIRE *Inc.*

BURBANK, CALIF.

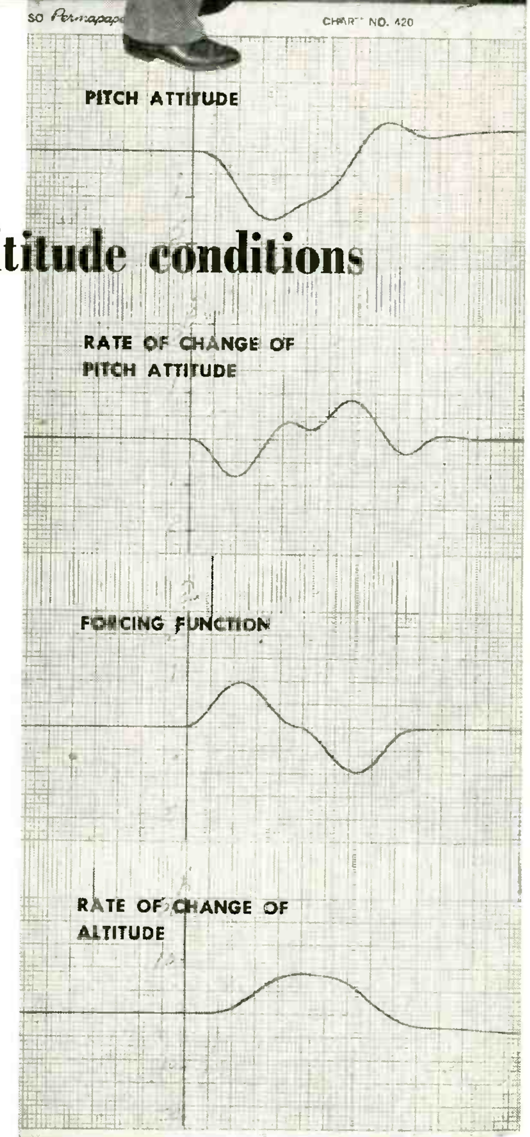
Subsidiary of Crane Co.

CONSULTANTS ON TRANSISTOR APPLICATIONS



Another example of Sanborn Oscillographic Recording Versatility

Four-channel recording correlates simulated jet bomber airspeed and altitude conditions



At Eclipse-Pioneer, engineers make good use of Sanborn 4-channel recording systems in conjunction with high precision analogue computers to establish performance criteria for automatic flight systems and components.

At other laboratories Sanborn Systems are being used to record such phenomena as: stress, strain, pressure, displacement, thickness, velocity, acceleration, current, voltage, temperature, torque, light, flow, force, load, position, rpm, radiation and tension.

SANBORN OSCILLOGRAPH RECORDING SYSTEMS HAVE MANY APPLICATIONS. They are used in a great many different fields where accurate and permanent graphic registration of almost any electrical phenomena (whose frequency range is zero to 100 cycles per second) is required.

Sanborn Systems are widely used because of the availability and ready interchangeability of amplifiers and preamplifiers, as well as such Sanborn advantages as: inkless recording in true rectangular coordinates, high torque movement, time and code markers and wide choice of paper speeds. In addition, a basic choice of systems, 1-, 2-, and 4-channels, provides a system to fulfill almost any laboratory requirements.

WRITE FOR CATALOG

Sanborn Company

INDUSTRIAL DIVISION

CAMBRIDGE 39, MASSACHUSETTS, U.S.A.

NEW! FOR PRINTED COMPLETE LINE

1 FOR AUTOMATION: EXCLUSIVE NEW Self-Supporting Snap-in Bracket Mounting. (See Type YGC-B45.)

2 NEW Twist-ear Mounting. (See Types XP45 and UPM45.)

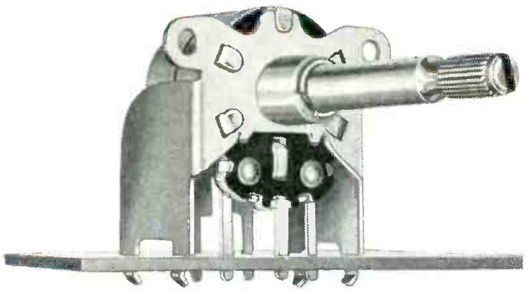
3 PLUG-IN BLADE-TYPE TERMINALS for vertical or horizontal mounting of control to printed circuit panel. (See all photos.)

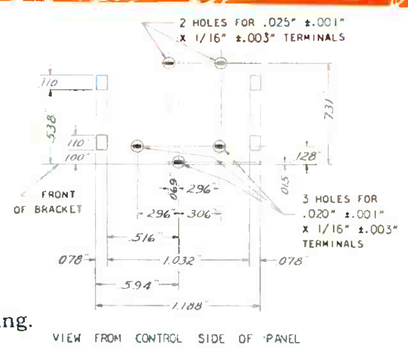
4 Threaded Bushing Mounting. (See Types XGC-45, GC-U45 and *miniaturized* U70.)

Consultation without obligation available on variable resistors for your printed circuit applications. Write today.

VERTICALLY MOUNTED to Printed Circuit Panel. Shaft above panel. (Types YGC-B45, XP45 and XGC-45.)

- NO shaft protection needed during soldering.
- PARALLEL terminals permit *small* round connecting holes instead of *large* elongated slots necessary for fan shaped terminals.
- Terminals available in 7/8" or 1-1/32" lengths from control's center.

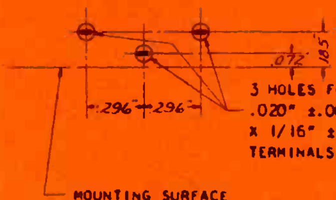




Suggested panel piercing.

Type YGC-B45 FOR AUTOMATION: *EXCLUSIVE NEW Self-Supporting Snap-in Bracket*

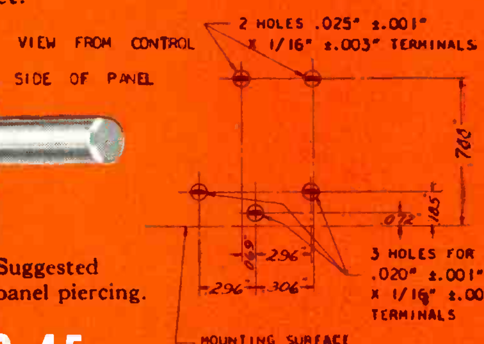
- Snaps instantly into place.
- Stays firmly put during soldering. Solder permanently anchors control to circuit panel.
- Terminal connections cannot loosen; bracket prevents mounting or operating strain on control or switch terminals.
- No mounting hardware, no separate supporting panel needed.
- No strain on printed circuit panel. Anchor tabs attach bracket to cabinet.
- Adequate clearance for circuit paths provided by ample spacing between terminals and by design of mounting lugs on bracket.



Suggested panel piercing.

Type XP45

For TV preset control applications using a mounting chassis to support printed circuit panel. Twisting 2 ears holds control rigidly to mounting chassis. Available in finger adjusted shaft lengths of 1/2", 5/8", 11/16", 7/8" and 1" from control's mounting surface. Also available with recessed screw driver slotted shaft (Type XPM45).



Suggested panel piercing.

Type XGC-45

For applications using a mounting chassis to support printed circuit panel. Threaded bushing mounting

All controls illustrated actual size.

CIRCUITS
OF VARIABLE RESISTORS

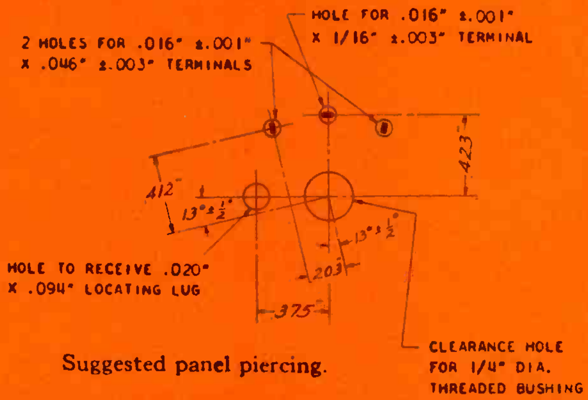
HORIZONTALLY MOUNTED

to Printed Circuit Panel. Shaft extends through panel. (Types U70, GC-U45 and UPM45.)

Type U70

(*Miniaturized*)

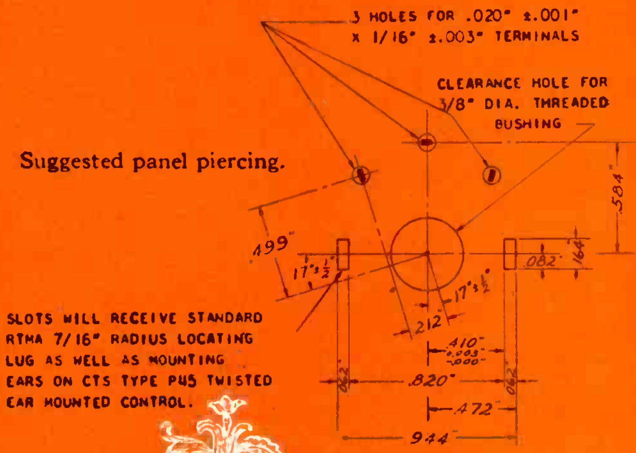
Threaded bushing mounting. Terminals extend perpendicularly 5/32" from control's mounting surface.



Suggested panel piercing.

Type UPM45

For TV preset control applications. Recessed screw-driver slotted shaft remains solder-free during panel dipping. Control may be held rigidly to panel before soldering by twisting 2 ears. If ears are left straight, the solder will permanently anchor control to circuit panel. Terminals extend perpendicularly 7/32" from control's mounting surface.



Suggested panel piercing.

Type GC-U45

Threaded bushing mounting. Terminals extend perpendicularly 7/32" from control's mounting surface. Available with or without associated switches.

Specialists in Precision Mass Production of Variable Resistors. Founded 1896.

REPRESENTATIVES

Henry E. Sanders, McClatchy Bldg., 69th & Market St., Upper Darby, Penna. Phone: Flanders 2-4420

W. S. Harmon Company, 1638 So. La Cienega Blvd., Los Angeles 35, California Phone: Bradshaw 2-3321

John A. Green Company, 6815 Oriole Drive, Dallas 9, Texas

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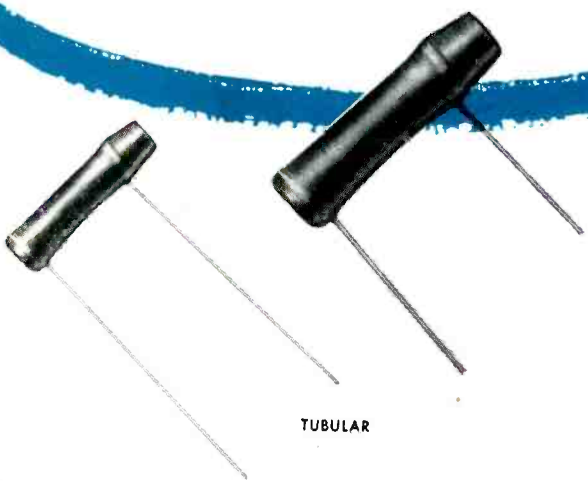
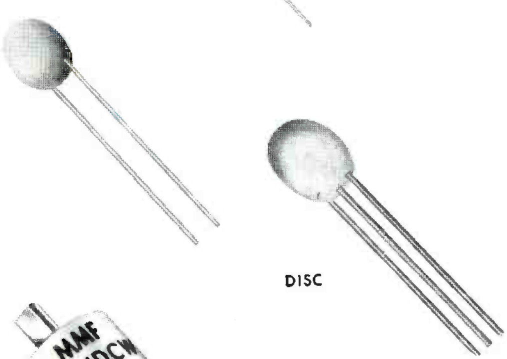
Consistently Dependable Cornell-Dubilier ceramic capacitors



TUBULAR



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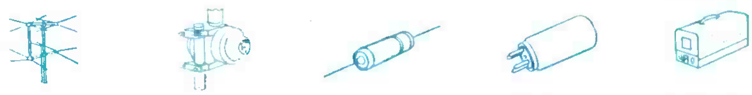
THERE ARE MORE C-D CAPACITORS IN USE TODAY THAN ANY OTHER MAKE

CORNELL DUBILIER *Capacitors*

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



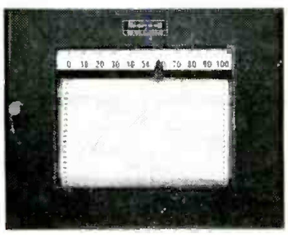
ANTENNAS ROTORS CAPACITORS VIBRATORS CONVERTERS

Want more information? Use post card on last page.

These instruments and components *can speed your research*

Listed here are some of the many special types of *ElectroniK* instruments and Honeywell components which are helping research men to measure, record and control in thousands of research projects. For information on how they can be utilized in your own work, write to MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne & Windrim Aves., Philadelphia 44, Pa.

Special ElectroniK recording instruments of interest to research men:



FUNCTION PLOTTER—automatically plots the relationship, $y = f(x)$, between any two variables that can be converted to electrical signals.

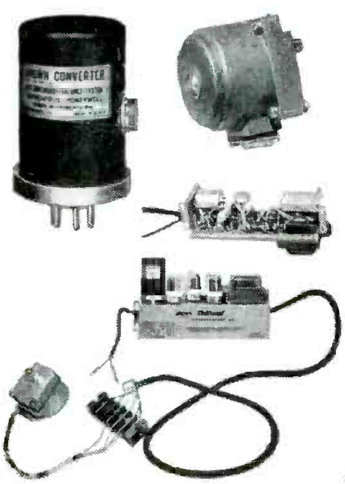
TWO-PEN RECORDER: simultaneously records two variables on a single chart . . . both pens can traverse full width of 11-inch chart.

ADJUSTABLE SPAN RECORDER: span can be adjusted over a 50/1 range . . . zero can be suppressed as much as 100% of maximum span.

½-SECOND RECORDER: for recording rapidly-changing variables; full 11-inch scale pen movement in only ½ second. Chart speeds from 1 inch to 14,400 inches per hour available.

NARROW SPAN RECORDER: measures spans as narrow as 100 microvolts without external pre-amplifier . . . completely self-contained.

Electronic components for laboratory use:



BROWN CONVERTERS: transform low-level d-c signals into 60 or 400-cycle alternating voltages . . . Unaffected by atmospheric pressure.

BROWN SERVO AMPLIFIER SYSTEMS: consist of converter, amplifier and servo motor . . . Sensitivities of 2.0, 0.5, and 0.05 microvolts are available, with corresponding voltage gains of 10^6, 4×10^6 and 40×10^6.

BROWN 60-CYCLE 2-PHASE SERVO MOTORS: Provide positive positioning . . . totally enclosed, self lubricated. Maximum torque: 27 RPM motor—85 oz.-in., 54 RPM motor—43 oz.-in.; 162 RPM motor—19 oz.-in.; 333 RPM motor—4 oz.-in.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

First in Controls

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INTERNATIONAL CRYSTAL Mfg. Co.

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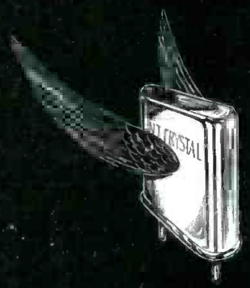
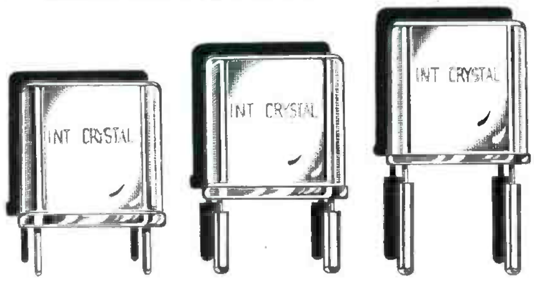


throughout the range of frequencies from 1500 kilocycles to 50 megacycles. Fundamental Crystals — 1500 KC - 15000 KC. Overtone Crystals — 15 MC - 50 MC.

All orders of less than five units of any one frequency in the range 1500 KC - 50 MC will be mailed within 24 hours from the time received.



F-605	F-609	F-612
Pin dia. .050	Pin dia. .095	Pin dia. .125
Pin lngth. .238	Pin lngth. .445	Pin lngth. .620

Pin spacing on each of above is .486

Calibration

All fundamental crystals are calibrated into 32 mmf unless otherwise specified. All overtone crystals are calibrated for series resonance, unless otherwise specified.

All units are calibrated to .0025% or better of their nominal frequency at 25° C.

WHEN ORDERING SPECIFY:

(1) Frequency (2) Holder Type*

(3) Circuit Data (32 mmf load, series resonance, etc.)

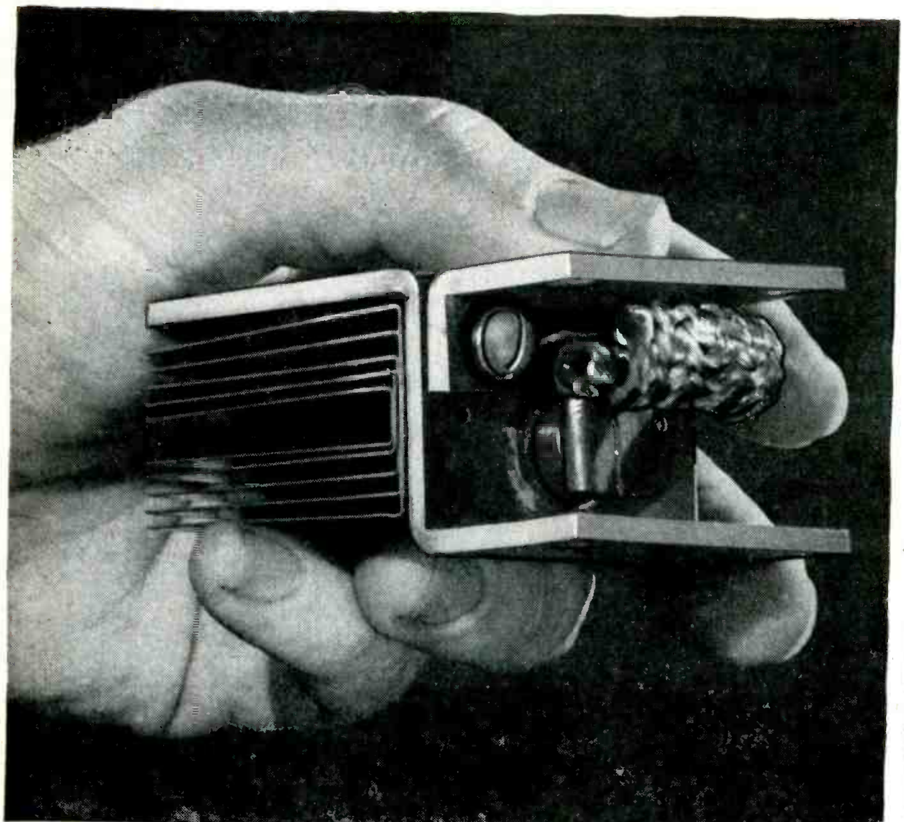
(4) End Use (Equipment type & manufacturer, development, etc.)

**Adaptors can be supplied for 3/4" pin spacing.*

For further information write, wire or call:

International CRYSTAL Mfg. Co., Inc. 18 N. Lee Phone FO 5-1165
OKLAHOMA CITY, OKLA.

Want more information? Use post card on last page.



THIS NEW MIDGET GERMANIUM RECTIFIER HAS AN OUTPUT OF OVER TWO KILOWATTS

Get High Power and Save Space With G-E Germanium Rectifiers

Germanium is a material to stimulate the imagination, so endless are its possible applications. Germanium rectifiers, pioneered by General Electric, offer design engineers tremendous possibilities for product improvement. Combining extreme compactness with the highest efficiency of any metallic rectifier known, G-E germanium cells show practically no aging. D-C power supplies for welders, battery chargers, and electrochemical processes are just a few of the possible applications.

COMPACT—The compactness of germanium rectifiers makes possible real savings in space, volume, and weight. The dime-sized cell, pictured above with its heat exchanger, has a rating of two kilowatts with air cooling at a rate of 1000 fpm. Six of these tiny rectifiers connected in a three-phase bridge will deliver up to 65 volts d-c with a rated capacity of over 14 kw. To do a comparable job with selenium would take six stacks of 30 cells each, or a total of 180 selenium plates.

OTHER RATINGS—Besides the rectifier illustrated above, two other types are available. One is a sealed convection-cooled unit with a half-wave rating of 0.4 amperes d-c output with up to 125 r.m.s. volts a-c input. A second is the plate-mounted convection or fan-cooled rectifier with half-wave ratings of from 4 to 20 amperes d-c output. All assemblies can be used in doubler, center-tap, and full-wave bridge circuits with corresponding increases in ratings.

MORE INFORMATION is available from your nearest G-E Apparatus Sales Office, or write *Section 461-32, General Electric, Schenectady 5, N. Y.*

You can put your confidence in—

GENERAL ELECTRIC

METALLIC RECTIFIER FACTS FOR ENGINEERS

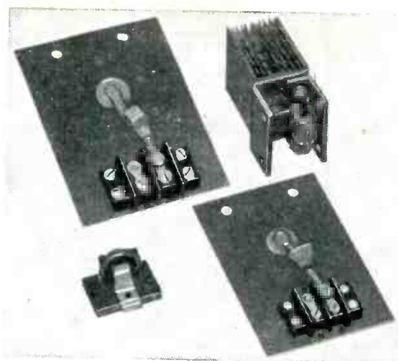
Germanium

The Rectifier of the Future
by C. E. Hamann

Seldom if ever has the rectifier industry experienced such widespread interest in a new development as has occurred with germanium. While much is being written of the capabilities of germanium in the low current area of diodes and transistors, its possibilities in high-power applications are equally amazing.

Perhaps a simple comparison with selenium of the relative current densities will serve to illustrate its fantastic properties as a power rectifier. It is standard industry practice to operate selenium in a 3-phase bridge circuit at a current density of 75 milliamperes per square centimeter of cell area. With an adequate air-cooling system this current density may safely be doubled.

Germanium is presently being operated successfully at a current density of 75 amperes per square centimeter of cell area with every indication that

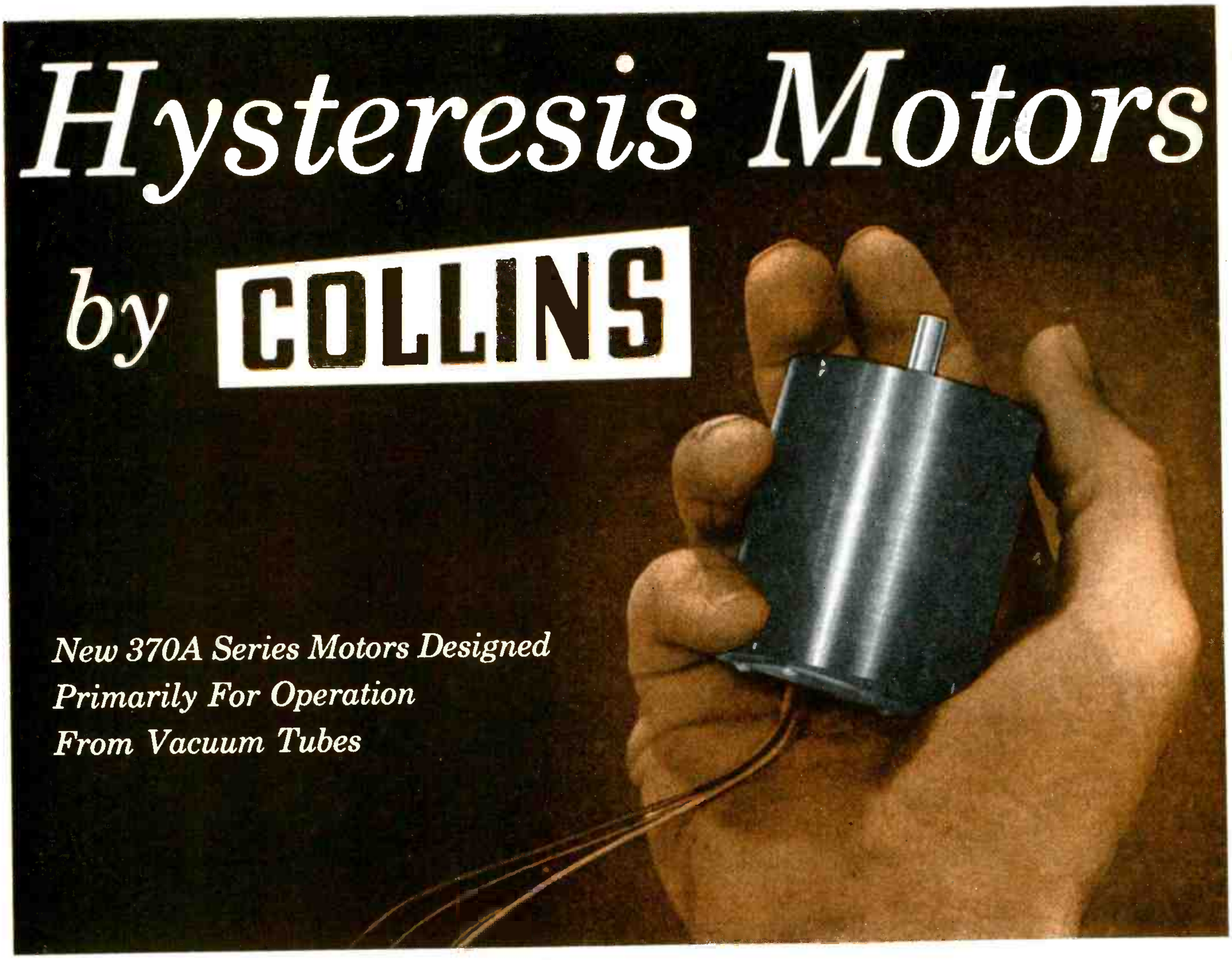


the top limit of capability has not yet been reached. Considering that germanium is also being operated at r.m.s. voltages per cell more than double that of the best available selenium, it will be seen that its power capabilities are at least 1000 times greater than selenium on a cell area basis.

The reason for this phenomenal ability lies in its inherently high efficiency which in turn means very little heat loss to be dissipated. The cell operating efficiency is in the range of 98 to 99 percent.

C. E. Hamann

General Electric Company



OUTSTANDING FEATURES of the latest addition to the Collins line of Industrial Components:

- high starting torques
- frequency ranges: 0 - 1000 cps, 0 - 500 cps, 60 cps, 400 cps
- absolute synchronous rotation

The superior efficiency and high starting torque of the Collins 370A-Series Hysteresis Motors make them suited for driving timing mechanisms, magnetic storage drums or any other device which must rotate at an absolutely constant speed regardless of fluctuations in load or line voltage. These motors have split windings for operation directly from the plate circuits of two push-pull direct-coupled amplifiers driven 90 degrees out of phase, eliminating bulky, frequency-limiting output transformers.

Typical of this latest Collins Industrial Component is the Type 370A-1 Wide-Band Hysteresis Synchronous Motor, particularly adaptable to operation in automatic frequency control systems with error signals from zero to as high as 1000 cps producing synchronous rotation from motionless to 30,000 rpm.

Other standard models of the 370A-Series include:

Type 370A-2; similar to 370A-1 but with higher torque; 0-500 cps frequency range.

Type 370A-3; single frequency, 60 cps; 1800 rpm.

Type 370A-4; single frequency, 400 cps; 12000 rpm.

Write today for complete information.

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Cedar Rapids, Iowa

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PERMANENT MAGNET

SHAKERS

THESE shakers provide vibratory sinusoidal forces of frequency and amplitude by which specific vibratory conditions can accurately be simulated. They provide the means of assesssing the effects of sudden acceleration on materials, structures and components; and are being extensively applied to FATIGUE TESTING, ELECTRICAL COMPONENT TESTING, FLEXTURE TESTING OF PLASTICS, ETC., and SPECIALISED GUIDED WEAPON RESEARCH. For certain pre-knowledge of vibration and its effects consult GOODMANS.

MODEL 390A

A medium duty model producing an alternating force of approximately ±25 lbs.

Thrust	Force factor 4.7 lbs. per amp.
Max. Continuous Current Rating (R.M.S.)	2 amps. uncooled; 4 amps. with air cooling of approx. 5 lbs. per sq. in.
Stroke	0.5 in total excursion.
Impedance	8 ohms matching.
Frequency Range	Up to 10,000 c/s.
Weight of Moving System	0.16 lbs.
Stray Fields	Operating zone less than 100 gauss.
Flux Density	11,000 gauss.
Weight	26 lbs.

MODEL 790

For Vibrating heavy components, and is capable of producing a force of ± 50 lbs.

This unit has a force factor of approximately 9.2 lbs. per amp. and a total current capacity, with air cooling, of 4 amps. (R.M.S.).

Stroke	0.5 in total excursion.
Impedance	24 ohms matching (approx.)
Frequency Range.	Up to 5,000 c/s.
Weight of Moving System	0.5 lbs. (approx.)
Stray Fields	Operating zone less than 100 gauss.
Flux Density	11,000 gauss.
Total Weight (inc. trunnion)	70 lbs.

MODEL 8/600

For the vibration of heavy loads or complete assemblies. Has a total force of approximately ± 300 lbs.

Stroke	1 in. total excursion.
Impedance	to suit driving equipment.
Frequency Range	Up to 3,000 c/s.
Weight of Moving System	6 lb. (approx.)
Stray Fields	Operating zone less than 25 gauss.
Flux Density	10,000 gauss.
Total Weight (inc. trunnion)	4 cwt. (approx.)

This unit can be fitted with (a) built in air cooling blower (b) switch to give high or low impedance armature coil and (c) pick-up unit for monitoring wave form and amplitude.

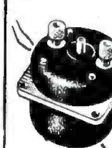
DRIVING EQUIPMENT

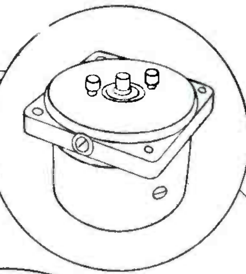
A range of appropriate driving equipments is available and takes the form of High-Power Amplifiers, Stabilised Power Supply Units and precisioned R.C. Oscillators specifically designed to give continuous power output to drive the particular shaker concerned.

MODEL V47

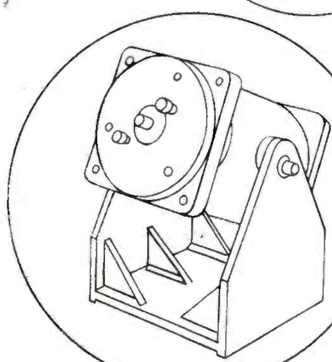
for the vibration of very light electronic components, optical-cell research, hair-spring torque testing etc.

Thrust	Force factor 0.9 lbs. per amp.
Max. Continuous Current Rating (R.M.S.)	1.5 amps.; 2.0 amps. up to 2 min. duration.
Stroke	0.2 in total excursion.
Impedance	Varies with frequency and load between 3 and 10 ohms.
Frequency Range	Up to 10,000 c/s
Weight of Moving System	6.5 grams.
Stray Fields	Operating zone less than 25 gauss.
Flux Density	11,000 gauss.
Weight	2 lbs.

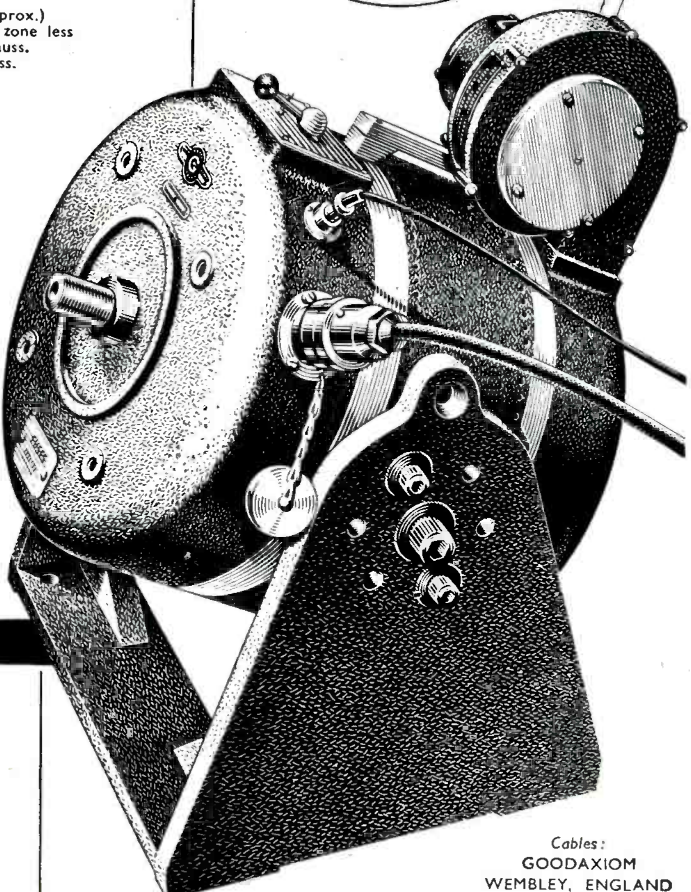




MODEL 390A



MODEL 790



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

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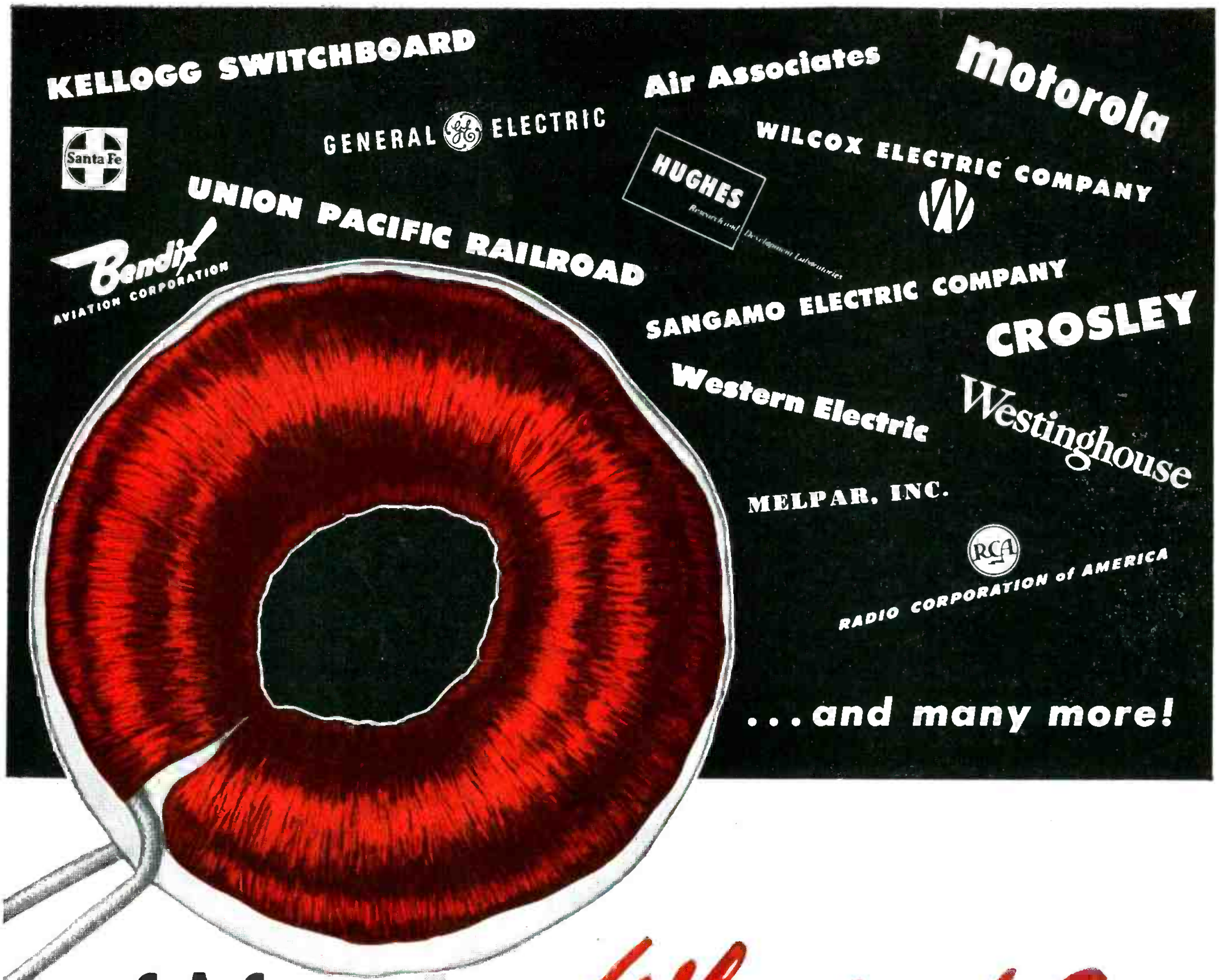

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Stocked in Standard Inductances for immediate delivery...

With the new molded toroid simplifying mounting problems and with the resultant demand increasing daily, C-A-C now offers an added convenience to buyers by stocking standard types for immediate delivery.

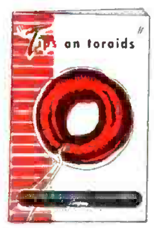
Write for file of complete specifications and listing of stocked inductances. C-A-C molded toroids meet the performance requirements of Military specifications.

Why is it?...

From a modest beginning five years ago, Communication Accessories Company has grown to one of the largest exclusive toroid coil winding producers in the U. S. today. Why?

We like to think that this growth is due to the thorough, careful handling we apply to each coil . . . and because of the particular skill of our people. Whatever the reason, we'll continue — doing the best we know how — thankful for the trust that important companies have placed in us.

write for this catalog



COMMUNICATION ACCESSORIES *Company*

HICKMAN MILLS, MISSOURI

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New! VARY-TALLY

Multiple-Unit Reset Counter

DESIGNED TO COUNT ANYTHING COUNTABLE

this new Vary-Tally can be supplied in any combination up to 6 banks high, 12 units wide, with the counting units arranged compactly on stands in tiers. Now check these special features of Veeder-Root design and construction:

- Easily Readable from any Angle . . . Bold Figures Always Centered in Window . . . No Glare . . . Figures not Covered by Fingers in Operation
- Easily Portable, yet Ruggedly Built for Long Wear
- Separate Counting Units Can be Rotated like Tires on a Car, to Distribute Wear Evenly
- All Parts Corrosion-Resistant
- Working Parts of Hardened Steel
- Operation Not Affected by Extreme Heat or Cold
- Individual Tag Above Each Counter-Window — Not Strip Tabs
- Veeder-Root Quality in Every Part

Now what's on *your* mind, that Vary-Tally can help you count? Write for news sheet and prices.

"The Name that Counts"

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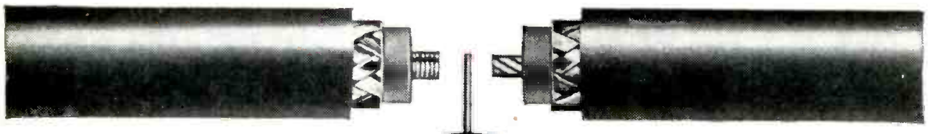
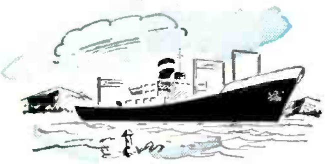
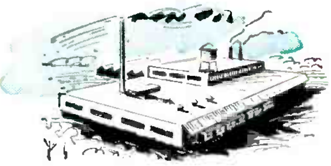


AVIATION



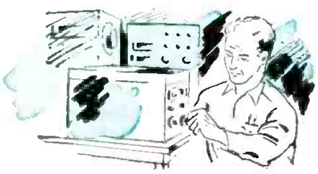
MARINE



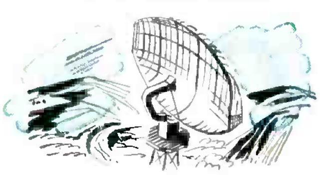
INDUSTRIAL

BROADCASTING

RADIO-TV LEAD-INS



TEST EQUIPMENT



RADAR, PULSE, EXPERIMENTAL EQUIPMENT AND SPECIAL TYPES

TRUSTWORTHY TRANSMISSION

For Every HF · VHF · UHF Application

With ***Federal's***

QUALITY-CONTROLLED

COAXIAL CABLES

Whatever your field of application . . . whatever your transmission line requirement . . . Federal is ready to serve you. If the cable you need doesn't exist, Federal will cooperate with you in developing and producing it in any quantity!

Federal offers you one of the nation's most diverse stocks of RG type cables—including the Federal-developed low-temperature, non-contaminating thermoplastic jacket.

Quality-controlled throughout the entire manufacturing process, Federal cables bring *trustworthy transmission* to every electronic application . . . *plus* top flexibility and superior resistance to abrasion, weathering and corrosion.

Before you specify cable—or complete cable assemblies—for any general or military application, get the facts and figures from Federal. *We have the answer or we can get it!*

FEDERAL HAS A NEW CABLE CATALOGUE

This new 28-page buying guide contains a world of up-to-date information on Federal's quality-controlled cables, plus numerous useful tables and diagrams. For your free copy, write to Federal today, Dept. D-713A.

Manufacturer of America's most complete line of solid dielectric cables

FEDERAL TELEPHONE & RADIO · FTR · DIVISION OF IT&T

Federal Telephone and Radio Company

SELENIUM-INTELIN DEPARTMENT • 100 KINGSLAND ROAD, CLIFTON, N. J.

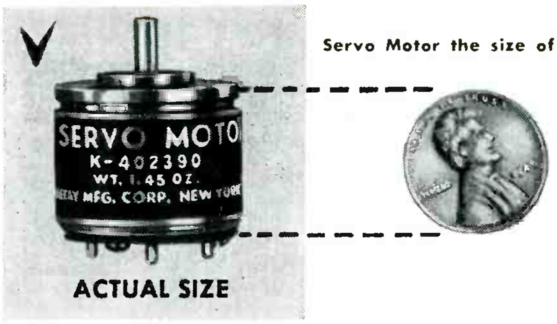
In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., N. Y.

Want more information? Use post card on last page.

TYPICAL CHARACTERISTICS

MECHANICAL DATA		ELECTRICAL DATA	
Weight	1.45 oz.	No load speed	6,500 RPM
Rotor inertia	.46 gm-cm²	Stall torque	.3 oz.-in.
Theoretical acceleration	49,000 RAD/SEC²	Maximum output	.490 W.
		Single phasing	None

DATA AT STALL	FIXED PHASE	CONTROL PHASE
Voltage (volts)	26	26
Frequency (cycles)	400	400
Current (ma.)	166	166
Power imput (watts)	3.1	3.1
Power factor	.63	.63
R—ohms	98.5	98.5
X—ohms	123	123
Z—ohms	157	157



Servo Motor the size of a Penny

Ketay's *Experience* helps you

Servo Motor in a size 23 Frame, 6 watt

TYPICAL CHARACTERISTICS

MECHANICAL DATA		ELECTRICAL DATA	
Weight	1.6 lbs.	No load speed	3,500 RPM
Rotor inertia	20.0 gm-cm²	Stall torque	7.5 oz.-in.
Theoretical acceleration	26,500 RAD/SEC²	Maximum output	6.0 W.
		Single phasing	None

DATA AT STALL	FIXED PHASE	CONTROL PHASE Series	CONTROL PHASE Parallel
Voltage (volts)	115	115	57.5
Frequency (cycles)	60	60	60
Current (ma.)	175	175	350
Power imput (watts)	14.0	14.0	14.0
Power factor	0.70	0.70	0.70
R—ohms	460	460	115
X—ohms	470	470	117
Z—ohms	660	660	164

Also for 115V or 230V operation on control phase.

Check these Servo Motors against your needs

Ketay offers a complete line of high precision **SYNCHROS, SERVO MOTORS and RESOLVERS.**

Ketay's experience also includes: automatic control devices for use in fire control and missile systems; computers and simulators; amplifiers; marine inter-communication equipment; remote indicators such as ship course indicators, drive angle indicators and salinity indicators; and automatic control systems.

Mail coupon today for bulletin containing specifications on 100 types of Synchros, Servo Motors and Resolvers.

Servo Motor in a size 15 Frame, 60 cycle, 115 volt

TYPICAL CHARACTERISTICS

MECHANICAL DATA		ELECTRICAL DATA	
Weight	7.3 oz.	No load speed	3,300 RPM
Rotor inertia	3.03 gm-cm²	Stall torque	1.45 oz.-in.
Theoretical acceleration	33,800 RAD/SEC²	Maximum output	1.23 W.
		Single phasing	None

DATA AT STALL	FIXED PHASE	CONTROL PHASE Series	CONTROL PHASE Parallel
Voltage (volts)	115	115	57.5
Frequency (cycles)	60	60	60
Current (ma.)	53	53	106
Power imput (watts)	5.0	5.0	5.0
Power factor	.82	.82	.82
R—ohms	1780	1780	445
X—ohms	1240	1240	310
Z—ohms	2170	2170	542

DESIGN
DEVELOPMENT
MANUFACTURE
... of precision instruments components, systems.

Ketay
MANUFACTURING CORPORATION

Executive Offices
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New York Division • Kinetix Instrument Division • Pacific Division
Electronic Instrument Division • Research & Development Division

Ketay Manufacturing Corp.
555 Broadway, New York 12, N. Y.

C

NAME ....
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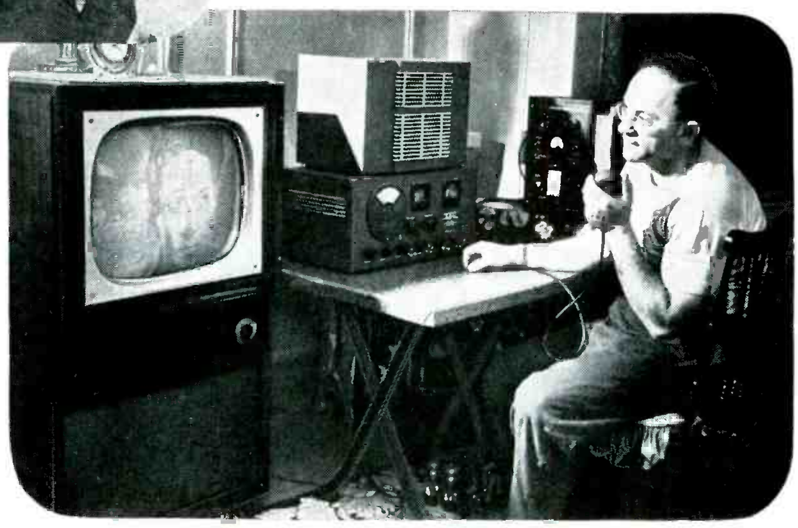
CITY .... STATE ....
Send data on ....
My current projects are ....

Interference from his amateur radio transmitter on the TV set drove Mr. Jack Saperstein from the house to the car. Then he discovered Metex TVI-20-S Monel shielding and cut out the interference. Now he can operate within two feet of the TV set. Manufactured of corrosion-resisting Monel by the Metal Textile Corporation, Roselle, N. J., TVI-20-S shielding material is sold in 20-ft. lengths by several large radio supply houses.



How Monel saved a ham from the role of a TVI villain

Mr. Jack Saperstein of Newark, New Jersey, was in a pickle!

He operates a television and radio repair business in a heavily populated area. At the same time he has his own amateur station.

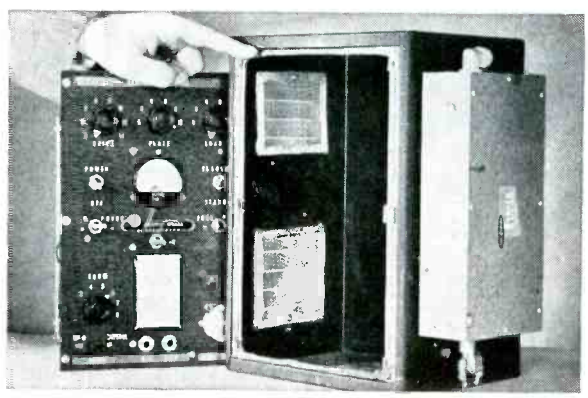
The two just didn't mix – when he operated his station on the 10 meter band, the second harmonic interfered not only with his own TV set but, worse yet, with those of his neighbors. Because of this, he was losing their good will.

He couldn't afford to give up the repair business and he didn't want to give up the station.

What to do?

After trying various ways to stop the leakage, he found a temporary solution by moving the station into the trunk of his car. The filters kept leakage off the antenna, and the lid of the trunk sealed in the second harmonic. But still he couldn't use the set in his house.

Then he heard about Metex "Electronic Weather-Stripping," a knitted Monel shielding material which has been widely used for shielding Army, Navy, Air Corps, and industrial equipment. Metal Textile Corporation packages this same material for hams in rolls of 20 feet per box under the name of TVI-20-S.



He put this resilient, conductive RF gasketing around the openings in his set (see photo), and found that he could operate on ten meters within two feet of his TV set, tuned to Channel 2, without interference.

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

Inco Nickel Alloys INCO

Monel® • "R"® Monel • "K"® Monel • "KR"® Monel
"S"® Monel • Inconel® • Inconel "X"® • Inconel "W"® • Incoloy®
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Lab Samples from STACKPOLE

. . . assure accurate engineering plus efficient production

Laboratory samples of Stackpole components are exactly what samples should be—true and accurate reflections of the product when made in quantities and bought for use on your production line.

Stackpole was one of the earliest pioneers in strict statistical quality control. This, plus many unique manufacturing techniques and facilities evolved over years of carbon, graphite and metal powder product specialization, means that the sample you get from Stackpole matches your specifications to the fullest possible extent.

Equally important, and regardless of size, shape or quantity, each production unit is a "twin" of the sample on which your engineering and production calculations were based.

Write for Engineering Data Bulletin on any type. Samples to quantity users on receipt of full information.

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FIXED RESISTORS
VARIABLE RESISTORS
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FIXED COMPOSITION CAPACITORS
TUBE ANODES
CARBON DISCS (Voltage Regulators)
LINE SWITCHES
SLIDE and ROTARY-ACTION SWITCHES

Electronic Components Division

STACKPOLE CARBON COMPANY

St. Marys, Pa.

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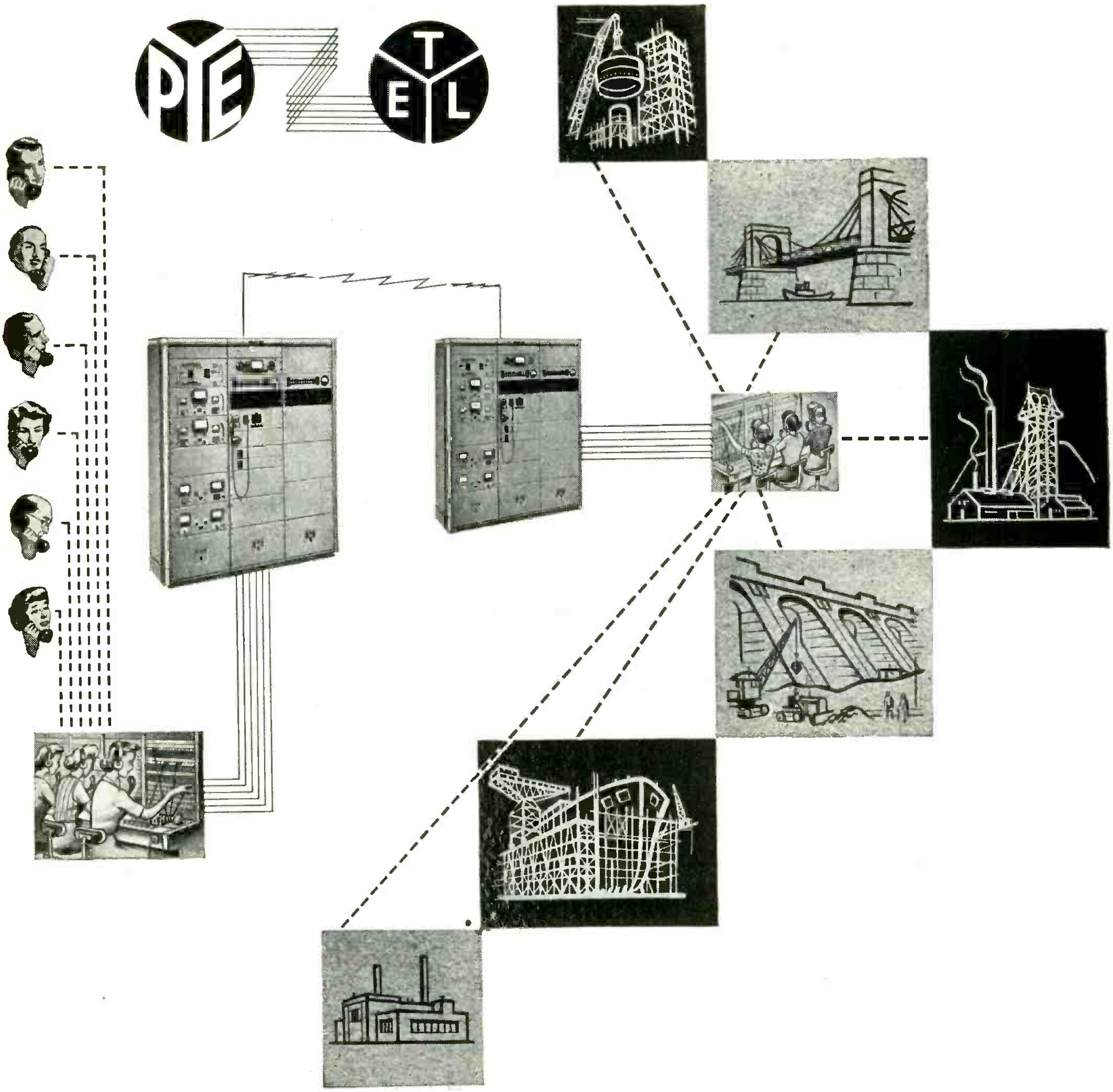

PYE-ERICSSON MULTIPLEX VHF RADIO TELEPHONE SYSTEM

The Pye-Ericsson V.H.F. multiplex radiotelephone system is already making its contribution towards the rapid expansion of telecommunications in overseas territories. Primarily developed to give telephone communication where wire and cable circuits are impracticable or, as is more often the case, uneconomical, the multiplex system provides a link that is invulnerable to both natural hazard and pilferage.

The Pye-Ericsson system retains the well established carrier technique and this, in conjunction with the inherent reliability of the equipment, assures simplicity of maintenance.

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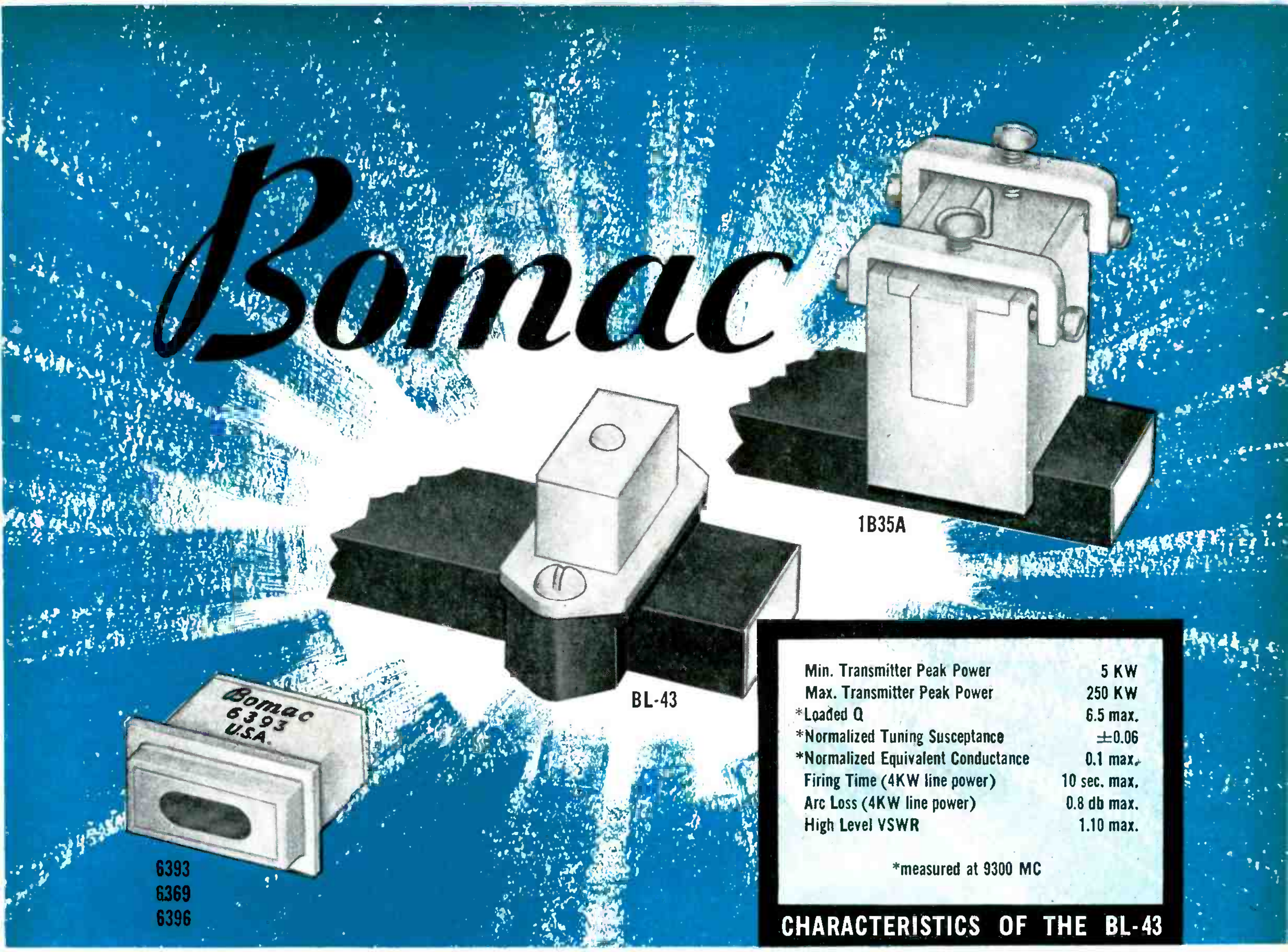


CHARACTERISTICS OF THE BL-43

Min. Transmitter Peak Power	5 KW
Max. Transmitter Peak Power	250 KW
*Loaded Q	6.5 max.
*Normalized Tuning Susceptance	±0.06
*Normalized Equivalent Conductance	0.1 max.
Firing Time (4KW line power)	10 sec. max.
Arc Loss (4KW line power)	0.8 db max.
High Level VSWR	1.10 max.

*measured at 9300 MC

X band ATR tubes

Another outstanding example of Bomac's continuous program of miniaturization and development is the new BL-43 (contact type) ATR switching tube. Its electrical characteristics are identical with the standard 1B35A, but structurally it offers several important advantages.

The 1B35A seats in a large "well" type socket where the electrical contact depends on a $\frac{\lambda}{2}$ choke. In contrast, the BL-43 eliminates the well socket and its awkward yoke clamps. Size and weight are cut to the minimum. The flange is mounted close to the window and contacts the seat directly. A special copper-rubber gasket insures excellent electrical contact, eliminates sparking at high powers and allows pressurization of the wave guide.

Several Bomac contact ATR tubes for X band are made for either E or H plane mounting (see illustration). The seat and method of mounting are left to the equipment designer. These tubes include:

#6393 — electrical characteristics same as 1B35A
#6369 — electrical characteristics same as 1B37A
#6396 — tuned to 9300 MC in .200″ x .900″ ID Wave Guide

We invite your inquiries regarding
- ENGINEERING
- DEVELOPMENT
- PRODUCTION

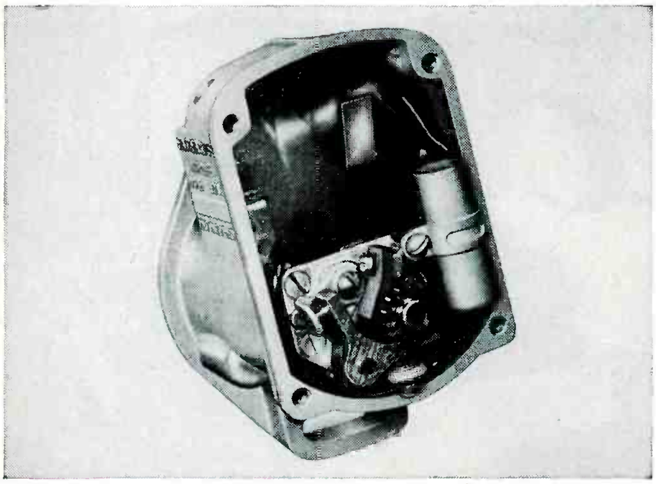
Bomac Laboratories, Inc.

BEVERLY, MASSACHUSETTS

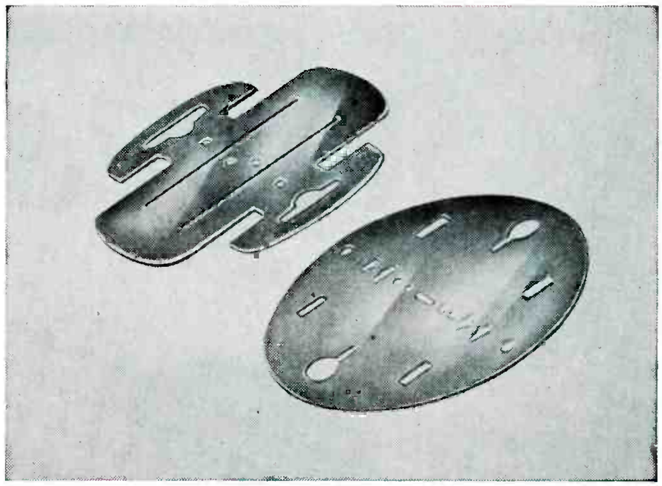
GAS SWITCHING TUBES · DIODES · HYDROGEN THYRATRONS · DUPLEXERS · MAGNETRONS · MODULATORS ·

Catalog on request. Write (on your company letterhead) Dept. E-1 BOMAC Laboratories, Inc. Beverly, Mass.

How many of these electrical insulation problems do *you* have?

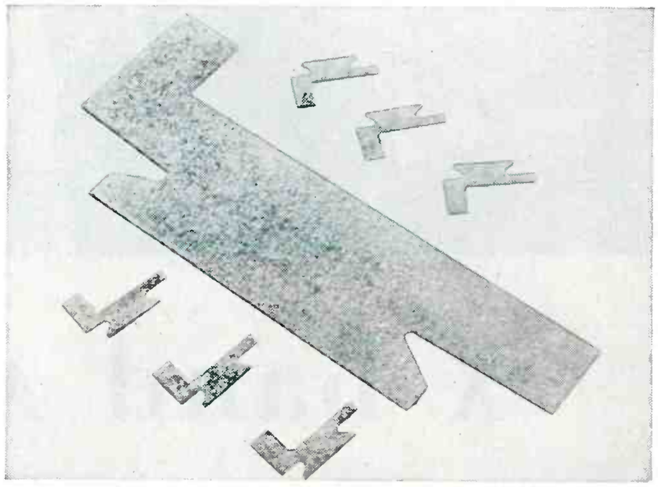


1. Looking for an efficient coil wrapping for small spaces? EMPIRE® varnished bias-cut nylon tape is highly flexible, strong and efficient . . . makes a thin insulation of unusually high dielectric strength with good resistance to oil and water.



2. Need accurately punched mica stampings for filament, grid and plate supports? MICO produces mica stampings to extremely fine tolerances. Whenever you need precision-fabricated mica parts of the highest quality, call on MICO.

3. Looking for a better material for wiring diagrams, controls, instruments, dials and nameplates? DECORATIVE LAMICOID® resists wear, aging, weathering, oils, corrosive vapors, moisture and temperature extremes. Won't warp, check or chip. Good electrical properties. Wipes clean with a damp cloth.



4. Need a class H segment plate that's easy to work with? ISOMICA* Segment Plate — made of built-up continuous mica sheet — shows no tendency to split or flake. Small segments of heavy thickness may be punched, and larger segments can be accurately sawed, milled, punched, etc.

Whatever electrical insulation material you need — standard or special — class A to class H — MICO makes it best. We manufacture it, cut it to size, or fabricate it to your specification. Send us your blueprints or problems today.

*Trade-mark

MICA *Insulator* COMPANY

Schenectady 1, New York

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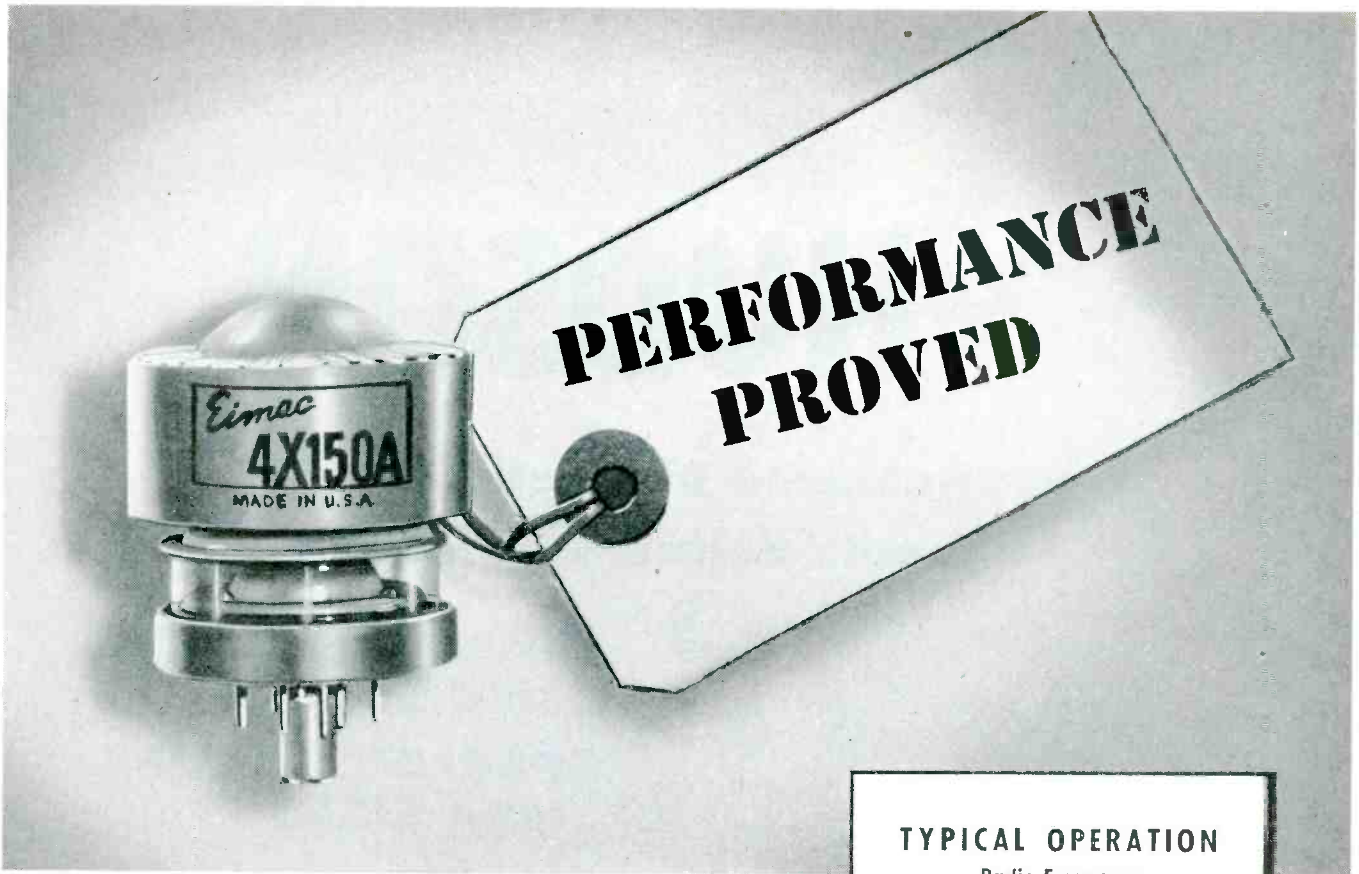
LAMICOID ® (Laminated Plastic) • MICANITE ® (Built-up Mica) • EMPIRE ® (Varnished Fabrics and Paper) • FABRICATED MICA • ISOMICA *



Eimac designed, Eimac produced — 4X150A radial-beam power tetrodes have given Eimac quality performance for more than five years in both fixed and mobile application in military and civilian transmitters. Rugged and compact, the 4X150A is the most powerful tube for its size that operates into UHF. Excellent power gain and stability with low plate voltages, plus simple circuit requirements, have made the 4X150A one of the most versatile tubes in the transmitting field.

Another Eimac development is the 4X150D, especially designed for the 24-28 volt electrical systems of mobile and airborne equipment. Other than a heater rating of 26.5 volts at 0.57 amperes, the 4X150D is identical to the 4X150A. It is recommended that both tubes be used with low inductance 4X150A air-system sockets which come in two models — with or without grounded cathode connections.

TYPICAL OPERATION

Radio-Frequency Power Amplifier or Oscillator

Class C Telegraphy or FM Telephony (Key-down conditions, per tube)

Frequencies up to 165 Mc.

D-C Plate Voltage	1000 volts
D-C Screen Voltage	250 volts
D-C Grid Voltage	—110 volts
D-C Plate Current	200 ma
D-C Screen Current	25 ma
D-C Grid Current	10 ma
Driving Power (approx.)	1 watt
Power Input	200 watts
Useful Power Output	150 watts

500 Mc. Coaxial Cavity

D-C Plate Voltage	1000 volts
D-C Screen Voltage	250 volts
D-C Grid Voltage	—80 volts
D-C Plate Current	200 ma
D-C Screen Current	7 ma
D-C Grid Current	10 ma
Driving Power (approx.)	20 watts
Plate Power Input	200 watts
Plate Power Output	120 watts

For further information contact our Application Engineering Department

Eimac TUBES

EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

Export Agents: Frazer & Hansen, 301 Clay St., San Francisco, California

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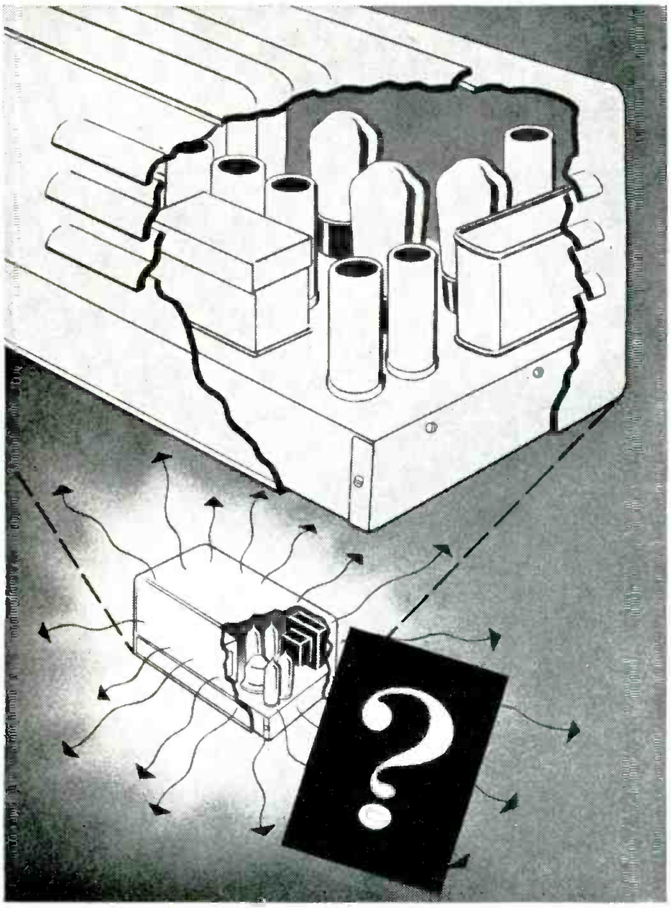
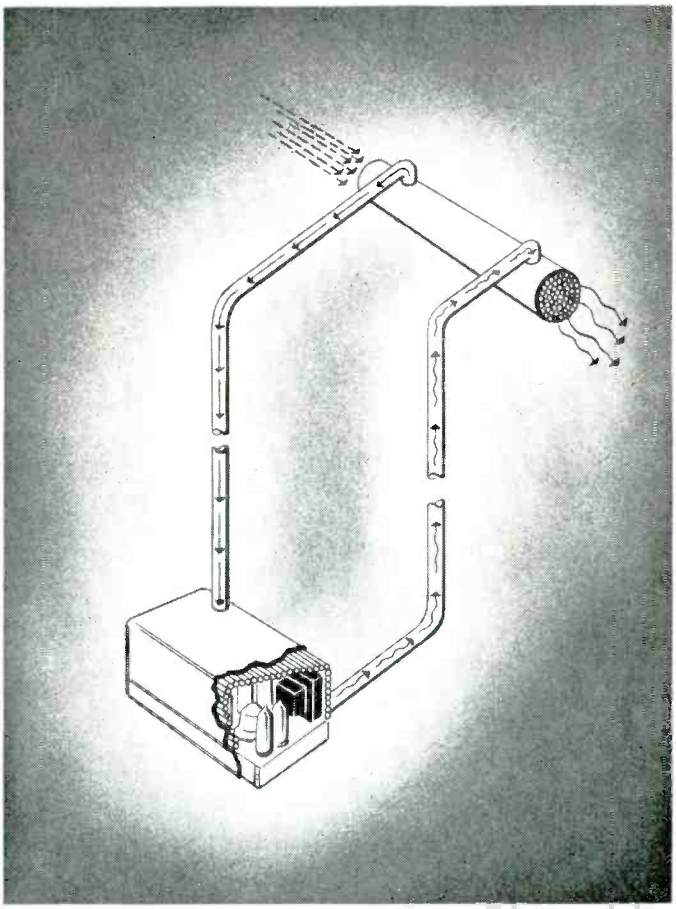
IDEAS that started in a HEAT EXCHANGER





THE PROBLEM

New high-efficiency electronic units (lower unit in above panel) occupy as little as one-twentieth the space of older, air-cooled types (upper unit) — but they generate just as much heat. And since their hermetic sealing prevents direct cooling by air flow, temperatures would rise far beyond safe limits unless the heat were removed and dissipated elsewhere. At the same time, cooling equipment must be kept light and compact enough for aircraft use.

THE SOLUTION

Working with a leading manufacturer of electronic equipment, Clifford engineers designed the case of this aircraft electronic unit as a liquid heat exchanger. Heat is extracted by connecting with a second exchanger of the airflow type, as shown. In jet-engined planes, however, heat is preferably dissipated by a liquid-to-liquid cooler into the fuel oil — thereby reducing drag on the plane and pre-heating the oil. Made entirely of aluminum, these Clifford heat exchange units combine thorough cooling with minimum size and weight.

You may have a cooling problem

Your own manufacture may or may not include aircraft applications. But now or later you may be looking for the best way of dissipating heat generated by high wattage elements in small spaces.

Then it will pay you to talk things over with Clifford engineers. These experts in a highly specialized field have developed successful liquid coolers for every type of aircraft — which includes some of the severest and most unusual working conditions any cooler is ever required to meet.

Clifford Feather Weights, for example, are the only all-brazed type of oil cooler. Their superior weight-strength ratio is the result of a patented brazing method and pretesting in Clifford's wind tunnel laboratory — largest and most modern in its field.

Take advantage of Clifford's long record of finding the most efficient and economical answers to the toughest cooling problems. Write to Clifford Manufacturing Company, 119 Grove Street, Waltham 54, Massachusetts. *Division of Standard-Thomson Corporation.* Sales offices in New York; Detroit; Chicago; Los Angeles; Waltham, Massachusetts.

HYDRON METAL BELLOWS

CLIFFORD
MANUFACTURING CO.
WALTHAM, MASS.
DIVISION OF STANDARD-THOMSON CORP.

Feather Weight HEAT EXCHANGERS

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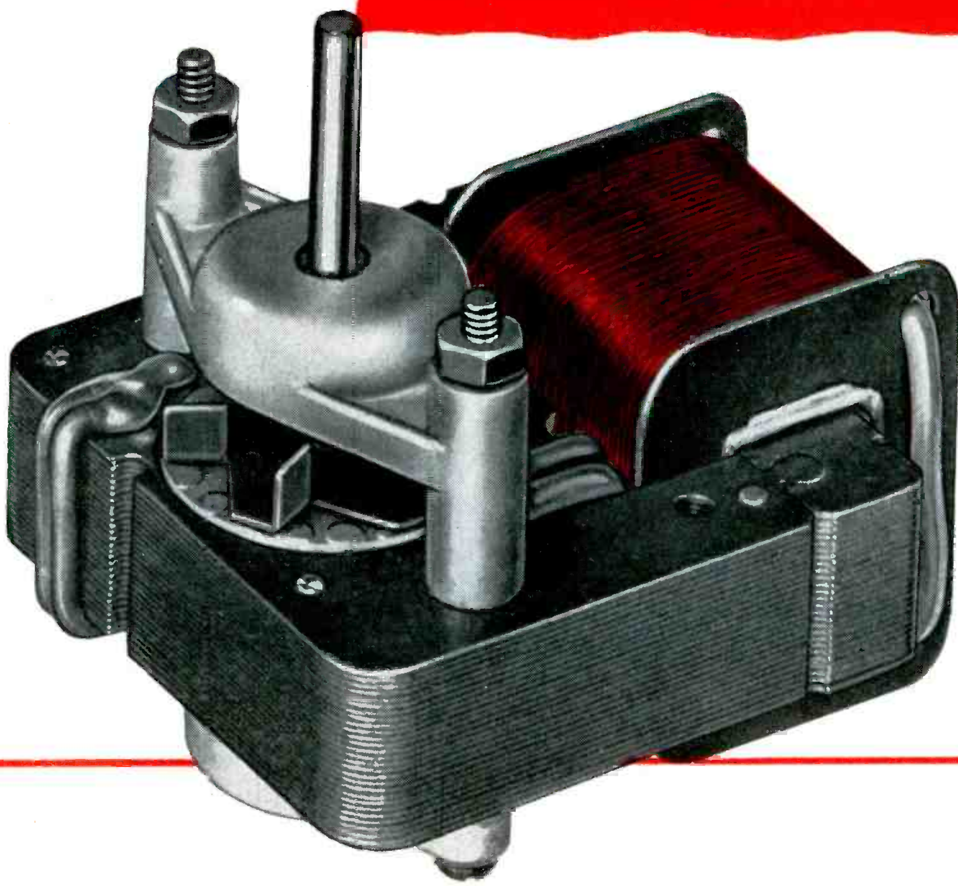
THE GENERAL INDUSTRIES CO.

PRODUCTS *wired for life*

with WARREN WIRE



The General Industries line of Smooth-Power Motors meets the most exacting demands for smoothness and dependability through the combination of advanced design . . . unrelenting research . . . sound engineering . . . skilled craftsmanship . . . the use of the finest materials! Here, as in the manufacture of many other fine electric and electronic products, Warren Wire is used for its easy handling, efficiency and dependability.

There's a Warren Wire Engineer near you trained to help you solve your wire problems right in your own plant. There is no obligation, of course.

NEW! Send for our new "Magnet Wire Reference Tables" Chart

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Manufacturers of Plain Enamel, Nylon, Formvar, Teflon and Served Magnet Wires . . . Teflon Hook-up and Lead Wire . . . Tinned and Bare Copper Wire.

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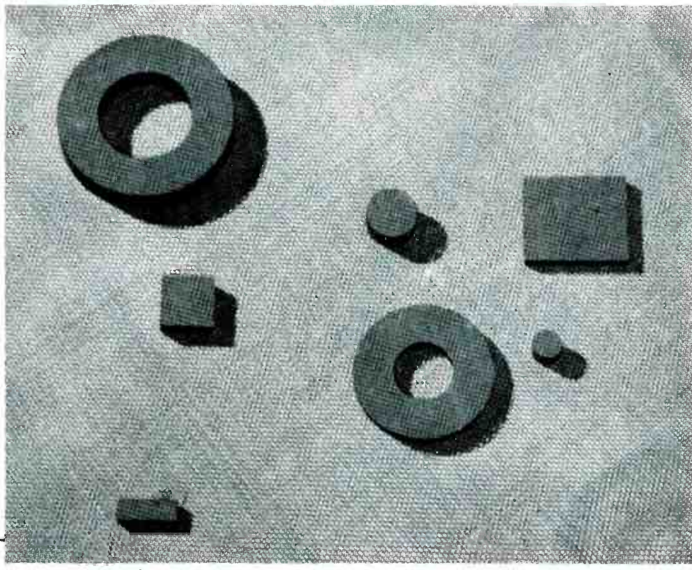
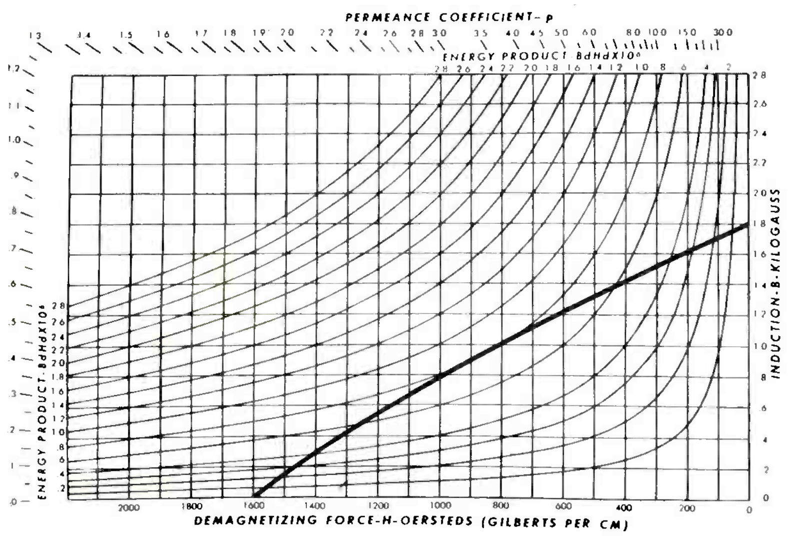
Presenting *INDOX I* . . . A

NEW CERAMIC PERMANENT MAGNET



▲ Typical INDOX I Permanent Magnets



▲ Demagnetization and Energy Product Curve for INDOX I

. . . Opens New Fields for Product Designs

INVESTIGATE THESE CHARACTERISTICS

- Higher coercive force than any other commercial permanent magnet material.
- Negligible hysteresis and eddy-current losses in magnetic circuits having an alternating-current component.
- High electrical resistivity.
- No critical materials required.
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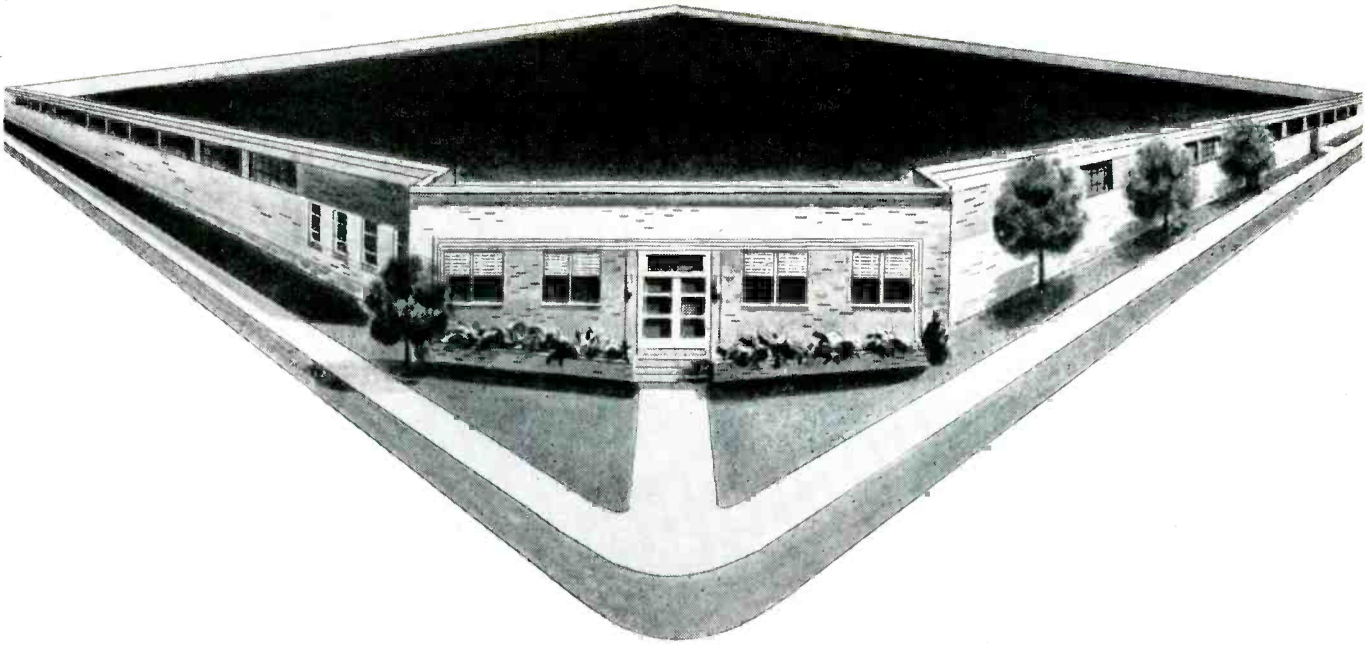
- Magnetization practical prior to assembly.

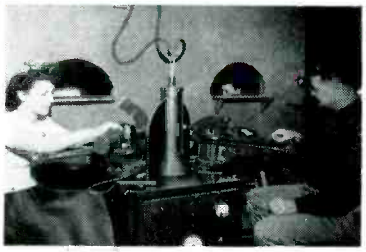
Let our forty-three years of accumulated permanent magnet experience help you to utilize this new magnet in your products. Write to Dept. IA for complete details.

INDIANA PERMANENT MAGNETS

THE INDIANA STEEL PRODUCTS COMPANY • VALPARAISO, INDIANA

WORLD'S LARGEST MANUFACTURER OF PERMANENT MAGNETS





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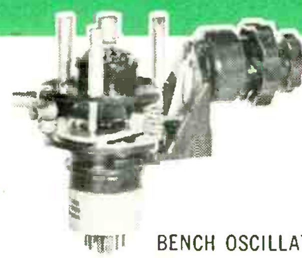
Klystron Tubes and

WIDE RANGE REFLECTS 16 YEARS OF EXPERIENCE IN MICROWAVE FIELD

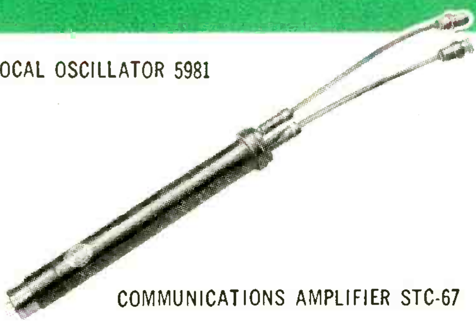
KLYSTRONS

Frequency Range from 750 megacycles to 26,000 megacycles.


LOCAL OSCILLATOR SRU-55

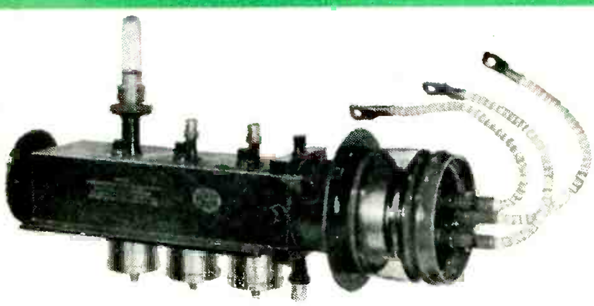

BENCH OSCILLATOR 2K41

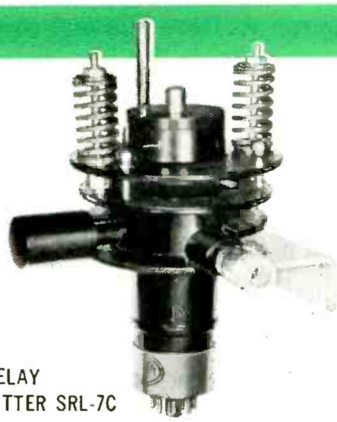

LOCAL OSCILLATOR 5981


COMMUNICATIONS AMPLIFIER STC-67


RADIO RELAY TRANSMITTER SRC-43


RADIO RELAY TRANSMITTER SAC-19

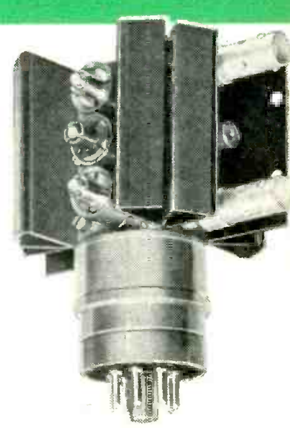

HIGH POWER TRANSMITTER SAS-28


RADIO RELAY TRANSMITTER SRL-7C


RADIO RELAY TRANSMITTER SAC-41


HIGH POWER TRANSMITTER SAC-33


HIGH POWER TRANSMITTER SAL-39


HIGH POWER TRANSMITTER SAC-9

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Since 1938, when Sperry sponsored the development of the Klystron, this company has extended its application to tubes for low, medium and high-power applications. As a pioneer in microwave measuring techniques, Sperry has developed Microline instruments which include every type of device essential to precise measurement in the entire microwave field. Research and development are continuous at Sperry and the results are always available to you.

*T.M. REG. U.S. PAT. OFF.

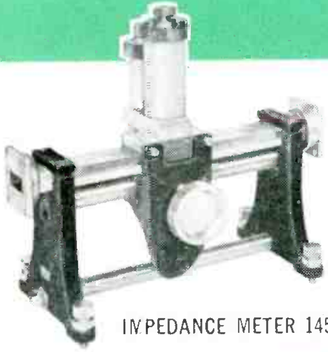
*Microline**

Test equipment covering 500 megacycles to 40,000 megacycles in 7/8 inch coaxial line and 8 waveguide sizes.

ATTENUATOR 152A

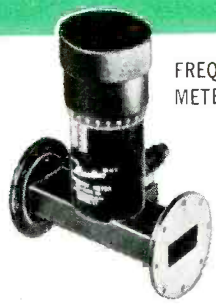
DETECTING SECTION 364

MIXER 337C

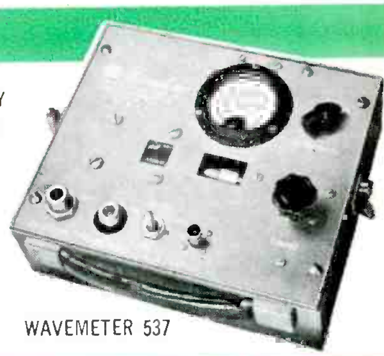


IMPEDANCE METER 145

DIRECTIONAL COUPLER 209



FREQUENCY METER 28B



WAVEMETER 537

RADAR RANGE CALIBRATOR UPM-11

VSWR TEST SET 539

RADAR TEST SET 38A

KLYSTRON POWER SUPPLY 555

On these pages, only one item in each product line is illustrated. Also included in the Sperry line, but not illustrated, are the following additional Microline instruments: Barretter and Thermistor Mounts, Barretter Elements, Impedance Transformers, Terminations, Adapters, Wattmeter Bridges and Adjustable Shorts. For complete details write our nearest district office.

SPERRY GYROSCOPE COMPANY

DIVISION OF THE SPERRY CORPORATION
Great Neck, New York

Cleveland • New Orleans • Brooklyn • Los Angeles • San Francisco • Seattle
In Canada—Sperry Gyroscope Co., Limited, Montreal, Quebec

UNDISTORTED

100%

MODULATION

AM

WITHOUT

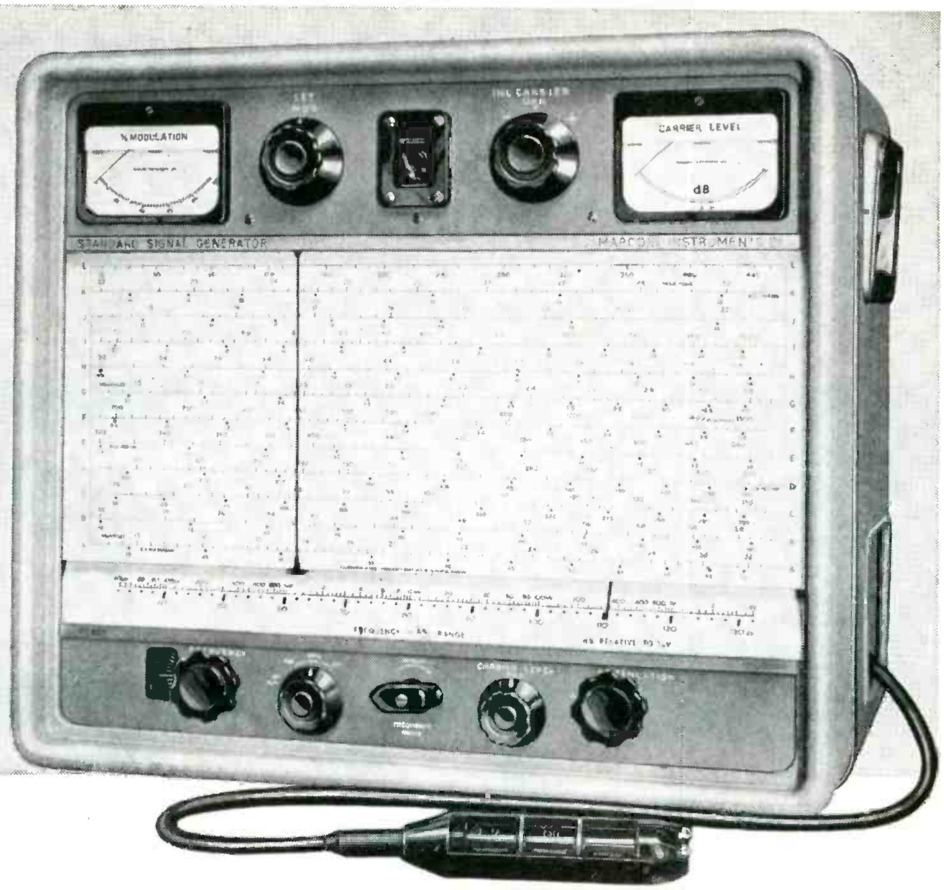
FM

WITH THE

STANDARD SIGNAL

GENERATOR

TYPE TF867



EXCELLENT amplitude modulation is an outstanding feature — a.m. accompanied by unmeasurable f.m. Other features include :

Wide Range: 15 kc to 30 mc on 15 ft. high-discrimination full-vision scale.

Crystal Accuracy: 0.01% with built-in 1 mc harmonic source.

High Output: 4 volts down to 0.4 microvolts.

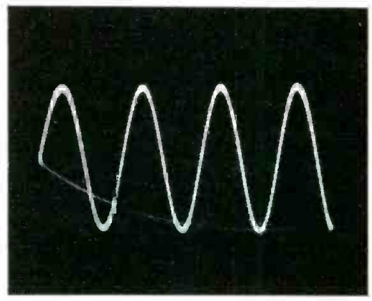
Flexible Modulation: Internal 400 and 1,000 cps, external 50-10,000 cps within a db.

Also incorporated : Automatic level control, overall negative feed-back from r.f. output to modulation input, modulation monitoring by dual-rectification and variable impedance termination with animated diagram.

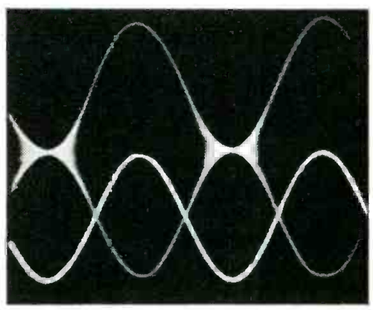
A signal generator also ideal as a video oscillator for wide-band television systems.

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

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



15 kc Unmodulated Carrier showing good waveform.



320 kc Carrier modulated at 400 cps — audio source on lower trace shows fidelity.

TEST OSCILLOGRAMS

MARCONI INSTRUMENTS

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CANADA : CANADIAN MARCONI CO., MARCONI BUILDING, 2442 TRENTON AVENUE, MONTREAL

ENGLAND: Head Office: MARCONI INSTRUMENTS LIMITED, ST. ALBANS, HERTFORDSHIRE

Managing Agents in Export: MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2

This is all you need to install AVIEN'S TWO-UNIT FUEL GAGE

You need no field calibration, no complicated data, and no "experts" to install this simplified system.

When it's time to install Avien's Two-Unit Fuel Gage, all you will require are simple tools.

You won't need calibration instruments, complex field data, or specially trained personnel. The Avien gage will have been precalibrated for your aircraft, so installation becomes as simple as "plug-in, plug-out."

This quick and easy installation avoids costly, time-consuming calibration on the flight-line.

You will also find Avien's Two-Unit Gage an advantage for replacement and repair. You can keep it in regular stock, ready for immediate use.

This ease of installation is just one of the factors which have made Avien's Two-Unit Gage the most talked-about system in the industry.

Because the system is reduced to a sensing unit and indicating unit, it weighs 50% less than previous three-unit systems. Fewer wires and connectors are needed. 158 separate parts are eliminated. Maintenance problems are brought to the minimum.

And it costs less.

With the industry's need for smaller units — and with the industry's problem of smaller budgets — the Avien Two-Unit Fuel Gage arrives at the right moment.

Every month, Avien produces over ten thousand major instrument components for the aviation industry.

If you haven't yet inquired about the Two-Unit Gage, right now is the time to do so.

Avien

AVIATION ENGINEERING DIVISION

AVIEN - KNICKERBOCKER, INC.

58-15 NORTHERN BOULEVARD, WOODSIDE, L. I., N. Y.

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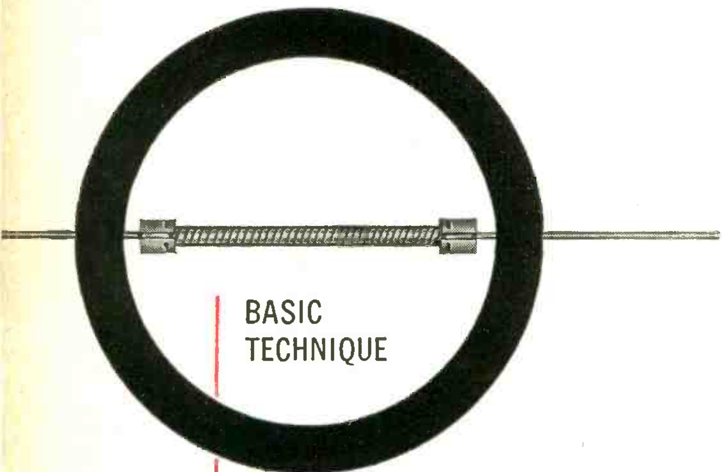
Frecision, high-speed winding equipment fcr IRC elements

ONLY IRC WINDING SKILL OFFERS



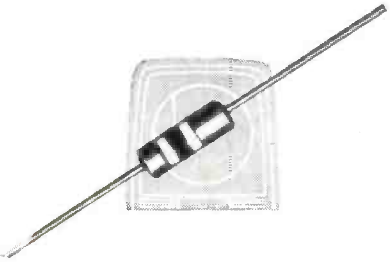
BASIC TECHNIQUE

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

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

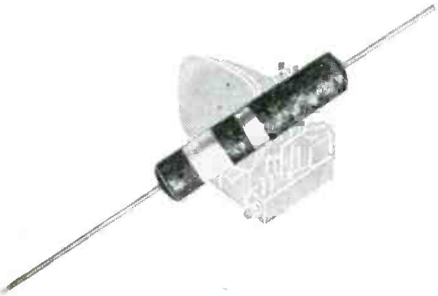
14c savings per car

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



low cost—low wattage

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



50% savings

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

THESE SAVINGS

inexpensive solution

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

NEW *specifications*

MIL-R-93A AMENDMENT 1

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

IRC PRECISION WIRE WOUNDS

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

MAXIMUM STABILITY

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

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

Wherever the Circuit Says

IRC

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

INTERNATIONAL RESISTANCE CO.

403 N. Broad St., Philadelphia 8, Pa.

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

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

Name__________

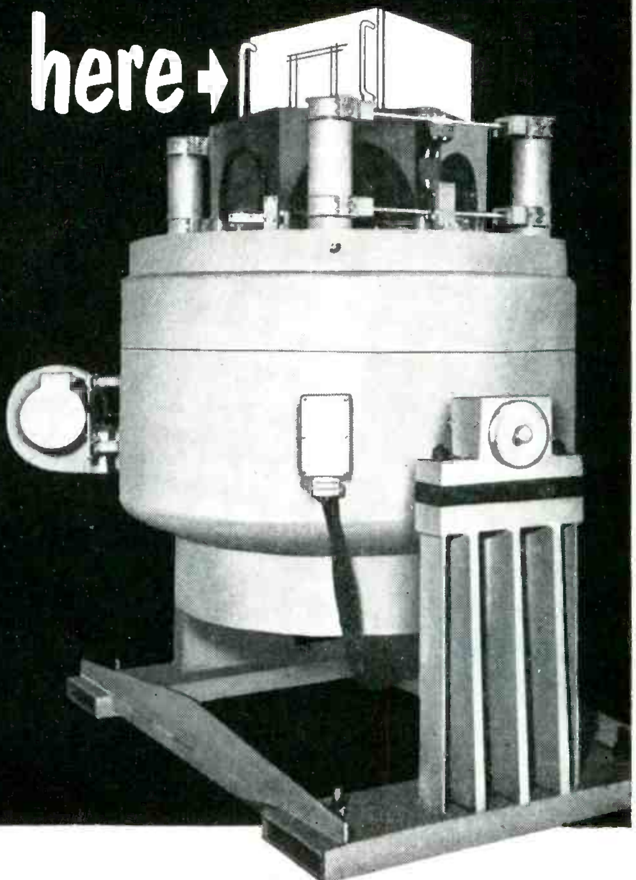
Title__________

Company__________

Address__________

City__________ State__________

Put your product here→ to shake-test it with 10,000 lbs force



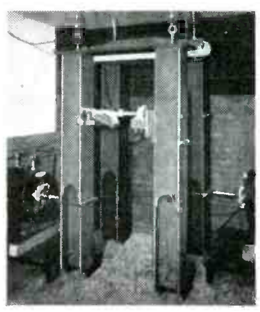
MB produces the largest exciter ever built to meet heavy duty vibration test specifications

THERE'S nothing like a good shaking to test out structural designs, electronic equipment, instruments or complete assemblies for faults or flaws. In fact, for many products put to military use, such tests are *specified*. However, since *all* products encounter some vibration or shock in service, many engineering departments use an MB Exciter to test all designs. By so doing, the "bugs" are discovered in the test laboratory instead of out in the field, at cost of good will.

Largest in the line of MB electromagnetic shakers, the Model C-100 shown delivers at least 5 tons continuous force. Its performance permits heavy duty vibration testing to MIL-E-5272 and other specifications. It incorporates a number of unusual design features for easy, quick, convenient operation—including interlocking controls for complete safety and provisions for cycling tests.

HOW TO HANDLE LARGE MASSES

MB can show you a setup of vibration exciter and resonating beam that multiplies the capacity of versatile MB Exciters many fold.



Shaker being used in this fatigue strength test of aircraft engine mounts is the model S-3 rated at 200 lbs. Others available down to 10 lbs. force output.

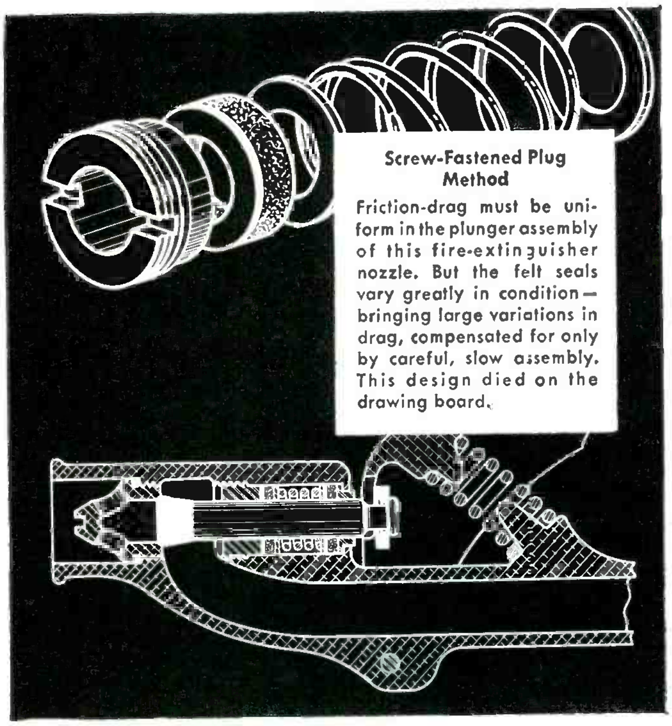
Vibration is MB's specialty. You're invited to draw on the benefits of this specialization—and get highly qualified products for testing and control, and technical help on your problem.

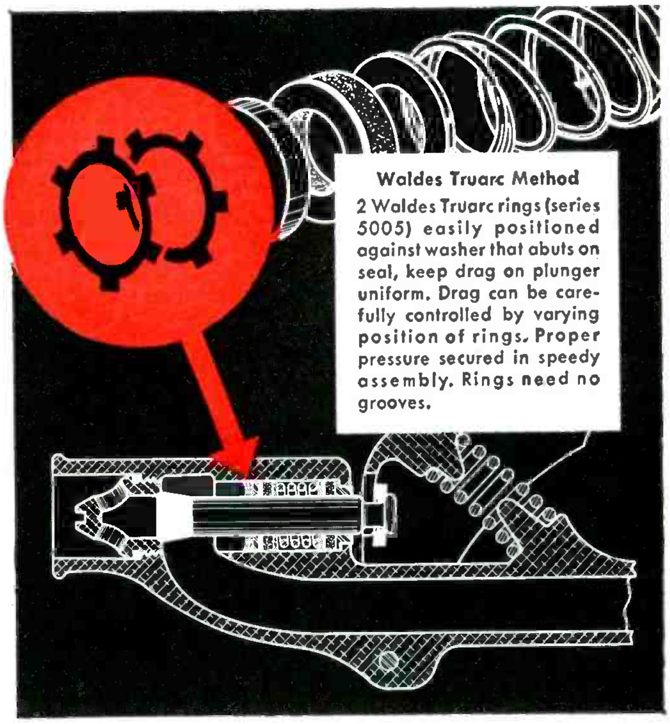
Valuable bulletins for test engineers
Calibrating vibration pickups to 2000 cps is comprehensively covered in MB Bulletin No. C-11-1. Bulletin No. 1-VE-1 describes vibration exciters and details their specifications. Write today.

THE MB MANUFACTURING COMPANY, INC.
1060 State Street, New Haven 11, Conn.

HEADQUARTERS FOR PRODUCTS TO INDUCE VIBRATION... TO MEASURE IT... TO ISOLATE IT

2 Truarc self-locking rings replace threaded plugs. Save 6¢ per unit, speed assembly by 140%.





Ansul Chemical Company's new watertight precision nozzle for their dry chemical fire extinguisher replaces conventional stainless steel plug with two Waldes Truarc Self-Locking Retaining Rings and washer. Rings hold entire nozzle packing securely in place — keep friction drag of plunger uniform. Adjustable in final assembly, Truarc rings speed production from 25 to 60 units per hour. They save 6¢ per unit in overall costs, 1/8" in length.

Redesign with Waldes Truarc Rings and you, too, will save on assembly, time, improve product performance, facilitate easier servicing of whatever you make.

Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together. They're precision-engineered... quick and easy to assemble and disassemble. They give a never-failing grip. Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

WALDES TRUARC RINGS MADE THESE SAVINGS POSSIBLE—

Discarded Design		Truarc Design	
Parts:	Cost Per Unit	Parts:	Cost Per Unit
threaded stainless steel plug	$0.0675	2 rings	$0.0146
Direct Labor	$0.0350	1 washer	$0.0280
	$0.1025		$0.0426

Total savings per unit with Truarc Rings $.0599

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

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RETAINING RINGS

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

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,081 AND OTHER PATENTS PENDING.

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

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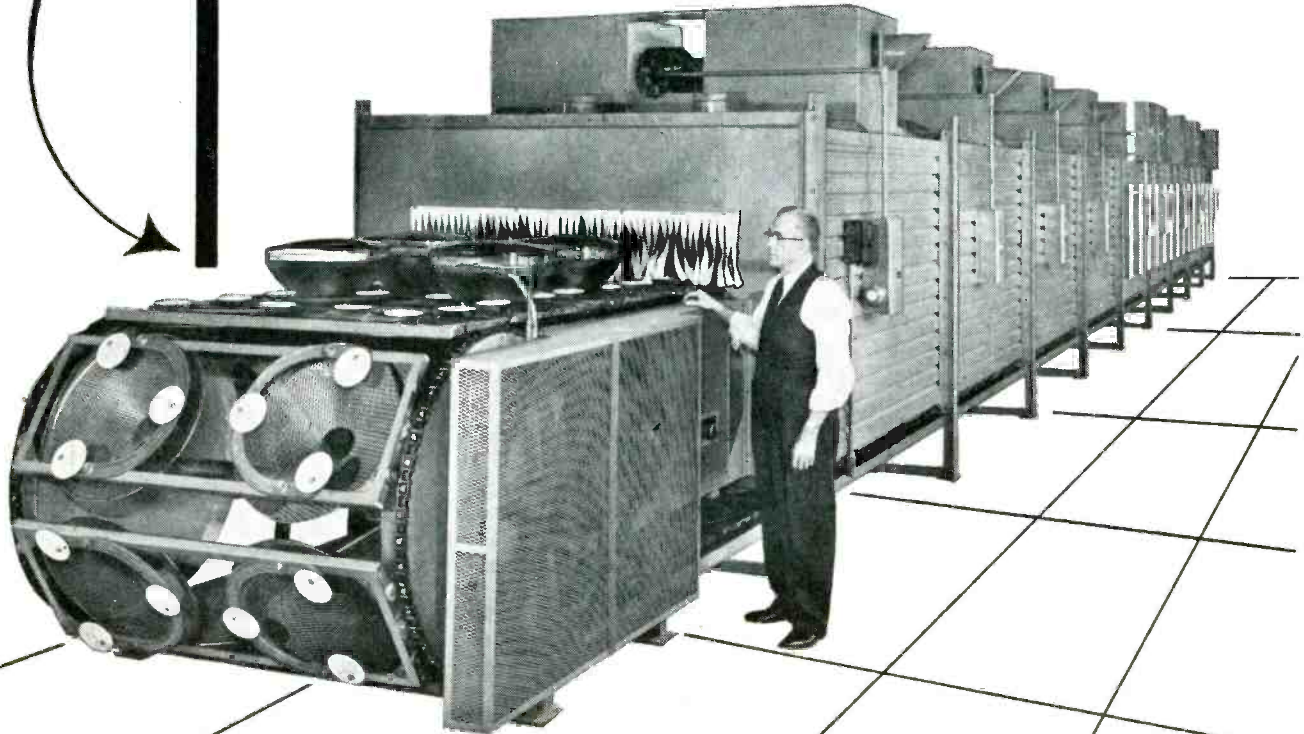
THE LATEST DESIGN IN CONVEYER SCREEN BAKE OVENS



with a built-in purging system to handle 21"-24" and 27" aluminized cathode ray tubes

STEINER-IVES CO. TRADE OVENS MARK EST. 1889 UNION, N.J.

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NATVAR 400 means this Stator is SET FOR *LONG* LIFE

Fairbanks-Morse has been building high dependability power generating equipment for 50 years. They have safeguarded the "name worth remembering" by sound engineering and workmanship, and careful selection of materials.

To insulate and protect stator coils of alternators, Fairbanks-Morse uses "Natvar 400" extruded tape because of its consistently good electrical and physical properties, and resistance to high temperatures.

If reliability is important to you, it will pay you to use Natvar flexible insulations. They are dependably uniform no matter when or where purchased, and are immediately available either from your wholesaler's stock or direct from our own.

Stator showing open slot construction of the Fairbanks-Morse Type TGZO Alternator, 1405 kva — 300 r.p.m. — 3 phase — 60 cycle — 2400/4160 volts — 80% p.f. — for direct connection to a diesel or dual-fuel engine, for utility, municipal and industrial power generation. Since they are frequently subjected to prolonged overloads in this type of service, they are designed for 50°C temperature rise above 40°C ambient. Coils, insulated and protected with "Natvar 400" extruded tape are tested at 9320 volts for one minute.

Two form wound coils for a Fairbanks-Morse 4160 volt Alternator. Lower coil has end sections insulated with "Natvar 400" extruded tape. Slot section is wound with a sacrifice tape, which is later removed and entire coil is wound with linen tape. Upper view of coil shows completed form, after final varnish dip and bake, ready for insertion in stator.

Natvar

Natvar Products

- Varnished cambric—cloth and tape
- Varnished canvas and duck
- Varnished silk and special rayon
- Varnished—Silicone coated Fiberglas
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- Slot cell combinations, Aboglas®
- Varnished-lacquered tubing and sleeving
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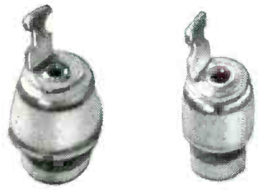
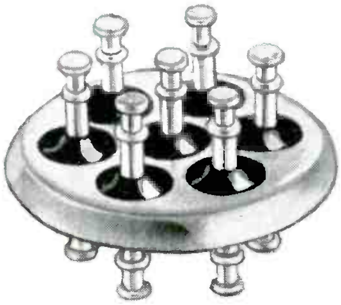


ALUMINA (CERAMIC) SEALS—

Metallized—ready for soldering. Extremely resistant to mechanical and thermal shock—meet top military specifications. Feed-through types.

GLASS-TO-METAL HERMETIC SEALS—

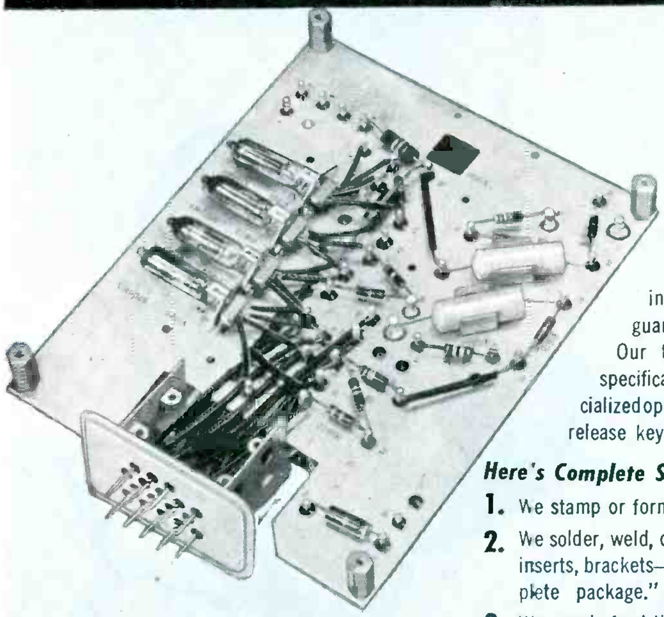
World's most complete line—over 1600 types and sizes, some small enough to be mounted on ⅛" centers. Protect vital electrical assemblies from moisture, atmospheric changes, corrosion, dirt, leakage. Also used as feed-through and stand-off terminals.



MULTIPLE HEADERS—

610 types always available—wide range of styles, shapes, pin arrangements. Can be incorporated into any panel or chassis requiring multiple connections. Fit standard receptacles. If required our engineers will design and build specially.

USE SEALTRON SEAL-SERVICE

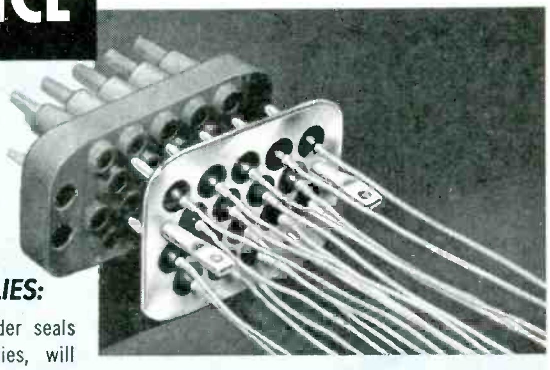


SEAL ASSEMBLIES:

Sealtron will solder seals into your assemblies, will guarantee hermetic perfection. Our technicians build to your specifications—eliminate your specialized operations, cut down overhead; release key personnel for other work.

Here's Complete Seal Assembly Service—

1. We stamp or form brackets and panels.
2. We solder, weld, or braze seals. Mount studs, inserts, brackets—all components—into complete package." Ready-to-use.
3. We supply feed-through or stand-off seals.



FLEXIBLE LEAD WIRES BUILT INTO MULTIPLE HEADERS

Sealtron welds flexible lead wires right into multiple headers. Eliminates difficult soldering in "close quarters"—saves space. Sealtron "Built-in" leads meet AN specifications, eliminate space-taking mechanical attachments required with soft-soldered leads, takes up as little as $^{3}/_{32}$" on back of panel.

METALLIZATION

Metallized glass and ceramic windows, tubes, discs, rods, coil forms—for use in hermetically sealed units. Built to your specifications—ready for soldering.

Our engineers are always ready to help you with design problems, will develop special seals, seal assemblies, metallized units to suit your needs.

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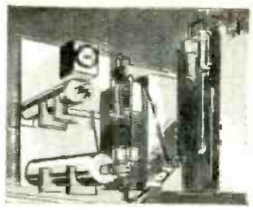
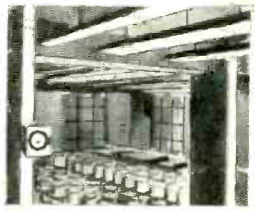
this timekeeper never takes time off



Laboratory life testing.

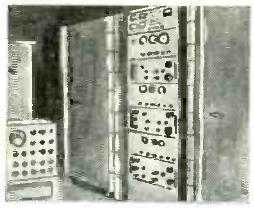
Cramer
TIMING DEVICES



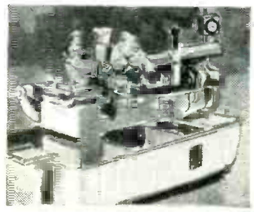
Indicates most efficient time to replace fluorescent lamps.

RUNNING TIME METERS

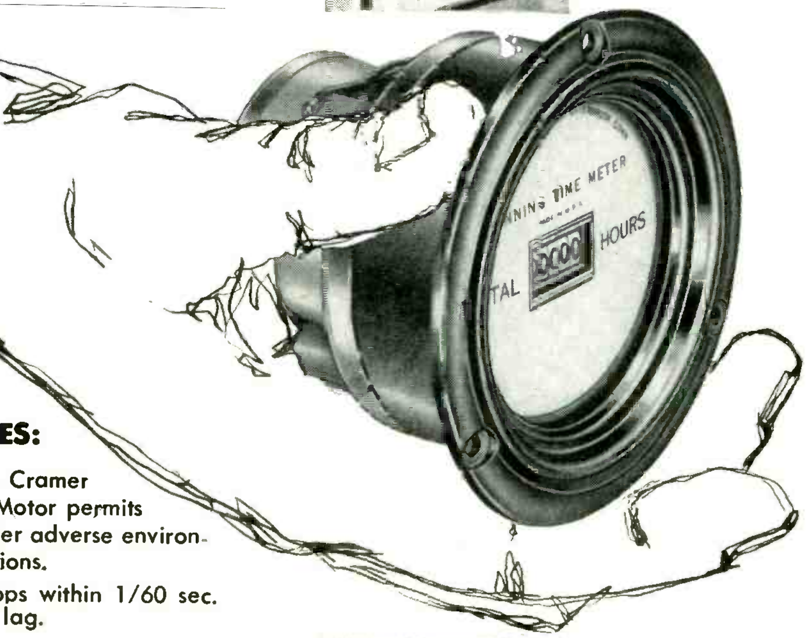
. . . record total operating time or downtime on any circuit, machine or system. Widely used for life test experimentation in laboratories and for preventive maintenance programs, especially as applied to such things as machines, power equipment, tools, vacuum tubes, fluorescent lamp installations, nuclear measurements, etc. Made in six standard 25, 50, and 60 cycle A.C. models — 400 cy., D.C. and sealed type also available. Write for information.



Replacement of vacuum tubes for radio transmitter.

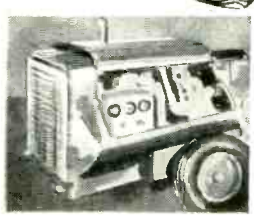


Records down-time on automatic screw machine.



OUTSTANDING FEATURES:

- Extra strength Cramer Synchronous Motor permits operation under adverse environmental conditions.
- Starts and stops within 1/60 sec. . . . no time lag.
- Convenient meter-type mounting.
- Precision-built 5-digit counter.
- Reset feature if desired.



Determines need for maintenance on portable power unit.

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SPECIALISTS IN TIME CONTROL

Interval Timers | Time Delay Relays | Time Totalizers | Cycle Timers | Running Time Meters | Pulse Timers | Hermetically Sealed Military Timers | Synchronous Timing Motors

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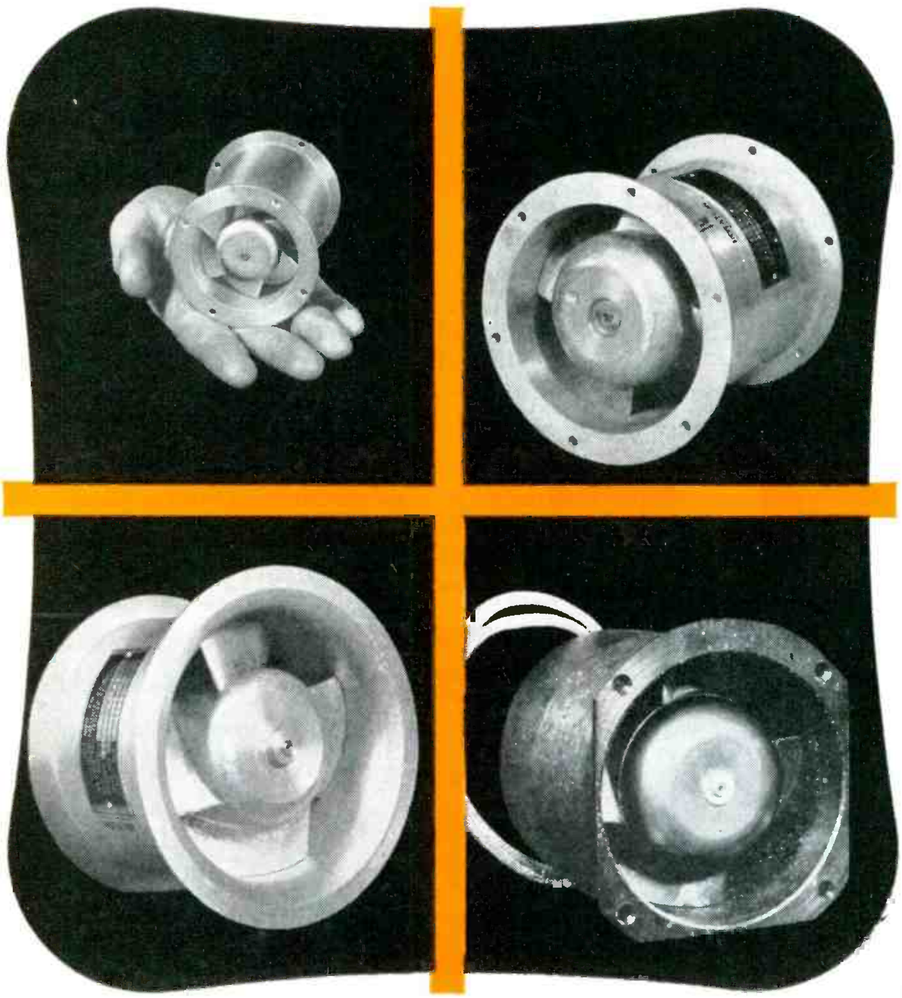

JOY AXIVANE* Fans offer you advantages in electronic equipment cooling which have been thoroughly proved in service. The higher pressure-output of these vaneaxial blowers generally permits more compact arrangement of the equipment. Additional advantages are: light weight, high strength, high shock and vibration resistance, and high efficiency in low or high pressure service.

For minimum weight, JOY electronic cooling fans are made of aluminum, magnesium, or combinations of these metals. They are designed to meet all present Air Force and Naval electronic specifications, and are available in fan sizes from 2″ I.D. up. Totally-enclosed or explosion-proof motors can be furnished where required. ● If you have a problem in heat dissipation from electronic units, no matter what the service conditions may be, let us place at your disposal JOY'S experience as the world's largest manufacturers of vaneaxial-type fans.

Consult a Joy Engineer

Over 100 Years of Engineering Leadership

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W&D I-4010

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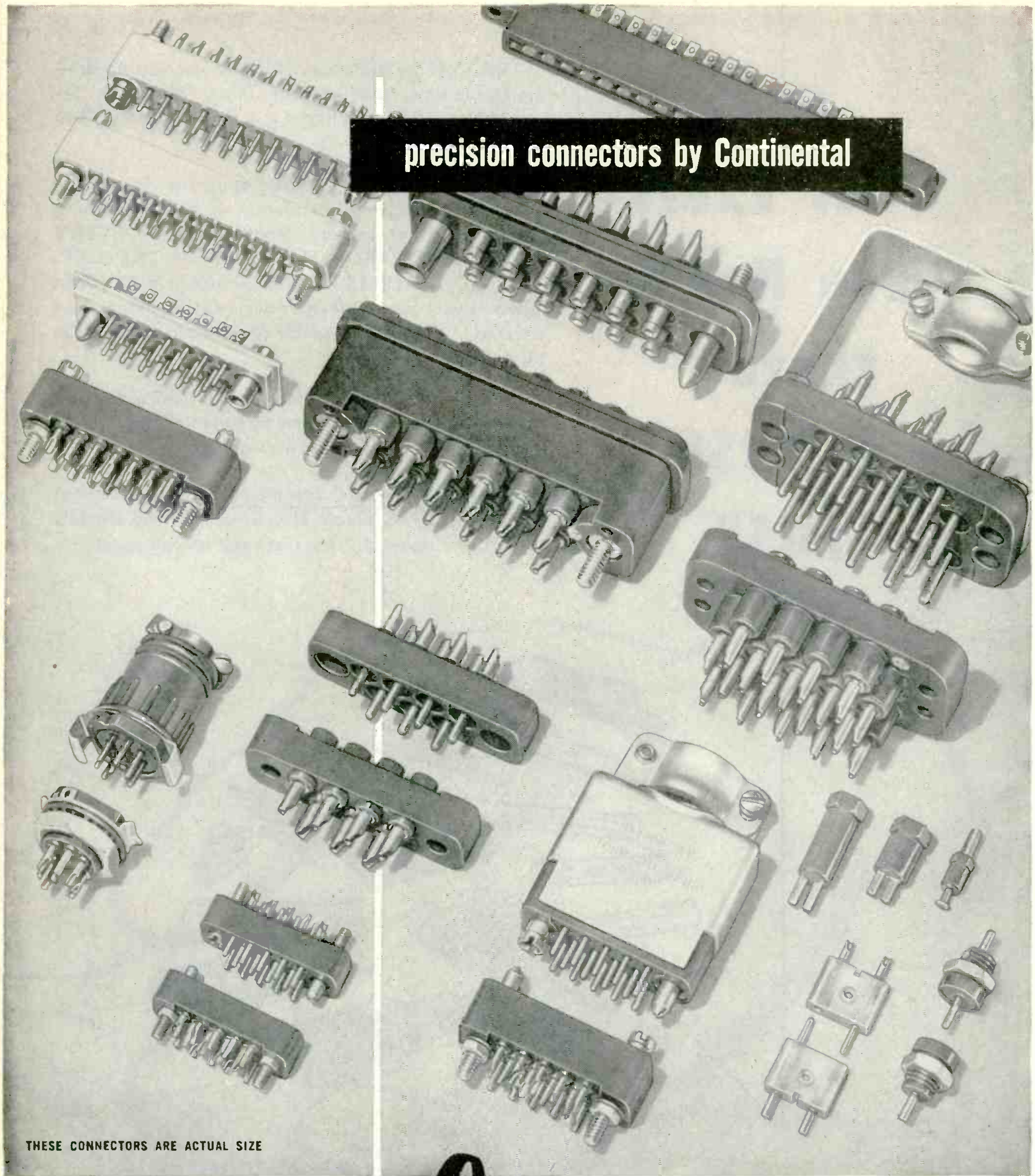

Series SM-20......Sub-Miniature Rectangular Connectors
Series 20....................Miniature Rectangular Connectors
Series H-20 ....Hermetical Seal Miniature Rectangular Connectors
Series C-20...................Miniature Hexagonal Connectors (Vibration Proof)
Series EZ-16.................Easy Release Power Connectors (Spring Loaded contacts)
Series 16..........................Rectangular Power Connectors
Series 14..........................Rectangular Power Connectors
Series PC...............................Printed Circuit Connectors
Miniature Precision Stand-offs
SPECIAL DESIGNS—submit your connector problems to our engineering department.

Continental Connectors

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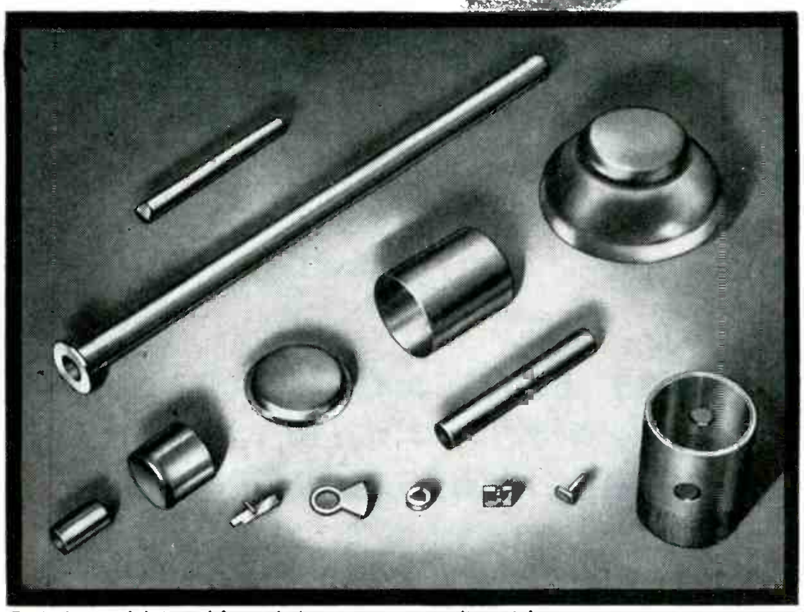
Let us show you how GENERAL PLATE Fabricated PLATINUM-GROUP Composite Metal Parts and Assemblies...

- ***Increase Strength***
- ***Reduce Weight***
- ***Provide Corrosion Resistance at high temperatures***
- ***Increase Electrical and Thermal Conductivity***



Typical parts fabricated from platinum-group composite metals

...and Reduce Material Costs!

By letting General Plate fabricate your platinum-group metal parts and assemblies, you will save money, time, and trouble . . . needless dies and other equipment costs and scrap disposal are eliminated . . . experimental and assembly adjustments are crossed from your books. The finished parts are made to your exact specifications and shipped to you ready for installation.

General Plate's complete fabricating facilities blank, stamp, form, spin, draw, turn, and mill parts; and produce staked, welded, or brazed assemblies.

Typical fabricated products include platinum-tipped contacts and contact assemblies, collector rings, linings for vessels, custom-made crucibles, thermocouple wires, electrodes, etc.

General Plate also produces platinum-group metals in solid and composite form in sheet, wire, tubing, foil, and gauze. In composite form, the noble metal provides the necessary performance characteristics, the base metal greatly reduces costs without sacrificing the desirable characteristics of the pure noble metals.

In addition, General Plate has complete modern assaying and refining facilities which include a complete refinery for the recovery of platinum and platinum-group metals.

Send in your specific problems for discussion and ask for Bulletin PR718.

You can profit by using General Plate Composite Metals!

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GPL

WNCT picks GPL cameras for TOP QUALITY PLUS ECONOMY

■ WNCT goes on the air in Greenville, N. C., with GPL studio and film equipment. On Channel 9, WNCT covers the rich eastern North Carolina tobacco and agricultural markets totaling close to 1,000,000 people.

"In this type of market," says A. Hartwell Campbell, general manager of WNCT, we shopped for not just quality but economy in cameras. That was a big factor in picking GPL.

"We checked with other stations, some with GPL chains, some with other makes. They confirmed our decision GPL was the best. The price was competitive, but we got all the GPL extras from picture quality to ruggedness, plus the economy mainly made possible by remote control operations.

"GPL projectors were the logicial choice, to give us quality plus economy again for films as well as live shows."

TV equipment that produces the best picture, and still gives a station owner economy, deserves consideration. Try these cameras, under your own operating conditions. Study the remote control features and compare operating costs. You'll discover how GPL can save you money . . . with the best.

Malcolm Nicholson, film editor of WNCT threads one of two GPL PA-100A projectors used by WNCT. Projectors have 4,000-foot capacity, and are remotely controlled.

WNCT's home nears completion in Greenville. Station has 100,000 watt video signal and 50,000 watt audio. The antenna towers 874 feet above the surrounding terrain.

WNCT engineers Bill Elks (left) and Heber Adams during practice sessions before completion of 35 x 50-foot studio. Lens change, focus and iris adjustment can be handled from control room, at any time as desired.

A phone call, wire or letter will bring complete information on cameras, projectors, transmitters, the new Watson-GPL vari-focal lens and all other TV equipment for studio or field.

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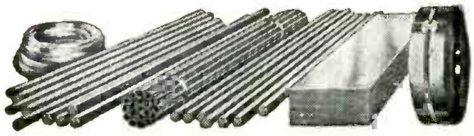

BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

Bridgeport Brass Co. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

The Production Control Quantometer can make a complete analysis of copper-base alloys in approximately four minutes as compared to several hours by the chemical method.

Bridgeport's Laboratory Service

Scientific Controls Protect Users of Mill Products

Uniform high quality of brass mill products is essential to modern metalworking practice, as cost of operation and salability of end product often depend upon it. Strict laboratory controls protect users of sheet, rod, wire, and tubing; help economical production; and govern uniformity.

Scientific tests are made of incoming raw materials, castings analyzed, and outgoing finished orders checked. This procedure assures conformity with specified composition, dimensions, temper, and other physical properties.

Quantometer Speeds Analysis

How the Bridgeport Laboratory keeps abreast of up-to-date testing methods is well exemplified by the Production Control Quantometer. With this new, automatic, electronic spectrometer, alloy composition is determined in a matter of minutes. Samples obtained from the molten stream during pouring are speedily delivered to the Quantometer room by a specially designed, pneumatic tube system.

A small test sample casting is machined for a smooth surface and placed on the platform of the Quantometer where it receives an electrical discharge. The resulting gaseous vapor of the melted metal has a luminosity which is broken up by a grating into wavelengths of light. These rays strike photomultiplier tubes arranged to receive light corresponding to the elements desired in the analysis. These tubes develop voltage which is registered on a strip chart recorder and converted into terms of calibrated concentrations by means of a calculating device. The complete cycle of machining, loading, calculating, and recording requires approximately 4 minutes. This remarkable instrument is operated in an air-conditioned room with temperature and humidity controlled to assure accurate performance.

With many thousands of pounds of metal being cast daily, speed is essential in testing composition so that any offmixture can be detected and corrected immediately.

Analyses are made of every alloy cast and other physical tests such as hardness, grain size, tensile strength, yield strength, elongation, are made when required.

Corrosion Studies Beneficial

Corrosion is probably the greatest enemy of metals. A specially trained staff studies the effects of corrosion so that more suitable metals can be recommended for longer service life. Electro-chemical studies are made in the laboratory, along with alternate immersion, total immersion, impingement and stress corrosion testing in acid, base, salt and organic solutions and gases. Field tests and examinations of corroded tubes are also performed.

Research Very Important

Bridgeport's consistent research program comprises studies of new processes and methods of production as well as possible new products; development of new alloys and improvement of old ones; comparison testing, etc., and study of the fundamentals of forming operations.

Experimental work also covers welding, machining, strain analysis, heat treatment, as well as evaluations of coolants, lubricants and metal cleaning.

Technical Service

Our experienced technical service staff can help customers on their metal problems in many ways:

1. To make sure that the correct alloy and temper are used on standard items.

2. To improve existing products by using stronger, more corrosion-resisting alloys.

3. To help designers to specify the correct copper-base alloys when bringing out new products.

4. To help reduce finishing costs by recommending the correct temper or grain size for minimum polishing effort.

5. To help reduce machining costs by recommending the proper free machining alloys.

6. To increase service life of tube installations by recommending more corrosion-resisting alloys.

If you have not yet used Bridgeport's laboratory controlled mill products, contact our nearest District Office. Write for your copy of Bridgeport's "Technical Handbook," using your company stationery. (1172)

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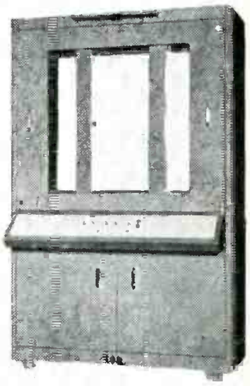
Designed to meet the demand for a highly accurate, dependable, and versatile general-purpose analog computor for solving problems in dynamics for industrial, research, educational, and military groups. Features a new high-gain, low-drift, contact-stabilized d-c amplifier with outstanding frequency response and power output characteristics; centralized operation from a control console which houses the problem board and its bay, attenuators, initial condition potentiometers, limiters, and other operating controls; precision network components contained in a controlled environment to insure reliable and accurate performance; a grounded 1800 position problem board which confines all terminal leakages to ground.



VARIPLOTTER MODEL 205J

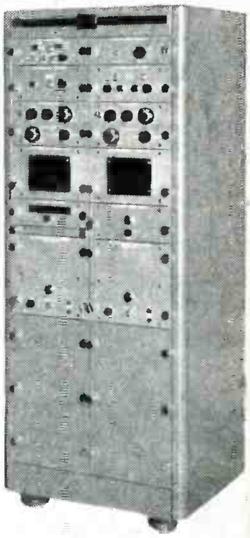
Variplotter - MODELS 205G and H

A self-balancing potentiometer type recorder designed to record one variable d-c voltage as a function of a second variable d-c voltage. Model 205G is a single pen board that will present a single X vs. Y plot. Model 205H has an additional arm and pen allowing it to record two independent sets of X vs. Y data simultaneously. Static error is .05 per cent of full scale at 70 degrees Fahrenheit. Dynamic error averages .05 per cent of full scale plus the static error. Standard sensitivity is 50 millivolts per inch or 1.5 volts for full scale deflection of 30 inches. Maximum writing speed is 8-½ inches per second. Continuously variable uncalibrated scale factor and parallax controls are provided for each axis.

VARIPLOTTER MODELS 205G AND H

Variplotter - MODEL 205J

Essentially the same characteristics as the Models 205G and H described above except that the plotting surface is vertical. The plotted result, in the form of an inked line, is presented on a 30 inch square of paper which is held firmly to the plotting surface by a unique vacuum system. Static error is .05 per cent of full scale at 70 degrees Fahrenheit and dynamic error average .05 per cent of full-scale plus the static error. Maximum writing speed is 8-½ inches per second. Standard sensitivity is 50 milli-volts per inch or 1.5 volts for full-scale deflection of 30 inches. Where floor space is limited, the MODEL 205J Variplotter is recommended for your recording needs such as analog computer output, guided missile data, engine performance, etc.



DIGI-VERTER GROUP TYPE 17-31A

Digi-Verter Group - TYPE 17-31A

The Digi-Verter can be used to convert digital information, such as that obtained from card reading machines or tabular lists, into analog form suitable for presentation as a point plot on a Variplotter plotting board. It is designed to accept two four-decimal digit numbers and their signs from an IBM machine such as Type 513, 517, 519, 523, etc. Complete operating controls include power switch, feed switch, input switch, storage clear, and scale factor and parallax controls for both X and Y. Scale factor will provide plot expansion up to 10 times and parallax controls allow the zero-zero origin to be located anywhere on the plotting surface. The complete digital plotting system consists of the Digi-Verter, Data Input Keyboard, Model 205G Variplotter plotting board

FUNCTIONAL POTENTIOMETERS

Functional Potentiometers

There are two models of sine-cosine potentiometers available—Type 462 which is a single unit and Type 315 which provides two sets of sine-cosine functions. Accuracy, is within .15% of the theoretical voltage for all points throughout 360° of shaft rotation. Angular resolution is .005% of 360° and electrical resolution, expressed as a percentage of the total voltage applied across one 90 degree quadrant is with .05%.

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MIL-R-93A NEW SEALED TYPES

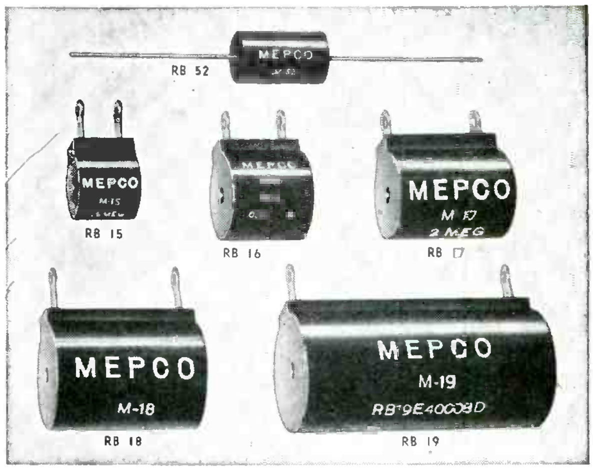
Over 2 years of laboratory development and testing were required to achieve a sealed resistor design up to Mepco's standard of quality. No sacrifice of our standard time-proven features has been made in order to perfect this sealed resistor.

Completely hermetically sealed, these resistors provide perfect protection against immersion and high humidity.

All requirements of MIL-R-93A and JAN-R-93 are exceeded.

The operating temperature is —65°C to +125°C. Temperature coefficients of ±.003%/°C to ±.017%/°C depending upon your requirements. (Refer to MIL-R-93A).

Other sizes available on special order.



MIL-R-93A JAN-R-93 STANDARD TYPES

Our standard time proven JAN, MIL and Commercial lug terminal resistor.

Manufactured and 100% tested in accordance with the applicable specifications, these resistors are used by every major electronic equipment manufacturer in the country.

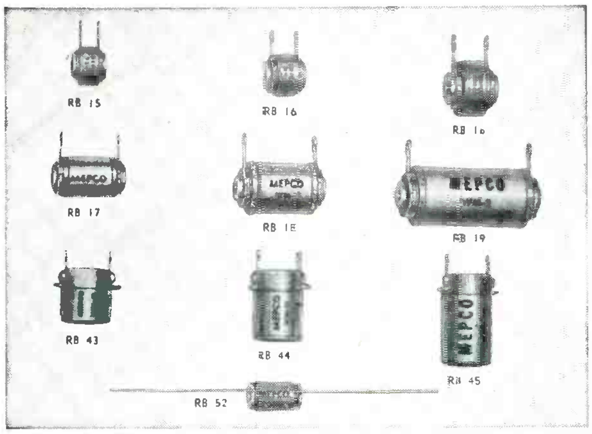
Reversed and balanced PI-windings for low inductance, with use of only the finest resistance alloys.

Impregnated with approval fungus, moisture and salt waterproofing compounds.

JAN approved non-hydroscopic steatite bobbin, specially treated prior to winding in order to provide additional protection for fine enameled wire.

Protective fungi resistant acetate label.

Rigid hot solder coated brass terminals for easier soldering.



WIRE TERMINAL TYPES

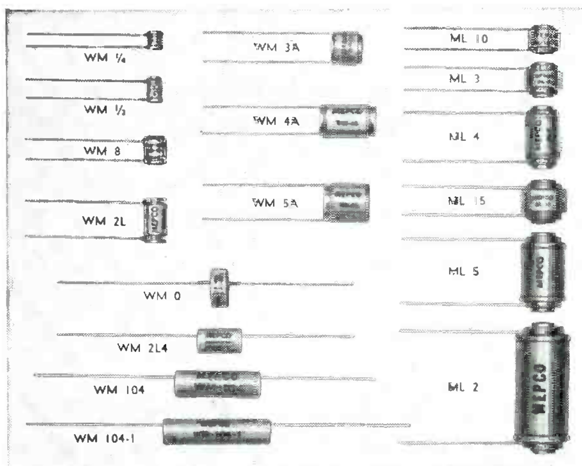
Designed for direct connection into circuit without use of additional leads.

These resistors are of the same basic construction and materials as standard JAN and MIL types therefore providing equal dependability and long life.

Low Temperature Coefficient alloys provide ±.003%/°C from —65°C to +125°C unless otherwise specified by your requirements.

Resistance tolerances range from ±1% down to ±.02%. Sets of matched resistors can be supplied ±.005% or lower.

Special types not shown can be manufactured to your exact specifications.



JAN-R-29 METER MULTIPLIERS

Surpass all requirements of JAN-R-29

HERMETICALLY SEALED: Insures dependable operation under most severe moisture conditions.

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WINDINGS: "Certified" low temperature coefficient resistance alloys properly "aged" to provide long term stability.

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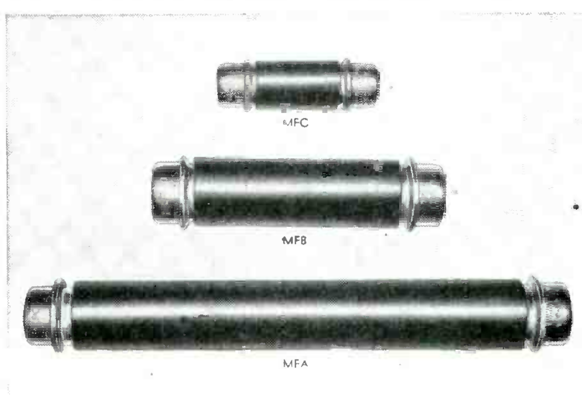
FERRULE TERMINALS: Heavy nickel plated brass. Corrosive resistant. Fit standard fuse clips.



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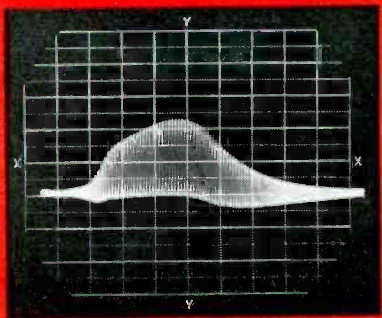
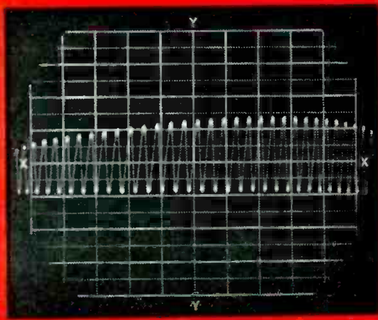


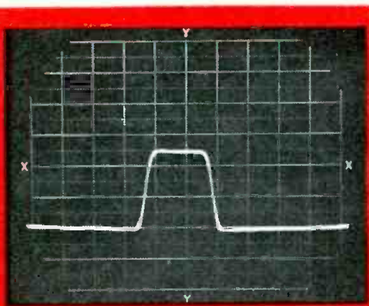
Sweep – 0.4 μ sec/cm



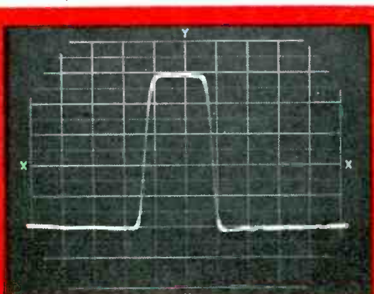
Sweep 0.1 μsec/cm, Pulse Center Expanded

HIGH SENSITIVITY AND WIDE FREQUENCY RESPONSE OF Y-AXIS AMPLIFIER

The vertical amplifier of the 401 provides uniform frequency response and high sensitivity from D-C. Coupled with a sensitivity of 15 Mv./cm peak to peak at *both D-C* and A-C is a response characteristic which is 3 db. down at 10 Mc. and 12 db. at 20 Mc. Alignment of the amplifier is for best transient response, resulting in no overshoot for pulses of short duration and fast rise time. An example of the wide band response of the amplifier is shown in the accompanying photographs.



37.5 Mv., 0.2 μ sec width, 1 μ sec sweep full scale



75 Mv., 0.2 μ sec width, 1 μ sec sweep full scale

LINEARITY OF VERTICAL DEFLECTION The vertical amplifier provides up to 2.5 inches positive or negative uni-polar deflection without serious compression; at 3 inches, the compression is approximately 15%. The accompanying photographs illustrate transient response and linearity of deflection.

SWEEP DELAY The accurately calibrated delay of the 401 provides means for measuring pulse widths, time intervals between pulses, accurately calibrating sweeps and other useful applications wherein accurate time measurements are required.

The absolute value of delay is accurate to within 1% of the full scale calibration. The incremental accuracy is good to within 0.1% of full scale calibration.

SPECIFICATIONS

Y-Axis

Deflection Sens. — 15 Mv./cm, p-p
Frequency Response — DC to 10 Mc
Transient Response — Rise Time (10%-90%) 0.035 μ sec
Signal Delay — 0.25 μ sec
Input line terminations — 52, 72 or 93 ohms, or no termination
Input Imp. — Direct — 1 megohm, 30 μ μ f
Probe — 10 megohms, 10 μ μ f

X-Axis

Sweep Range — 0.01 sec/cm to 0.1 μ sec/cm
Delay Sweep Range — 5-5000 μ sec in three adjustable ranges.
Triggers — Internal or External, + and −, trigger generator, or 60 cycles, undelayed or delayed triggers may be used.
Built-in trigger generator with repetition rate from 500-5000 cps.

General

Low Capacity probe
Functionally colored control knobs
Folding stand for better viewing
Adjustable scale lighting
Facilities for mounting cameras

PRICE: $895.00

Additional Features:

TRIGGER GENERATOR with variable repetition rate from 500 to 5000 cps.

POSITIVE & NEGATIVE UNDELAYED TRIGGERS and a **POSITIVE DELAYED TRIGGER** are externally available.

An **INPUT TERMINATION SWITCH** for terminating transmission lines at the oscilloscope.

A **FOLDING STAND** for convenient viewing.

FUNCTIONALLY COLORED KNOBS for easier location of controls.

Designed and built *for* electronic engineers, the 401, with its high gain and wide band characteristics, and its versatility, satisfies the ever-increasing requirements of the rapidly growing electronics industry for the ideal medium priced oscilloscope.

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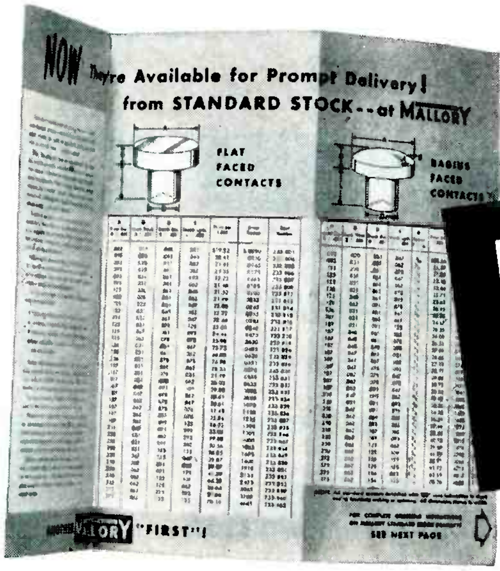

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Here is another Mallory "first"! A standard stock program on fine-silver headed rivet contacts makes possible immediate shipment of most requirements.

Engineering analysis of thousands of customer prints resulted in the selection of 70 flat and radius faced fine-silver headed rivet contacts to be carried in stock. These designs are suited to thousands of varying applications. The advantages to our customers are obvious . . .

- ***Prompt shipment, normally within 24 hours.***
- ***Saving in time and cost of special designs and tooling.***
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Write today for the leaflet listing dimensions, prices and part numbers of the 70 standard stock Mallory Contacts. It has been designed for quick checking against your present requirements and also for reference in your new design work.

If the special nature of your design requires special contacts, call on the specialized experience of Mallory engineers. Modern facilities and a complete range of materials are available to produce contacts or contact assemblies to meet your requirements.

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CROSS TALK

▶ **BIG JIM** . . . We run 25 watts on the ham bands and thought it was pretty lush to operate a half kilowatt before the war, so it was a thrill to watch RCA's General Sarnoff transmit Admiral Carney's first official message to the fleet from Navy's new 1,200,000-watt transmitter (p 98, Dec. 1952) northeast of Seattle. The old man has not lost his skill with a key. We understand he has one on his desk, uses it occasionally for short-haul work around the office.

Jim Creek Valley is in the clouds through much of the winter season, so 1,000-foot leads running straight up to the antenna disappeared in the mist before reaching the mountaintop-to-mountaintop catenaries. Nearest thing we've ever seen to the proverbial skyhook or, if you prefer a simpler simile, the Indian rope trick.

There is a conventionl television receiver in the shadow of the most powerful radio transmitter in the world and it operates beautifully during transmissions. Interference with other services has yet to be reported, despite the fact that there are no harmonic filters of any kind in NLK's antenna circuit. Designer J. C. Walter told us this is because the station operates on a very low frequency (14.5 to 35 kc) into an extremely efficient antenna that just won't soak up power anywhere else.

▶ **TEACHERS' PAY** . . . A Central Intelligence Agency man tells us, on the record, that the Russians are rapidly building up their supply of engineers by every possible means. Aside from military requirements, it seems they now need them to design consumer goods that the people have reluctantly done without. The current lull in pressures applied to other countries may be due to the need for consolidation inside the Soviet Union.

Key to the training of engineers in any country is good teachers. We met a lot of them recently at Rensselaer Polytechnic's Industrial Council, and one thing crept in between the lines of most conversations. Many American educators are in the profession because they feel more than the average man and woman that they have an important mission to perform. This fact notwithstanding, unless something is done to raise teachers' pay nearer the levels paid people with comparable qualifications by industry the quality as well as the quantity of available educators will steadily decline.

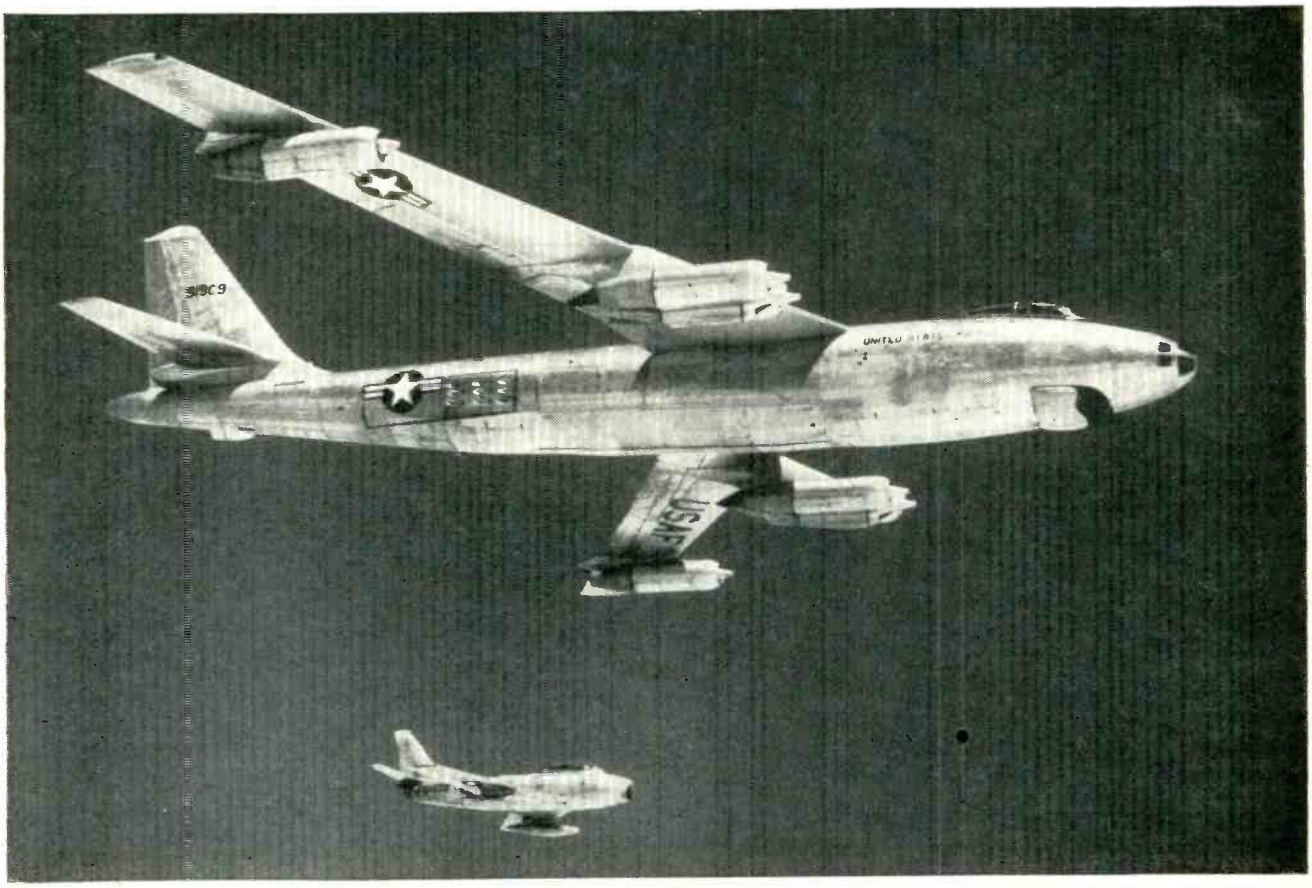
▶ **ENGINEER-LAWYERS?** . . . Columbia University is using a $50,000 grant from our industry's Major Armstrong to study the technical data upon which certain court decisions have been based. The question: How right have the courts been when rendering decisions revolving around complex scientific subjects?

Says the Major: "It has been my observation over a long period of years that public bodies, in order to discharge their functions, are frequently required to make findings of fact on technical and scientific matters that are beyond the comprehension of laymen. The techniques involved in the ascertaining of such facts have not been adequately developed, with the result that important decisions sometimes have been made, and important actions taken, upon erroneous findings of fact in technical and scientific fields."

▶ **COMING ATTRACTIONS** . . . Our survey of subscriber needs continues and, in general, you say: "Give us more of the same."

The editors of ELECTRONICS plan to add three extras in this new year. There will be, before spring, a four-page foldout that should have considerable reference value. Around mid-summer we hope to start a series of articles (now that the transistor series is out of the way) that will be "must" reading for assemblers of just about any kind of electronic gear. And in the fall there will be an extensive insert dealing in a practical way with the specific problems of a particular group of engineers who have hitherto been served more or less in passing.

Designing Radomes



With the exception of radar-steered missiles, radomes on these two planes take about the toughest punishment of any on planes in production today. For the Boeing B-47 Stratojet, the bombing and navigation radome is almost directly under the pilot; a later model B-47 also has a tail radome for gunfire control. Flying below is the North American F-86 Sabre with a nose radome

New honeycomb, foam and sandwich materials form radomes that transmit radar signals with minimum boresight shift, absorption and reflection loss, yet withstand effects of hail, icing, rain, wind, temperature, static charges and gunblast at supersonic speeds and stratospheric altitudes of modern military aircraft

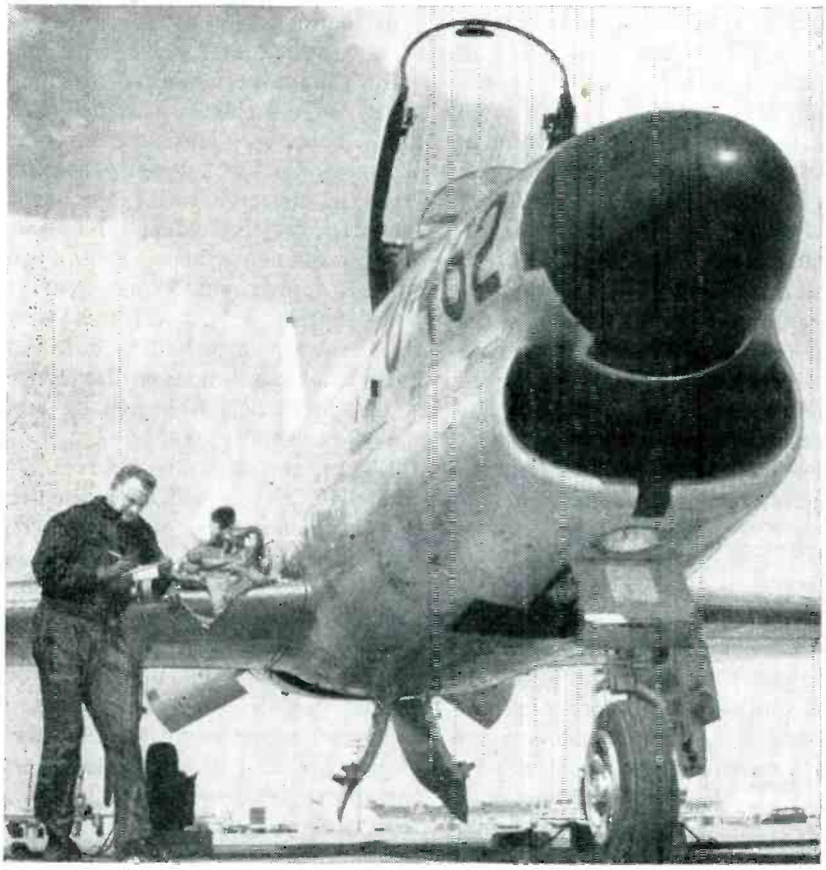
UNIFIED DESIGN of an airborne radar radiating system, from the magnetron all the way through to the antenna and radome, is today a necessity. No one element of the system can be reasonably considered to the complete disregard of the other elements, since the interdependence of all contributes vitally to the efficient performance of the entire system. This is particularly true of the radome through which the outgoing and incoming pulses must pass.

To the aeronautical engineer the radome is merely a plastic disfiguration of his airframe. To the structural designer, it is a potential weak spot in an otherwise all-metal fuselage. To the gunner, it is a part of the radar system that contributes—or is responsible for—errors in the accuracy of his automatic gun-laying equipment. To the electronic engineer, it is a dielectric housing that affects the electromagnetic fields in the vicinity of the antenna to the extent that the major lobe of the radiation pattern may be distorted and the side lobes increased, displaced or otherwise modified.

The first radomes were hemispherical and were fabricated from molded plywood. They reflected considerable energy back into the antenna. The usual result of such reflection was the failure of the magnetron and with it, the collapse of the radar system.

New materials then made their entry into the field of radome design. One of them involved a combination of fibrous glass, in both woven and unwoven form, with

for Supersonic Speeds



Official Air Force photo showing nose radome of F-86 interceptor. The radome is designed to withstand transonic speeds at high altitudes. Radar here is used for both search and gunfire control on attack missions

By SAMUEL S. OLEESKY

Vice-President and Chief Scientist
Micronics, Inc.
Gardena, Calif.

thermosetting organic resins added.

As a design goal, the engineer visualizes a radome which will not deflect, attenuate or distort the radar beam. It will not cause a mismatch in the antenna system. It will not discriminate between polarizations. Local transmission efficiencies must be high, with reflections low. Transmission efficiencies must be, as far as possible, independent of incidence angle.

Radome efficiency is the ratio of output to input. In other words, it is the answer to the question of how much of the microwave energy that impinges upon the inside surface of the radome wall continues through to its destination and returns to the radar antenna. This answer depends, of course, upon the loss caused by the dielectric material in the radiation field. This divides into three components—reflection, absorption and scattering or diffraction losses. Modern construction techniques minimize all these loses.

Several types of construction have evolved for today's radomes. Where low frequencies in the microwave region are considered. it is possible to use the thin-wall construction, where the radome wall is thinner than 0.1 wavelength. At normal incidence, a wavelength in the dielectric is approximately equal to the wavelength in free space divided by the square root of the dielectric constant of the wall. Where other than normal incidence angles are considered—by far the majority of cases—a correction factor must be applied.

A second type of construction is the sandwich wall. This consists of two very thin skins of dense material, such as resin-impregnated glass cloth, separated by a spacing medium of low density. The latter may be air, a honeycomb structure of glass cloth or paper, or an expanded material such as foamed resin. The use of simple air space between the skins has been practically abandoned for the construction of radomes.

A third type of construction is the half-wave wall, whose thickness is one-half wavelength in the dielectric at the angle of incidence involved.

Acceptable Losses

With the careful quality control of modern radome fabrication, a surprisingly large percentage of the radomes in use today have transmission efficiencies greater than 90 percent, and many approach 97 or 98-percent efficiency. In cases of high-incidence radomes, occasioned by the streamlining required for sonic speeds, 85 percent becomes an acceptable figure.

Since most of the current radome materials are of extremely low loss, the reflection from the wall is the greatest contributor to decreased efficiency. In general, a 10-percent power reflection is the maximum acceptable. However, geometrical optics determines how much of the reflected energy returns to the antenna and back into the system. It is this reflected energy which causes magnetron pulling and system failure. Consequently, it is the system engineer who can best specify the acceptability of the reflected energy.

For any given material and any chosen angle of incidence, it is possible to design a radome wall with reflection closely approaching zero. However, since most antennas scan in azimuth while passing through various angles of tilt, an angle of incidence chosen for a particular point on the radome will change constantly as the antenna's position changes. The optimum thicknesses for average incidence angles must therefore be determined.

Design Procedure

As an example, start with an arbitrary paraboloidal antenna in a hemispherical radome, as shown in Fig. 1. Ray 1, starting at the edge of the dish, intersects the wall at point a at an angle θ_1 which is complex because of the double curvature of the hemisphere at that point. Ray 2, starting closer to the center of the dish, has an incidence angle θ_2 at its point of intersection b, which is different from the angle at a. Ray 3, starting at the dish center, strikes the wall at point c with normal incidence, if the dish is centered in the radome.

First of all, the average angle of incidence is not one-third the sum of the three angles, for they are but typical rays. The power illumination contour of the reflector dish must also be considered. This may be represented as a $(\sin x)/x$ function, with the power at the edge 10 or 20 db below the maximum power at the center. Under these conditions, weightings must be applied to the various rays, depending upon their contribution to the total energy. For that purpose, the radome surface must be divided into small differential areas and the weighted value of the incidence angle at each area determined. Next, an integrated average of all of these weighted angles is obtained. The procedure is repeated for each position of the antenna in scan and elevation, to get the optimum angle of incidence for each point. This is tedious, but it results in the design of a radome with optimum properties.

If making a thin-wall radome, the reflection and expected transmission efficiency at the critical areas must be computed next, to make certain that the radome will meet the specifications if the fabricating tolerances are maintained.

Honeycomb Sandwiches

If designing a sandwich radome for a search-type radar, the odds are that it will be a honeycomb sandwich, since extreme accuracy of the radar system is not a serious problem. Honeycomb radomes are made by a process which uses only one mold, usually conforming to the outside contour. The molding pressure is applied by flexible bags, either evacuated, pressurized or both. Since the honeycomb core is sliced from blocks on a bandsaw, it is most convenient to use a uniform wall thickness, as tapering of the slices is expensive.

A sandwich thickness is chosen that will provide the best possible transmission over the widest range of incidence angles. There are detailed mathematical procedures for determining the optimum core thickness.[1] In some cases, it is possible to determine approximately, from curves similar to those in Fig. 2, the acceptable range of incidence angles for any given choice of core thickness. Here two sets of data have been plotted as functions of incidence angle and core thickness. The curves represent the amount of power reflection from the dielectric wall. The lower set of curves give values for a first-order radome whose skins are spaced approximately one-quarter wavelength apart. With a core thickness x_1, there will be zero reflection at an angle of incidence θ_a and that reflection will be less than 5 percent from θ_b to θ_c.

Where aerodynamic loads indicate that the core thickness chosen is insufficient to provide the strength required, it may be necessary to use a second-order thickness, which is approximately three-quarter wavelength. This is represented by the upper set of curves, which gives an optimum thickness x_2 for angle θ_a. Because of greater wall losses the slope of the curves is greater and the effective range of angles has been reduced. This problem becomes more critical at higher radar frequencies due to reduction in the magnitude of the quarter-wavelength dimension.

Gunnery Radar Problems

Where gunnery radar equipment is concerned, the effect of the dielectric wall on the wavefront must be

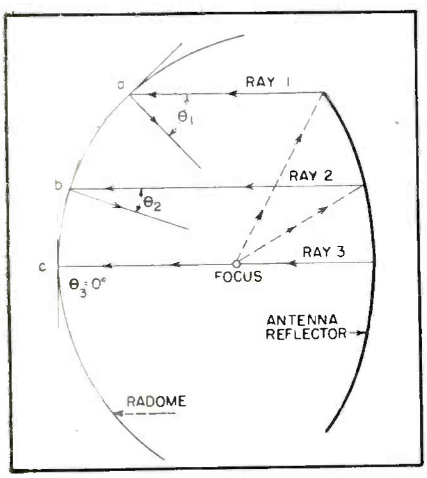


FIG. 1—Finding average angle of incidence in typical radome layout

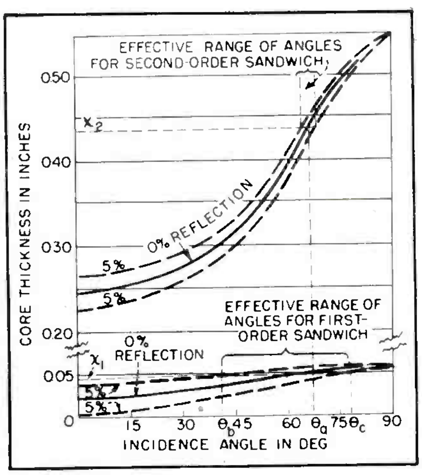


FIG. 2—Optimum-core-thickness chart for two types of sandwiches

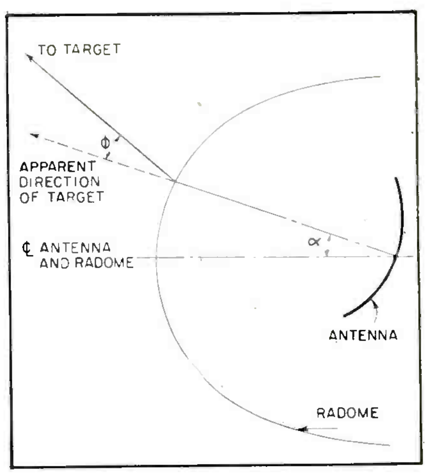
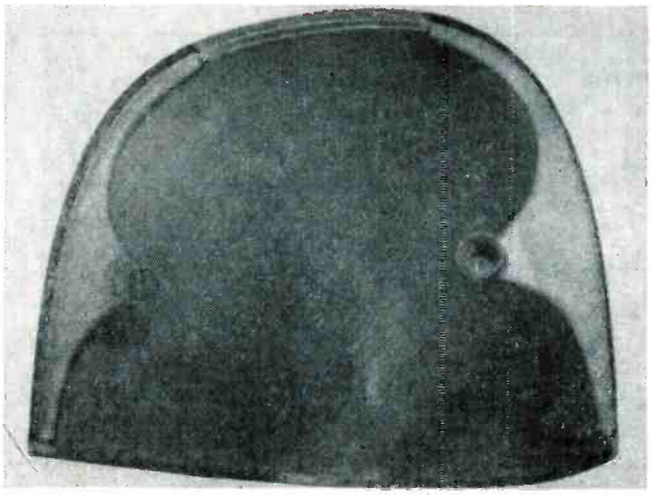
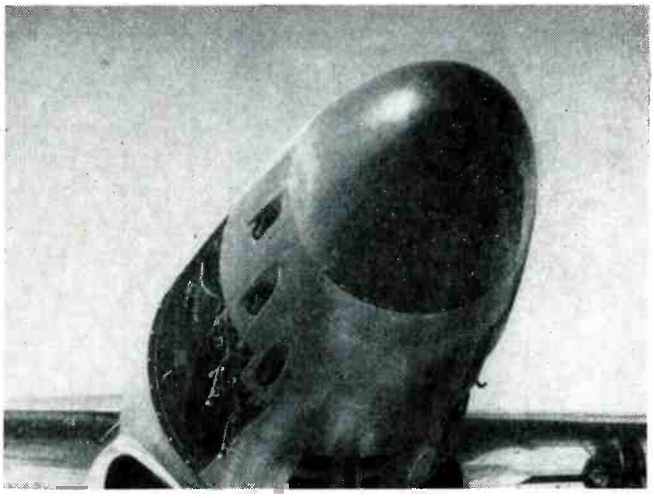


FIG. 3—Boresight error caused by curve radome in gunnery radar



Anti-ice radome for Fairchild C-119 airplane. Hot-air manifolds on each side act with molded anti-icing channels to warm plastic surface and break up ice on solid-wall construction



In addition to withstanding speeds over Mach 1 in all weather conditions, the nose radome of this Northrop Scorpion F-89 must be immune to muzzle blasts of six 20-mm cannon

considered to a much more precise degree. The problem is illustrated by Fig. 3, which represents an antenna in a radome. With the antenna tilted at an angle α, the system shows an echo from some target. It would be logical to assume that the bearing of the target from the airplane is precisely that angle α. However, because of the presence of the radome wall, an additional shift of the radar beam has been introduced. This is shown, in exaggerated form, as the angle ϕ. This error angle is known as the beam-bending angle, the boresight shift, the crossover-point shift and various other names. All of them refer to the fact that the radar beam is not going in the direction which the antenna seems to indicate. As a consequence of this deviation, the information fed by the antenna servo system to the gun computers is erroneous and a miss results.

Foamed-in-Place Radomes

One of the solutions to this boresight shift has been the manufacture of the foamed-in-place sandwich radome. This is, in general, a more expensive method of fabrication than the honeycomb procedure, but is usually dictated by the necessity for a more homogeneous core material. Most foams in current use are of the alkyd-isocyanate type, in which a thermosetting organic resin of the alkyd family is reacted with foaming agents such as tolylene di-isocyanate to produce a rigid, homogeneous, low-loss foam with discrete cells that are resistant to the passage of moisture. Earlier foams, mostly carbonates, had interconnecting cells which encouraged the flow of water and water vapor, to the detriment of the radome's electrical properties.

For foamed-in-place radome construction, a more costly tooling setup is required. Usually, one set of metal or cast phenolic tools is used to preform the radome skins. After the skins are made and measured to determine their compliance with design thickness specifications, they are placed on a set of matched metal tools, usually on a large hydraulic press or on some type of lifting device that can locate the male plug accurately with respect to the female cavity. The resin foaming batter is poured into the female skin and the plug is lowered into place. Spacer blocks are used to maintain core dimensions when the entire assembly is bolted together. Heavy bolts are required to withstand the tremendous pressures exerted by the foaming mass. After the foam has risen to fill the space between the skins, it is subjected to a cure cycle which develops its full physical properties.

With foamed-in-place construction, it is possible to take full advantage of any thickness variations that may be required by different angles of incidence over the wall area. Thus, a virtual tapered-wall construction can be built into each radome with no more effort than would be required for uniform wall thickness. Good control of boresight shift has been achieved by this method of construction.

Half-Wave Radomes

The half-wave radome wall is rapidly gaining prominence. Here, the use of either vacuum-bag molding techniques or matched tooling may be determined by the economic considerations of prototype fabrication or mass production. Again, tapered-wall advantages may be realized where required. Where weight offers an obstacle to the use of normal materials in the half-wave construction—and weight is usually critical in aircraft design—modifications to the resin or glass filler may be made to raise the dielectric constant of the laminate, thus reducing the necessary thickness to achieve the half-wave criterion.

Design Calculations

Table I gives a method of determining the reflection coefficient from an air-dielectric interface.

The impedance concept is used to compute the optimum spacing of the skins of a sandwich. If a plane-polarized wave is transmitted by the radar system, it must be ascertained whether that polarization is parallel or perpendicular. The microwave ray *AO* and the perpendicular *OB* to the dielectric sheet in Fig. 4 determine what is known as the plane of incidence. When the

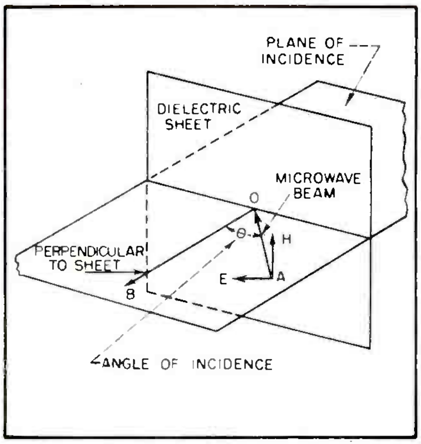


FIG. 4—Identification of polarization of transmitted radar wave

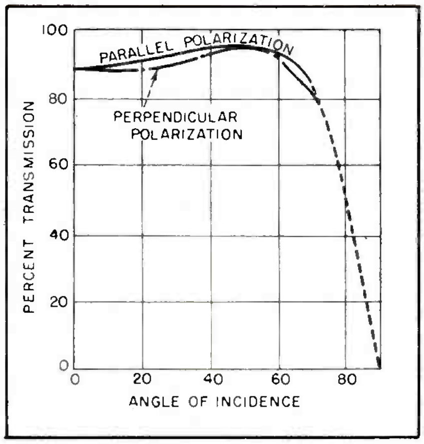


FIG. 5—Transmission efficiency curves for dielectric radome panel

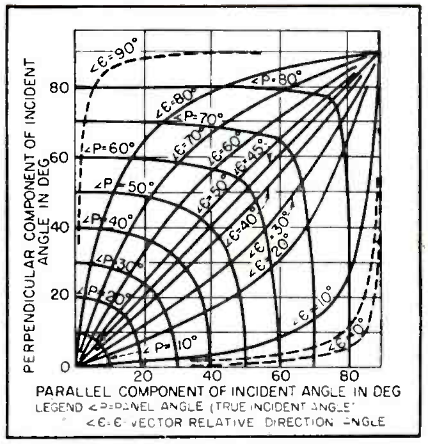


FIG. 6—Relative polarization and incidence-angle components chart

electric or E-vector lies in or parallel to that plane, the polarization is defined as parallel. When the E-vector is perpendicular to the plane of incidence, the polarization is perpendicular. These are respectively called horizontal and vertical polarization.

Except at normal incidence, the transmission of a given panel will differ at parallel polarization from its transmission at perpendicular polarization. Figure 5 shows a pair of typical curves for such transmission efficiencies.

In working with compound curvature, which exists in almost all radomes, the designer must realize that neither true parallel nor true perpendicular polarization exists. Actually, there is within the radome a complex resultant polarization at the point of ray incidence. Figure 6 gives a method for ascertaining the true polarization angle when both components of the incidence angle are determined from plan and elevation views of the ray study.

Where a circularly polarized wave is radiated, the effect of phase-shift on the circularity of the polarization must be determined. A relatively simple method[2] of obtaining a first approximation for the phase shift is given in Table II. Only the dielectric constant of the panel is considered, the loss tangent being neglected. While such an approach is useful for the purpose, no material is lossless in fact. A loss tangent of 0.02 can result in an absorption loss as high as 30 percent. Consequently, any design work based on the lossless approach should be verified by the measurement of experimental panels prior to construction of the radome.

A knowledge of the insertion phase retardation will enable the radome designer to predict probable boresight error and compensate properly in the construction techniques.

Weather Problems

In the course of normal flight, an airplane occasionally encounters a hailstorm. The resistance of the common plastic radome to the impact of hailstones while traveling at 300 or more miles an hour is not so good. However, by the proper choice of rigid and flexible resins in a blend, together with special weaves of glass fabric, it was possible to develop a nose radome for the DC-4 and DC-6 which withstood the impact of two-inch ice pellets moving at 360 mph. Hundreds of these radomes were built without a single reported failure in flight.

A radome covered with ice is useless. One solution, developed by the Douglas Aircraft Co., is a fluted-core construction that supplants honeycomb where icing problems are expected. Here, the core is built with parallel channels designed in a maze that permits the passage of hot air between the skins. Thus the outer surface is kept at a temperature sufficiently high to prevent ice accretion.[3]

The temperatures encountered in supersonic flight impose a severe test upon common plastics used for radomes. Organic resins in current use can seldom withstand, for any protracted period, temperatures as high as 300 F. Missile noses may reach 1,000 F or more. Several approaches to this problem have been pursued. One involves the use of glasses and ceramics with special electrical properties. Another suggests the use of the fluorinated ethylenes, such as DuPont's Teflon (polytetrafluoroethylene) and Kellog's Kel-F (polymonochlorotrifluoroethylene). Both of these materials offer properties not available in alkyd or polyester resins.

Table I—Calculation of Reflection at Radome Interface

THE REFLECTION occurring when electromagnetic radiation passes from one medium to another may be readily calculated from the following four equations if the dielectric constants of the two media are known (β = relative dielectric constant), together with the loss tangent ($\tan\delta$) of each medium and the angle of incidence θ of the energy beam.

$$Q = \sqrt{\beta - \sin^2\theta} \qquad (1)$$

$$L = \frac{\beta \tan\delta}{2Q^2} \qquad (2)$$

$$\bar{Z} = \frac{(1 - jL)\cos\theta}{Q} \qquad (3)$$

$$\bar{r} = \frac{1 - \bar{Z}}{1 + \bar{Z}} \qquad (4)$$

Here $\bar{Z}$ is the apparent impedance and $\bar{r}$ is the reflection at the interface, both in vector form. The values of Q and L are constants for the particular values of the parameters, and are used later in computing the phase shift.

Another problem besides that of physical properties must also be considered. The dielectric constant and loss tangent of most conventional radome materials are both functions of temperature. Consequently, a design that may give optimum performance at room temperature may be completely inadequate at the elevated temperatures of high-speed flight.[4,5]

The problem of rain erosion is another serious one. At subsonic and supersonic speeds, plastic—and metal—structures are rapidly washed away by even light rainfall. A new radome or wing leading edge may be completely eroded in just a few minutes. To counteract this, both Goodyear Tire and Rubber Co. and Gates Engineering Co. have developed synthetic coatings that may be applied in very thin layers over the outside surfaces. These coatings give a tremendous extension in life expectancy to the plastic parts.

At the speeds of current aircraft through humid and dry atmosphere, exceedingly high electrostatic charges are built up on the surfaces of the radomes. From time to time, the potentials become high enough to cause discharge, either by arc or leakoff. In either case, the concomitant electromagnetic radiation is sufficient to paralyze the radio-communications systems of the airplane, as well as the direction finders and other vital equipment. The conductive coating used for this purpose must be a compromise of several factors. If the resistivity is too low, the charge leakoff will be rapid but the radar transmission will be seriously degraded, if not completely nullified. If the resistivity is too high, no static-suppressing effect will be obtained. In addition, this coating must be compatible with the rain-erosion-resistant coating previously applied.

Coatings must be considered in computing the thickness of the outer skin when designing a radome sandwich.

Shock Problems

A radome is sometimes mounted in such a position on the airplane that the gun muzzles are only an inch or two from the surface of the radome. The shock wave, combined with the corrosive gases of explosion, rapidly cause delamination with subsequent failure of the radome.

To help in eliminating that source of difficulty, Zenith Plastics Co., Gardena, California, has developed Zenofoam G, a modified isocyanate foam that has been built into hundreds of sandwich radomes without a single reported failure caused by gunblast. Other constructions, involving nylon cloth sandwiches, have been tried with a moderate degree of success.

The wave slap on the nose of a large flying boat is another problem for the radome designer when his radome is the nose. Special types of construction have been devised for that problem too, as well as for the many others that arise during the design of modern airborne radar systems.

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(3) S. S. Oleesky, A Study of the Problem of Anti-Icing for Radomes and its Possible Solutions, U. S. Naval Air Development Center report No. ADC EL-86-50.

(4) S. S. Oleesky, The Effect of Elevated Temperature on Transmission of Microwave Energy Through Dielectric Sheets, U. S. Naval Air Development Center report No. ADS-EL-148-49.

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Table II—Calculation of Phase Shift Produced by Radome

FOR APPROXIMATION of phase shift, the insertion phase function Φ represents the retardation in phase resulting from insertion of the dielectric sheet in the field. The transmission coefficient function T represents the amplitude of the transmitted wave with respect to the incident wave. For any arbitrary incidence angle θ, the functions Φ and T may be determined from

$$|T|^2 = \frac{(1 - r_{12}^2)^2}{(1 - r_{12}^2)^2 + 4r_{12}^2 \sin^2 \phi} \qquad (5)$$

$$\Phi = \tan^{-1}\left[\frac{(1 + r_{12}^2)}{(1 - r_{12}^2)} \tan \phi\right] - \frac{2\pi d}{\lambda} \cos \theta \qquad (6)$$

where $\phi = (2\pi d/\lambda)\sqrt{\epsilon' - \sin^2 \theta}$, $\epsilon' = \epsilon_1/\epsilon_o$, ϵ_1 = dielectric constant of sheet, ϵ_o = dielectric constant of surrounding medium, d = sheet thickness and λ = wavelength. The reflection coefficients r_{12} and r_{21} may be determined from the boundary conditions imposed upon the field vectors of the plane wave at the dielectric interface, r_{12} being equal to $-r_{21}$.

For perpendicular polarization

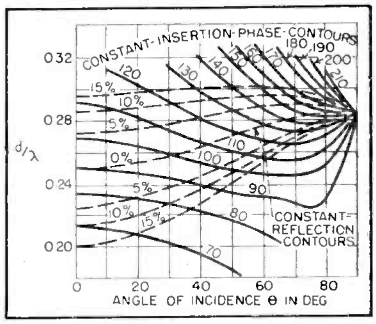
$$r_{12} = \frac{\cos \theta - \sqrt{\epsilon' - \sin^2 \theta}}{\cos \theta + \sqrt{\epsilon' - \sin^2 \theta}} \qquad (8)$$

$$\Phi = \tan^{-1}\left(\frac{\cos^2 \theta + \frac{\epsilon' - 1}{2}}{\cos \theta \sqrt{\epsilon' - 1 + \cos^2 \theta}} \tan \frac{2\pi d}{\lambda} \sqrt{\epsilon' - 1 + \cos^2 \theta}\right) - \frac{2\pi d}{\lambda} \cos \theta \qquad (9)$$

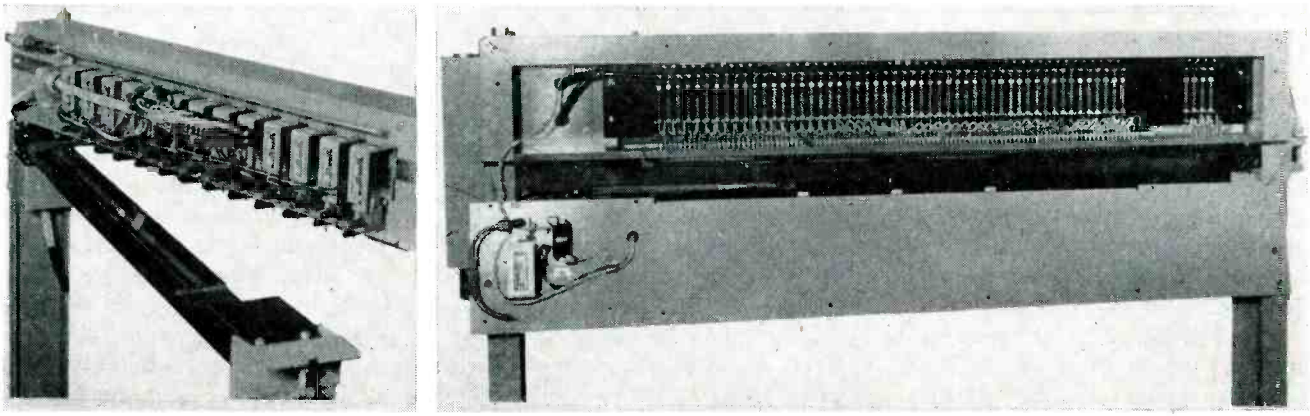
For parallel polarization

$$r_{12} = \frac{\epsilon' \cos \theta - \sqrt{\epsilon' - \sin^2 \theta}}{\epsilon' \cos \theta + \sqrt{\epsilon' - \sin^2 \theta}} \qquad (10)$$

$$\Phi = \tan^{-1}\left[\frac{\epsilon' + (\epsilon')^2 \cos^2 \theta}{2\epsilon' \cos \theta \sqrt{\epsilon' - 1 + \cos^2 \theta}} \tan \frac{2\pi d}{\lambda} \sqrt{\epsilon' - 1 + \cos^2 \theta}\right] - \frac{2\pi d}{\lambda} \cos \theta \qquad (11)$$



From these values the accompanying sets of curves were prepared, to give graphically the information required for design purposes. These are for a single dielectric sheet, with $\epsilon' = 4.0$ and perpendicular polarization. Ideally, the insertion phase should be independent of incidence angle and polarization.



Views of detecting head, showing marking-circuit solenoids, high-voltage electrodes and voltage-dropping resistors

Automatic void detector for inspecting mica insulating tape doubles production and cuts reject rate. Spark discharges through voids are counted and measured, giving ratio of void to total tape area. Largest voids are dye-marked for subsequent hand-patching

Detecting Voids

By **ROY E. ANDERSON**

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DESIGNED TO GIVE a continuous indication of the ratio of void area to total area, the void detector shown in Fig. 1 can also dye-mark all voids that exceed a selected size. These functions are performed before the top layer of paper is applied so that corrective measures may be taken.

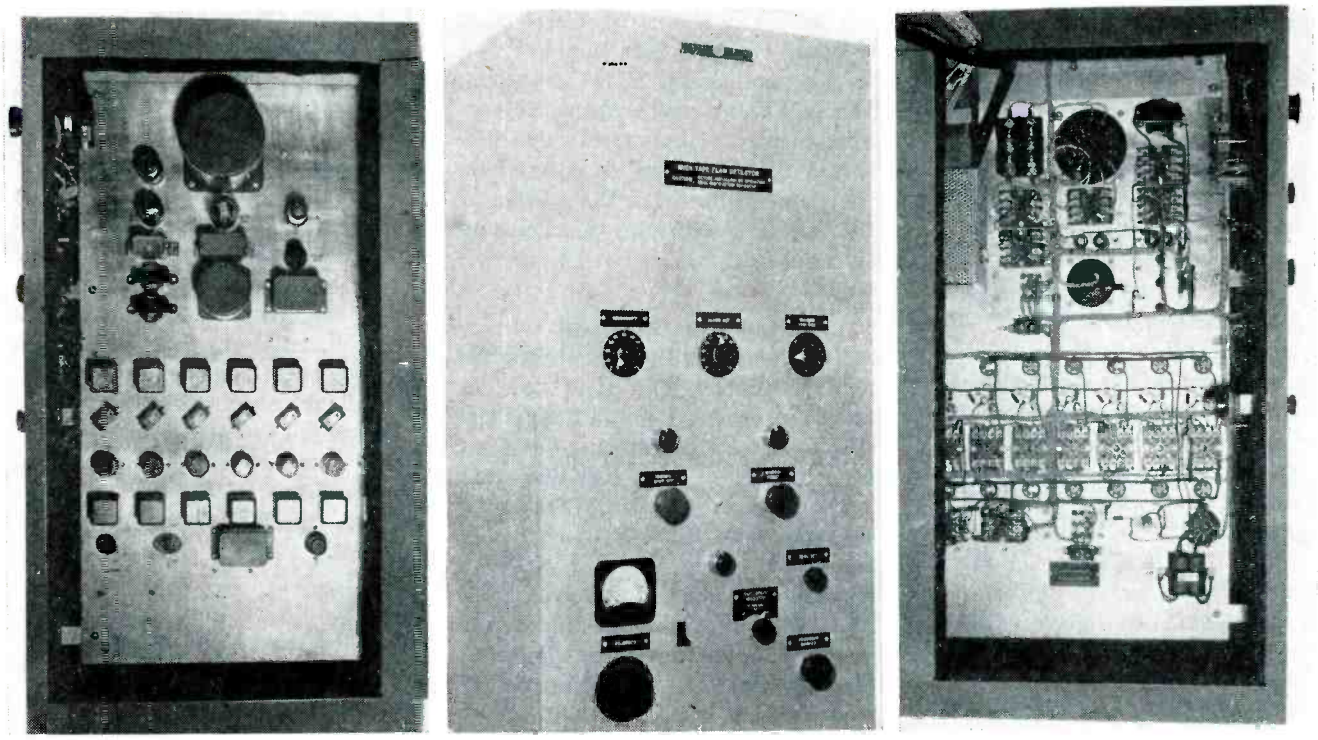
The dye-marking function did not prove valuable when inspecting machine-laid mica tape since skilled operators who could see the voids directly found the marks distracting. However, the marker function would be very helpful when inspecting a material that does not require continuous correction.

Voids are detected by measuring the current in arcs formed when voids are present between high-voltage electrodes. The detection elements are pointed electrodes spaced 0.15-inch above the tape and plane electrodes in contact with the underside. The points are spaced ¼-inch apart across the 27-inch width of tape. A d-c potential of 7,500 volts is applied to the points so that a current flows when a void passes between a point and plane, while no current flows when good mica is between them. A 200-megohm resistor in series with each point allows it to function independently of all the others. When one point breaks down, the voltage drop due to its current flow is across its own series resistor and the high voltage is still applied to the other detector electrodes.

ELECTRONIC INSPECTION CUTS REJECTS, BOOSTS PRODUCTION

Use of automatic inspection equipment can sometimes turn a losing manufacturing process into a profitable one. The equipment to be described detects voids in sheet insulating materials. Its first application has been in inspecting machine-laid mica tape.

- Use of this equipment enabled the manufacturer to increase his mica insulating tape production to 260 percent of former level.
- During the first year after installing the machine, there were no customer rejects. Previously, the average monthly customer rejection rate was 5 percent.
- Only the solution of a materials-handling problem remains before this machine that locates and evaluates flaws can be teamed with a device to patch the voids and thus provide almost fully automatic manufacture of tape.
- The void detector illustrates a general approach to flaw detection that is important to the development of automation



Flaw-detector control console. Vertical rack mounting is used. Left-hand door gives access to tubes; right-hand door, to circuit wiring

In Insulating Tape

If the tape were uncharged as it moved between the detecting electrodes, it would absorb a charge. The current required to supply the charge would be of the same order of magnitude as the current due to voids. To keep charging current out of the void-detecting circuits, the tape is precharged by a set of electrodes similar to the detecting electrodes, but located so that the tape must pass between the charging set just before it passes between the detecting electrodes.

Marking Circuits

To mark the larger voids within an inch of their position, the bottom plane electrode in the detecting circuit is divided into two-inch lengths across the tape. Each of these thirteen plane electrodes is connected to a marking circuit like that shown in Fig. 2A. Each marking circuit operates a marking mechanism whenever a void exceeding a preselected minimum size passes between the electrodes. The marking circuits operate independently of the speed of the tape machine over the range of ten to thirty feet per minute.

When good tape passes between the detecting electrodes, no current flows in R_1 (Fig. 2A). The voltage on the grid of the type-5691 tube V_1 is then the sum of a negative voltage established by the position of R_2 and a smaller positive voltage established by R_3. The sum of these voltages is a function of the minimum void size that is to be marked and of the speed of the tape machine. Bias values for minimum void sizes of ½ in. × ½ in. and ¼ in. × ¼ in. are shown in Fig. 2B. The dashed lines are the negative voltages established by R_2. The solid lines are the total bias voltages.

When a void comes between the upper and lower detecting electrodes, a current roughly proportional to the width of the void flows in the grid circuit of V_1. If the void is of such a width that one point conducts, the current is ten microamperes. If two points conduct, the current is twenty microamperes. It is proportionately greater for wider voids.

The effect of the void current on the grid voltage of V_1 is shown in Fig. 2C. Two bias levels are shown, one for a ½ in. × ½ in. void size at a tape speed of 14 ft per minute and the other for ½ in. × ½ in. void size at 28 ft per minute. Bias voltages are automatically adjusted for tape speed so that no manual control is operated when going from one tape speed to another.

When a ½ in. × ½ in. void comes between the detecting electrodes, a twenty-microampere current flows in the grid circuit of V_1. Capacitor C_1 starts to charge toward forty volts. By the end of time A, the grid of V_1 will have reached conduction. Tube V_1 is so operated that there is just two volts difference in grid voltage from cutoff to full conduction. Therefore V_1 closes the relay in its plate circuit at the end of time A, which is the time required for a ½ in. × ½ in. void to pass through the detector electrodes at 28 ft per minute. If the tape is moving at 14 ft per minute, C_1 again charges toward forty volts, but since it starts at a lower voltage, time B is required for the grid voltage to reach conduction. Time B is the time required for a ½ in. × ½ in. void to pass through the electrodes at 14 ft per minute.

The lowest curve in Fig. 2C shows what happens if a smaller void passes through the electrodes when the minimum-void-size control is set to permit only voids ½ in. × ½ in. and larger to be marked. A ¼ in. × ¼ in. void will cause C_1 to charge toward twenty volts. At 14 ft per minute, the time required for the small void to pass through is time A. The grid voltage is still far below conduction when the void leaves the electrodes.

The relays in the plate circuits of the marking-circuit tubes open solenoid valves that can be seen in the photograph of the detecting head. When a valve opens, it permits a drop of fluorescein dye dissolved in alcohol to be ejected on the tape in line with the middle of the bottom electrode section and therefore within one inch of the void.

Quality Indicator

The quality-indicator circuit has made possible both a large increase in production and the virtual elimination of customer rejections. It produces a meter reading that is proportional to ratio of void area to tape area. It also provides a signal to a recorder that makes a permanent record of the tape quality. The quality-indicating meter is mounted so that it is visible to the tape-machine operators at all times. Since it gives an indication of the quality of the tape being made at each moment, it is possible for the tape-machine operators always to operate the machine at maximum speed for the prevailing conditions. The permanent record is examined by the chief inspector. He uses it to determine whether or not there are any rolls of tape that should be down-graded or rejected.

The quality-indicator circuit is diagrammed in Fig. 3. The blocks indicate the relationship of the quality-indicator circuit to the other circuits. The d-c current path is indicated by arrows. The total void current from all thirteen marking circuits flows through an averaging circuit consisting of a potentiometer R_1 and the 10-μf capacitor. A portion of the voltage developed across the potentiometer is applied to the grid of the type-5692 tube V_1. This tube is connected in one arm of a bridge circuit. Current flowing in potentiometer R_1 unbalances the bridge and causes a current to flow through the tape-quality indicator, and also through a recorder.

Potentiometer R_1 in the grid circuit of V_1 serves as a sensitivity control. The tape quality required for full-scale deflection of the quality-control indicator and recorder may be varied over a wide range. This is an advantage because it is possible to have the same reading be the reject level for all grades.

The bias is established on the grid of V_1 by a voltage divider consisting of R_2, R_3 and R_4. Potentiometer R_4 is the zero-set control used to adjust the bias on V_1 so that the readings of the quality-indicator and recorder are zero when perfect tape is between the detecting electrodes.

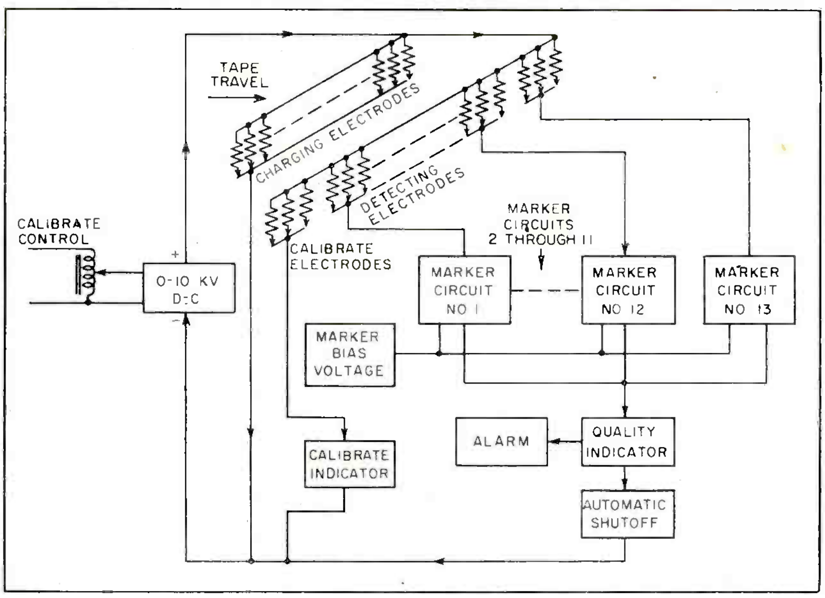


Fig. 1—Block diagram of automatic void detector gives electrical relationship of circuits between detecting, indicating and calibrating

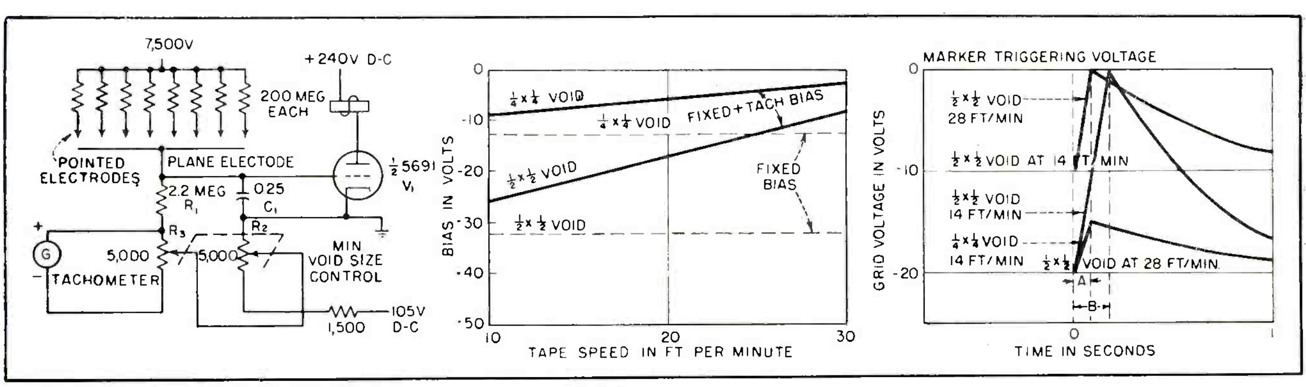
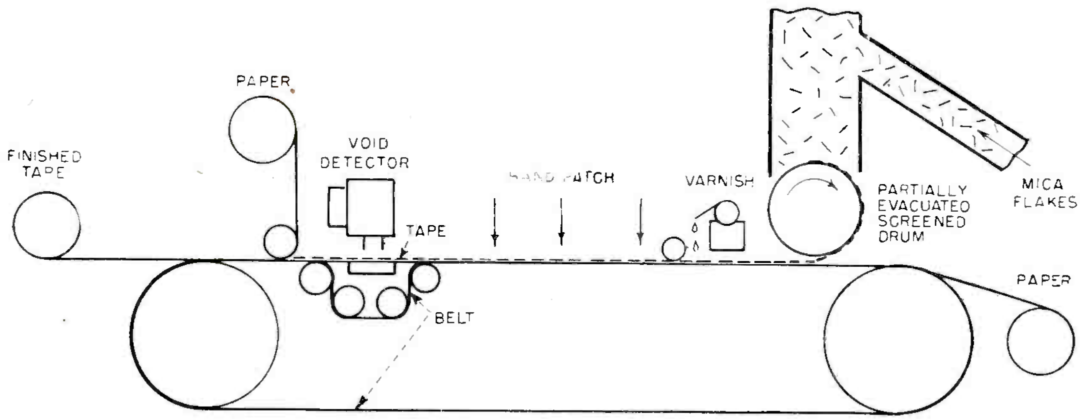


FIG. 2—Basic marker circuit (A), grid-bias voltages (B) and grid waveform (C) that results when a void is detected



HOW MICA TAPE IS MANUFACTURED

Mica tape consists of a layer of mica splittings sandwiched between two layers of paper or cloth bonded together with varnish or a similar insulating binder. Mica tape is manufactured in several grades:

(1) High-Quality Tapes—Large mica flakes are laid by hand with such care that there are practically no voids.

(2) Machine-Laid Tapes—These tapes are not intended to be entirely free from voids. The tape is wound several layers thick on electric motor or generator conductors so that the probability of voids overlapping to form a weak point is exceedingly small.

Machine-laid tape is made in the manner illustrated in the drawing. Mica splittings about the size of a half dollar fall like snowflakes onto a partially evacuated screened drum. The drum deposits the flakes on a moving web of varnish-soaked paper.

Numerous voids are left and a crew of six to eight operators hand-patch most of the voids as the tape moves past them on a belt. Not all voids are patched, however, and it would not be economically practical to do so. The highest grade machine-laid tape has an average of 50 voids in an area 27-in. wide and 10-ft long. The poorest grade of tape has about 250 voids in the same area. Most voids are very small but some are larger than a dime.

After hand-patching, a top layer of varnish-soaked paper is placed over the flakes and the tape wound onto a revolving steel cylinder

The information on the recorder chart must be identified with the portion of the tape to which it corresponds. This is accomplished by operating one of the recorder-marker pushbuttons that cause R_5 to be shorted and the bridge to be unbalanced. This in turn causes a large deflection of the recorder pen.

The remote recorder-marker control is mounted on the tape machine near the windup roll. When the tape-machine operator cuts the tape on the fly at the end of a roll, he presses the recorder-marker pushbutton. He then writes on the recorder chart the number of the roll being made on the machine. The recorder chart thus indicates the beginning and the end of each roll by a large deflection.

Auxiliary Circuits

An alarm circuit is provided that can be adjusted to sound an alarm for any desired reading of the tape-quality indicator. It is used to alert the operators if the quality of the tape falls below specifications. The signal for operating the alarm circuit is derived from the plate of the tube in the quality-indicating circuit. The alarm circuit employs a thyratron that conducts and sounds an electric horn whenever the quality indicator shows an excessive ratio of void area to total area.

An automatic-shutoff circuit de-energizes the detecting electrodes when an excessively large current passes between them such as would be the case if the tape were run out of the machine. The circuit is included to prevent the markers from pouring fluid onto the belt. The automatic-shutoff circuit employs a thyratron that is cut off when the total electrode current exceeds 500 microamperes. When the tube is cut off, it permits relay contacts to open and turn off the high-voltage power source.

Stability

Current in spark discharges is inherently unstable. It varies with humidity and perhaps with other ambient conditions. To insure that the indications are truly a measure of tape quality, a calibrating means

Operators hand-patching mica insulating tape. Void-detector console and strip-chart recorder are at left, with detecting head and quality indicator at right

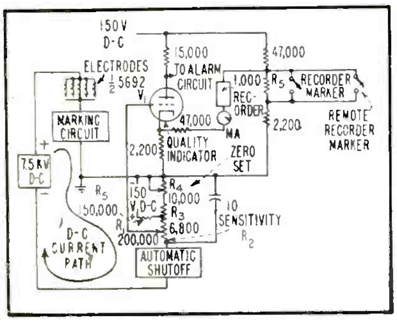


FIG. 3—Quality-indicator circuit

is provided. This is done by a set of eight pointed electrodes above a separate bottom plane electrode like the ones in the detecting circuit. The calibrate electrodes are beyond the edge of the tape. The bottom electrode in the calibrate circuit is not connected with the marking or quality-indicating circuits but is returned directly to the negative terminal of the supply through a microammeter. This is the calibrate meter shown in Fig. 1. The high voltage is adjusted by the variable autotransformer identified as the calibrate control (Fig. 1) until the reading on the calibrate meter is 80 microamperes.

To minimize the effects of high humidity, a heater is provided inside the upper electrode housing. A stream of air at approximately 10 cubic feet per minute is directed past the heater and exhausted through holes between the charging and detecting electrodes. The heater, which is turned on only in very humid weather, lowers the relative humidity in the vicinity of the electrodes.

The air stream, which always flows when the void detector is in operation, keeps the upper electrodes clean and also prevents accumulation of inflammable vapors of toluol, the varnish solvent.

The air is not necessary as a safety measure, however. Repeated tests in the laboratory indicate that it is not possible to ignite any concentration of toluol vapor or the fluid itself with sparks having a current magnitude of 100 microamperes. To provide an ample safety factor, the current in the individual arcs is limited to 10 microamperes by the 200-megohm resistors in series with the resistance of the air gap. The auxiliary circuits may be seen in Fig. 4.

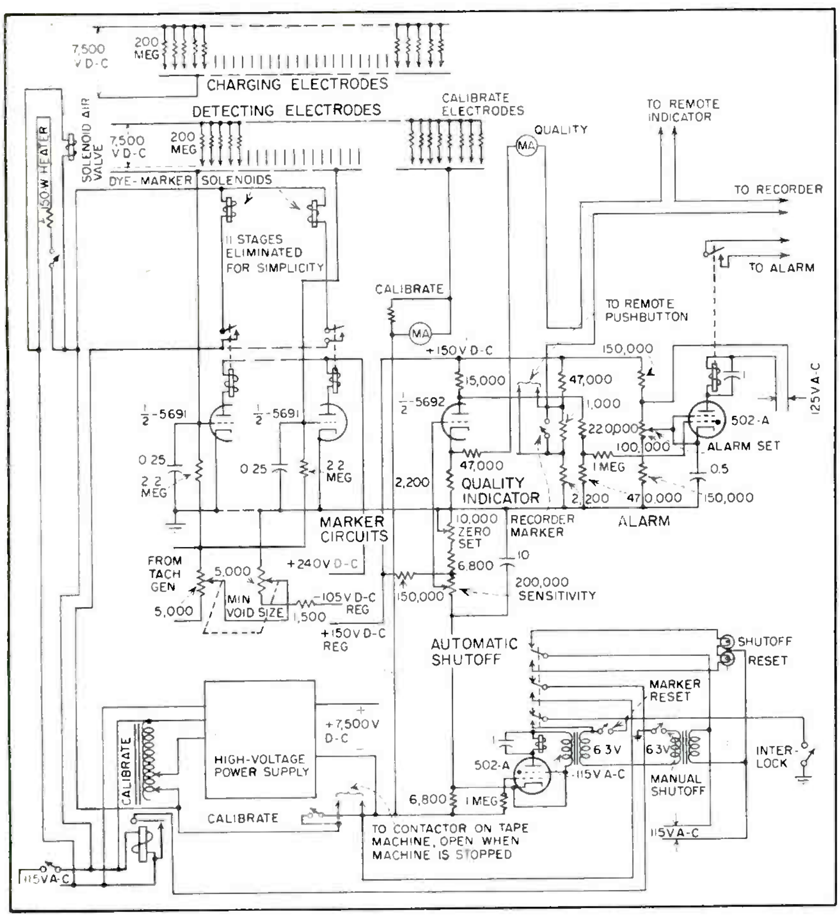


FIG. 4—Complete schematic shows automatic-shutoff and calibrating circuits

Physical Description

The construction of the detector electrode housing is shown in the photograph. When the head is locked in place over the lower electrode plate on the mica-tape machine, it occupies only seven inches along the belt. It is made so that the upper part can be pivoted away from the tape machine to facilitate threading tape through the detector.

The control cabinet is also pictured in photographs. All the operating controls except the heater switch and a remote recorder-marker push-button are located on the front panel. The electronic circuits are mounted on a vertical panel that is in a plane perpendicular to the front control panel. This type of construction provides easy access when the cabinet is mounted in the assigned factory space.

Performance

Before the void detector could be accepted as the standard by which tape quality could be judged, a long trial period was necessary to prove that the instrument was stable over long periods of time and changing conditions and that the readings were truly a measure of tape quality.

To prove this, a special piece of hand-laid tape was punched with definite ratios of void area to total tape area and run through the void detector at different speeds and on different days. The recorder charts of these runs show readings proportional to void area. Charts made on different days agree even to the smallest details. There is no evidence of any change in reading with change in speed of the tape machine.

Another test is made at frequent intervals to test the condition of the points and their spacing. After the instrument is calibrated, different groups of four electrodes are permitted to conduct. The quality indications for each group of four are compared with those for the other groups and with the indications obtained when the same test was made previously.

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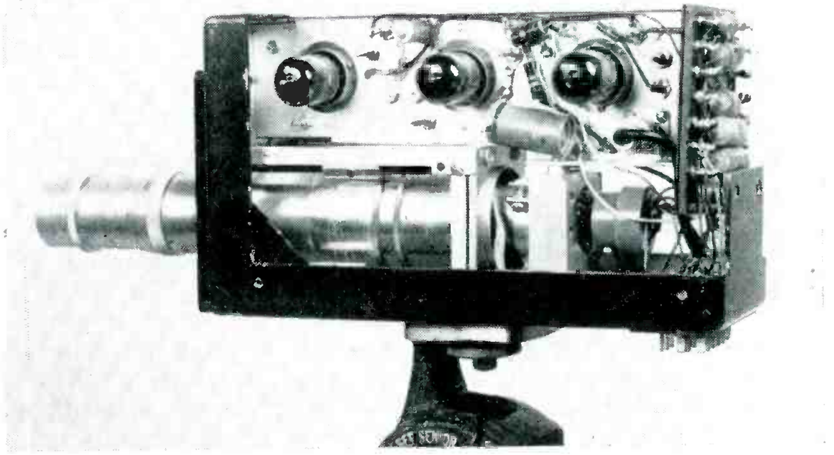


Vidicon pickup tube constitutes heart of compact television camera unit

Camera Adapter for TV Receivers

Compact industrial-type television camera for home and business transmits video signals over cable to standard home receiver. Video rides on vhf carrier corresponding to an unused television channel. Receiver supplies both d-c and scanning voltages

CLOSED-CIRCUIT television finds increasing use in industry, medicine, business and education.[1,2] Although compact industrial-tv equipment has been developed,[3] costs have often limited its range of application, particularly for classroom teaching,[4,5] home use and everyday business activity.

The camera adapter to be described operates in conjunction with a standard home tv receiver. It consists of a compact Vidicon camera unit and control box. Video signals are transmitted to the receiver on a vhf carrier by cable. Scanning and d-c voltages for the camera are derived from receiver circuits. Adaptation to the receiver may generally be made by plug-in adapters for tube sockets and the deflection coils plug on the receiver chassis.

Amplifier

Figure 1 is a schematic diagram of the camera-adapter setup. The 6U8 triode-pentodes conserve space and offer the most video gain available in a single envelope. The circuit consists of a four-stage video amplifier driving a modulator electron coupled to a vhf oscillator. Tubes V_{1A} and V_{1B} are conventional single-peaked video amplifiers; V_{2A} is a frequency-compensating stage to compensate for the loss of high frequencies at the input to the amplifier. The inductance of L is adjusted so its natural resonance in the circuit is above the normal pass band of the amplifier. The gain of this stage can be made to increase with frequency from essentially zero at low frequencies to a gain limited by the impedance of the coil and associated circuit at the top of the pass band. The low-frequency gain is adjusted by variable resistor R in series with the inductance. By adjusting this resistor the shape of the gain characteristic of this stage can be made to match closely the attenuation characteristic of the input circuit.

Tube V_{2B} is a conventional double-peaked stage; V_{3B} is connected with its cathode, grid and screen forming a Hartley oscillator. The plate of V_{3B} is coupled to the cathode circuit of V_{3A}, which has high r-f impedance but essentially none at video frequencies. This circuit provides electron coupling between the oscillator and the modulator V_{3A} so that there is a negligible amount of frequency modulation of the oscillator as the output signal is amplitude modulated.

The video signal from V_{2B} is applied to the grid of V_{3A} and effectively modulates the plate current. The plate of V_{3A} is coupled directly to a 75-ohm line that carries the r-f signal to the receiver. A crystal diode on the grid of the modulator maintains an approximate d-c level and stabilizes the black level of the picture. Pulses from the blanking circuits are inserted at the screen and plate of V_{2B} to provide synchronizing pulses in the signal, which can then be used to operate auxiliary receivers if desired.

The amplifier has a 4-mc bandwidth and a reasonable light level on the camera tube (about 0.2 μa photo current) will provide 80-percent modulation. An r-f signal level of about 100 mv can be supplied to the 75-ohm line. A heater current of 1.35 amperes at 6.3 volts and a plate supply of 150 volts at 50 ma are required.

With an accelerating voltage of 300 volts and a 40-gauss magnetic field, a deflecting field produced by 40 ampere-turns with the particular yoke construction used is required to deflect the cathode-ray beam in the pickup tube.

Deflection

A typical receiver provides a 1-amp peak-to-peak deflecting current in the horizontal yoke. If the deflection coil for the pickup tube is placed in series with the receiver deflection coil, then a camera coil of 40 turns is sufficient. Such a coil has about 0.1 mh inductance compared to 10 to 13 mh in the receiver coil. Thus the presence of the extra coil in series has negligible effect upon receiver deflection.

In many receivers, the horizontal deflection coils do not return to a-c ground. To ground the horizontal circuit in the camera, since fairly long cables are involved, the camera horizontal deflection coils are coupled to the receiver through a transformer, the primary of which is in series with the receiver coil. This also eliminates the danger of opening the receiver horizontal deflection coil in the event that the camera coil should become disconnected.

A two-to-one step-up transformer is used to reduce I^2R loss in the cable and provide a higher pulse voltage across the camera coil, which is also advantageous since the pulse is used for return-trace blanking of the camera tube. The camera vertical coils, shunted by a variable resistor for size control, are directly in series with the low side of the receiver vertical-deflection coils.

The horizontal sweep is free running although the vertical is synchronized with the 60-cycle power line. Thus there is no definite relationship between the horizontal and vertical speeds and hence no definite interlace.

However, neither is there a definite noninterlaced condition so that as the horizontal frequency drifts slightly there is a condition of random interlacing that reduces the deterioration of vertical resolution that might be expected with no interlacing. The random spacing of horizontal lines does show up in a twinkling of sharp horizontal lines occurring in the picture because of the randomness of the interference between horizontal lines in the picture and in the raster. This is not noticeable in most pictures and has seldom been objectionable.

Desirable d-c voltages for the camera tube with respect to cathode are: +300 acceleration, +250 to 300 focus, +10 to 50 target and

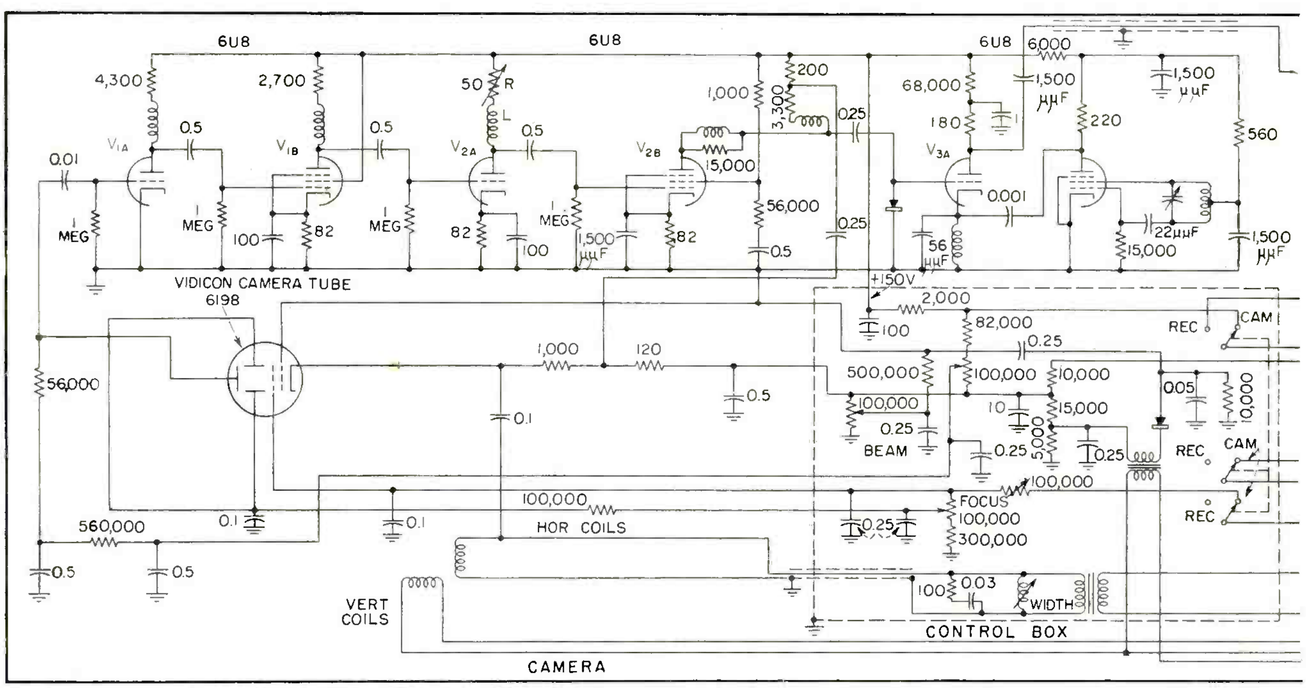
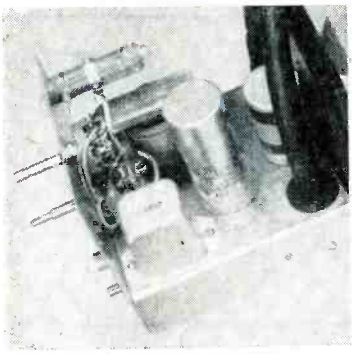


FIG. 1—Complete schematic diagram of camera-adapter installation for home or office illustrating interconnection of camera control



Control box contains no tubes; has necessary controls for adjustment of receiver-derived voltages for optimum camera operation

0 to −100 control grid. Most modern receivers do not have a negative supply so it is necessary to elevate the camera-tube cathode above ground to obtain control-grid bias.

Voltage Supply

Such receivers do, however, have a stiff low-voltage supply running between +120 and 160 volts. This is conveniently bled to 100 volts since the total cathode plus bleeder current need not run more than 2 or 3 ma. Likewise, practically all receivers have a boosted-B voltage of 400 to 500 volts that can supply voltage above cathode for acceleration and focus.

Normal B-supply voltage in receivers is usually between 220 and 280 volts. This can be dropped by an R-C decoupling filter to 150 volts for the camera amplifier. The axial 40-gauss magnetic field necessary for focusing the camera tube is provided by a permanent magnet made up of four Alnico rods set at the corners of square iron pole plates. The entire cage surrounding the camera tube can be seen in the photograph.

Blanking

It is necessary to blank the camera-tube beam during vertical and horizontal fly-back to prevent the generation of spurious signals. Horizontal blanking is accomplished by applying the 10-volt positive pulse across the camera horizontal coils to the cathode of the camera tube.

To obtain a vertical pulse adequate for blanking, a pulse transformer, which may be of the blocking-oscillator type, is connected across the receiver vertical coils. The transformer may be connected to give a negative pulse on the secondary for the particular pulse direction on the receiver coil. This is important since vertical pulse amplitude and polarity have been found to vary with different makes of receivers. The base line may be straightened and the pulse lengthened by a biased crystal rectifier and an R-C circuit. The negative pulse is then applied to the camera control grid.

Control Unit

The camera contains the pickup tube and the amplifier-modulated oscillator unit. At the receiver end of the connecting cable is a control box containing the necessary controls to operate the camera, the horizontal transformer, vertical blanking circuits and miscellaneous dropping resistors, plus a heater transformer for the camera. There are no tubes in the control box.

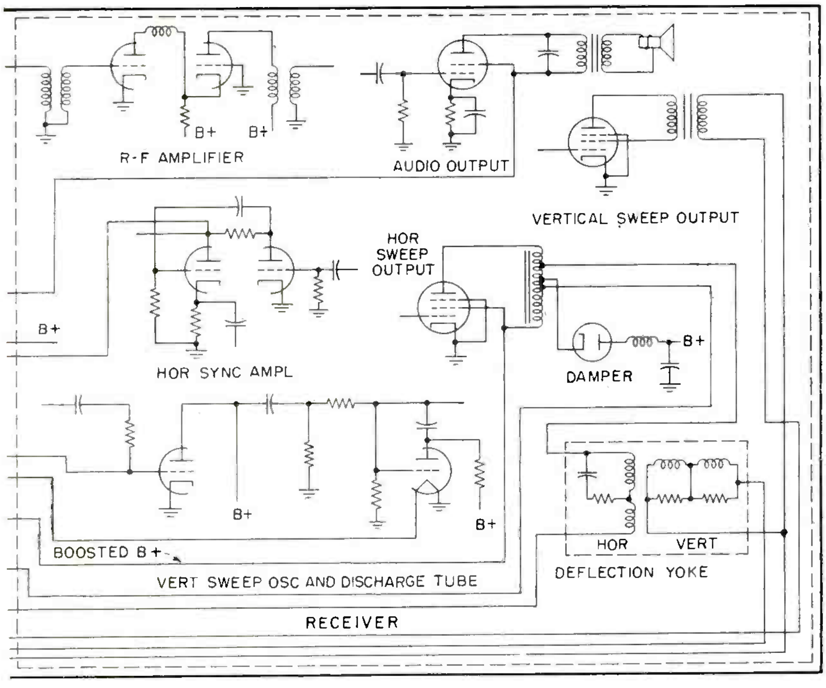
Adaptation

To make the adaptation of the camera to a receiver as simple as possible, all connections to the receiver are made whenever possible by adapters placed under tubes and in the deflection plug.

In practically all receivers in which the deflecting coils are connected to the chassis by a plug, the adaptation can be made with no alteration of the receiver since all the other voltages appear at some of the tube pins.

In receivers without a deflection plug the necessary wires to the deflection coils can be cut and a connector inserted without removal of the chassis. Necessary voltage adjustments are made in the control box. Actual adaptation of several current receivers has been made and a study has been made of many others. No difficulty is anticipated in adapting the camera to any of them.

The authors acknowledge the continued interest and inspiration of V. K. Zworykin under whose direction the work was done. They are also indebted to J. M. Morgan of RCA Laboratories for his help in design of deflection components and to Frank Janda of the RCA Victor Division for his work in building early models of this equipment.



box and home television receiver

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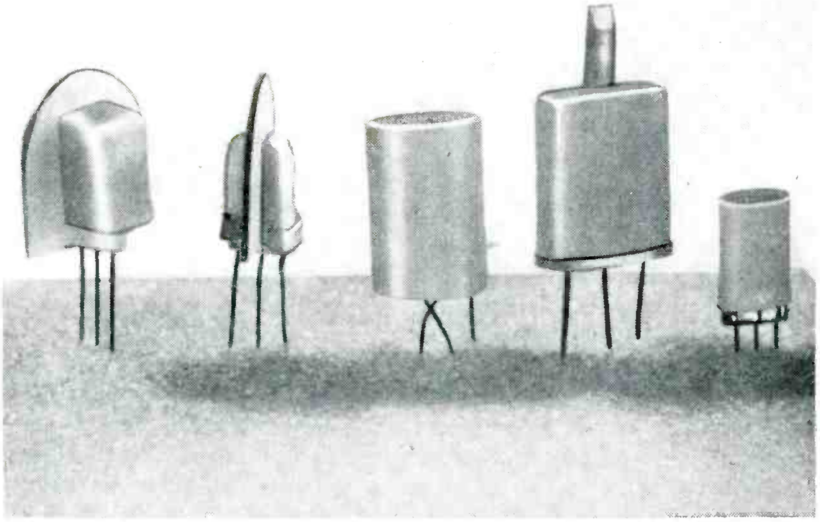

Typical power junction transistors. Second from right and center transistors are discussed in text and shown in detail in Fig. 1. Unit on far right is small transistor encased in plastic; two on left have radiating fins connected to base and emitter

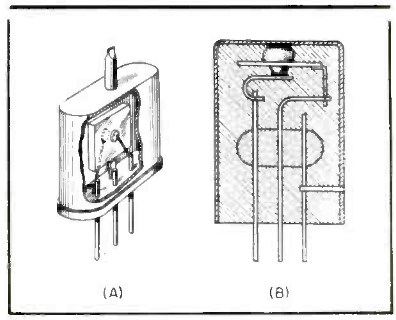

FIG. 1—Assembly details of liquid-cooled (A) and metallic-conduction cooled (B) power transistors

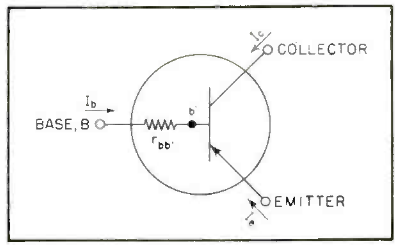

FIG. 2—Diagram shows intrinsic transistor together with extrinsic base-lead resistance found in practical units

Power Transistors for

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DEPENDENCE of transistor characteristics on temperature presents a difficult problem to equipment designers, especially those involved in power circuit work where unavoidable internal power losses may be appreciable.

This article presents a method for analysis of transistor power amplifiers. For purposes of illustration, calculations have been carried out using a typical experimental power transistor. The method of calculation is developed generally so that circuit design using other junction transistor types can be readily carried out.

General Types

The photograph shows several experimental power transistors[1]. The liquid-filled enclosure, shown in detail in Fig. 1A, is a reasonably simple and effective method of construction. The transistor is fabricated by standard techniques and then encased in a liquid-filled metal shell. Heat generated by the transistor is transferred to the metal shell by the liquid coolant. Benzene, toluene, and xylene are suitable liquids. Toulene has proved the most successful due to its low viscosity and relatively high boiling point. In addition to the simple method of construction, the liquid-enclosed power transistors have been particularly attractive because the germanium junctions suffer very little deterioration.

The use of a liquid, particularly an inflammable liquid, is not a very satisfactory solution for most applications. Consequently, the method of construction shown in Fig. IB was developed. Here, a large metal surface is soldered directly to the germanium assembly. Heat is transferred to the large metal surface by metallic conduction with very little drop in temperature. The metal surface may be soldered to any of the three transistor elements and then encased in plastic for mechanical and environmental protection. The sketch shows a metal cup soldered to the collector.

Maximum Dissipation

Heat transfer[2] can take place by radiation, conduction and convection. All three of these processes are potentially of importance in the removal of heat from a power transistor. Using heat transfer equations to calculate the effects of radiation, conduction and convection heat powers, the total heat power transfer for the cup power transistor previously mentioned is 1.28 watts for a 50-degree C temperature rise above a 25-degree ambient temperature. For these operating conditions, the cup power transistor can be rated as having a maximum power dissipation of approximately one watt.

This maximum power rating depends to a considerable extent upon the maximum permissable operating temperature, which has been

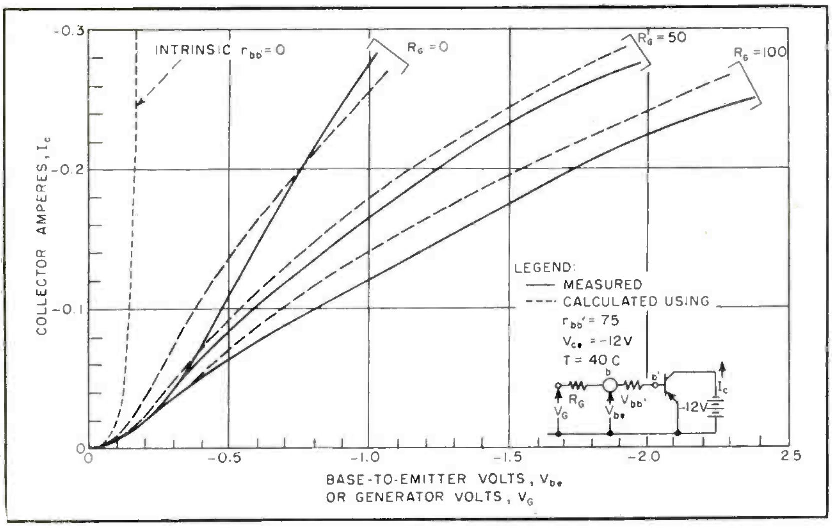

FIG. 3—Static transfer characteristics for power transistor

Table I—Power Junction Transistor Coefficients and Saturation Currents

Temp. °C		25°	40°	50°	75°
g_{ee}	Millimhos	2.1	8.3	18	101
$g_{ec} = g_{ce}$	Millimhos	−1.9	−7.5	−16	−91
g_{cc}	Millimhos	3.0	12	26	146
g_{be}	Millimhos	−0.21	−0.86	−1.9	−10
I_{ee}	Milliamperes	0.054	0.22	0.51	3.0
$I_{ec} = I_{ce}$	Milliamperes	−0.048	−0.20	−0.47	−2.7
I_{cc}	Milliamperes	0.077	0.32	0.74	4.4
I_{be}	Milliamperes	−0.0055	−0.023	−0.053	−0.31
I_{es}	Milliamperes	"	"	"	"
I_{cs}	Milliamperes	−0.029	−0.12	−0.28	−1.7
I_{bs}	Milliamperes	0.035	0.14	0.33	2.0

Analysis of operating characteristics of typical power transistors and influence of finite base-lead resistance, temperature, frequency, and generator resistance. Biasing problems for typical audio power output stages are also considered

Audio Output Circuits

arbitrarily picked at 75 C. The maximum permissable operating temperature will depend rather critically upon the changes in operating characteristics with temperature, an item to be considered subsequently, and upon life test data.

The operation of a junction transistor has been analyzed[3]. Careful measurements of small-signal junction transistors indicated that Shockley's analysis may be used for quantitative results if it is applied to an ideal intrinsic transistor. The actual transistor has certain extrinsic elements which must be added to the intrinsic transistor. A very important extrinsic element is a base-lead resistance, $r_{bb'}$, shown diagramatically in Fig. 2.

One of the basic assumptions of Shockley's analysis is that the minority carrier density is much smaller than the majority carrier density throughout the base region. This assumption is hardly satisfied by power transistors where the minority carrier density is generally many times the majority carrier density. Nevertheless, as will be seen, many of the gross aspects of power-transistor characteristics are given by the Shockley analysis. In those cases where there is a considerable difference, use can be made of modified analyses[4] to determine the appropriate results.

According to Shockley's analysis, the d-c characteristics of a junction transistor are given by equations

$$I_e - I_{es} = \frac{1}{\Lambda}\left[g_{ee}\epsilon^{\Lambda V_{eb}'} + g_{ec}\epsilon^{\Lambda V_{cb}'}\right] \quad (1)$$

$$I_c - I_{cs} = \frac{1}{\Lambda}\left[g_{ce}\epsilon^{\Lambda V_{eb}'} + g_{cc}\epsilon^{\Lambda V_{cb}'}\right] \quad (2)$$

In these equations I_e and I_c are the emitter and collector d-c currents respectively and V_{eb}' and V_{cb}' are the emitter-to-internal-base and collector-to-internal-base d-c voltages respectively. The four g's are d-c conductance coefficients which can be considered similar to the perveance coefficient employed in electron tube studies. These d-c conductance coefficients must not be confused with a-c conductance parameters although the coefficients can be measured[5] by the same means employed for measuring the a-c parameters when the d-c terminal voltages and currents are both zero. The Greek letter Λ is used in place of e/kT where e is the charge of an electron in coulombs, k is Boltzmann's constant in joules per degree K, and T is the operating temperature in degrees Kelvin (At room temperature, 27 C (300 K), $\Lambda = -38.6$ volts^{-1} for electrons and $+38.6$ volts^{-1} for holes.)[6] Currents I_{es} and I_{cs} are the emitter and collector saturation currents, respectively, and represent currents due to thermally-generated carriers in the base that flow to the emitter and collector when both are biased more than a few tenths of a volt in the reverse direction. Thus

$$I_{es} = -\frac{1}{\Lambda}(g_{ee} + g_{ec}) \quad (3)$$

$$I_{cs} = -\frac{1}{\Lambda}(g_{ce} + g_{cc}) \quad (4)$$

If the collector-to-internal-base

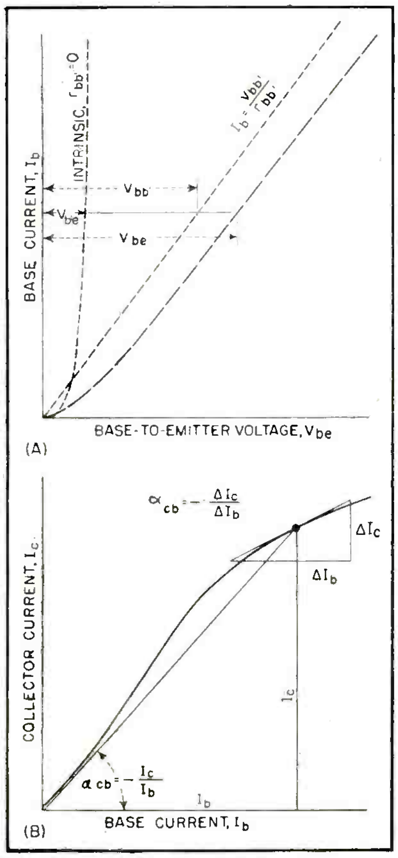

FIG. 4—Construction of base characteristics (A) and d-c and a-c collector-to-base current amplification factors (B)

voltage is always more than a few tenths of a volt in the reverse direction, (collector always in the saturation region) the contribution of the last term of Eq. 1 and 2 is negligible compared to the first term. For this condition

$$I_e = I_{es} + I_{ee}\,\epsilon^{-\Lambda V_{b'e}} \qquad (5)$$

$$I_c = I_{cs} + I_{ce}\,\epsilon^{-\Lambda V_{b'e}} \qquad (6)$$

and

$$I_b = -(I_e + I_c) = I_{bs} + I_{be}\,\epsilon^{-\Lambda V_{b'e}} \qquad (7)$$

In the equations, the d-c current coefficients are related to the corresponding d-c conductance coefficients by

$$I_{ee} = \frac{g_{ee}}{\Lambda} \qquad (8)$$

$$I_{ce} = \frac{g_{ce}}{\Lambda} \qquad (9)$$

$$I_{be} = \frac{g_{be}}{\Lambda} = -\frac{g_{ee} + g_{ce}}{\Lambda} \qquad (10)$$

The base saturation current is the base current that flows for emitter and collector saturation currents. Thus

$$I_{bs} = -(I_{es} + I_{cs})$$
$$= \frac{1}{\Lambda}\,(g_{ee} + g_{ce} + g_{es} + g_{cc}) \qquad (11)$$

Since the d-c conductance coefficients are measurements of a passive element, it is always necessary that $g_{ec} = g_{ce}$. Equations 5, 6 and 7 have been written in terms of the internal base-to-emitter voltage in anticipation of studies of operating characteristics of a common-emitter circuit.

If the d-c conductance coefficients are known, the intrinsic-transistor characteristics can be readily computed by means of Eq. 5, 6 and 7. This has been done for the collector current for a typical power transistor, and the results are shown by the dotted curve in Fig. 3.

The measured d-c conductance coefficients used in these calculations together with the corresponding d-c current coefficients and saturation currents are tabulated in Table I under the appropriate temperature heading of 40 C. The dotted curve of Fig. 3 can be considered to be the intrinsic transfer characteristic of the transistor; that is, the transfer characteristic that would be obtainable if $r_{bb'}$ were zero.

Of considerably greater importance is the actual transfer characteristic. The voltage drop that occurs across $r_{bb'}$ must now be introduced. Equations 6 and 7 can be written in terms of the applied base-to-emitter voltage as

$$I_c = I_{cs} + I_{ce}\,\epsilon^{-\Lambda(V_{be} - r_{bb'} I_b)} \qquad (12)$$

$$I_b = I_{bs} + I_{be}\,\epsilon^{-\Lambda(V_{be} - r_{bb'} I_b)} \qquad (13)$$

If $r_{bb'}$ is known, the actual characteristics can then be determined.

The graphical relationship between the intrinsic and actual base characteristic is shown in Fig. 4A. The actual base-to-emitter voltage is obtained by adding to the intrinsic voltage $V_{b'e}$ the voltage drop $V_{bb'}$ across the base-lead resistance. The latter voltage will generally be several times larger than the former, particularly at larger currents, so that the base characteristics will be essentially linear. That is the base current will be approximately linearly related to the base-to-emitter voltage. Actual transfer characteristics can be obtained by a similar graphical construction with the use of the base characteristics. An alternate method of calculation is to use the relationship between collector current and the base current. This relationship can be expressed in terms of a d-c current-amplification factor α_{cb} defined as

$$\alpha_{cb} = -\frac{I_c}{I_b} \qquad (14)$$

Figure 4B shows how the d-c and a-c collector-to-base current-amplification factors are related to the currents. As shown in Fig. 5, the d-c current-amplification factor decreases approximately hyperbolically at larger collector currents. This drop-off is an important aspect of power-transistor operation and can be explained by modified analyses.[4] With the aid of Fig. 5 the actual transfer characteristics can be determined since by combining Eq. 12 and 14

$$I_c = I_{cs} + I_{ce}\,\epsilon^{-\Lambda(V_{be} + \frac{r_{bb'}}{\alpha_{cb}} I_c)} \qquad (15)$$

The actual transfer characteristics determined by this manner are shown by the dashed curve labelled $R_G = 0$ in Fig. 3. For comparison purposes the measured transfer characteristics are shown by the corresponding solid line in the same figure.

Base-lead resistance can be measured directly by small-signal methods, but for the purposes described herein, it can best be determined by fitting a calculated characteristic to a measured characteristic.

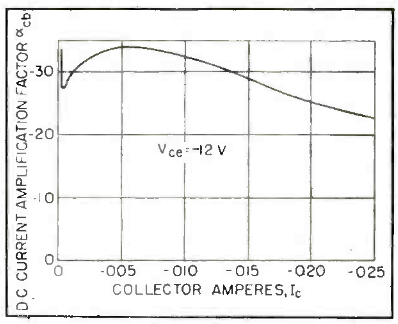

Fig. 5—Amplification factor (d-c) as a function of collector current

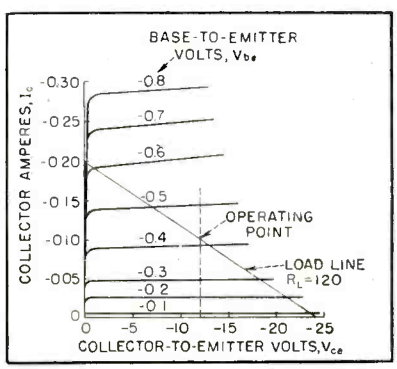

FIG. 6—Output load characteristics

The implication thus far has been that the base-lead resistance $r_{bb'}$ is independent of current. This is not exactly the case as $r_{bb'}$ will decrease somewhat as the collector current is increased. This, in part, accounts for the discrepancy between the calculated and measured transfer characteristics of Fig. 3.

Most calculations on power transistors can best be carried out with the aid of the transfer characteristics. Occasionally the base and collector characteristics may be of interest. The base characteristics as shown in Fig. 4A have already been considered. The collector characteristics for the power transistor under consideration are shown in Fig. 6. These curves will be employed subsequently in considering the optimum output loading of the transistor.

Frequency Characteristics

For small-signal operation the input equivalent circuit has the form shown in Fig. 7. The resistor marked $r_{b'e}$ represents the flow of carriers to the base and is reciprocally proportional to base current. For a power transistor operating at a collector current of 100 ma, $r_{b'e}$ would be of the order of 10 ohms. Capacitor $C_{b'e}$ represents the storage of charge carriers in the base region. Its value is directly proportional to the square of the base thickness and to emitter current. Accordingly the actual value of $C_{b'e}$ will depend greatly upon the base thickness. As an example, for a base thickness of 0.002 in. $C_{b'e}$ would be of the order of 0.5 μf at a collector current of 100 ma. On a small-signal basis, $C_{b'e}$ will have a pronounced frequency effect. For large-signal operation, $r_{b'e}$ and $C_{b'e}$ will vary with the applied signal. It is this variation together with similar variations in other reactive elements that complicate even an approximate study of large-signal frequency characteristics.

Temperature Effects

Germanium is a semiconductor, and as such exhibits a pronounced temperature-resistivity variation.[6] The relatively impure germanium customarily employed in transistors will generally exhibit an increase in resistivity with temperature at approximately room temperature. At higher temperatures the impure germanium decreases in resistivity with increasing temperature in the same manner as pure germanium.

The manner in which temperature enters into transistor operation can be ascertained with the aid of Eq. 11 and 12. The transistor characteristics will be affected by temperature variations due to a change in the value of Λ. In addition, the saturation currents, I_{cs} and I_{bs} and the current coefficients. I_{ce} and I_{be}, change rapidly with temperature.

The saturation currents and current coefficients have a common multiplier of the form

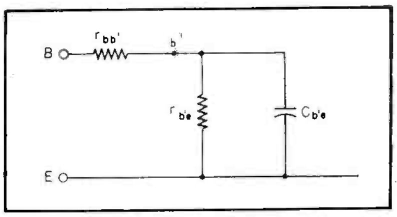

FIG. 7—Input equivalent circuit for small-signal transistor operation

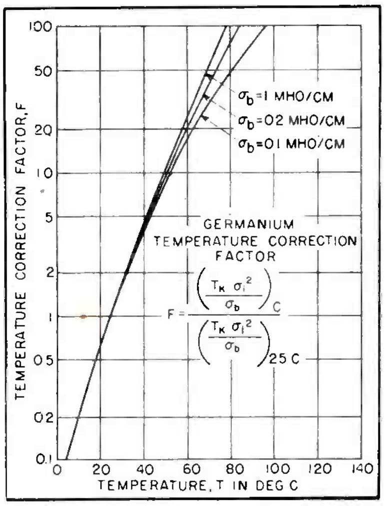

FIG. 8—Curves for finding germanium temperature correction factor

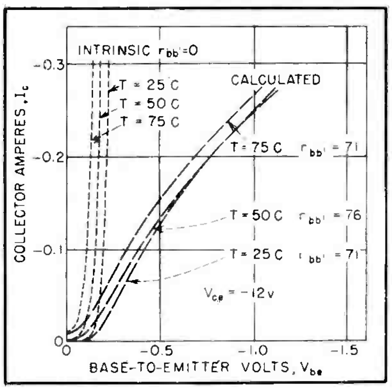

FIG. 9—Change in static transfer characteristics with tempertaure

$$\frac{1}{\Lambda}\,\frac{b}{(1+b)^2}\,\frac{\sigma_i^2}{\sigma_b}\,\frac{A}{W_b}$$

where b is the ratio of electron to hole mobility and is essentially independent of temperature; A and W_b are the cross-sectional area and base thickness which are also independent of temperature.

The temperature dependent terms are contained in the factor $\sigma_i^2(\Lambda\sigma_b)$ where σ_i is the pure germanium conductivity, σ_b is the germanium conductivity of the impure germanium employed in the transistor base, and Λ as already defined is e/kT. If the saturation currents and current coefficients are known at one temperature, their values at some other temperature can be determined by applying a suitable temperature correction factor. For convenience, this temperature correction factor which is approximately the same for both n and p germanium normalized to room temperature of 25 C is given in Fig. 8. It is apparent from the values of the temperature correction factor that the saturation currents and current coefficients will change rapidly with temperature. The data in Table I exhibit this very rapid variation with temperature.

Fortunately, the actual transistor characteristics are not quite so sensitive to temperature changes. As temperature is increased, I_{ce} and I_{be} increase rapidly, but Λ decreases, and since Λ enters as a positive exponent some of the increase in I_{ce} and I_{be} is compensated. The temperature stability of a junction transistor is adversely affected by the presence of r_{bb}'. As the temperature is increased, base current decreases. The resulting change in voltage across r_{bb}' is in such a direction as to further increase the collector current. The decrease in base current with increase in temperature is due to the presence of I_{bs} in Eq. 13. Current I_{bs} has a sign opposite of I_{be} and its increase with temperature is uncompensated. Accordingly, as the temperature is increased, I_{bs} contributes a progressively larger share to I_b and may actually produce a reversal in the direction of I_b.

The manner in which the calculated transfer characteristics change with temperature is shown in Fig. 9. For these calculations, it was assumed that the transistor was made of 4 ohm-cm n-type germanium. Maximum resistivity of this material occurs at approximately 50 C, and the resistivities at 25 C and 75 C are about equal.

Audio Output Stage

In the design of an output stage the d-c power supply voltage is usually specified. Let this be 12 volts. Generally, the d-c supply voltage will be limited to about half the collector breakdown voltage.

The maximum power dissipation for the cup transistor has been determined to be 1.28 watts for a 50 C temperature rise above 25 C ambient. Thus, a static collector current of 100 ma can be accommodated. For maximum power output an output resistance of 120 ohms is indicated. A resistance of this value is shown by the load line in Fig. 6. A maximum a-c power output of about 0.6 watt can be expected.

Additional details concerning the output stage can be obtained by referring to the transfer characteristics in Fig. 3. The transfer curve (solid curve marked $R_G = 0$) shows that a base-to-emitter bias voltage of -0.48 volt is required for the 100-ma operating point. A peak driving voltage of $0.76 - 0.48 = 0.28$ volt is required. Since the input resistance will consist mostly of r_{bb}', the a-c input power will be approximately 5.2×10^{-4} watt and the power gain 1,150 or 30.6 db. These calculations are approximate. With the aid of the transfer characteristics output distortion can be computed.[7]

The preceding calculations are based upon a zero resistance signal source. This will normally not be the case. The actual situation ($R_G > 0$) is similar to a vacuum tube being driven into grid conduction resulting in increased distortion plus an increase in driving voltage required for full output. Frequency response also suffers from the presence of R_G.

The circuit operation when $R_G > 0$ can be determined by Thevenin's theorem, considering the source as a voltage generator V_G in series with R_G. In the transistor circuit R_G is in series with r_{bb}' and the two can be lumped together and considered part of the transistor. The result is a transistor with a larger effective r_{bb}' being driven from a generator of zero internal resistance. The transfer characteristics for the new transistor can be constructed in the same manner as already described. Figure 3 shows two transfer characteristics determined in this manner when $R_G = 50$ and 100 ohms. The base-to-emitter voltage includes the voltage drop across R_G and is therefore the generator voltage. The corresponding measured transfer characteristics are also shown.

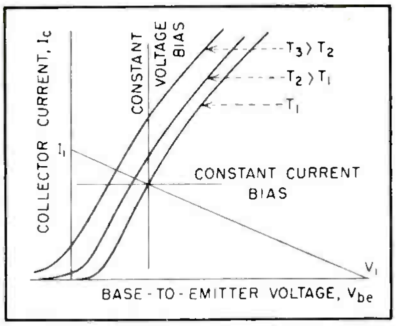

FIG. 10—Curves show effect of changes in temperature on bias

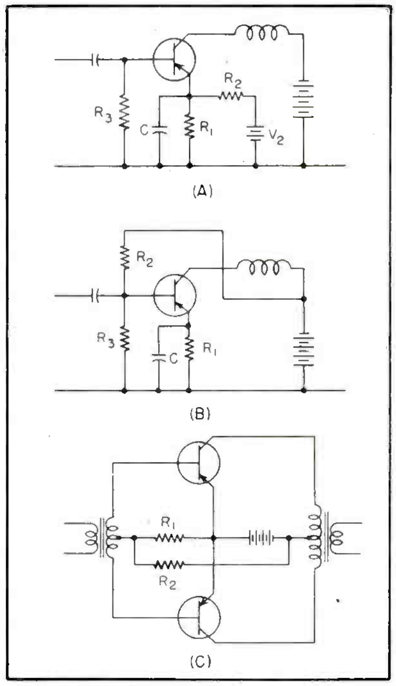

FIG. 11—Bias arrangements for typical audio output power amplifiers

To get satisfactory operation over a range of temperatures, the biasing of the output stage must be given careful attention. Figure 10 indicates the change in the operating point with changes in temperature. For stability, constant-current bias has the most advantages even though it is more difficult and expensive to achieve. An absolute constant-current bias is not feasible; an intermediate bias condition is generally used.

Two methods of obtaining intermediate bias for class-A operation are shown in Fig. 11A and 11B. The biasing of a push-pull class-B stage is somewhat less complicated. A typical arrangement is shown in Fig. 11C. Since the base current will generally decrease as the temperature is increased (Fig. 9), the base bias with the circuit of Fig. 11C will tend to increase as the temperature is increased. The net result of these two effects will be to cause the quiescent collector current to increase. This factor must be taken into account in designing the class-B stage to insure that operation remains within the maximum limitations of the transistor. One method of achieving stability is to use a temperature-sensitive resistor for R_1 or R_2.

Complementary symmetry circuits[9, 10] provide numerous additional circuit possibilities for audio output stages using power transistors. For example, the relatively simple biasing requirements of the push-pull amplifier can be taken advantage of without addition of bulk and weight in the form of transformers.

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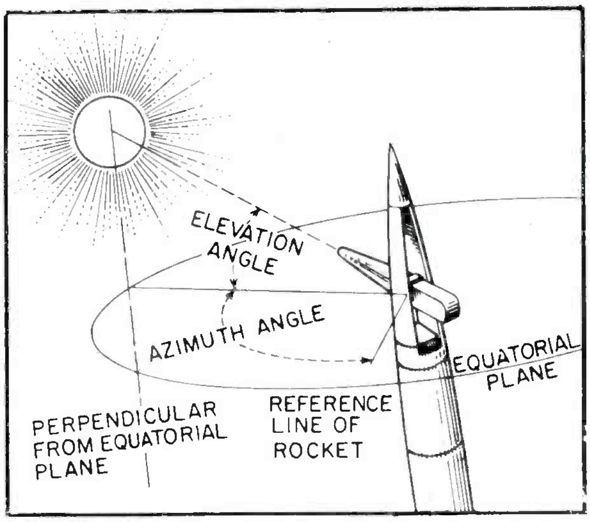
Rocket-Borne Servo Tracks the Sun



Solar pointing control mounted in nose cone of rocket

Spectrograph mounted in nose cone of Aerobee rocket is continually aimed at sun by biaxial servo system. Deviation is detected by balanced phototube system with coarse and fine control. Selection of components for rocket-borne instrumentation is described

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SOLAR RADIATION in the far ultraviolet spectrum is almost wholly absorbed in the earth's atmosphere and its study on the surface of the earth is impossible.

Radiation of these wavelengths may be studied by instruments mounted in research rockets.[1,2,3]

The biaxial solar pointing control to be described in this article is installed in the nose cone of one such rocket, the Aerobee, and keeps the instruments aligned with the sun despite gyrations of the vehicle in flight.

A spectrograph aimed by the pointing control made the first known observation of the Lyman-alpha hydrogen line at a wavelength of 1,216 angstroms.[4]

General Description

To correct for the deviation of the missile, the solar pointing control is rotated about two axes by servos. The entire forward end of the nose cone is rotated about the longitudinal axis of the rocket by an azimuth servo. Within this section the instrument is pivoted about an axis perpendicular to the azimuth axis by an elevation servo. The two servo systems are similar but operate independently.

Until the rocket has cleared the major part of the atmosphere and the air loads have become negligible, the instrument is stowed parallel to the rocket axis behind streamlined doors. Then the doors are jettisoned and servo operation starts.

The basic servo systems are shown in Fig. 1 and 2. The eye systems, each comprised of an array of phototubes, produce voltages that correspond to the errors in pointing. After traversing suitable lead and lag networks, these voltages are applied to amplifiers. The amplifiers drive a field-control motor in the case of the elevation servo and a magnetic-clutch system in the case of the azimuth. As a result, the instrument swings to the target with speed and little overshoot. From then on, in normal flight, the unit continually points at the sun until the rocket re-enters the effective atmosphere. The instrument then retracts to the stowed position in preparation for landing.

Eye System

To detect an error in pointing, a balanced phototube system is used.[5] For each servo, there is a coarse eye and a fine eye. The coarse eye, with a sensitivity of about $\frac{1}{3}$ volt per degree, is used to detect large errors and determines the transient response. The fine eye, with a sensitivity of about $\frac{1}{2}$ volt per minute, determines the ultimate accuracy.

Response Network

A d-c servo system was chosen in preference to an a-c system because the d-c system is simpler and considerably lighter and because high-performance requirements on both transient response and ultimate accuracy necessitate derivative damping as well as integral control. These are more easily realized in a d-c than in an a-c system. Drift, the principal disadvantage of most d-c systems, contributes a negligible error.

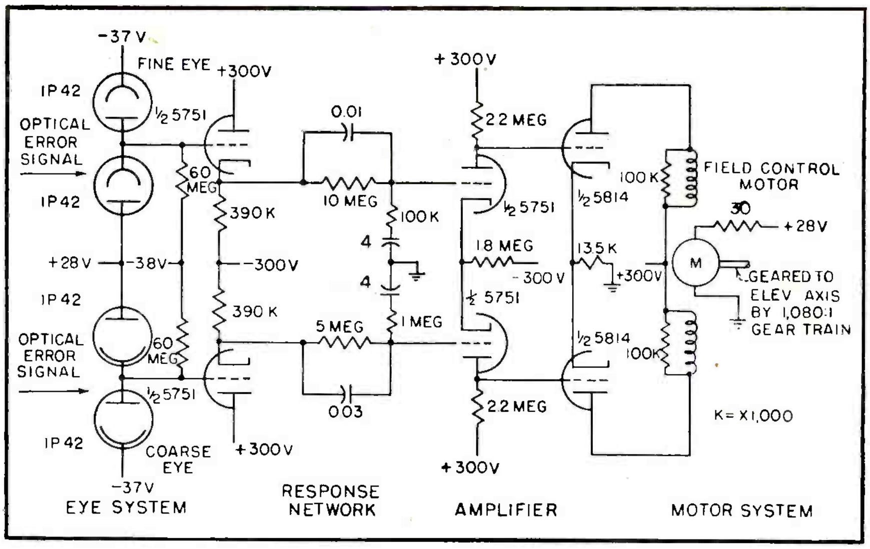

FIG. 1—Elevation servo system is geared to elevation axis by 1.080-to-1 train

Inasmuch as the rocket may be spinning as fast as 90 rpm when servo operation starts, the catching ability of the azimuth servo has to be exceptional. This requires use of appreciable lead control and system elements that have negligible time delay. Also, to reduce pointing errors, integral control is used. This reduces not only velocity errors but in the presence of friction also reduces static errors.

For each servo there is an output voltage from the coarse eye and one from the fine eye. These signals are balanced against change in supply voltages but are essentially single ended. Because of different functions and different loop gains, they require different response networks.

The output of the response networks is fed to a push-pull amplifier that effectively adds them. Thus the advantage of a balanced system is realized in spite of the separation of eye systems.

Amplifiers

The two amplifiers receive d-c push-pull signals and produce enough current to drive the motor systems. The voltage gain required is low and the main problem is to keep drift to a negligible value. Under the worst supply-voltage conditions encountered in flight, the amplifier drift is equivalent to a pointing error of 0.5 minute of arc, which is small compared to other sources of error.

The selection of tubes for rocket work is still a problem. Severe vibrations of unknown magnitude are present during takeoff. All tubes are aged fifty hours and then put through a shake test. At present the selection of types is based upon previous tests plus operating failures. In some cases high-reliability tubes have been an improvement—in other cases they have had a record inferior to ordinary types.

Motor System

The choice of motor units to power the servos is determined by the performance to be delivered. The elevation servo has a design accuracy of one minute of arc and a response speed of 10 rpm. Several seconds may be needed to zero-in on the target. A field-control motor drives the instrument through a precision gear train with a ratio of 1,080 to 1.

While the backlash can be adjusted to give one minute of arc accuracy, it is easier and cheaper to provide a small amount of spring torque on the output shaft. Thus, even when the servo is on target, backlash and its associated problems are removed inasmuch as the motor must still exert a torque through the gear train.

The azimuth servo is also designed for one-minute accuracy, but much higher speed of response. Because of the spin of the rocket the azimuth servo must be able to

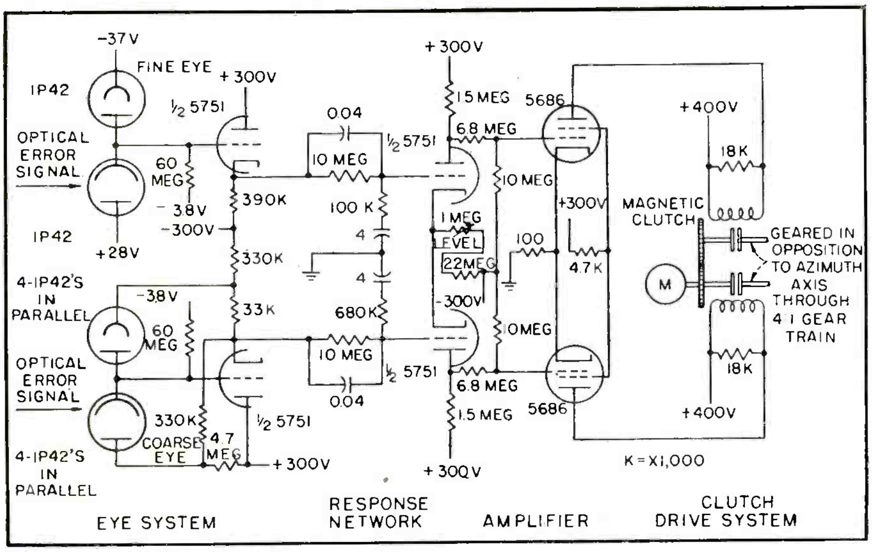

FIG. 2—Azimuth channel output controls magnetic clutch on azimuth drive motor

catch with complete reliability a target moving at 1.5 rps. A 28-volt motor with a flywheel, for stability, drives a gear train that in turn drives two counterrotating magnetic clutches.

Gears and Clutches

The output gears of these clutches are connnected to the azimuth drive shaft. Current in the coil of one clutch drives the azimuth one way while current in the other drives the azimuth the other way. Because of small residual drag, the backlash is always taken out. This system gives a smooth, powerful drive with excellent accuracy capabilities.

Programing

Although the altitude of the rocket is the fundamental criterion for starting and stopping operations, it cannot be measured with ease and reliability. Therefore the sequence of operations is controlled by a timer. The timer is a governor-controlled d-c motor. Cams driven by the timing motor through a reduction-gear train actuate a bank of snap-action in sequence.

Telemetering

Up to 120 separate voltages may be telemetered by an ASCOP commutator in conjunction with the AFCRC beacon-telemetering system. Each voltage is sampled for 6 milliseconds 2.5 times a second. Commutation segments may be combined to give longer or more frequent sampling.

The ASCOP commutator has two channels with 60 sampling segments. The commutator output goes to the AFCRC beacon-telemetering system. Each of the two beacon-telemetering channels has a working range of 0 to 5 volts d-c.

Normally, one channel is devoted to the instrument being pointed and one to the pointing control. Thus the complete operation of the nose-cone unit may be monitored.

Accuracy of Pointing

The pointing control was designed for an ultimate accuracy of plus or minus one minute of arc. At present there are a number of factors that contribute to produce a larger error. Some of these can be removed by careful adjustment while others require refinement of components.

Photosight

The present series of pointing controls is rated conservatively at 30 minutes of arc. During flight this accuracy is continuously monitored by an independent photoelectric sight.

The output from the sight is telemetered to the ground. On a recent flight, the measured error during operation did not exceed 15 minutes of arc. With each succeeding unit the accuracy is being improved and the design accuracy may soon be achieved.

Two biaxial solar pointing controls have reached operating altitude. One was partially successful. The azimuth servo performed satisfactorily but the elevation servo did not operate because of failure of an elevation eye phototube, apparently at takeoff.

Instruments

The second was successful, producing an accuracy of fifteen minutes of arc. The first one carried an instrument provided by the University of Rhode Island and designed to measure total solar radiation. This experiment will be repeated in the near future.

The second pointing control carried an ultraviolet spectrograph provided by the University of Colorado. The scientific data obtained from this flight, including the picture of the Lyman-alpha hydrogen line,[6] were presented to the American Physical Society during the January 1953 meeting in Boston.

A solar monochromatic camera[7] was flown in a pointing control in a rocket that did not reach operating altitude.

A rocket-borne coronagraph has been tentatively designed by the University of Colorado.

Development of the pointing control has been due to the efforts of a team of workers. The work was directed by a planning board consisting of W. B. Pietenpol, project supervisor; F. C. Walz, J. M. Jackson and D. S. Stacey. Section heads were: R. H. Crawford, W. E. Lowrey, R. A. Nidey, W. A. Rense, C. E. Shelden, G. A. Stith and M. O. Williams. The project is sponsored by the Air Research and Development Command under contract W19-122 ac-9.

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Automatically Deiced

Ground-based beacon antenna for 9,220-9,430-mc band provides omnidirectional azimuth pattern and narrow vertical beamwidth. Radome deices automatically and is built to withstand wind velocities exceeding 150 knots without damage

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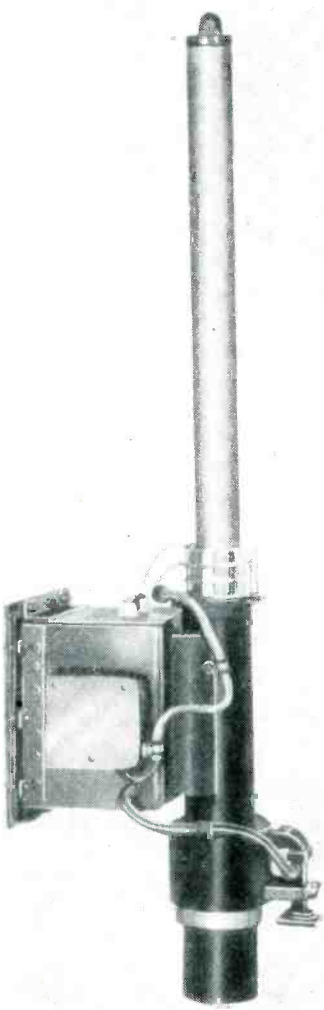

Beacon antenna with fiber glass radome in place. Automatic deicing circuit is located in housing at left

PROTECTION from the elements and a radiation pattern ideal for its use in ground-based aircraft beacons characterize the microwave antenna shown in the photograph.

The antenna is horizontally polarized with an essentially omnidirectional azimuth pattern. In the vertical plane, the beam maximum is tilted upward from the horizon. The assembly incorporates circuits for automatically deicing the radome. The structure can withstand wind velocities exceeding 150 knots. The antenna has been tested for five months under the severe weather conditions atop Mount Washington in New Hampshire. During this period, the radome was kept continually ice-free and the structure withstood wind gusts greater than 175 mph.

The antenna was require to be horizontally polarized with an essentially omnidirectional azimuth pattern. In the vertical plane, the half-power beamwidth was to be three to five degrees with the beam maximum elevated between one and one and one-half degrees above the horizon.

Means were required for automatically deicing the radome under all weather conditions and the antenna and radome structures were designed mechanically to withstand wind velocities in excess of 150 knots without damage.

Electrically the antenna is an omnidirectional slotted array composed of a relatively thin X-band waveguide with pairs of shunt slots placed opposite each other on the broad faces of the guide. The slots are spaced on half the guide wavelength and offset on alternate sides of guide centerline. The antenna presents a small cross-section, desirable for low wind loading and small deicing heat requirements. Table I summarizes the antenna's electrical and mechanical characteristics.

Slot Radiation

Figure 1 indicates how an omnidirectional radiation pattern is obtained. In Fig. 1A two slots are shown, one on each side of an infinitely thin hollow metal sheet with their narrow dimensions in the plane of the illustration. These are excited in opposite phase as shown by the voltage vectors across the slots.

These slots will radiate uniformly around their respective half-circles. If the metal sheet is removed some distance from the slots, the radiation fields will form a continuous circle with no discontinuity, as shown in Fig. 1B. In Fig. 1C the infinitely thin metal sheet has been replaced by a thin waveguide with the pair of slots offset from guide centerline. The radiation field from

X-Band Beacon Antenna

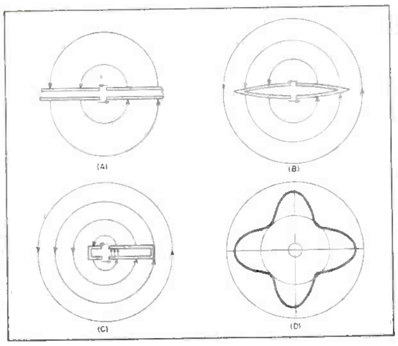

FIG. 1—Antenna radiation pattern

Table I—Antenna Performance Over the Band, 9,220 to 9,430 mc

Elevation pattern	Half-power beamwidth 3.0 to 3.3 deg Tilt, 1.0 to 1.3 deg above horizon
Azimuth pattern	Circularity ratio (max radiated power/min radiated power) less than 2 to 1
Gain	21.5 db
Impedance	Voltage-standing-wave ratio less than 1.7 over band; less than 1.4 at 9,310 mc
Peak power capacity	40 kw
Wind loading	150 knots
Radome deicing	240 watts, automatically controlled

this slotted waveguide approximates the idealized condition of Fig. 1B.

Measurements show that for a slotted waveguide 1 in. × 0.25 in. outside diameter, the radiation pattern is circular within a ratio of 2 to 1 as shown in Fig. 1D. Thicker waveguides give less circular patterns and thinner waveguides are increasingly difficult to manufacture.

The specified beamwidth requires an array of twenty slot pairs with an overall length of approximately 20 inches. The array is composed of two halves fed at the center. Each half of the array, consisting of ten pairs of slots, is designed to have a low input voltage-standing-wave ratio over the specified frequency band. Measurements made of the conductance of slots of several widths and offsets from the waveguide centerline indicated that slots ⅛ inch wide and 0.600 inch long, offset 1/16 inch from the guide centerline, would provide the desired input impedance.

Beam Tilt

The variation of beam-tilt angle for a conventional end-fed array exceeded the specified tolerance of one-half degree over the required frequency band. Two antenna designs were developed that were capable of producing the required upward beam tilt with little variation of tilt angle versus frequency. In both antenna designs, the slot arrays were driven at the center so that the variations of the phase front as a function of frequency would be symmetrical along the antenna's length and would produce no variations in beam-tilt angle.

Preliminary Design

The first antenna design utilized a slot array in which the spacing of slot elements in the upper half of the array was slightly greater than $\lambda_g/2$ and in the lower half was slightly less than $\lambda_g/2$, as shown in Fig. 2A. Beam tilt in this antenna is produced by the conical phase front of the radiated energy. The feed point is chosen to produce no discontinuity at the array center for the midband frequency. The phase front is not uniformly retarded along the array at other frequencies, but the deviation from a straight line varies symmetrically about the antenna feedpoint as shown and produces no variation in beam tilt above the horizon, although slight beam broadening occurs.

The second antenna design producing no beam tilt variation utilized an array in which the upper and lower halves have identical slot spacings of $\lambda_g/2$, but in which the feedpoint of the array is displaced a fraction of a wavelength downward along the axis of the waveguide from the midpoint of the array. Beam tilt in this second antenna is produced by the phase difference between antenna halves, as shown in Fig. 2B.

In this design, the phase front from each antenna half is tilted at frequencies above or below midband frequency but the tilt varies symmetrically about the feedpoint. Because of this symmetry, the antenna pattern maintains its constant tilt with respect to the horizon.

The second antenna design unfortunately causes increasingly high side lobes as the beam tilt is increased, because of the abrupt phase discontinuity at the center of the array. Measurements show that the beam tilt cannot be held constant over the required frequency band with antennas of the first design. The variation of beam tilt is apparently caused by the dissimilarity of input impedances of the antenna halves as a function of frequency, causing a power split at the array feedpoint which varies both in phase and amplitude as a function of frequency.

Final Design

For this reason, the final antenna design utilizes identical antenna halves, with the feedpoint displaced to produce the desired beam tilt. Figure 3A shows the vertical radiation pattern of the centerfed antenna and Fig 3B shows the verti-

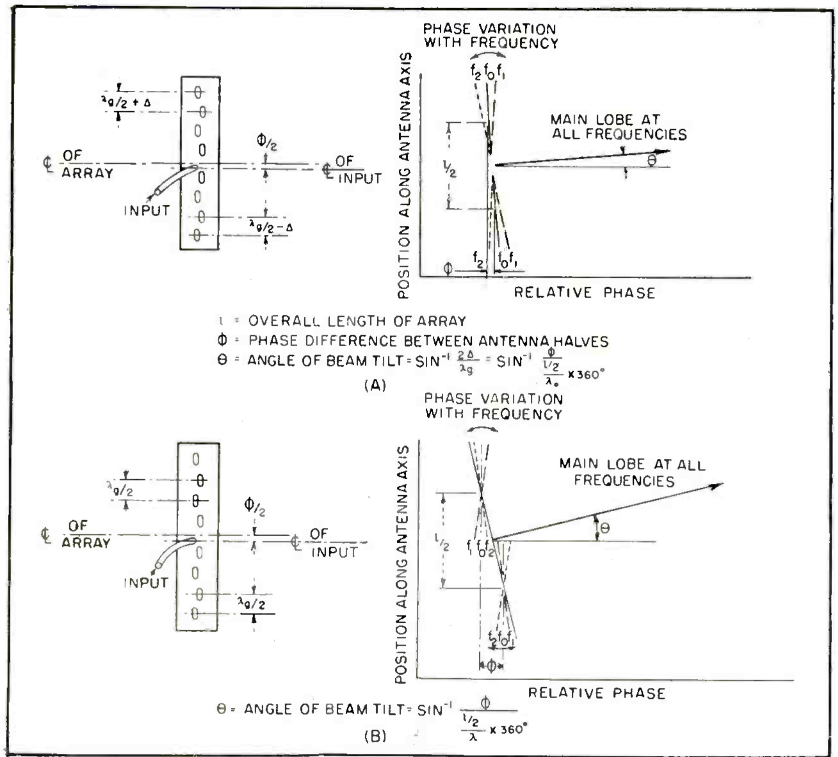

FIG. 2—Beam tilt and physical conformation of antenna having different slot spacings top and bottom (A) and one having identical halves (B)

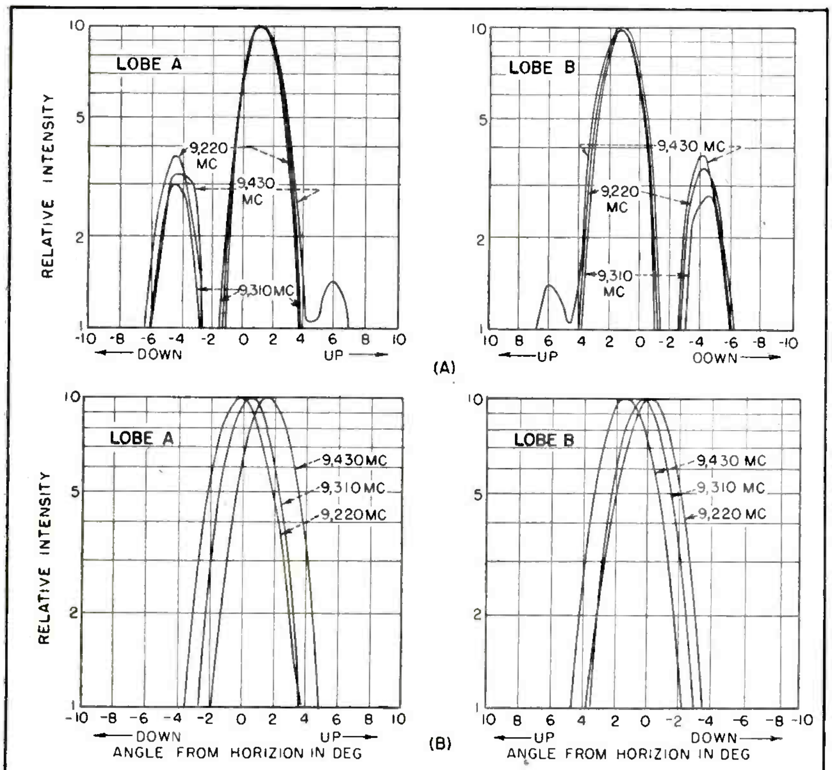

FIG. 3—Vertical radiation pattern of center-fed array (A) and endfed array (B) illustrate how beam energy is concentrated in a narrow lobe

cal radiation pattern of an endfed array of approximately the same overall length. The variation of beam tilt of the centerfed array is less than $\frac{1}{4}$ degree while that of the end-fed array is 2 degrees over the specified 210-mc bandwidth.

Feed System

Design of a feed system for the center-fed array was carried out simultaneously with design of the radiating elements. The requirements for the feed were that it should divide the power equally to each antenna half with equal phase. The best means for accomplishing this was found to be a coaxial-to-waveguide transition consisting of an E-plane post across the waveguide at the feed point of the array. This transition forms a shunt junction that produces the required equal-power split by its symmetry. To retain the small antenna cross-section, this coaxial feed line is carried down one narrow edge of the waveguide to the bottom of the array, where a second conventional coaxial-to-waveguide transition provides a waveguide input to the antenna. Figure 4 illustrates the antenna feed system.

Radome

The deicing radome for the antenna is a thin-wall cylindrical housing of laminated fiber glass. Radome dimensions were so chosen that they satisfied requirements of high mechanical rigidity, small heated area and small effect on antenna impedance and aximuth pattern.

Several experimental thin-wall radomes were made, whose diameters ranged from $1\frac{1}{4}$ inches to $2\frac{1}{2}$ inches. Figure 5A shows the input admittance as a function of frequency for the 10 slot-pair half-length antennas with radomes of different diameters. The smallest admittance spread was obtained with a radome having a $1\frac{3}{4}$-inch inside diameter.

Figure 5B shows the input admittance as a function of frequency for the same antenna with radomes of $1\frac{3}{4}$-inch inside diameter and several wall thicknesses. The effect of radome thickness is small up to

0.055 inch when the admittance starts to spread out again.

The circularity deteriorates steadily with increasing radome diameter. This effect necessitated a compromise choice of radome diameter. The requirements of pattern and impedance were best met with a radome having a 1$\frac{5}{8}$-inch inside diameter and 0.055-inch wall. Impedance-matching irises were designed to give the optimum input voltage-standing-wave ratio with this radome.

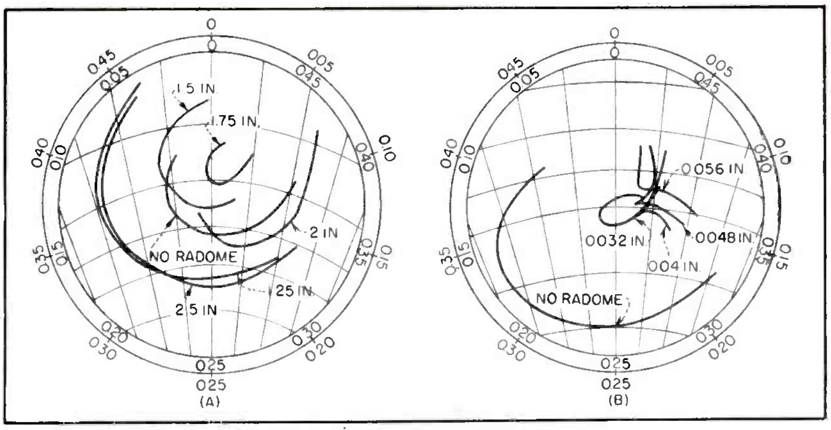

FIG. 5—Effect on input admittance of radome diameter (A) and radome thickness (B)

Mechanical Design

The required mechanical strength of the radome was obtained with an ample safety factor with the chosen radome dimensions. The radome is molded from thermosetting resin and fiber glass cloth wound on a split mandrel with a clamshell outer mold.

Molded flanges at the top and bottom of the radome provide mechanical attachment to the antenna; O-rings clamped against both end flanges provide a pressure seal.

The heat required for deicing the radome was determined from studies of the rate of icing in severe weather. This data indicated a heat requirement of about 450 watts but the problem of overheating the radome under relatively high ambient temperatures and low icing rates made it necessary to limit the radome heat in the final antenna to 240 watts.

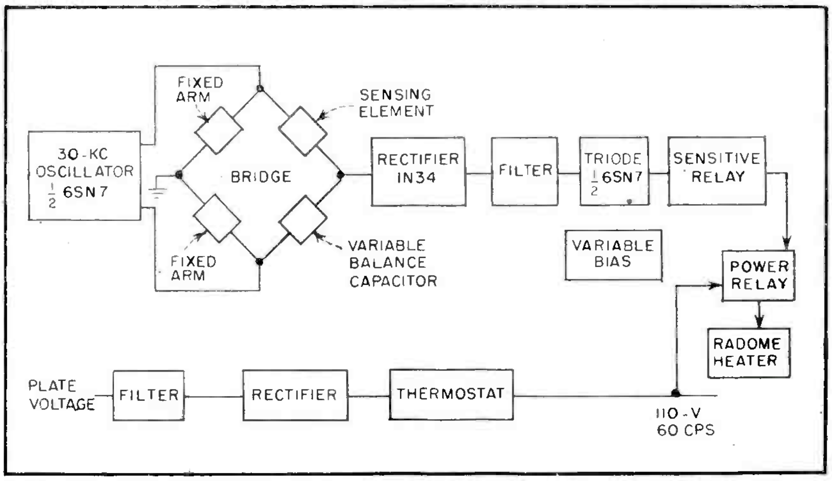

FIG 6—Radome deicing control circuit depends for its operation upon balanced reactance bridge. Sensing element is air-dielectric capacitor exposed to weather

Heating Elements

The radome is heated by Nichrome wires embedded under the top layers of the fiber glass laminate. These wires were placed parallel to the radome axis, normal to the polarization of the radiated energy and have no measurable effect on the radiation pattern.

A single length of the Nichrome wire is run up and down the radome fourteen times with the wires spaced about $\frac{3}{8}$ inch apart. Flexible insulated leads are molded into the fiber glass to provide weatherproof electrical connections to the radome heater.

Deicing Control

An automatic deicing control that energizes the radome heating element under any icing conditions consists of an ice-sensing bridge circuit operating at approximately 30 kc, an unbalance-signal amplifier and a relay to actuate the radome heater, as shown in the block diagram in Fig. 6. The bridge circuit consists of two capacitors and the center-tapped secondary of the oscillator tank coil.

One capacitive arm of the bridge circuit is a parallel-plate air-dielectric capacitor mounted around the base of the radome and exposed to the weather. The other capacitive arm is a small air-dielectric capacitor mounted inside the control housing.

Snow, ice or water on the plates of the external capacitor produce an unbalance signal in the bridge circuit that is rectified, amplified and used to actuate a relay controlling the radome heating element. The radome heater removes ice from both the radome surface and the ice-sensing capacitor. When the ice and water are completely removed, balance is restored to the bridge and the radome heater is turned off automatically. The deicing control is mounted in a pressurized housing at the base of the antenna assembly, as shown in the photograph. The antenna was designed under Contract AF 28-(099)-85 sponsored by Rome Air Development Center, USAF.

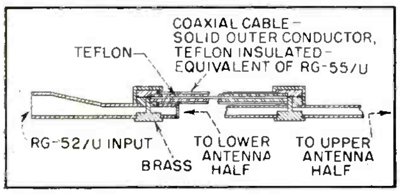

FIG. 4—Feed for center-fed array

Conelrad Receiver With

Design and construction of highly reliable broadcast-band receiver having internal carrier-failure alarm, for use in controlled broadcast stations required to monitor regional parent station of Civil Defense system. Cost of required components is under $100

WITH THE ADVENT of Conelrad operation, additional equipment requirements are presented not only to commercial broadcast stations but also to Civil Defense radio operating and monitoring facilities. To date, little information has been available on the alarm equipment directly associated with the monitoring of the regional parent stations.

While this particular receiver was designed for operation at the controlled broadcast stations, it has application wherever an alarm indicating removal of the parent-station carrier is required.

Those alarm circuits which have appeared in various technical publications are almost without exception of the accessory type, designed to be added to existing receiving equipment. This feature has been found a source of difficulty. If the existing receiver is of broadcast monitoring quality, the receiver expense is too high or there is hesitancy to modify for fear of reducing the quality of operation. If the available receiver is of the home type, the quality is such that it does not meet the stringent requirements of continuous operation.

The design requirements for the requisite receiver are identical to those for any communications receiver. There are, however, several additional requirements that must be met for specific Conelrad operation. For single-unit operation, the receiver-alarm should operate as an integral unit with no external alarm devices required. The unit should operate completely from the powerline supply, without external battery packs or auxiliary units. Conventional tuning and adjustment are essential, with no critical alarm adjustment. The alarm should function positively, either as a result of carrier or internal receiver failure. The entire receiver should require no special components or fabrication facilities. For this reason, the component selection has been restricted to standard replacement types, observing a high safety factor. Cost of the complete unit is less than one hundred dollars, excluding labor.

Appearance of receiver as constructed for mounting on standard rack

Although the circuit features could be added to an existing receiver, the advisability of this is questionable since the labor involved is considerable and the ultimate results doubtful.

Receiver Circuit

The block diagram of the receiver is shown in Fig. 1. The basic receiver design is conventional with the exception of the alarm, control and signaling circuits. A number of special modifications are applied to certain stages for this particular design and application, as shown in Fig. 2.

The receiver, as originally conceived, was to be operated in close proximity to a broadcast transmitter. To prevent receiver blocking, a series wave trap across the primary of the antenna transformer is tuned to the transmitter frequency.

To reduce further extraneous pickup, the receiver should be completely shielded, including a chassis bottom plate and a low-impedance shielded antenna transmission line. The antenna requirement is not critical, although the length of the antenna should be as short as possible, consistent with the desired parent-station signal strength and the problem of locally caused receiver blocking.

For flexibility, continuous tuning is employed rather than fixed crystal-controlled frequencies. For simplicity, a 0-1 vernier dial is used instead of the usual 550-1,700 kc scale. This simplification eliminates problems in receiver tracking and at the same time permits use of a small logging chart for those dial settings required for operation. For stability, afc is used, resulting in operational frequency stability comparable to crystal control. After a short initial warmup, the receiver holds frequency over an ambient temperature range of better than 70 deg F.

Two stages of i-f amplification are used for selectivity. The i-f transformers are of the iron-core input type. It is important that only iron-core input transformers be used, because of their undercoupled characteristic. For amplifier stability, a 68,000-ohm resistor shunts the secondary of the first i-f transformer.

Since the maximum gain possible with these transformers is not re-

Built-In Alarm

By ROBERT E. QUENSTEDT
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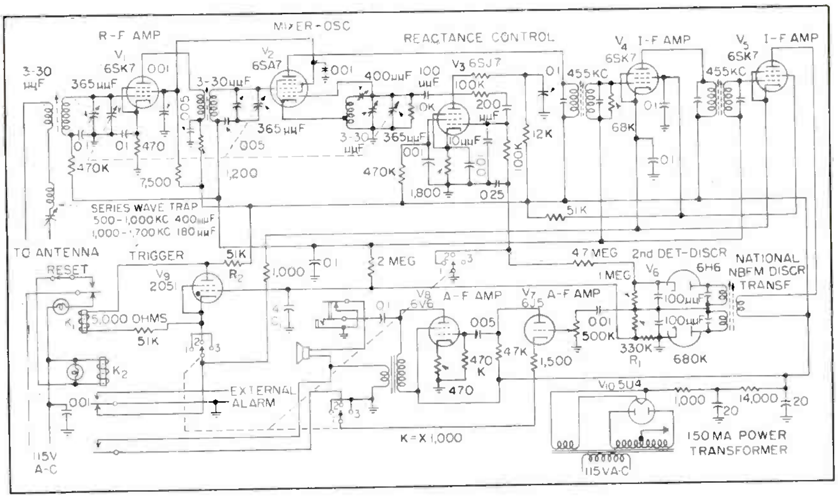

FIG. 2—Complete circuit of receiver. Switch positions are as follows: 1—afc disabled to permit tuning; 2—monitoring, with afc operating, for direct operating check of receiver; 3—normal operating position, in which alarm will sound for carrier or receiver failure as required for Conelrad operation

quired, the overall i-f gain is reduced to an optimum value by low screen voltage on V_4 and V_5. The selectivity of the i-f strip is narrower than that of a conventional receiver to prevent erratic afc operation during signal fading, station riding and adjacent-channel interference. Although there is an apparent lack of stage decoupling throughout, the receiver is perfectly stable. There can not be, however, a trace of regeneration in any stage if the alarm threshold is to be stable.

The discriminator furnishes the afc and avc control voltages as well as the demodulated audio voltage and the triggering voltage for the thyratron control circuit. The lower portion of the discriminator load resistor may be replaced by a potentiometer if an adjustable alarm threshold is required.

The actual value of the time constant for the alarm triggering voltage, roughly 90 seconds, is determined by R_1 and C_1. A large time constant is required to prevent triggering during deep fades and momentary carrier interruptions caused by the parent transmitter leaving the air due to automatic overload recycling or changeover of antenna arrays during the broadcast day.

Alarm Circuit

The alarm triggering circuit is a 2051 triode-connected thyratron operated as a degenerative d-c amplifier across an electromechanical lockup circuit. During normal operation (carrier on), relay K_1 is energized and the green pilot lamp across its contacts illuminated. When the signal is removed, the control bias applied to the thyratron ceases and K_1 drops out due to the increased voltage drop across R_2. Now K_2 is energized, illuminating a red pilot lamp and removing the 2051 plate voltage. Reset of the alarm is accomplished by deenergizing K_2 with a pushbutton switch. The alarm will not reset unless there is a carrier present or the cathode of the thyratron is opened.

The aural alarm is supplied by the receiver through its speaker. A regenerative feedback loop between the cathode of the first audio stage and the secondary winding of the output transformer converts the audio stages into an oscillator operating at roughly 400 cps. When K_2 is energized, the loop is closed and simultaneously the cathode circuit of the i-f stages is opened. The presence of the second-detector output and the alarm tone produces an unpleasant garble which is eliminated by this circuit arrangement.

With the circuit parameters specified, the audio oscillator frequency is roughly 400 cps. The secondary connections to the output transformer must be phased by trial and error to determine the regenerative loop.

Preliminary receiver alignment, including the afc circuit, is conventional. The latter may be aligned either by using a sweep generator or the carrier displacement method.

The receiver has been in continuous operation for over 18 months without circuit or component failure, aside from normal tube replacement.

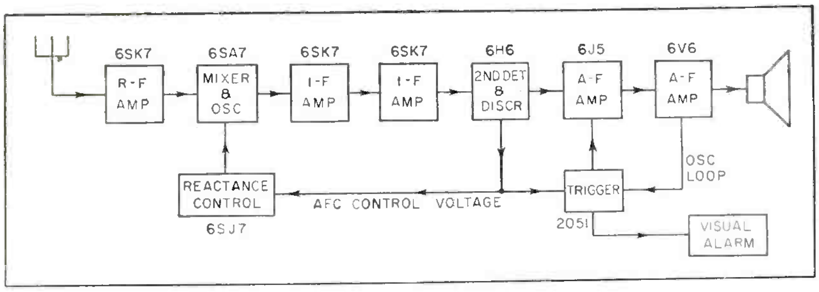

FIG. 1—Block diagram of receiver. Feedback loop from output stage converts audio amplifier to oscillator to produce loudspeaker howl when alarm is triggered

TRANSISTORS: Theory and Application

Cascading Transistor

Part XI

By ABRAHAM COBLENZ and HARRY L. OWENS

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Although transistors are capable of high voltage, current and power gains, particularly in selected methods of connection, many applications require more than one stage of amplification. The transistor is adaptable to cascade connections where its resistive character permits economies in size, weight, power and additional components required.

Possible Arrangements

There are nine possible interconnections for cascading two transistor stages. These may be summarized as follows:

GB↑ to ↓GB* GE↑ to ↓GB** CC↓ to ↓GB*
GB↑ to ↑GE* GE↑ to ↑GE* GC↓ to ↑GE*
GB↑ to ↑GC* GE↑ to ↑GC GC↓ to ↑GC

Of these, not all are practicable. Those marked with a single asterisk cause difficulty by virtue of inherent instability when point-contact transistors are used. While certain techniques may be applied to stabilize these circuits, the use of such techniques often introduces even more serious difficulties. The double asterisks indicate a combination involving serious impedance mismatch between stages. The arrows indicate high (above 1,000 ohms) or low (below 1,000 ohms) impedances (input when placed at left, output at right).

Equivalent circuits for each configuration appear in the table on the following pages. Coupling capacitors and d-c voltage sources are eliminated, and identical transistors are assumed for reasons of simplicity. Also, the load resistor of the first stage is eliminated since it is invariably much larger than the output impedance of the first stage or the input resistance of the second.

Solution of basic loop equations for the various circuit parameters yields some rather cumbersome expressions. However, certain simplifications which introduce negligible errors shorten these expressions to the forms shown on the following pages.

General Theorems

It can be shown that for cascaded transistor amplifiers the load impedance of the first stage is the input impedance of the second. Also, the output resistance of the second stage is obtained using the output resistance of the first stage as the generator resistance of the second.

In computing the voltage gain of the second stage, in a cascaded arrangement, the second stage may be considered to operate from a source of zero impedance, if, when computing the gain of the first stage, it is assumed that its load resistance is the input resistance of the second.

In computing power gains of two cascaded transistor stages, when the power gain of the first stage is computed using the input resistance of the second as a load for the first, the power gain of the second stage is obtained by multiplying the ratio of the load resistance to the input resistance of the second stage by the ratio of the squares of the coefficients of the loop II and III currents, respectively (see equivalent circuits) in the Kirchhoff's equation for loop III.

Typical Values

Table I is a summary of the characteristics of typical two-stage transistor amplifiers using typical operating parameters ap-

Previous Articles in this Series

Part I—Transistors: Theory and Application, Mar. 1953, p 98.
Part II—Energy Levels in Transistor Electronics, Apr. 1953, p 138.
Part III—Physical Properties of Electrons in Solids, May 1953, p 162.
Part IV—Transistor Action in Germanium and Silicon, June 1953, p 166.
Part V—Point-Contact Transistor Operation, July 1953, p 158.
Part VI—Operation of Junction Transistors, Aug. 1953, p 156.
Part VII—Equivalent Transistor Circuits and Equations, Sept. 1953, p 156.
Part VIII—Small-Signal Transistor Operation, Oct. 1953, p 158.
Part IX—Grounded Emitter and Collector Circuits, Nov. 1953, p 166.
Part X—Switching Circuits Using the Transistor, Dec. 1953, p 186.
PART XI—This completes the series of articles on transistor electronics by Coblenz and Owens. The entire series, plus some additional material prepared by the authors, will be published in book form by the McGraw-Hill Book Company early in 1954.

Amplifier Stages

Circuit equations for practical configurations of transistor amplifiers are presented in convenient table form for reference. Typical values are given to guide designer in picking right combination for a particular application

Table I—Typical Values of Circuit Parameters for Transistors in Cascade

Circuit		R_i (ohms)	R_o (ohms)	VG (1st stage)	VG (2nd stage)	VG_o (overall)	CG (1st stage)	CG (2nd stage)	CG_o (overall)	PG (1st stage)	PG (2nd stage)	PG_o (overall)		
GB to GB	pc	−6	14,560	0.7	133	93	−2.35	1	−2.35	6.78	133	900	U	C
	j	45	1 meg	0.156	990	155	−0.96	0.87	−0.84	0.55	860	472	S	C
GB to GE	pc	165	−19,400	35	−133	−4,650	−6.96	−230	162	73.5	31,100	2,280,000	U	V
	j	1,000	40,000	1.23	1.015	1,240	−0.96	−6.85	6.56	4.36	6,720	29,600	S	
GB to GC	pc	268	−7,800	45.6	0.998	45.5	−0.017	100	−1.75	2.07	100	207	U	C
	j	245	14,000	535	1	535	−0.56	7.14	−4	788	7.3	5,760	S	C
GE to GB	pc	5	15,300	0.52	133	69	−1.74	1	−1.74	3.54	133	470	S*	C
	j	1,125	1 meg	−1.31	980	−1,290	24.3	0.872	21.2	39.2	845	33,200	S	V
GE to GE	pc	620	−20,400	−73.5	−133	9,720	2.33	−233	−545	304	31,160	9,450,000	U	C
	j	1,175	44,000	−10.22	−985	10,100	23.9	−6.85	−164	302	6,700	2,040,000	S	C
GE to GC	pc	273	122,000	−45.5	1	−45.5	0.017	100	1.74	2.07	100	207	S	V
	j	557	2,300	−86	1	−86	1.27	7.14	9.1	2,000	7.3	14,600	S	V
GC to GB	pc	−10	26,000	−0.292	133	−40	0.76	1	0.76	1.135	133	151	U	V
	j	2,400	26,000	0.75	985	740	−25	0.872	−21.8	12.8	845	10,900	S	C
GC to GE	pc	34,500	−24,000	0.98	−133	−130	−0.975	−230	224	0.054	31,000	1,720	U	V
	j	40,000	82,500	0.975	−985	−958	−24.5	−6.86	168	2.69	6,740	18,100	S	V
GC to GC	pc	15,270	700	0.99	0.994	0.98	0.007	−100	−0.75	0.001	100	0.1	S	C
	j	947,000	50	1	1	1	1.33	−7.14	−9.52	0.002	7.26	0.02	S	C

Abbreviations: pc, point contact; j, junction; U, unstable; S, stable; C, current phase reversal; V, voltage phase reversal.

plied to the equations given. Table I also shows whether a particular configuration is stable or unstable and whether or not a phase shift occurs from input to output.

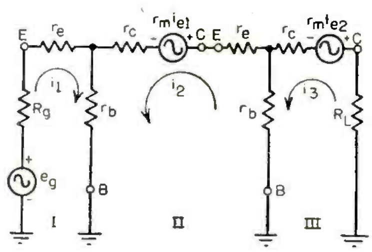
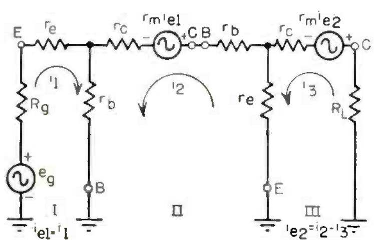
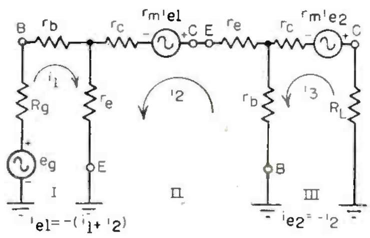
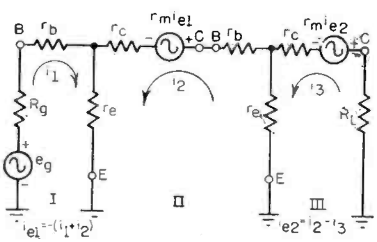
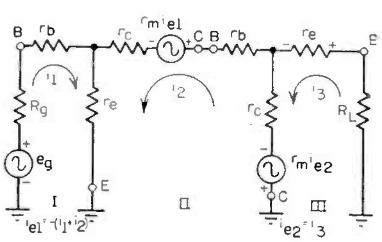
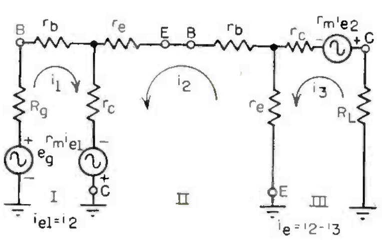
In general, the values shown in the table must be considered to represent approximations, but these are sufficiently close to be suitable for general design decisions.

Results obtainable in practice will differ from values given for two principal reasons: variation of r_c with temperature and the use of low values of d-c biasing resistors. The latter errors are unimportant for values under 2,000 ohms. Errors due to changes in r_c can be quite substantial.

The GE to GE connection is capable of the highest orders of power, voltage and current gains, with very satisfactory magnitudes of input and output impedances (for junction transistors). The GE to GB, GB to GE and GC to GE are runners-up—again, for junction units. The only cascading connection that appears to be stable for point-contact transistors is the GE to GC, but gains are unimpressive and no particular improvement over a single unit is realized by the combination. The GE to GB connection cannot be considered unconditionally stable, since the input resistance (with point-contact units) is five ohms; too close to negative values for comfort.

Tabulation of Circuit Equations Appears on Following Pages→

Table II—Approximate Expressions for Operating Characteristics of

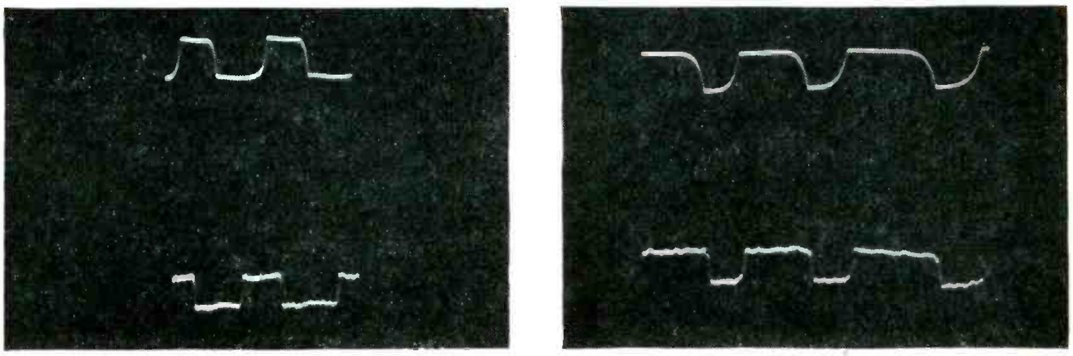
Circuit	Simplified Equivalent Circuit	Approximate Expressions for Input and Output Resistance
Grounded Base to Grounded Base		$R_i \cong r_e + r_b - \frac{r_b (r_b + r_m)(R_L + r_c + r_b)}{(2r_b + r_e + r_c)(R_L + r_c + r_b) - r_b (r_b + r_m)}$ $R_o \cong r_c - \frac{r_b r_m (R_g + r_b + r_e)}{(R_g + r_e + r_b) r_c - r_b r_m}$
Grounded Base to Grounded Emitter		$R_i \cong r_e + r_b - \frac{r_b r_m (R_L + r_e + r_c - r_m)}{(R_L + r_e + r_c - r_m) r_c + r_e r_m}$ $R_o \cong r_c - r_m + \frac{(R_g + r_b + r_e) r_m r_e}{(R_g + r_e + r_b) r_c - r_m r_b}$
Grounded Emitter to Grounded Base		$R_i \cong r_b + r_e + \frac{r_e r_m (R_L + r_c + r_b)}{(r_c - r_m)(R_L + r_c) - r_b r_m}$ $R_o \cong r_c - \frac{(R_g + r_e + r_b) r_m r_b}{(R_g + r_e + r_b)(r_c - r_m) + r_e r_m}$
Grounded Emitter to Grounded Emitter		$R_i \cong r_b + r_e + \frac{r_e r_m (R_L + r_e + r_c - r_m)}{(r_c - r_m)(R_L + r_e + r_c - r_m) + r_e r_m}$ $R_o \cong r_c - r_m + \frac{r_e r_m (R_g + r_b + r_e)}{(R_g + r_b + r_e)(r_c - r_m) + r_e r_m}$
Grounded Emitter to Grounded Collector		$R_i \cong r_e + r_b + \frac{r_e r_m (R_L + r_e + r_c - r_m)}{(2 r_c - r_m)(R_L + r_e + r_c - r_m) - r_c - r_m)}$ $R_o \cong r_c - r_m - \frac{(R_g + r_b + r_e)(r_c - r_m) r_c}{(R_g + r_b + r_e)(2 r_c - r_m + r_e r_m}$
Grounded Collector to Grounded Emitter		$R_i \cong r_c - \frac{r_c (r_c - r_m)(R_L + r_e + r_c - r_m)}{(R_L + r_e + r_c - r_m)(2 r_e + r_b + r_c - r_m) - r_e r_m}$ $R_o = r_c - r_m + \frac{(R_g + r_b + r_c) r_m r_e}{(R_g + r_b + r_c)(2 r_e + r_b + r_c - r_m) - r_c (r_c - r_m)}$

Cascaded Transistor Amplifiers (continued from page 159)

Approximate Gain Expressions for Cascaded Stages	Remarks
$VG_o \cong \dfrac{(r_b + r_m)^2 R_L}{(R_g+r_e+r_b)(R_L+r_b+r_c)(2r_b+r_e+r_c)-r_b(r_b+r_m)(R_L+R_g+2r_b+r_e+r_c)}$ $PG_o \cong \dfrac{4 R_g R_L (r_m + r_b)^4}{[(R_g+r_e+r_b)(R_L+r_b+r_c)(r_e+r_c+2r_b)-r_b(r_b+r_m)(R_L+r_b+r_c)]^2}$ $CG_o = \dfrac{-(r_b + r_m)^2}{(2 r_b + r_e + r_c)(R_L + r_b + r_c) - r_b (r_b + r_m)} = \dfrac{-r_m^2}{(R_L + r_c) r_c - r_b r_m}$	**GB to GB** Gains not particularly impressive. Negative R_i for point-contact transistors indicates instability in that connection. For junction units, R_i is lower than for any other configuration.
$VG_o \cong \dfrac{-r_m^2 R_L}{(R_g+r_e+r_b)[(R_L+r_e+r_c-r_m) r_c+r_e r_m]-r_b r_m (R_L+r_e+r_c-r_m)}$ $CG_o \cong \dfrac{r_m (R_L + r_e + r_c - r_m)}{r_c (R_L + r_e + r_c - r_m) + r_e r_m}$ $PG_o \cong \dfrac{4 R_L R_g r_m^2}{(R_g+r_e+r_b)[(R_L+r_e+r_c-r_m) r_c+r_e r_m]-r_b r_m (R_L+r_e+r_c-r_m)^2}$	**GB to GE** Input resistance is higher than for single GB stage, but negative R_o indicates instability for point-contact units. For junction units, R_i is about 1,000 ohms with fair gain.
$VG_o \cong \dfrac{-r_m^2 R_L}{(R_L + r_c)[(R_g + r_b + r_e)(r_c - r_m) - r_e r_m]}$ $CG_o \cong \dfrac{r_m^2}{(r_c - r_m)(R_L + r_c) - r_b r_m}$ $PG_o \cong \dfrac{4 R_g R_L r_m^4}{\{(R_L + r_c)[(R_g + r_e + r_b)(r_c - r_m) - r_e r_m]\}^2}$	**GE to GB** Both R_i and R_o are positive for point-contact transistors. This configuration offers high voltage and power gains using junction units. Input resistance may be negative for point-contact units.
$VG_o \cong \dfrac{r_m^2 R_L}{(R_g+r_b+r_e)[(r_c-r_m)(R_L+r_e+r_c-r_m)-r_e r_m]+r_e r_m (R_L+r_e+r_c-r_m)}$ $CG_o \cong \dfrac{-r_m^2}{(r_c - r_m)(R_L + r_e + r_c - r_m) + r_e r_m}$ $PG_o \cong \dfrac{4 R_g R_L r_m^4}{\{(R_g+r_b+r_e)[(r_c-r_m)(R_L+r_e+r_c-r_m)-r_e r_m]+(R_L+r_e+r_c-r_m) r_e r_m\}^2}$	**GE to GE** Best arrangement. Both R_i and R_o above 1,000 ohms. Offers high voltage, current and power gains for junction units. Requires stabilizing resistance for use with point-contact transistors.
$VG_o \cong \dfrac{-r_c r_m R_L}{(R_g+r_e+r_b)[(2r_c-r_m)(R_L+r_e+r_c-r_m)-r_c(r_c-r_m)]+r_e r_m(R_L+r_e+r_c-r_m)}$ $CG_o \cong \dfrac{r_c r_m}{(2 r_c - r_m)(R_L + r_e + r_c - r_m) - r_c (r_c - r_m)}$ $PG_o = \dfrac{4 R_g R_L r_m^2 r_c^2}{\{(R_g + r_e + r_b)[(2 r_c - r_m)(R_L + r_e + r_c - r_m) - r_c (r_c - r_m)] + r_e r_m (R_L + r_e + r_c - r_m)\}^2}$	**GE to GC** Stable with point-contact transistors. Gains available are limited, but unconditional stability warrants use in many applications where gain requirements are not too severe.
$VG_o = \dfrac{-r_c r_m R_L}{(R_g + r_b + r_c)[(2 r_e + r_b + r_c - r_m)(R_L + r_e + r_c - r_m) + r_e r_m] - r_c (r_c - r_m)(R_L + r_e + r_c - r_m)}$ $CG_o \cong \dfrac{r_c r_m}{(2 r_e + r_b + r_c - r_m)(R_L + r_e + r_c - r_m) + r_e r_m}$ $PG_o = \dfrac{4 R_g R_L r_c^2 r_m^2}{\{(R_g + r_b + r_c)[(2 R_e + r_b + r_c - r_m)(R_L + r_e + r_c - r_m) + r_e r_m] - r_c (r_c - r_m)(R_L + r_e + r_c - r_m)\}^2}$	**GC to GE** Third best arrangement. Very high input impedance offers advantages when used with crystal microphones, pickups and other high-impedance devices. Good voltage and power gains available.

Uncompensated

Compensated



Oscillograms illustrate improvement in response to square-wave inputs at 60, 180, 240 and 300-cps repetition

Negative Inductance Cuts

Magnetic-amplifier lag due to inductance of control winding is completely eliminated by introducing electronically-produced negative inductance in control circuit to balance control-winding inductance. Added tube may be replaced by transistor

By GEORGE M. ETTINGER*

London, England

BANDWIDTH LIMITATION, or slow response, of magnetic amplifiers has two causes: the time constant of the control circuits, and the relatively low excitation frequencies dictated by eddy-current effects in the magnetic cores. In magnetic amplifiers for servomechanisms and audio-frequency systems, the effect of control-circuit time constant usually predominates.

Several methods have been developed[1, 2, 3] for reducing magnetic-amplifier time constant. The circuit here described employs a negative-inductance arrangement by which the effect of control-circuit inductance may be reduced to any desired extent, or eliminated entirely. This method of compensation causes substantially no loss of magnetic-amplifier sensitivity.

Principle of Operation

An uncompensated magnetic-amplifier circuit is shown in Fig. 1A. Given a control-circuit inductance L_c henrys, and a control-circuit resistance R_c ohms, the time constant is L_c/R_c seconds and the pulse rise time is 2.3 L_c/R_c. Figure 1B shows the same circuit with the addition of a negative inductance of magnitude $-L_c$ henrys. The control-circuit time constant is now $(L_c - L_c)/R_c$ seconds, or zero. The bandwidth of the compensated magnetic amplifier is limited only by the excitation frequency.

Figure 2 shows a circuit constructed to test the negative-inductance compensation method. Square voltage pulses at various repetition rates are injected into the control circuit of a magnetic amplifier through a low resistance. The current pulses are displayed on an oscilloscope. A switch is provided to make the negative inductance inoperative, so compensated and uncompensated response can be compared.

The results are shown in the oscillograms. The upper set of traces shows the uncompensated response; a pulse rise time of 13 milliseconds is found. The lower traces show the compensated response. The pulse rise time, in this case, is only 2 milliseconds. Comparison of the upper and lower pulse trains shows that there has been negligible loss of sensitivity.

The circuit of Fig. 2 was tested with sine-wave input from a high-impedance source. Curve *A* Fig. 3 shows the variation of voltage drop across the circuit when no compensation is provided. The voltage rises at the rate of 6 db per

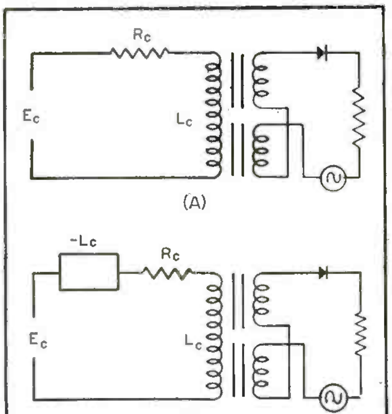
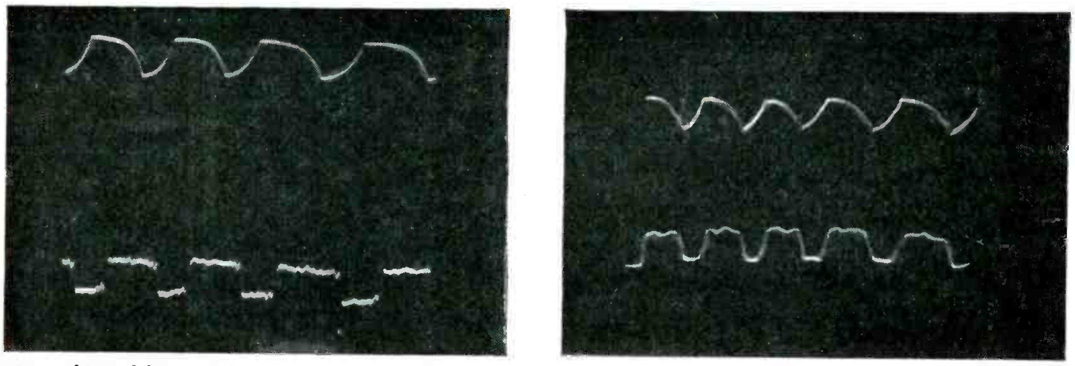


FIG. 1—Basic magnetic-amplifier circuits with and without compensation

* Work described in this article was done while author was with Standard Electronic Research Corp., New York, N. Y.



Uncompensated

Compensated

rates achieved by introduction of compensating negative inductance in control circuit of magnetic amplifier

Magnetic-Amplifier Lag

octave from a break point at 25 cps. Curve B shows performance with complete cancellation by means of a negative inductance. There is no increase of voltage drop up to 2 kc; above this frequency, the response of the experimental negative inductance falls off. Curve C shows the response of the circuit when the negative inductance is set to a magnitude approximately twice as great as that of the positive inductance L_c. In this case, the amplitude of the voltage is similar to that obtained without compensation, but the phase is reversed. Therefore the voltage across the negative inductance lags the current by almost ninety degrees.

Negative Inductance

Details of the negative-inductance circuit are given in Fig. 4. It comprises a 10-ohm series resistance across which is developed a voltage proportional to current i flowing in the circuit, a simple vacuum-tube amplifier and an iron-core mutual inductance. If the mutual conductance of the vacuum tube is G, and the mutual inductance has a magnitude M henrys, then the voltage across its secondary is $Md/dt\ (iRG)$ or $MGR\ di/dt$. The mutual inductance is connected to have a negative sign, so that the secondary voltage becomes $-MGR\text{-}di/dt$, which may be written $-L'di/dt$. The circuit behaves as a negative inductance of magnitude $-L'$ henrys.

The magnitude of the negative inductance depends on the mutual conductance of the tube. A simple method of varying the negative inductance is available by varying the bias on one of the electrodes of the tube. It is an important feature of the negative-inductance compensating circuit that it does not affect the d-c or very-low-frequency performance of a magnetic amplifier or other system in which it is connected. Thus, the d-c stability of a magnetic amplifier is not reduced in any way by the negative-inductance compensation.

The negative inductance described may be used to increase the bandwidth of any inductive device. Besides magnetic amplifiers, there may be considered systems employing electromechanical relays or electroacoustical transducers.

Transistors may ultimately replace the vacuum tube in the negative inductance circuit.

Thanks are due to F. Fua, Standard Electronic Research Corporation, for much helpful advice and criticism.

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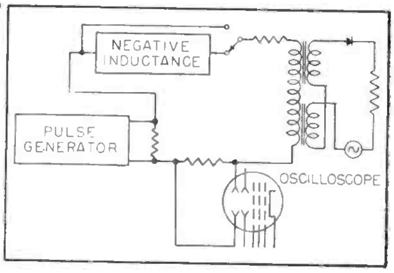

FIG. 2—Test circuit for negative-inductance compensation system

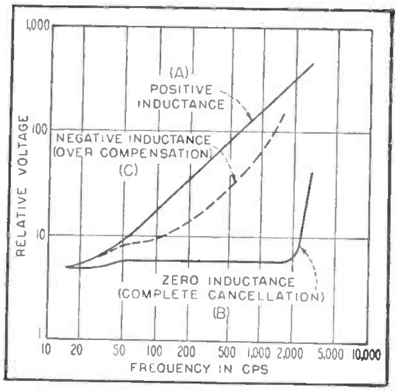

FIG. 3—Curves show performance of negative-inductance circuit with sine-wave input to magnetic amplifier

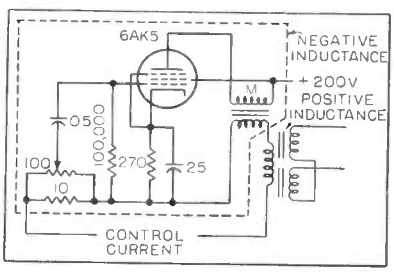

FIG. 4—Details of negative-inductance circuit; 100-ohm potentiometer varies value of negative inductance

Phantastron Computes

Phantastron divider computes width ratio of two pulses occurring simultaneously in separate channels. Developed for an experimental radar system, the computer can measure the ratio of any two quantities from which a voltage signal can be obtained

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IN AN EXPERIMENTAL radar system, it was necessary to determine the ratio of the widths of pulses occurring simultaneously in two channels. The pulses had a repetition rate of about 20 pps and could vary in width over a 10-to-1 range. Since the ratio of widths of one pulse pair bore no relation to the ratios of following or preceding pairs, the computer had to determine a pulse-width ratio and then clear itself in readiness for the succeeding pulse pair.

The pulse-width ratio computer developed uses a phantastron circuit as the divider element. It computes the ratio for two simultaneously appearing pulses whose durations range between 0.1 and 1 millisecond; its output is readily converted to digital form for recording and the pulses may have repetition rates up to 20 pps. Computation accuracy is about two to three percent.

Other Applications

The computer can easily be converted to more general use. Suggested uses include: rapid measurement of phase shift or delay in a circuit in which the signal frequency can vary over wide limits; setting two signals to a predetermined ratio of amplitude, frequency or phase; and measuring the ratio of any two quantities from which voltage signals, albeit transient ones, may be obtained.

Phantastron Divider

The principal element of the computer is a phantastron,[1] the basic circuit of which is shown in Fig. 1. The circuit can be described more completely as an externally gated Miller integrator. Operation of the phantastron is covered in detail in the cited reference. The duration, Δt, of the positive pulse of screen voltage is given by

$$\Delta t = R_1C_1\,(E'_1 - e_2 - e_1)/(E'_2 + e_2) \quad (1)$$

The value of e_2 corresponds approximately to the cutoff voltage of V_3, and is dependent to a large extent upon the voltage at which the suppressor of V_3 is clamped during the discharge of C. If the suppressor can be clamped at zero bias or, preferably, some slightly positive bias during the discharge of C, the value of e_2 will remain fairly constant for wide variations of plate voltage and E_1'.

The trailing edge of the positive screen pulse is not as abrupt as would be desired. However, if the portion of the pulse between two fixed voltage levels is selected by clipping circuits and amplified, a reasonably square pulse will result. The duration of this amplified portion of the pulse corresponds to the time that the screen voltage is greater than the lower clipping level. Since the suppressor voltage is clamped at a given bias and the control voltage is held constant by feedback, the plate voltage corresponding to a screen voltage equal to the lower clipping level is fixed in value. This value of plate voltage is e_1 in Eq. 1.

If the values of e_1 and e_2 are fixed, Δt in Eq. 1 will then be a function only of E_1' and E_2', and e_1 and e_2 can be introduced as bias voltages on the inputs to the phantastron divider circuit.

Assume that a positive voltage E_1 is applied in place of E_1', and is based on a bias voltage equal to $(e_1 + e_2)$. Also, assume another positive voltage E_2 replacing E_2' and based on a bias voltage equal to e_2. Then

$$E'_1 = E_1 + e_1 + e_2 \quad (2)$$

and

$$E'_2 = E_2 - e_2 \quad (3)$$

Equation 1 will then reduce to

$$\Delta t = R_1C_1\,(E_1/E_2) \quad (4)$$

Therefore, by proper d-c bias at the inputs, the duration of the phantastron's screen-voltage pulse can be made proportional to the ratio of two input voltages.

D-C Voltage Ratio Computer

As the first step in design, a computer circuit was built and checked on d-c voltage inputs. The circuit is given in Fig. 2. It consists of two input cathode followers V_1 and V_2, a phantastron divider circuit V_3, V_4 and V_5, a clipper and amplifier V_6, a suppressor enabling circuit V_7 and V_{8A} and an output circuit V_{8B} and V_9.

The input cathode followers serve the dual purpose of furnishing high-impedance inputs to the computer and of supplying proper bias levels. These bias values can be obtained by the choice of operating points for the constant-current triodes, V_{1B} and V_{2B}. For the circuit values shown in Fig. 2, it was found experimentally that the plates of V_{1B} and V_{2B} should rest at about +4.0 and −4.7 volts, respectively, when the input voltages to the

Pulse-Width Ratios

triode grids are equal to zero.

The phantastron divider circuit is essentially the same as shown in Fig. 1. A constant-current triode V_{4B} was added to increase the range of constant-gain operation of the cathode follower V_{4A}. The diode V_{3B} was added to provide a low-impedance path for recharging C at the end of the computing cycle.

Dual triode V_6 is a limiting clipper circuit for marking a fixed voltage level on the trailing edge of the phantastron screen-voltage pulse. When the pulse decreases on its trailing edge to a value where the first section of V_6 becomes unsaturated, the positive feedback across the tube causes the plate voltage of the second section to decrease rapidly. This negative transition triggers the control multivibrator V_7 and disables the suppressor of the phantastron. The point at which the trailing edge is marked is determined by the bias voltage across R_1.

Control bias for the suppressor of the phantastron is supplied by the bistable multivibrator V_7 through a cathode follower V_{8A}. The cycle of the computer is initiated by a negative trigger pulse into this multivibrator. Until this pulse is applied, the suppressor is held at about -20 volts and afterwards at about $+5$ volts. The positive bias on the phantastron suppressor is maintained until the disabling trigger pulse from V_6 is applied to the multivibrator. The suppressor voltage is thus a square-wave replica of the screen-voltage pulse and is used as the output pulse of the divider.

Conversion of the positive output pulse to digital form is accomplished by applying it to the suppressor of a 6AS6 gate tube V_9. Short pulses of fixed repetition rate are constantly applied to the control grid of this tube so the number of pulses appearing at the plate is a measure of the duration of the enabling pulse on the suppressor.

The pulses at the plate can be counted with a suitable counter, and the count recorded. By adjusting the value of R_2 and the repetition rate of the pulses on the control grid of V_9 any desired calibration count representing unity or other chosen ratio of the input voltages can be obtained. For the values of C, R_3 and R_2 shown in Fig. 2, the output pulse for equal input voltages can be varied from about 1.6 to 2.1 milliseconds by adjusting R_2.

Circuit Performance

The circuit shown in Fig. 2 was checked experimentally using various values of d-c voltages E_1 and E_2. The pulses applied at the control grid of V_9 had a repetition rate of about 200 kc and the output pulses at the plate were counted with a four-stage decade counter. Values from 10 to 180 volts were used for E_1 and from 25 to 250 volts for E_2. These voltages were measured to an accuracy of ± 0.5 percent. The results obtained using this circuit to calculate the ratios for many values of E_1 and E_2 were then analyzed to determine the accuracy of computation.

The value of the pulse width obtained when $E_1 = E_2 = 150$ volts was used as the calibration point. This value was called Δt_{cal}. The measured values of pulse widths Δt_{meas} obtained for the various ratios of E_1 and E_2 were then compared with an expected value, Δt_0 given by

$$\Delta t_0 = \Delta t_{cal} \, (E_1/E_2) \qquad (5)$$

The results showed that the standard deviation of the function

$$\xi = \Delta t_{meas}/\Delta t_0 \qquad (6)$$

from unity was about 0.017, or the probable error was about ± 0.011.

This means that approximately 68 percent of the pulse widths measured were within ± 1.7 percent of the value that would have been obtained if the relation between the input voltage ratio (E_1/E_2) and the pulse width were linear. This accuracy was adequate for the intended use of the computer. The operation of the circuit for values of E_1 and E_2 outside the ranges of 10 to 180 volts and 25 to 250 volts, respectively, was not satisfactory. The deviation from linearity outside these ranges became several percent.

The sampling rate of this computer is dependent upon the output pulse duration and the recharging time of C. Because of the low-impedance charging path through the diode V_{3B} the circuit is ready for another computing cycle within a fraction of a millisecond after the end of the output pulse.

The circuit shown in Fig. 2 is

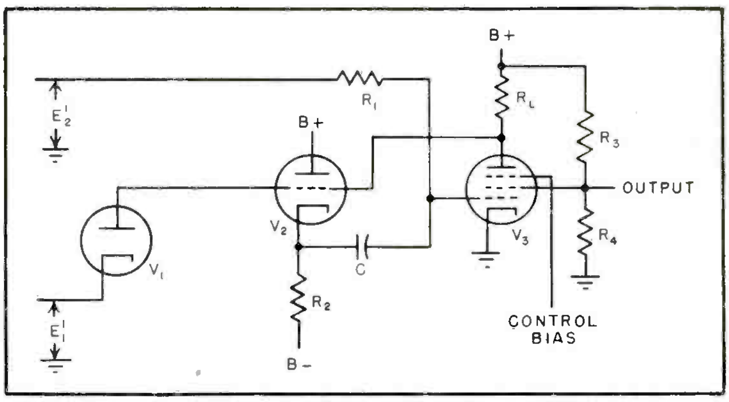

FIG. 1—Basic phantastron circuit

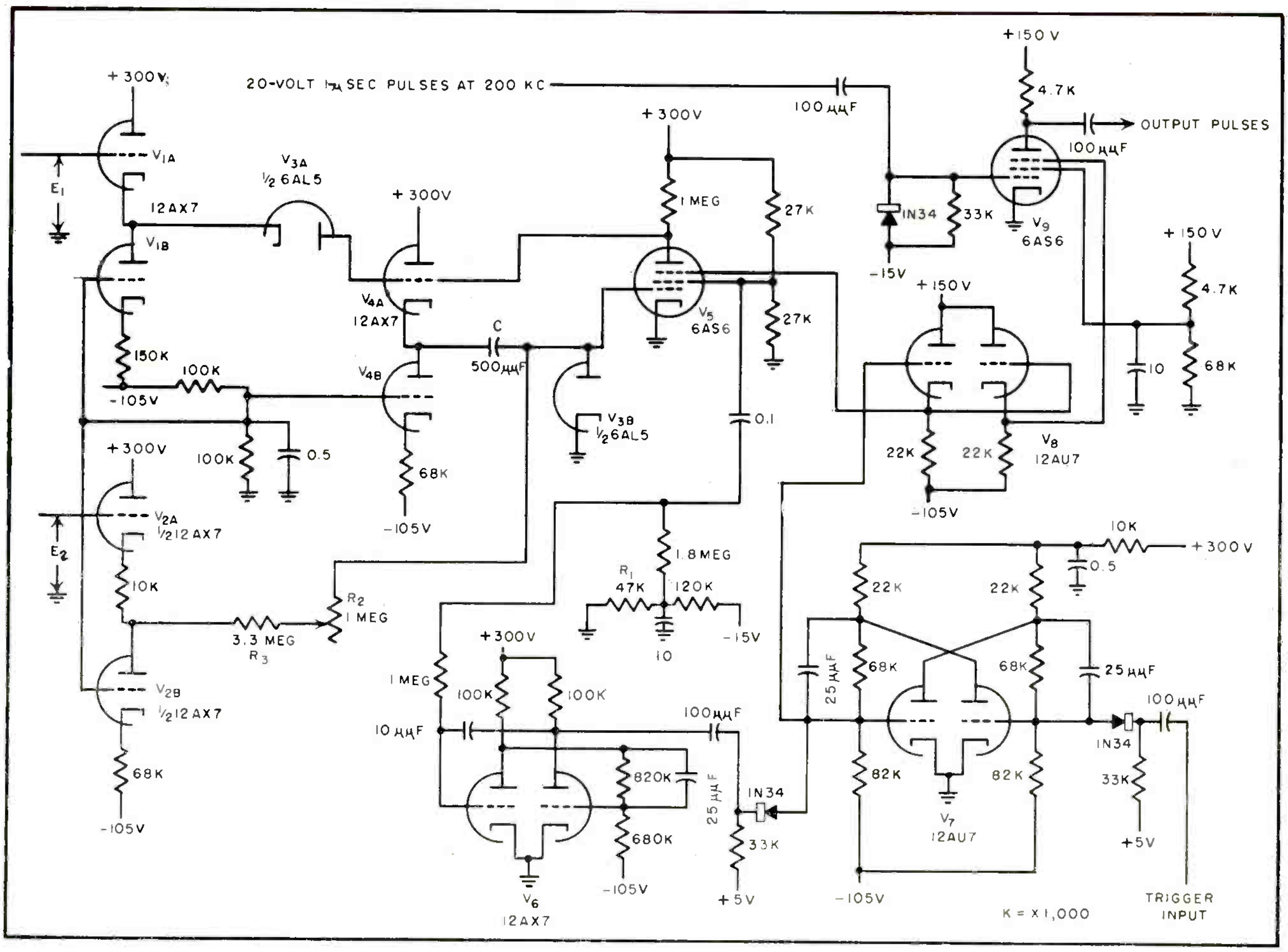

FIG. 2—Ratio computer for d-c voltages uses phantastron divider

primarily for use with direct voltages applied as E_1 and E_2. However, within certain limitations, the input voltages can vary during the computing cycle. Voltage E_1 can increase at any rate during the cycle, but must not decrease faster than the discharge of C. If it decreases too fast, C will be partially discharged through diode V_{3A}. Voltage E_2 cannot vary to any appreciable extent during the computing cycle without disturbing the accuracy of the computation. Between cycles, the only limitation is that E_1 must not vary faster than C can charge or discharge.

Pulse-Width Ratio Computer

The circuit of Fig. 2 was adapted for the determination of pulse-width ratios by preceding it with circuits for converting pulse widths into stored direct voltages. The conversion was accomplished by sawtooth generators followed by rectifiers and capacitors to store the peak values of the generated waves.

A schematic diagram of a complete pulse-width ratio computer is given in Fig. 3. With the component values given, input pulse 1 may have any duration between 0.045 and 0.9 millisecond; pulse 2 may vary from 0.1 to 1.0 millisecond. The two extremes in the output pulse count will be of the order of 16 and 3,200, their actual value being dependent upon the setting of the variable resistor in the phantastron circuit. Over this range of input-pulse durations, the computing accuracy of the circuit is of the order of ±2.5 percent.

Tubes V_1, V_{2A}, V_{3A} and V_{4A} form the bootstrap sawtooth generator for input pulse 1 and V_{2B}, V_{3B}, V_5 and V_{6A} serve the same purpose for pulse 2. The two generating circuits are identical; the negative input pulses open switch tubes V_{2A} and V_{2B} and positive waveforms are generated whose durations correspond to that of their respective input pulses. The slope of each wave is about 200 volts per millisecond and the calculated maximum deviation from linearity is about one percent for a 200-volt sawtooth wave. The waves are rectified by V_{4B} and V_{6B} and the peak values stored in the two 0.01-μf, 1-percent capacitors. Tubes V_{7A} and V_{7B} serve as discharging switches across these capacitors.

The switch-control multivibrator V_9 is triggered from the first leading edge of the two pulses through a diode mixing circuit and trigger tube V_{8A}. The output of the monostable multivibrator is a negative pulse to the switch tubes V_{7A} and V_{7B} opening the discharge circuit across the storage capacitors. The discharge circuits must be opened long enough for the stored voltages to be held for the duration of the computing cycle. In Fig. 3, the period of the multivibrator is about 35 milliseconds, which is sufficient

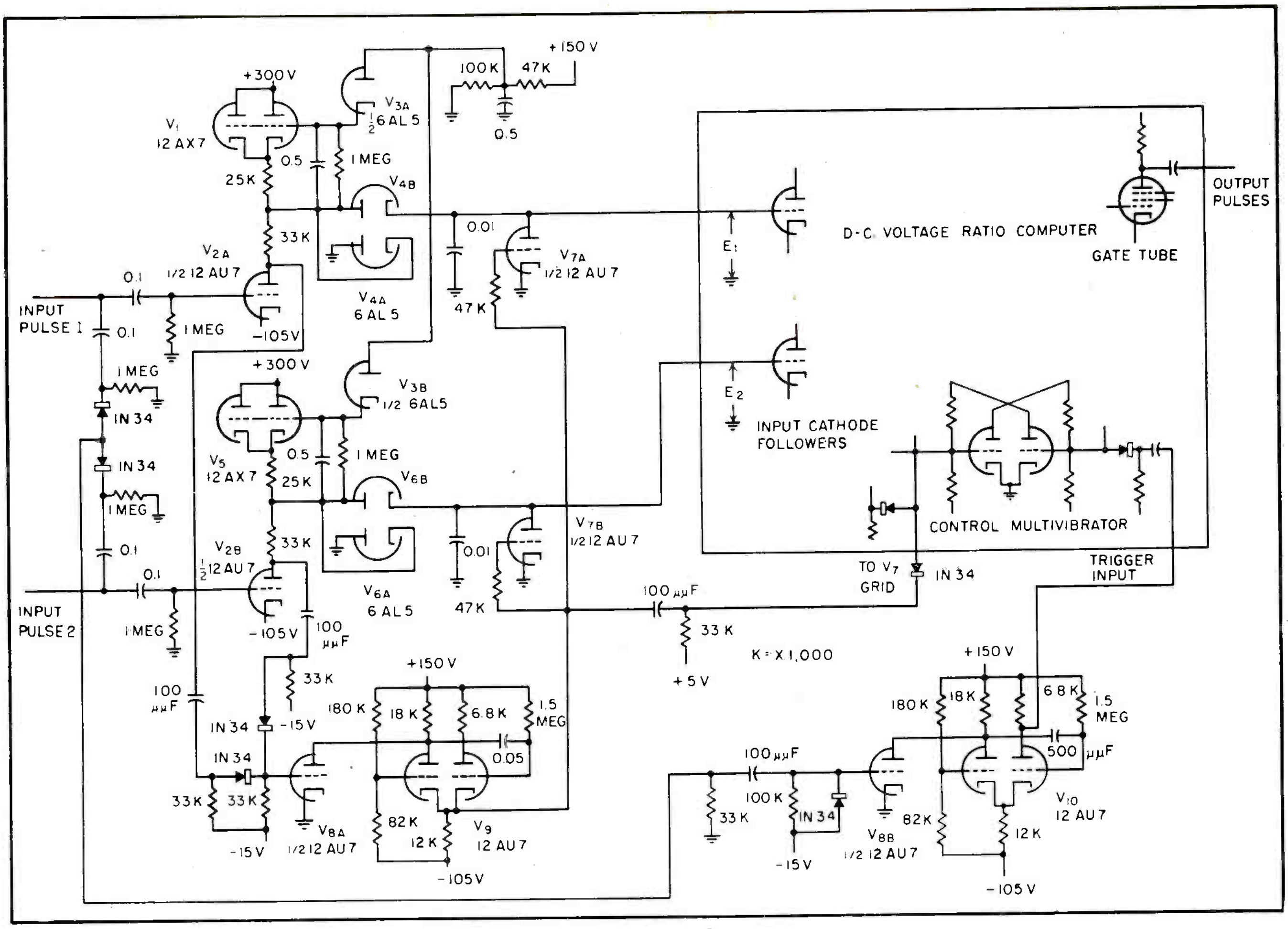

FIG. 3—Complete pulse-width ratio computer includes sawtooth generators to convert pulse widths to d-c voltages

for all expected ratios of input-pulse duration.

Increasing Accuracy

More accurate results were obtained when the start of the computing cycle of the phantastron divider was delayed slightly after storing the peak voltages of the sawtooth waves. The delay multivibrator V_{10} with a period of about 250 microseconds supplies the delayed trigger pulse for the phantastron circuit. It is triggered from the last trailing edge of the input pulses by a diode mixing circuit and trigger tube V_{8B}. The design of this mixing circuit makes it necessary that the pulses overlap.

An extra triggering pulse is supplied to the suppressor-control multivibrator of the direct voltage ratio computer from the output of V_9. This is a safety trigger pulse to prevent the computer from missing more than one sampling cycle.

If the screen pulse from the phantastron circuit fails to disable its suppressor through the control multivibrator, the output gate remains open and following input pulses are not correctly handled. This may occur if either or both input pulses are too narrow. However, the safety trigger pulse will disable the suppressor at the same time the storage capacitors are discharged. Pulses whose durations are outside the limits of computer capabilities may give erroneous answers, but the safety trigger will prevent interference with the computation for succeeding pulse pairs.

The sampling rate of this computer is determined by the period of the switch-control multivibrator V_9. With a period of about 35 milliseconds as in the circuit of Fig. 3, a sampling rate of 20 computations per second is easily obtained.

The computer will compute the ratio of two simultaneously appearing pulses the durations of which are in the order of 0.1 to 1 millisecond. The output is in a form that is readily converted to digital form for recording and the pulses may have a repetition rate up to 20 cps. Accuracy of computation is about two to three percent but by means of more complex circuits it could probably be increased by a significant factor.

Although designed for a special purpose, the computer may easily be adapted for more general use. Suggested uses include: rapid and direct measurement of phase shift or delay and setting two signals to a predetermined ratio of amplitude frequency or phase.

Acknowledgement is gratefully given to R. R. Hancox and H. L. Stout, under whose supervision this work was performed, for their many comments and criticisms.

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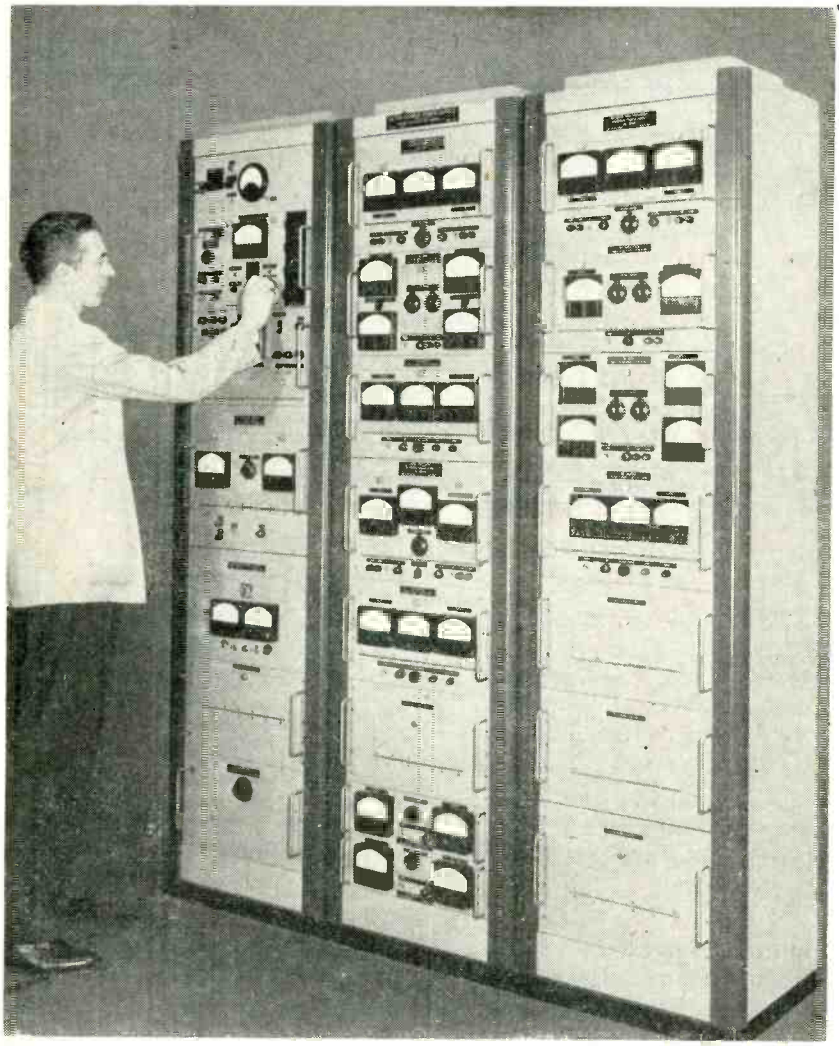
Stable Power Supplies



Ultrastable power supplies are mounted in three racks. Rack at left holds general-purpose supply, heater supply and stability monitor. Center rack contains supplies for superhigh-frequency and local oscillators, and right unit houses supplies for extremely-high-frequency klystrons used as frequency standards

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PRIMARY and secondary standards of electrical quantities at microwave frequencies require power sources of very high stability. The power-supply system described in this article has been designed and built for the microwave standards section of the National Bureau of Standards to provide highly stabilized voltages for the operation of superhigh-frequency, extremely-high-frequency and local-oscillator klystron tubes. Application and specifications of the various supplies in the system are given in Table I.

Except for the low-voltage heater supplies, all of the electronically regulated units use a degenerative-type regulating circuit[1] shown in block diagram, Fig. 1.

A bleeder sampling circuit samples a portion of the output voltage equal to the reference voltage. This bleeder is a linear network of special low-temperature-coefficient wire-wound resistors. In the variable-voltage supplies the voltage control is part of the sampling circuit and here again the wire used in the 10-turn potentiometer has a low temperature coefficient, on the order of 0.002 percent.

To keep the heat rise of the resistors a minimum, the current in the sampling circuit is only about 10 percent of the maximum allowed by the resistor power rating.

To provide stability and reliability, mercury-cell batteries are used as a reference source. These batteries, Mallory type-IR cells, are made into 100-volt packs. These packs show a voltage change over a 10-minute period of about 18 parts per million under a current drain of 500 microamperes. Under actual operating conditions the reference-battery drain is 1 microampere, resulting in a lower drift.

To keep temperature effects a minimum, all reference batteries are stored in a thermally insulated box at the bottom of the relay rack.

Comparison Circuits

The difference between the sample voltage E_s and the reference voltage, E_b is applied to the comparison amplifiers. Any change in the sample voltage will be amplified and fed to the control element, which will oppose the initial change.

The comparison circuit is divided into two branches, the d-c amplifier and the modulator comparison circuit. The circuits of these units are shown in Fig. 2.

A two-stage balanced d-c amplifier using 12AX7 twin triodes provides high gain and low drift. Plate current of a balanced amplifier is least affected by changes in filament voltage[2], particularly if the plate current is kept small. Potentiometer R_8 in the common cathode lead of V_1 is used to set the operating point to provide maximum regulation and minimum hum. To keep the plates of V_1 close to balance, the plate load resistors are 1-percent carbon-film resistors. The cathode of V_2 is maintained at grid potential by the voltage across cathode resistor R_7.

The modulator comparison circuit[3] consists of a 60-cycle chopper

for Microwave Standards

Driftless comparison circuits and battery reference sources cover a supply range from 6.3 to 3,000 volts for klystron frequency standards. Voltage stability is on the order of 20 parts in a million, comparable to battery operation

and a two-stage a-c amplifier. This circuit corrects for any drift in the balanced d-c amplifier due to heater-voltage variation and provides fast response to correct for line or load changes.

The inputs to the d-c and modulator comparison circuits are in parallel and any change in E_s is fed simultaneously to both circuits. This voltage difference is applied to filter R_3C_2 that isolates the input to the d-c amplifier from the chopper signal. Series resistor R_4 limits the current drawn from the reference batteries for large error voltages. The chopper converts any error voltage into a square wave, which is applied to the input of a-c amplifier V_3.

After two stages of amplification, the square-wave signal is fed back to the other pole on the chopper and rectified. This half-wave rectified pulse is changed to a d-c voltage by the two-stage filter R_5C_4 and R_6C_3. The amplified error voltage is 180 deg out of phase with the initial error voltage and is applied to the opposite grid of V_1. Thus, for any error voltage, the plates of V_3 will swing in opposite directions and the grids of V_2 will follow the same voltage swing.

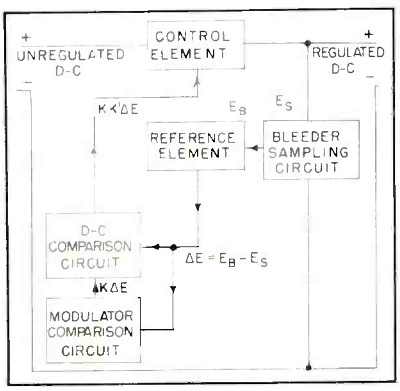
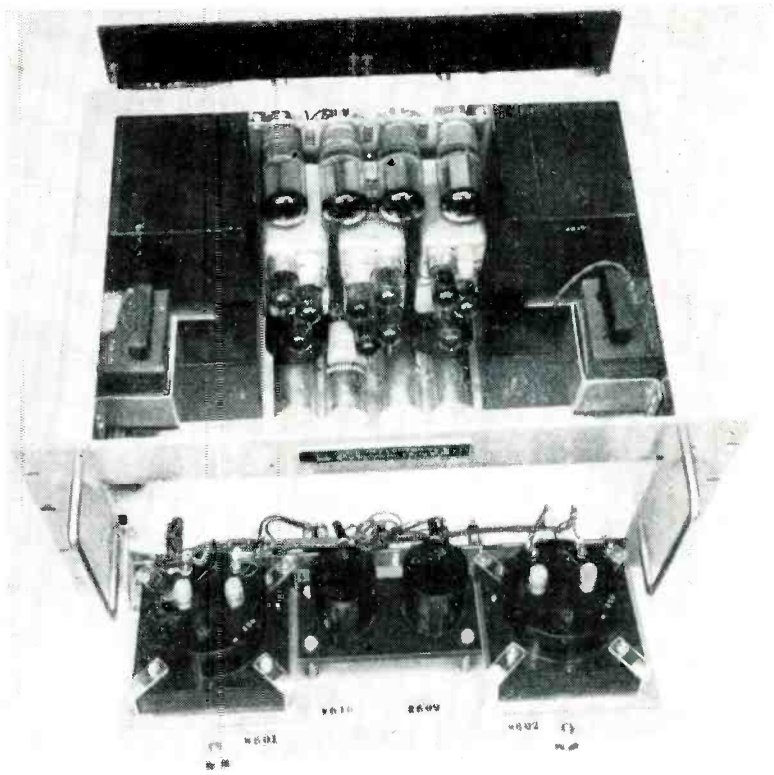


FIG. 1—Block diagram of basic regulating circuit. Modulator comparison circuit corrects for drift in d-c comparator



Components mounted on vertical U-shaped chassis are reached through front-panel doors. Vertical chassis makes tubes and wiring readily accessible

This swing in voltage is added in the common cathode resistor R_7 of V_2. Capacitor C_6 lowers the frequency response of the a-c amplifier to prevent instability.[4]

Filters

The time constant of the filter network R_5C_4, R_6C_3 must be low enough to permit rapid response to large error voltages. Normally this time constant is approximately ten times the time constant of R_4C_2. The d-c gain of the modulator comparison circuit is approximately 10, and it is by this factor that the drift is reduced. Overall gain of the combination is equal to the product of the separate gains, which is approximately 15,000.

The control element is essentially a variable impedance. In most of the supplies a triode-connected 5881 beam-power amplifier is used.

In those supplies having wide-range voltage variation, 400 to 1,500 volts and 1,500 to 3,500 volts, a system must be incorporated to hold the voltage across the control element within its operating range. This is accomplished by varying the unregulated d-c voltage as well as the output voltage. A variable transformer in the primary circuit of the plate transformer is ganged to the output-voltage control through an appropriate gear train, to maintain a constant voltage across the control element over the entire voltage range.

Figure 3 shows the schematic diagram of the regulated heater

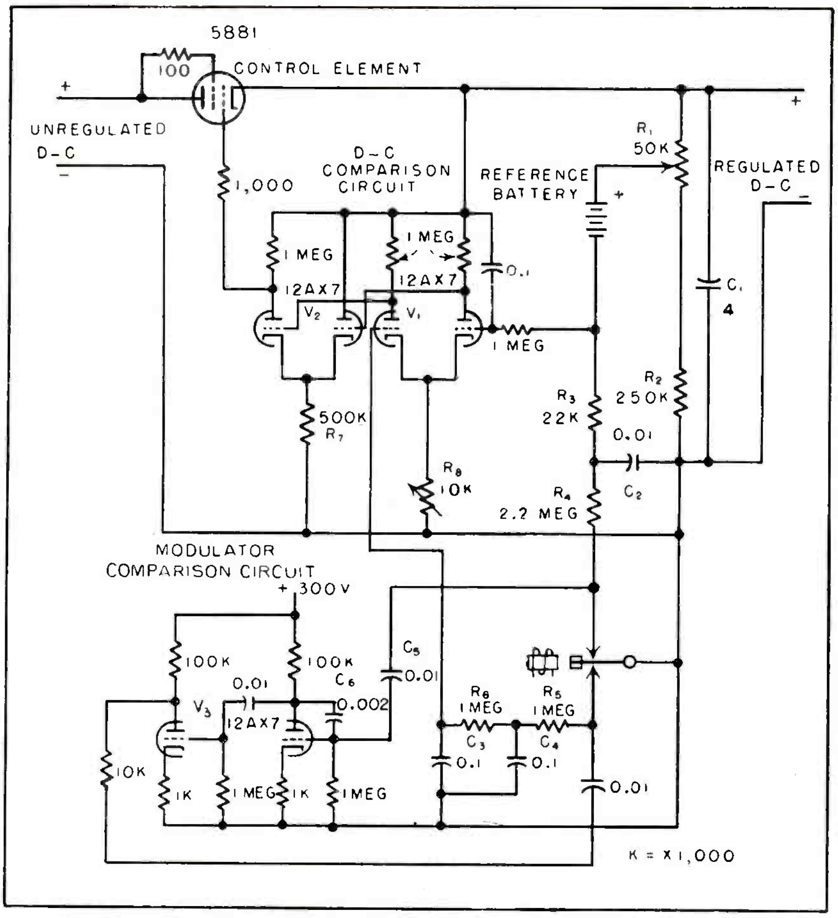
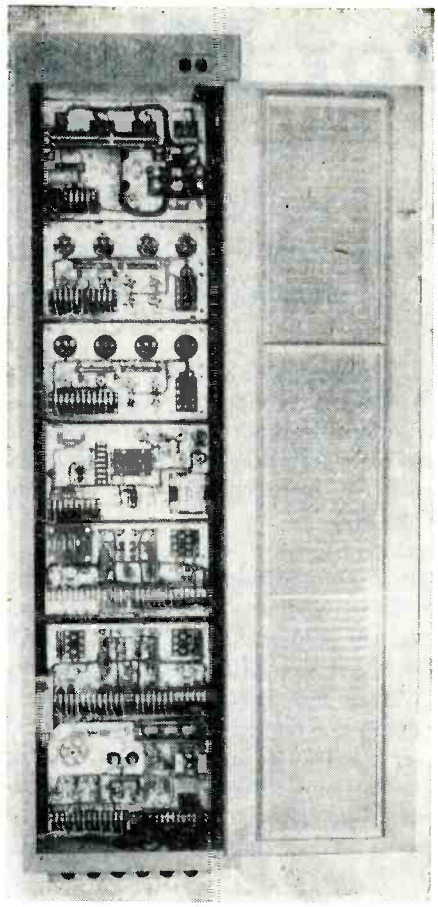


FIG. 2—Circuit of d-c amplifier and modulator comparison circuits. Number of paralleled control-element tubes used depends on current requirements



Wiring of power supplies is accessible through the back of the cabinets

Table I—Specifications for Ultrastable Power Supplies

Power Supply	Unit	D-C output voltage	Output current	Type	Maximum output impedance 0 to 50 kc	Maximum ripple and noise	Line-voltage* regulation	Static stability drift in 10 min
Superhigh-frequency klystron	beam	400 to 1,500 v	180 ma	electronic	2.5 ohms	2 mv	0.002%	20 mv
	reflector	0 to 1,100 v	0.05 ma	battery	....	......	......	......
	grid	dual 0–300 v	30 ma	electronic	0.5 ohm	0.5 mv	0.002%	5 mv
	heater	6.3 to 7.3 v	3 amps	electronic	0.03 ohm	10 mv	0.03%	1 mv
Extremely-high-frequency klystron	beam	1,500 to 3,500 v	100 ma	electronic	10 ohms	3 mv	0.005%	30 mv
	reflector	dual 0 to 400 v	10 ma	electronic	0.5 ohm	0.5 mv	0.005%	10 mv
	grid	dual 0 to 400 v	10 ma	electronic	0.5 ohm	0.5 mv	0.005%	10 mv
	heater	6.3 to 7.3 v	3 amps	electronic	0.03 ohm	10 mv	0.03%	1 mv
Local-oscillator klystron	beam	200 to 400 v	120 ma	electronic	0.5 ohm	0.5 mv	0.002%	5 mv
	reflector	0 to 800 v	0.05 ma	battery	....	......	......	......
	heater	6.3 to 7.3 v	3 amps	electronic	0.03 ohm	10 mv	0.03%	1 mv
General purpose	....	300 v	500 ma	electronic	0.5 ohm	0.5 mv	0.002%	5 mv

* Maximum drift that will occur during line-voltage changes from 110 to 120 volts.

supply using a saturable reactor as a control element. The reactance of the reactor depends upon the magnitude of d-c current through the control winding in the plate circuit of the 6AS7 triode. The plate current of this tube is controlled by a d-c amplifier similar to those used in the high-voltage supplies. This d-c amplifier monitors the output of the heater supply through a reference battery. Any tendency of the heater voltage to change will be counteracted by the saturable reactor.

If the output of the heater supply tends to decrease due to an increased load, then through the reference battery, this change appears as a negative voltage on the grid of the first d-c amplifier. The action of the amplifier will make the grid of the 6AS7 triode go positive and increase plate current. Since the d-c control winding of the reactor is in the plate circuit of the 6AS7, this increase in current will decrease the reactance of the saturable reactor.

The reactor is placed in the primary circuit of the heater supply, controlling the voltage applied to the low-voltage transformer. Hence, when the reactance of the reactor is decreased, a higher voltage is applied to compensate for the initial decrease of the low-voltage output.

A self-saturating rectifier prevents the a-c current through the reactor from reversing and opposing the flux set up by the d-c current in the control winding. This feature permits operation of the reactor over a wider range of control.

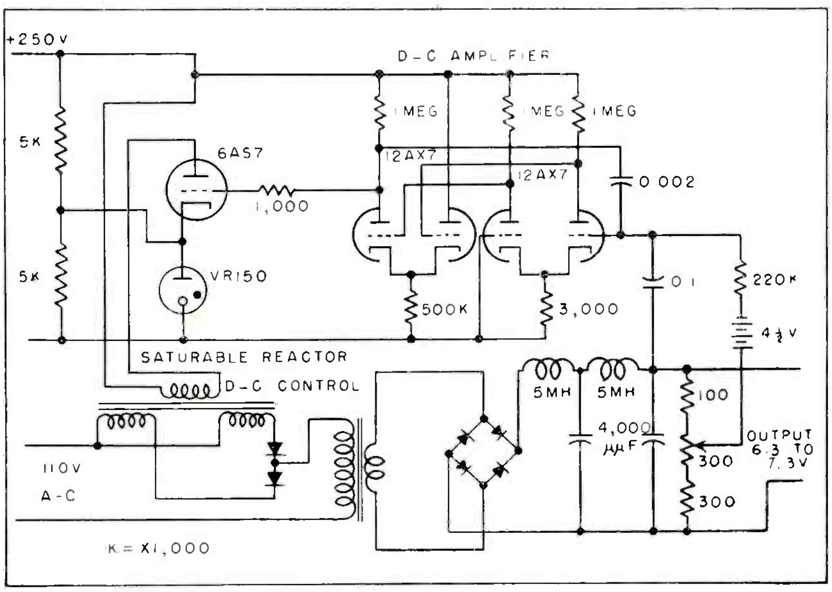


FIG. 3—Circuit of heater power supply using saturable reactor as control element

Drift Measurements

A null-balance method of measuring the drift voltage is incorporated in the system for monitoring any of the supplies. Figure 4 shows a block diagram of this setup.

The output of the power supply under test is compared with a bank of reference batteries through a resistive dividing network. The resistance of the balance network can be varied so that a 10-turn fine-balance control has a 100-millivolt-per-turn sensitivity for any applied voltage up to 1,500 volts. The difference or drift voltage is measured by an electronic zero-center millivoltmeter with a sensitivity of 5-millivolts per scale division.

The 1-megohm input impedance of the meter circuit has a very small loading effect on the batteries under large-unbalance condition. The 100-volt battery packs have an internal resistance of approximately 1,000 ohms. If the battery potential is 50 millivolts above the potential of the power supply under test, a 1-megohm resistance will cause a current of 50×10^{-9} ampere to flow from the battery.

For one 100-volt battery the drop in its terminal voltage will be $E_b = R_i \times i_b = 1{,}000 \times 50 \times 10^{-9} =$ 50 microvolts. This change in battery voltage is 1,000 times smaller than the initial change to be measured, and results in negligible error when measuring the difference voltage.

For long-time-stability measurements, a continuous recording system is used. The difference voltage is fed to a d-c converter that changes the small d-c difference voltage to a 60-cycle sine wave. The phase and amplitude of the wave depend on the polarity and magnitude of the d-c voltage. This sine wave is applied to a phase detector that provides a balanced d-c voltage of sufficient amplitude to drive a zero-center recording milliammeter. By controlling the gain of the d-c converter, full-scale sensitivities of 0.25, 2.5, 25, 250 and 2,500 millivolts can be obtained on the recorder unit.

Construction

To simplify wiring and maintenance, all of the d-c and a-c amplifiers are constructed as plug-in units. An attempt has been made to standardize the amplifiers used in the various regulated supplies to permit interchangeability for rapid location of circuit failures. All chassis are U-shaped with components mounted in a vertical plane. All circuits and output voltages are available at the rear of each rack. Tubes and plug-in units are accessible through front-panel doors.

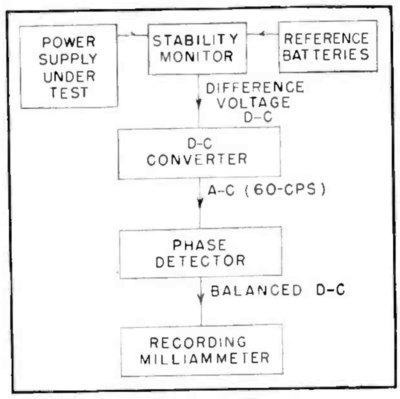


FIG. 4—Drift-measuring system uses a null-balance arrangement to monitor power supply voltage change

The extreme stability and regulation obtainable from this power-supply system can be seen from the data in Table I. In most cases the static stability figures indicated are conservative. For instance, the average drift after a one-hour warmup for the general-purpose supply is less than 1 millivolt per hour over an 8-hour period. Under full-load conditions these power supplies have the stability of a battery under a microampere load.

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Salinity Meter for

Conductivity-measuring device uses r-f signal to determine salt content of ocean water without immersion of electrodes. Problems of polarization and electrode fouling are eliminated. Precision is ±0.04 over range of 5 to 35 parts per thousand

PRECISE measurement of the salinity of ocean water is necessary for computations of refraction gradients and sound velocities in sonar operations, in determinations of dynamic heights for ocean current predictions, and as an aid in biological, chemical and geological studies.

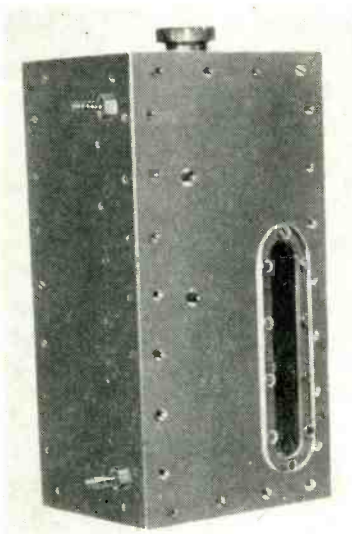
The term salinity, as generally used, denotes the number of grams of dissolved solids per kilogram of sea water.[1] The average salinity of ocean water is approximately 35 parts per thousand, but may vary from 33.5 to 37 parts per thousand.[2] In lagoons and estuaries, value ranging from 1 to 100 parts per thousand can sometimes be found.

Chemical analysis for halides[3] is the procedure commonly used for making highly accurate salinity determinations. This method, however, is slow, expensive and inadequate for many purposes.

At constant temperatures the conductivity of ocean water varies rapidly with salinity and can be used to accurately indicate salinity. Instruments[4,5] for measuring conductivity have been built, but since they operated at audio frequencies it was necessary to have the electrodes in direct contact with the water sample. Fouling and polarization difficulties have prevented these instruments from attaining widespread use.

R-F Conductivity

The conductivity of ocean water has been accurately determined at 1,000 cycles[6] and it is believed that these values do not change with increasing frequency until frequencies in the neighborhood on the order of 100 mc are approached.[7]



Absorption cell has window on front of aluminum body for observing water-temperature thermometer in test chamber

The use of r-f current for conductivity measurements provides the advantage that the electrodes need not be placed in direct contact with the water,[8] thus eliminating corrosion and polarization problems.

General Design

Conductivity is measured in a glass tube of about 10 mm inside diameter and 120 mm long. A band of metal about 20 mm long is fused to the outside of the tube near each end to form electrodes. A 14-mc signal from a stabilized source is passed across the electrodes through the solution and then rectified with a crystal rectifier. The resulting d-c voltage provides an indication of the salinity of the sample.

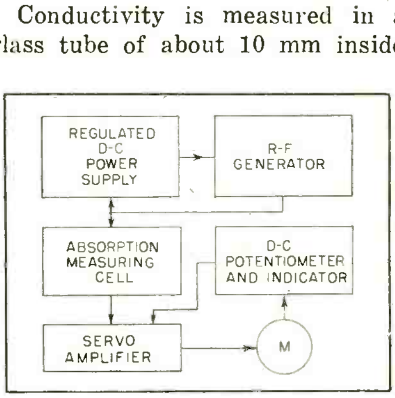


FIG. 1—Block diagram of the r-f salinity measuring instrument

The block diagram in Fig. 1 shows the units of the salinity instrument. The circuit is given in Fig. 2.

The r-f generator consists of a modified Pierce oscillator operating at 7.0 mc, followed by an amplifier doubling to 14.0 mc. Stabilization is obtained by rectifying a fraction of the r-f output with a pair of 1N34 germanium diodes. This control voltage is added to the normal reference voltage from the OD3 regulator tube in the power supply. The voltage is polarized so that a decrease in r-f output voltage will cause an increase in plate-supply voltage.

The reference voltage from the OD3 tube will undergo small changes with line voltage fluctuations, but these variations are partially compensated for since the measuring potentiometer is supplied with current from this same tube.

The d-c voltage resulting from rectification of the r-f current through the cell is measured with a d-c chopper-type servo-amplifier driving a potentiometer through a two-phase motor.

A precision ten-turn helical potentiometer is used with a 1,000-division dial. Since it is desired to read salinity with a precision of one part in 2,000; high and low poten-

Sonar Measurements

By KENNETH E. HARWELL and DONALD W. HOOD

Texas A. and M. Research Foundation and the Department of Oceanography College Station, Texas

tial ranges are provided, making 1,000 divisions available for each range.

Salinity-Measuring Cell

The salinity-measuring cell is shown in Fig. 3. Both active electrodes are operated above ground potential, but the incoming and outgoing streams of water must be grounded to prevent radiation and body-capacitance effects. Isolating sections were made of 5-mm o-d glass tubing about 420 mm long and folded to conserve space. Additional electrodes on the outer ends of the isolating tubes bypass the small amount of r-f current that comes through the isolating sections.

A rigid case of $\frac{3}{16}$-inch aluminum plate is used because even slight changes in case dimensions will alter electrode-to-ground capacitance and introduce relatively large errors into the salinity readings.

The r-f current through the sample tube is measured by a 1N34 germanium diode in a peak-reading circuit connected across a precision 50-ohm r-f resistor. For calibration, an impedance consisting of small high-quality capacitors may be switched into the measuring circuit.

High sensitivity requires a large percentage change in d-c output voltage for a given change of conductivity. If the total series impedance of the measuring circuit is large compared to the resistance of the sample tube, the change in sample conductivity will be a small percentage of the total impedance and sensitivity will be low. All impedances in the measuring circuit are made small compared to that of the measuring tube in order

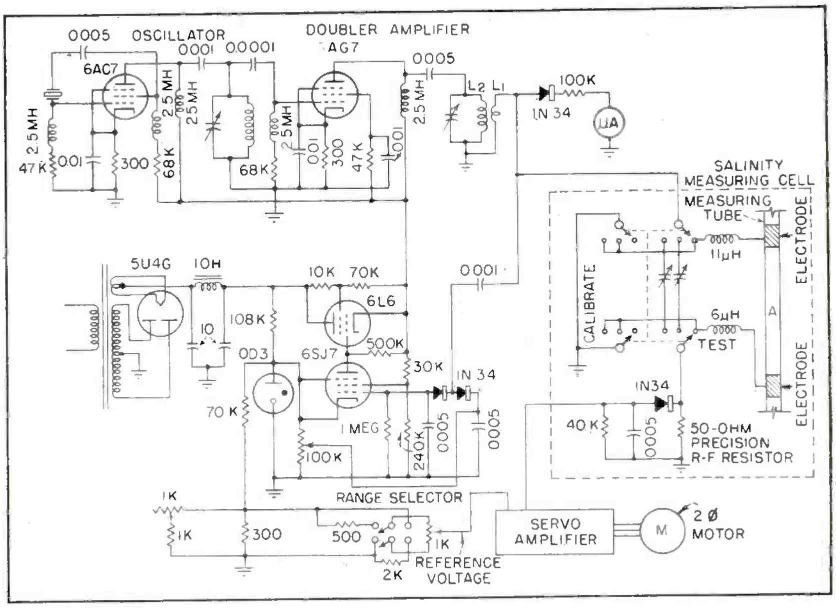


FIG. 2—Circuit of salinity meter has plate supply voltage controlled by output of oscillator section. Servo amplifier drives indicator potentiometer

to obtain the maximum sensitivity.

A relation between the resistance in the measuring tube and the d-c output voltage was derived. The relationship between the interelectrode capacitance and d-c output was also derived by circuit analysis. The analysis showed that the instrument is sensitive only to changes in conductivity and that the normal changes in dielectric constant of ocean water produce negligible changes in reading. Experimental data obtained thus far has confirmed theoretical analysis within the limits of experimental error.

Table I—Accuracy of Salinity Measurements

	Salinity in parts per thousand 15	35
Sensitivity in parts per scale division	0.020	0.017
Precision	±0.02	±0.04

Temperature Effects

Conductivity of sea water changes rapidly with temperature, approximately 2.1 per cent per degree centigrade, while salinity is practically unaffected. Because of this large coefficient it is necessary to measure the temperature of the sample with an accuracy comparable to that of the conductivity measurements. A change in temperature of 1.34 deg C causes a change in conductivity equivalent to a change of one part per thousand in salinity in the

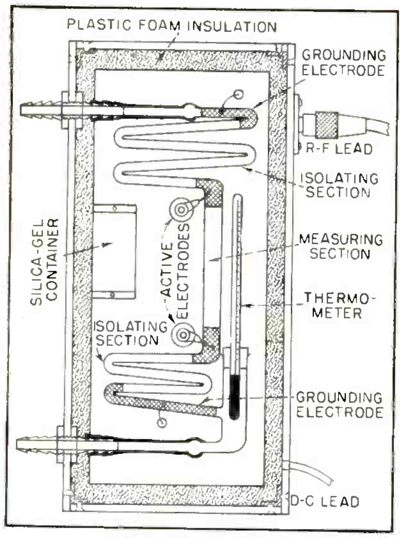


FIG. 3—Cross-section of absorption cell shows folded isolation sections and placement of electrodes

high salinity range. Since it is often desired to measure salinity with a precision of 0.01 to 0.05 parts per thousand, the temperature must be measured to approximately 0.01 deg C.

The temperature of the sample in the present instrument is measured with a mercury thermometer inside the cell case, visible through a narrow plastic window. To avoid temperature changes caused by heat absorption while the sample is in the cell, the cell case is lined with plastic foam insulation. A container of silica gel mounted in the case dehydrates the air to eliminate condensation on the glass tube between the electrodes.

The oscillator and r-f amplifier are tuned to optimum output and plate voltage is adjusted to a value well below maximum. The r-f output voltage, about 2 volts, is obtained by adjusting the coupling between the pickup coil and the amplifier tank coil.

Instrument Operation

A sample of water having a salinity near the maximum value to be measured is placed in the measuring tube and the potentiometer is adjusted to an arbitrary high scale reading by changing the potentiometer d-c voltage or by readjusting the r-f coupling coil. The standard impedance is then switched into the measuring circuit to replace the sample tube and this impedance is adjusted to give an arbitrary reading near the high end of the scale. The standard is not changed during any given series of runs, but is frequently switched into the circuit to check scale reading for drift or other errors. The potentiometer is adjusted to give the same reading each time the standard impedance is in the circuit, establishing a fixed relation between scale reading and conductivity.

Calibration

A series of solutions covering a range of salinities were used to calibrate the instrument over the salinity range from 5 to 38 parts per thousand and a temperature range from 10 to 38 deg C.

These calibration data were used to plot the curves shown in Fig. 4 and Fig. 5 and to obtain the data given in Table I.

Neither family of curves fit any simple equation very closely, thus a temperature compensator or other type of simple electrical calculator will not be useful where precision measurements are required.

This instrument is adequate for a large percentage of the salinity measurements ordinarily made, although its precision of $\pm$ 0.04 mil is somewhat less than that obtainable by chemical analysis.

The accuracy of the instrument seems to be limited by the stability of the r-f output voltage, accuracy of temperature measurements and instability of the germanium diodes. Because of these limitations it is doubtful that the accuracy can be very greatly increased.

Acknowledgement is due W. T. Matzen of the Electrical Engineering Department of Texas A and M College for his work on the circuit analysis, and to the U. S. Navy, Bureau of Ships for sponsorship of this project under Contract NObsr-57244.

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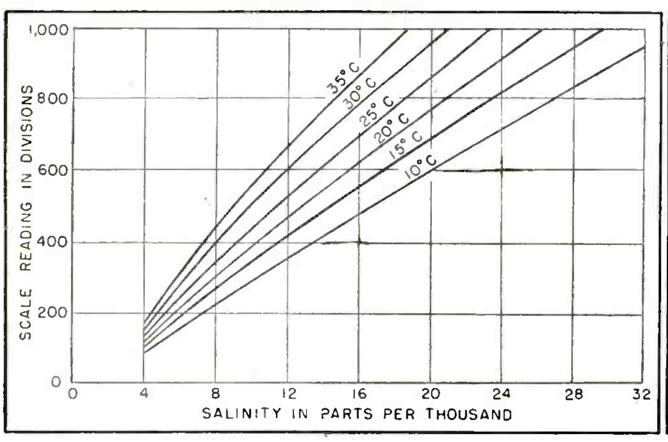

FIG. 4—Salinity calibration chart for low range of salinity meter

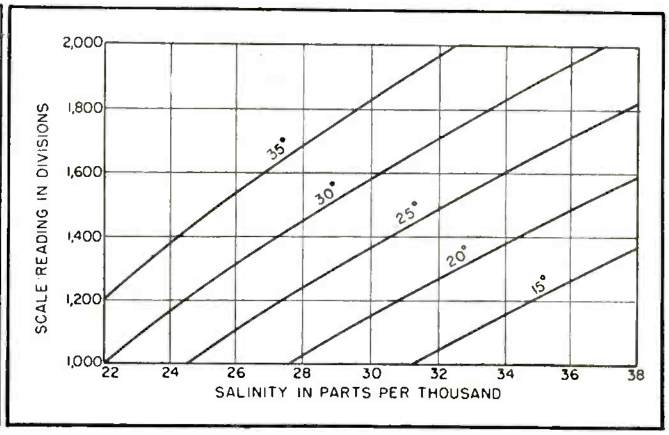

FIG. 5—High range calibration chart for salinity indicator

A-M System Measures Microwave Attenuation

Inherently simple audio-modulation substitution system measures up to 40-db attenuation from 200 to 40,000 mc. Output indicator detects 0.01-db changes. Electrical and mechanical design features minimize noise and instability

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AUDIO-MODULATION SUBSTITUTION measurement of microwave attenuation is useful over the frequency range from 200 to 40,000 mc and can measure up to 40 db. In the system to be described, several novel electrical and mechanical design features are incorporated to reduce the detrimental effects of noise and instability.

A simplified block diagram of the system is shown in Fig. 1. The audio-modulated klystron oscillator provides a stable source of r-f power and the barretter is a square-law detector. Any attenuation of the microwave carrier results in a linearly proportional change of the superimposed modulation.

The modulated r-f power develops an a-f voltage across the barretter. This voltage passes through the audio attenuator, is amplified and then measured by the output-level indicator. This level, once selected, is held constant by matching any change produced by the unknown microwave attenuator being tested with an equal and opposite change produced by the standard audio-substitution attenuator. The change in the microwave power level at the barretter is then equal to the change indicated by the calibrated audio attenuator.

The basic principles involved in this method are relatively simple. However, a careful analysis has disclosed many possible sources of error. This article summarizes the improvements that have been made in the measurement system in use at the present time.

Barretter

The particular use of the barretter in this system should not be confused with its use in the measurement of microwave power.

Ordinarily a barretter is used in conjunction with a bridge circuit to measure microwave power. In this system, however, it is used as a detector to recover modulation from a carrier.

The detecting ability of a barretter is based on the physical property that its resistance is a function of temperature. The static characteristics of a typical barretter are such that the rate of change of resistance with applied power is linear over a major portion of the operating range.

Generally, a quiescent operating

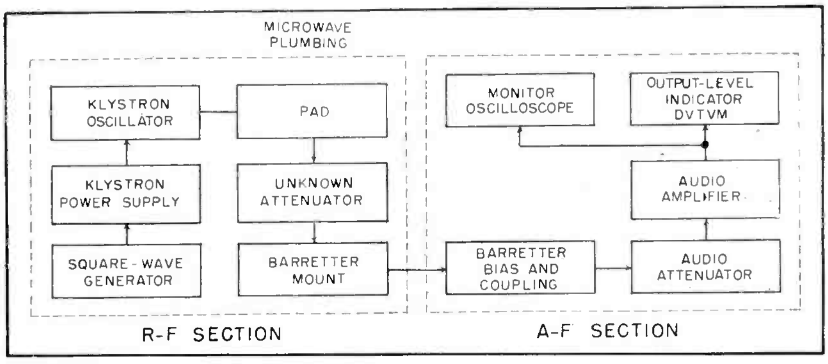

FIG. 1—Audio-modulation substitution system for microwave attenuation measurements. Barretter is used as a-m detector

point is chosen by biasing the barretter with d-c power. The sensitivity of the barretter, expressed in ohms per watt, is primarily a function of the slope of the resistance-power characteristic at this quiescent point modified by the type of biasing circuit used.

Application of modulated r-f power to the barretter causes temperature changes and corresponding resistance changes in accordance with the modulation. When this variable resistance is fed from a constant-current source, the voltage developed across it is directly proportional to the change in resistance ΔR. Since ΔR is directly proportional to the applied r-f power, the output voltage is directly proportional to the applied r-f power. Complications arising from the physical and electrical characteristics of the barretter cause negligible error when the applied r-f power is much less than the d-c bias power.

The circuit in use for barretter bias and coupling is the result of a number of compromises in attempting to obtain a voltage-transfer device that is linear and relatively noise-free for the maximum possible signal-to-noise ratio.

D-C Bias

Figure 2A is a diagram showing the bias and coupling arrangement. The a-c coupling circuit consisting of a 2,000-μf capacitor blocks d-c from the audio attenuator and provides a low impedance to the barretter output signal.

Constant bias current is obtained from three parallel 45-v B-batteries in series with a high-resistance potentiometer. This constant-current source has a maximum current change of less than 0.1 percent over the resistance range of the barretter.

A Thevenin's equivalent a-c circuit (Fig. 2B) shows that the effective lossless-generator voltage is the voltage developed across the barretter and the effective series-generator impedance is the internal resistance of the barretter.

When the barretter is properly biased with the 200-ohm audio attenuator coupled to the circuit, and only low microwave power is being detected, the voltage across the attenuator input e_A is almost half the value of the voltage developed across the barretter e_B.

However, when the microwave attenuation of the measured component is removed from the r-f portion of the system during a measurement, the power level at the barretter increases from some fraction of a microwatt to possibly a milliwatt. Such a change in r-f power results in an increase of about seven ohms in the internal impedance of the barretter which changes the voltage-transfer ratio. This change represents a maximum since the maximum power is always limited to less than 1 mw to avoid nonlinearity effects in the barretter. Curves showing the magnitude of this effect on the measurements are shown in Fig. 3. The actual measurement error Δ db as a function of range and maximum power level is about 0.02 to 0.03 db.

Attenuator

The drum-type audio-attenuator is electrostatically shielded and has four dials calibrated in decibels. It has a characteristic impedance of 200 ohms and a range of 0 to 110 db with increments of 10, 1.0, 0.1 and 0.01 db. The insertion loss at the zero setting is less than 0.01 db.

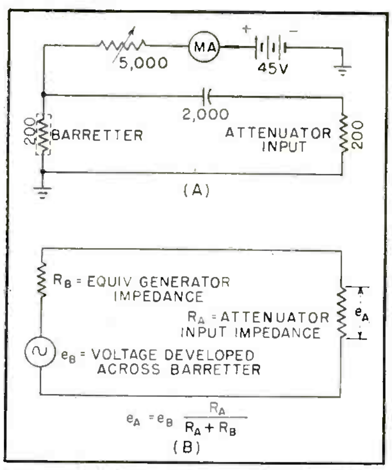

FIG. 2—Bias and coupling circuit (A) and Thevenin's equivalent circuit (B)

The design accuracy in db is ± 0.1 percent from d-c to 10 kc. Laboratory calibration showed the accuracy at d-c to be better than design accuracy.

In a measurement the actual microwave attenuation is half the calibrated increment of the audio attenuator. This factor is required because the r-f power ratio at the barretter is measured as a ratio of output voltages that are directly proportional to the applied power rather than to the square root of the applied power as in a linear circuit.

The attenuator is designed for operation with a 200-ohm resistive termination at both input and output terminals. Although the amplifier input impedance is not exactly a 200-ohm resistive load, it has been shown that adjustment of the attenuator will change the actual transmission loss of the attenuator by increments equal to the calibration steps of the attenuator regardless of the load impedance as long as a 10-db loss is maintained in the attenuator.

The use of small signal voltages implies the use of a high-gain amplifier. However, gain is limited by the input noise level of the amplifier. This includes noise developed in connecting the barretter to the amplifier, extraneous audio pickup and thermal noise.

By using the present barretter bias and coupling circuit, noise from this source is reduced considerably. Since the audio attenuator is a passive network and well shielded, it contributes no extraneous noise.

Amplifier

Direct control of input noise level is possible by use of narrow-band techniques. An amplifier tuned to a low audio frequency was selected so that a bandwidth of 10 cps could be utilized. This necessitated a low a-f modulation voltage, which in turn satisfied the required relationship for the barretter, namely, that the pulse length be much greater than the thermal time constant of the barretter.

The thermal time constant of the

barretter is approximately 320 μsec. The modulation frequency is 100 cps giving a pulse length of 5,000 μsec.

The amplifier has four resistance-coupled stages but the input to the first stage is coupled through a specially shielded, high-gain input transformer. A 60-cps parallel-T rejection filter is inserted between the second and third stages to discriminate against hum pickup. Another parallel-T filter provides degenerative feedback in the third stage at all frequencies except the tuned frequency. The amplifier is shielded electrostatically and mounted on springs to avoid microphonic disturbances. Its power supply is mounted on a separate chassis.

The electrical specifications of the amplifier are: gain 3,000,000, noise input 1.2×10^{-8} volt, peak frequency 100 cps, bandwidth 10 cps, input impedance 200 ohms.

With an amplifier input noise level of 1.2×10^{-8} volt, an r-f power level at the barretter of about 0.1 μw can be detected. This power level compensates for the 6-db voltage loss in the barretter coupling circuit and the 10-db padding in the attenuator and will still provide an input signal voltage almost 100 times the input noise level. Hence, up to 40 db can be measured and the power level at the barretter can still be kept below 1 mw.

Output-Level Indicator

The output-level indicator used in the system is a differential vacuum-tube voltmeter similar to a unit in use at the National Bureau of Standards. It has a maximum differential sensitivity of 0.2 db for full-scale deflection and it is possible to detect changes in output of less than 0.01 db. Such an indicator permits the evaluation of any noise, jitter or instability in the system and improves the readability for small changes in level.

The heart of the indicator is the differential tube, a dual triode having a common cathode resistance and equal plate load resistances. Connected between the plates of the two triodes is a microammeter requiring a current of 100 μa for full-scale deflection. A difference in conduction in the two triodes as controlled by the grid potentials results in a difference in voltage level at the plates.

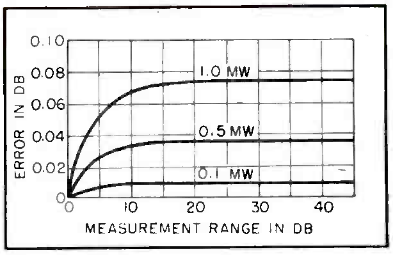

FIG. 3—Voltage transfer error in barretter coupling unit as a function of range and power level

The meter is balanced initially at the center of the dial with the level of one grid fixed by a d-c battery. The other grid is biased by the signal input after amplification and rectification.

Square-Wave Modulator

The 100-cps modulation frequency meets the barretter's thermal-time-constant requirements and also permits use of a narrow-bandwidth amplifier. However, in using such a highly selective amplifier, it was found that the frequency stability of a free-running multivibrator was inadequate.

This problem was overcome by using an overdriven amplifier excited from the 100-cps multivibrator of a primary frequency standard whose frequency stability is better than one part in ten million. The amplifier itself has a regulated power supply and a low-impedance cathode-follower output. The output is a square wave of 50-percent duty cycle with a rise time of less than 3 μsec. This rise time is desirable in modulating the klystron to avoid any frequency modulation of the signal source. The output amplitude is variable from 0 to 100 volts, which is sufficient to provide 100-percent amplitude modulation.

Minimizing Noise

To maintain a low noise level at the input of the amplifier, it has been necessary to operate the system in a shielded room. In those circuits where one side is intended to operate at ground potential, it is necessary that only one point in that side of the circuit is connected to an external or earth ground. In the case of coaxial cables where the outer sheath has the dual function of being an r-f shield and also part of the active circuit, the entire system interconnected by the cable is connected to external ground at only one point. Other pieces of equipment connected by the cable must be isolated from ground to avoid noise and hum pickup caused by ground loops.

The hum pickup from the stray magnetic fields of the various power supplies, oscilloscopes and amplifiers used in the system are eliminated by a trial and error procedure.

Another source of noise and jitter is the effect of waveguide slots in tuners and open secondary arms of directional couplers. Such openings in the waveguide plumbing are subject to erratic changes of air pressure due to klystron blowers or air conditioning ducts in the proximity of the system. When the air in the waveguide at these openings is subjected to such conditions, this turbulence is transmitted through the air inside the line to disturb the air surrounding the barretter cartridge. This upsets the rate of heat dissipation of the barretter at an audio rate, and an a-c noise voltage can be developed across the barretter.

If such waveguide components must be used in a system, waveguide openings should be sealed with tape to prevent any noise pickup from this source.

Crosschecks on this system have been checked to better than 0.1 db. These crosschecks were made with reference standards calibrated at the National Bureau of Standards and also by the 30-mc sweep-frequency heterodyne substitution measurement system.

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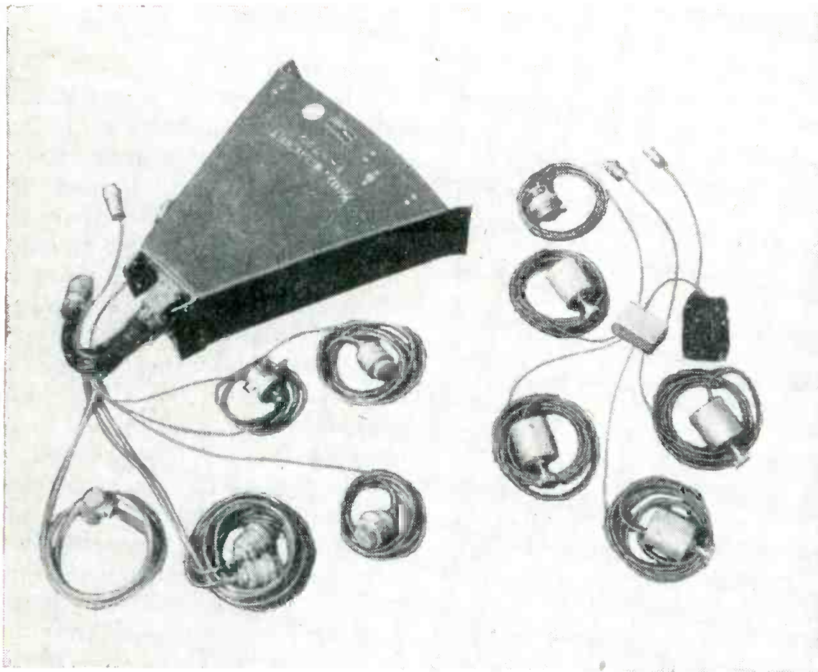
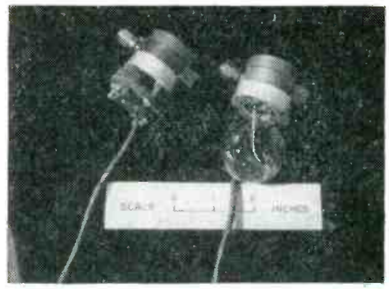
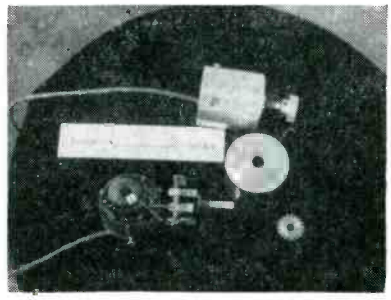


Comparison of tube (left) and transistor (right) telemetering systems having comparable capacity illustrates space saved by new design



Detail of resistance-controlled oscillator assembly using a junction transistor



Inductance-controlled transistor oscillator shown mounted on gage

Transistors in Telemetry

Transistorized oscillator circuits for f-m/f-m telemetering are mounted in same can with electromechanical transducer. Equipment is light, compact and efficient in operation. Telemeter equipment is shortlived hence long-term transistor instability presents no problem

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EXAMINATION of an f-m/f-m telemetering system shows that transistors can be used as information oscillators. It is possible to make the transducer and electronic circuit a unit complete in itself. The f-m/f-m telemetering system carries information by frequency modulation of a sine-wave oscillator. Full bandwidth for a particular channel is 15 percent of the frequency of oscillation. The transmitting end of the system consists of an audio oscillator for each information channel and an r-f transmitter which is modulated by the mixed audio frequencies.

Information of interest modulates the oscillator frequency of operation. Transducers commercially available provide a change of resistance, inductance, or capacitance with variation of the parameter to be measured.

In general, then, all of the advantages of transistors can be utilized in making oscillators for the f-m/f-m telemetering system. The variation of transistor parameters with temperature is the only disadvantage that affects the use of transistors in this application. Such variation produces a change in frequency with change of transistor temperature. This has been the primary problem in developing sat-

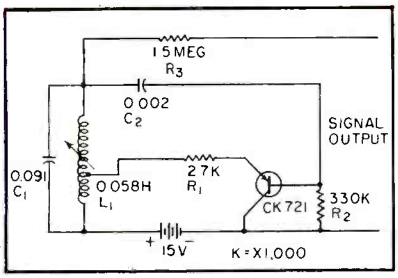

FIG. 1—Inductance-controlled transistor oscillator for use in telemetry

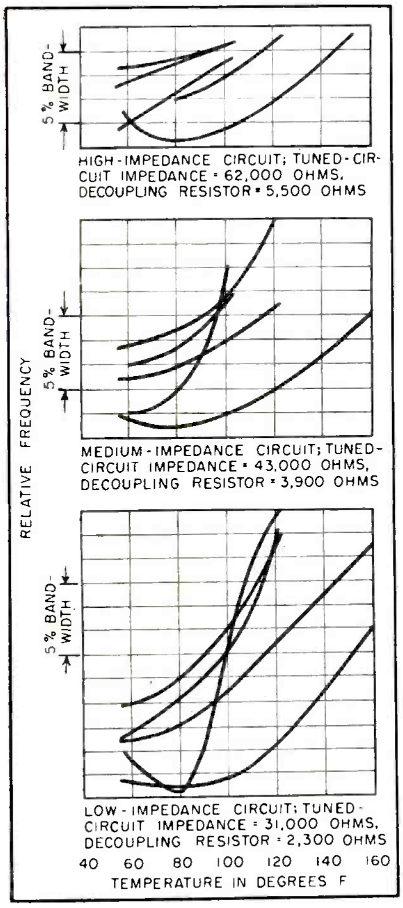

FIG. 2—Curves illustrate performance of inductance-controlled oscillator

isfactory transistor telemetering circuits.

Circuits Developed

Some of the more successful circuits using transistors with commercially available gages are now described in detail. Oscillators must be sensitive to variation in either resistance, reactance or voltage. Development of circuits to respond to these parameters was approached in the order of minimum expected difficulty. The first circuit to be developed was an oscillator that changes frequency with a changing reactance. The variable-inductance gage is made part of the tuned circuit. A number of different circuits work satisfactorily; however, the one having the most advantages is shown in Fig. 1.

This is essentially a Hartley oscillator with the tuned circuit between collector and base and with transistor driving power applied between base and emitter. Variable-inductance L_1 is a commercially available gage that responds to changes in pressure, mechanical motion or acceleration. The inductance change is large enough to provide a tuned-circuit resonant frequency change of 15 percent.

Frequency of operation is set by selecting the proper value of C_1. Resistor R_1 serves two purposes: (1) it decouples the low emitter-to-base impedance of the transistor so that it does not load the tuned circuit and (2) it regulates the feedback from the tuned circuit to the transistor. Capacitor C_2 blocks direct current from the base. The resistor R_2 is used in conjunction with the 15-volt battery as a constant-current supply to adjust the transistor operating point. The output is taken through decoupling resistor R_3, which is large enough in magnitude to permit use of resistance mixing with other channels. In this case the output leads of all the oscillators may tie directly to the grid resistor of the modulator tube in the transmitter.

Performance of these units is uniform so that they may be made and used without individual adjustment. Selection of transistors is necessary, however. The transistors are selected on a breadboard circuit using the amplitude of output as a quality indicator. No units were found which would give more than 10 volts across the tuned circuit. Of twenty units tested, none failed to oscillate but five gave low output voltages. Collector current drawn by the transistors averages 1 milliampere. Total power required by the circuit is 15 milliwatts.

Temperature Effects

The variation of oscillator frequency with transistor temperature is a major problem. Information to be telemetered causes a frequency shift in the oscillator; thus any random change due to temperature variation is false information. The object in development of transistor circuits has been to obtain less than ½-percent frequency drift over a temperature range of 60 to 140 F. In terms of the channel bandwidth ½-percent drift corresponds to 3-percent error introduced into the data. If 3 to 5-percent accuracy of the telemetered information can be tolerated, oscillator drift of 3 percent is acceptable.

Actually the situation is not as bad as just indicated. The useful life of the telemeter is generally so short that very little temperature change occurs while information is being sent. The frequency of the operation is known at the start of the data recording. Usually the initial conditions are also known so that a zero can be established. Data are accurate if these conditions are met because there is little time during the use of the telemeter for the transistor to heat up and cause a frequency drift.

In spite of the accuracy just described, frequency drift is of major concern. An indication of the stability is shown in Fig. 2. These data are taken using the inductance-controlled oscillator circuit of Fig. 1. The three sets of curves correspond to three different tuned-circuit impedances. Five transistors were checked in each of the circuits.

The curves indicate that the high-impedance tuned circuit has the greatest stability. The condition of greater stability is due to the fact that, with the higher-impedance tuned circuit, greater decoupling between the tuned circuit and transistor is possible. As these curves show, oscillation ceases at fairly low transistor temperatures, and it is necessary to compromise between oscillator stability and reliable transistor operation by increasing the coupling between tuned circuit and transistor.

Resistance Circuits

A variable resistance can be used to control frequency in several ways. Two methods which look promising for use with transistors are: (1) controlling reactance across an L-C tuned circuit by a series or shunt resistance associated with a small percentage of the reactance or (2) using resistance directly in a resistance-capacitance or phase-shift oscillator.

The first method is successful and works according to theoretical calculations. A resistance-capacitance transistor oscillator has not been tested at the time of this writing.

Experimental work has been done with the resistance associated with the capacitor in Figs. 3A and 3B. For a controlling variable resistance of 5,000 ohms, which is a reasonable value for gages of this type, Fig. 3B gives the highest Q and the best waveform. A high L/C ratio is used so that the circuit reactance is high and the effect of the resistance on the circuit Q is a minimum. In Fig. 3B the tuned-circuit Q varies from approximately 5 to 5.5 as the resistance gage varies from 0 to 5,000 ohms.

In order that the circuit in Fig. 3A work with equal success, the gage resistance would have to be about 20,000 ohms. The high resistance is necessary in order to raise the circuit Q high enough to maintain oscillations with a majority of the transistors. A further disadvantage is poor wave shape, which is due to the low Q of the first circuit. Figure 3B gives a very good wave shape throughout the range of the controlling resistor. Maximum harmonic distortion is 5 percent second and 2 percent third. Temperature stability should be the same order of magnitude as that of the variable-inductance oscillator already described.

Voltage Circuit

Developing a stable voltage-sensitive transistor oscillator is more involved than in the case of the previous oscillator types. The stability required can be approached only by holding the transistors at a fixed temperature. The circuit (Fig. 4) used is similar in appearance to a vacuum-tube multivibrator. This is a bistable circuit that is highly regenerative. Triggering is accomplished by decay of base-to-emitter current through inductance-resistance circuits. When this current drops to the collector voltage-cutoff point, the system flips to the opposite state. The output voltage is a square wave and requires filtering before mixing with other signals.

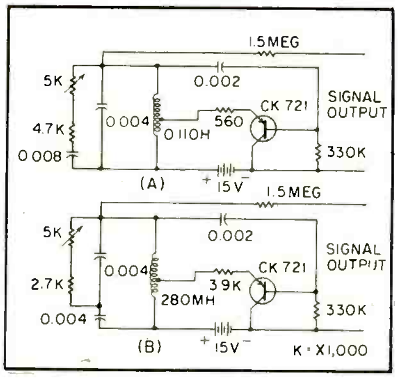

FIG. 3—Two typical resistance-controlled junction-transistor oscillators for telemetering service

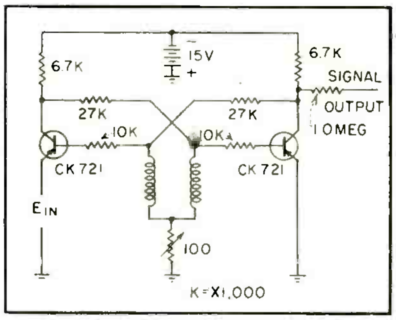

FIG. 4—Voltage-controlled oscillator operates on multivibrator principle

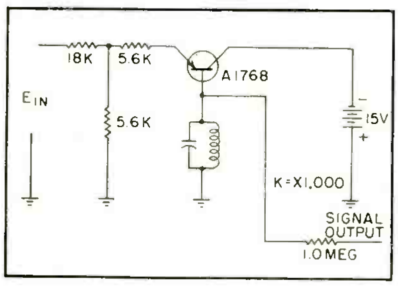

FIG. 5—Measurement of instantaneous voltage change is readily achieved using a point-contact transistor negative-resistance oscillator

The voltage sensitivity of this circuit is high, and the input impedance is low. Full bandwidth (df/f = 15 percent) is obtained with 0.1-volt input. An ideal device for use with this circuit is a thermocouple.

At the present state of development this circuit is impractical where good accuracy is required. By using temperature control of the transistors, stability of 5 percent of bandwidth could be obtained. One advantage of transistor multivibrators over vacuum-tube multivibrators is their frequency insensitivity to shock and vibration.

Successful voltage oscillators for measuring instantaneous changes in voltage where the measurement of interest is the magnitude of the change have been built, using point-contact transistors. These circuits give an indication of a switch closure, commutated voltages, or some sort of yes or no information. In the proper circuit the point-contact transistor has a negative-resistance effect in the base lead. When a parallel L-C tuned circuit is placed in the base lead, the circuit oscillates. The resistance in the emitter-to-base loop adjusts the transistor operating point on the negative-resistance curve. This type of circuit is shown in Fig. 5. The frequency of this oscillator changes with a change in operating point. The change is due to the variation in loading on the L-C circuit. Frequency of operation goes down as the resistance across the tuned circuit decreases.

The circuit is necessarily a low-Q circuit, and hence drift with temperature is quite large. Such drift does not cause difficulty, however, in the measurement of instantaneous voltage changes.

The big advantage of the transistor circuits is the compactness of packaging obtainable. Since transducers are fairly large and solid, they can be used as a mechanical support for the circuit-component package. In a typical case the transistor and associated circuit are wired without using terminals or mechanical support of the componets. This assembly is then potted against a circular disk having two feed-through terminals. These terminals are used for mounting the tuning capacitor which adjusts the operating frequency. The completely assembled unit is fastened directly to the gage. The unit is complete in itself. The cable takes power to the unit and brings the signal out.

This paper presents the results of one phase of research carried out at the Jet Propulsion Laboratory, California Institute of Technology, under Contract No. DA-04-495-Ord 18, sponsored by the Department of the Army, Ordnance Corps.

Magnetic Amplifier Uses Conventional Inductors

Reasonably high power gain, speed of response and power-handling ability are obtained with magnetic amplifiers made from readily available components. Power-supply, photoflash and television high-voltage transformers are used as saturable reactors

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MAGNETIC AMPLIFIERS having reasonable gain, speed of response and power-handling ability can be constructed from standard power transformers.

Power or photoflash transformers used as reactors in a parallel-connected self-saturating circuit have given power gains exceeding 2,000 per stage, outputs of over 50 watts and response times of 4 to 5 cycles. In addition to a pair of transformers, the complete magnetic-amplifier circuit requires only a pair of diodes, preferably of the semiconductor type, and possibly a pair of capacitors. Such a circuit offers an inexpensive and satisfactory method for controlling moderate powers—50 to 100 watts—with small control powers. The circuit can easily be driven by receiving-type tubes.

The self-saturating parallel-connected magnetic-amplifier circuit is shown in Fig. 1. The transformer T is chosen to match the output to the load. The other two transformers, shown as R, are the saturable reactors; they may be standard power-supply transformers having a 110-volt primary, high-voltage secondary and one or more filament windings, the latter being connected series aiding to form a single filament winding.

Considering first the circuit with the rectifiers replaced by short circuits, the primaries are connected in parallel. A lead of one of the high-voltage windings is connected to a lead of the other and a high-impedance a-c voltmeter connected across the remaining high-voltage terminals. A low voltage is then applied to the power-source terminals and the voltage read at the high-voltage terminals. This voltage should be the difference rather than the sum of the secondary voltages. If it is not, the leads on either a primary or a secondary must be interchanged. The voltage across the control terminals CC with full input voltage applied should then be small, no more than ten volts with 1,800-volt secondaries. The filament loop is then closed, connection being made such that no current flows in the closed loop. Finally the rectifiers are added.

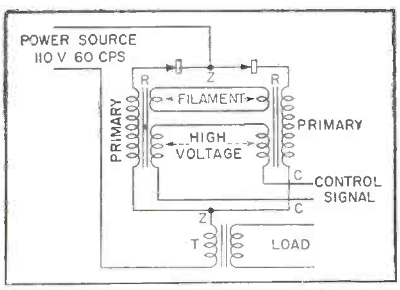


FIG. 1—Self-saturating parallel-connected magnetic amplifier

Circuit Operation

When there is no control current flowing in the control windings, the cores are saturated by the direct current in the primary loop. As a result of this saturation, there is effectively a low impedance between terminals ZZ and the voltage at the primary of T is high—typically about 70 percent of the voltage at the power source.

If direct current is now made to flow in the control loop in a direction such as to oppose the saturating effect of the direct current in the primary loop, the cores will become less highly saturated and the effective impedance ZZ will increase, reducing the voltage at T. The power gain may be over 2,000 with typical components. The control-loop current can be increased until it exactly cancels the effect of the primary-loop d-c, at which time the impedance ZZ becomes the parallel combination of the primary inductances and the voltage at T is a minimum. Further increases in control current tend to saturate the cores in the opposite direction, increasing the output voltage again. Such a minimum in the output voltage versus control current is illustrated in Fig. 2A.

If the control current is applied in a direction to aid the primary direct current in further saturating the cores, relatively little increase in output voltage occurs. This indicates that with no control current the cores are already near full saturation. This effect may, however, be modified.

Operating Point

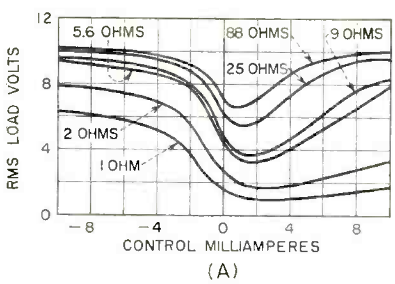
A minimum of output power typically occurs at some control current and the circuit can be operated with power gain on the sloping portions of the curve on either side of the minimum. Usually the operating region giving highest gain is to the left of the minimum. Cases may occur in which the other side of the valley is useful or use may be made of the fact that some of these curves exhibit several maxima and minima, such as the curve in Fig. 2C, for 4 μf across each of the primaries of R (Fig. 1).

If the rectifiers were not in the primary circuit, the primary voltages and hence the h-v secondary voltages would be equal on both transformers and there would be no a-c voltage at control terminals CC. When the rectifiers are inserted, the primaries are no longer in parallel and the h-v secondary voltages do not quite cancel. In a typical case of a transformer having 600-volt secondaries, the a-c voltage across terminals CC may be sixty volts or more.

Filament Loop

When the filament loop is closed the voltages across both filament secondaries must be equal and the h-v secondary voltages are equalized as well as the primary voltages. The first of these effects reduces the a-c voltage at CC. The sixty-volt figure mentioned above may thus be reduced to twenty or thirty volts. The second effect equalizes the primary voltages, and hence reduces the inverse voltage applied to the rectifiers. Both these benefits could also have been obtained by placing a sufficiently large capacitor across CC but only at the expense of an increase in response time of the amplifier as well as the cost of an extra component. The

	Manufacturer	Model	Load Impedance (Ohms)	Control Resistance (Ohms)	Driver Impedance (Ohms)	Primary Capacitance (μF)
A	Freed	F14142	1–88	6,000	10,000	1
B	Thordarson	T22R42	2	9,600	10,000	0–6
C	Stancor	P8151	2	8,000	10,000	0–7
D	Stancor	P8151	2	8,000	Infinite	0–7
E	Freed	F14142	2	6,000	10,000	0–3
F	Thordarson	T15R04	2	3,200	1,000	0–1.5
G	Thordarson	TV24R91	2	15,000	10,000	0–5



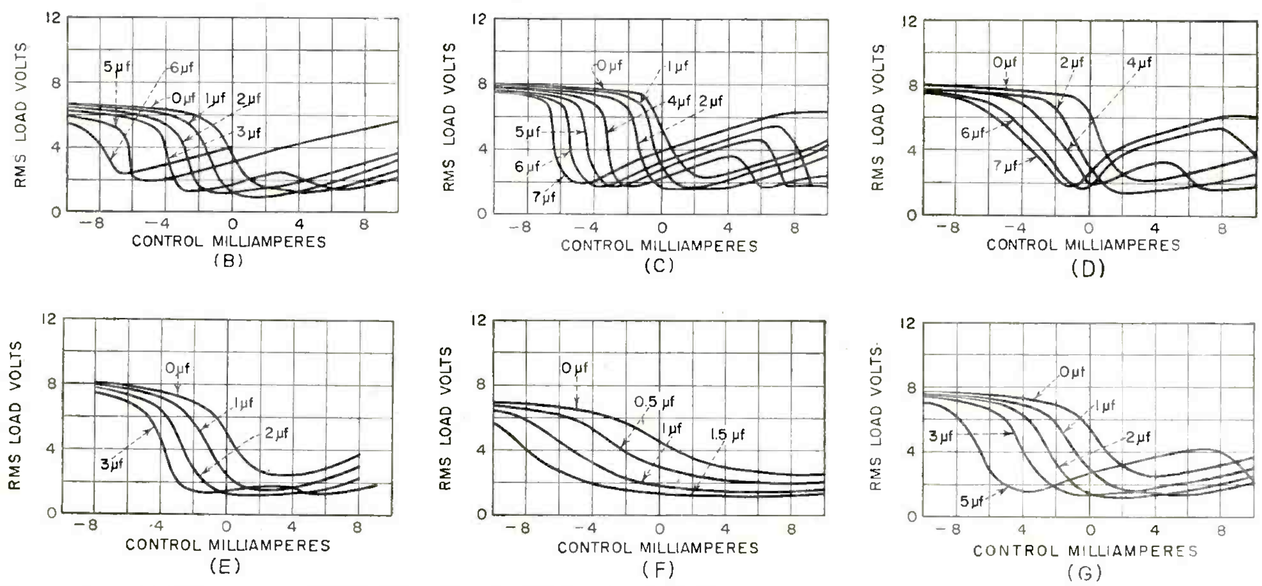


FIG. 2—Characteristics of magnetic-amplifier circuits constructed using common transformer types

filament connection appears to have little effect on response time, which has been observed to be 4 or 5 cycles.

Primary Resonance

With the circuit in Fig. 1, the output voltage at T can not be reduced below a certain minimum. This minimum can be further reduced by placing across each primary sufficient capacitance to resonate the primary inductances at the supply frequency thus raising the impedance ZZ and consequently lowering the output voltage.

The capacitors have also the effect of shifting the output voltage versus control-current curves along the control-current axis by an amount depending on the capacitance used and in a direction such as to move the operating region through the origin and past it. This behavior is shown in the accompanying curves. With a proper choice of capacitors, the operating range may be placed on either side of the origin or partially on each.

The capacitors do not seem to have much effect on the response time. Placing a single capacitor across ZZ does not have an equivalent effect. Apparently such a capacitor cannot circulate the required magnetizing current through the rectifiers in the back direction. It is, however, possible to obtain nearly identical results if all the capacitance is placed across either one of the primaries. Magnetizing current for the other core is then supplied by the filament-winding cross-connection.

Rectifier Types

Semiconductor area-contact rectifiers are most suitable for use in the primary circuit. The back-voltage applied to them is small of the order of one or two volts. The back resistance at this point should be large enough to make the reverse current very small compared to the forward current on the next half cycle. This forward current will depend on the load and its peak value is the peak primary current through T. It is believed that most dry-disk rectifiers of suitable forward-current and inverse-voltage characteristics will give comparable performance.

Photoflash transformers such as the Thordarson T22R42 or high-voltage television power transformers such as the Stancor P8151 will yield power gains above 2,000.

A circuit using the Thordarson T15R04, a power transformer with a 510-volt 25-ma secondary, gave a power gain of about 700 and a ratio of maximum to minimum output power smaller by a factor of two than that of the higher-voltage transformers. This ratio is about ten for h-v transformers.

Transformer Types

Some control characteristic curves are given for a number of transformers, Fig. 2. Transformer T in Fig. 1 was a Thordarson-T21F18 10-volt filament transformer, whose secondary is the load winding; the transformers used as R were the Freed-14142, Thordarson-T22R42, Stancor-P8151, Thordarson-T15R04 and Thordarson-TV24R91 types. The resistance of the driving source for most of the curves was about 10,000 ohms. The curve for a constant-current driving source shows considerable difference from the curves with finite source impedance. Effect of varying load impedance can be seen in Fig. 2A. The capacitances specified in Fig. 2 are in parallel with the primaries of R (Fig. 1).

Other Transformers

For many applications photoflash transformers will be satisfactory although for powers of one hundred watts or so it may be necessary to use television power transformers. Transformers for this purpose should have a secondary of as high a voltage as possible and a core of small cross-section as long as this does not limit the output power too severely. This insures that the cores will saturate on a small control current. An examination of the B-H curves of a half-dozen different types and sizes of power transformers showed almost no significant differences. Audio-transformer cores appeared very difficult to saturate and thus not suitable for magnetic-amplifier work.

If the transformers have more than one filament winding, it is possible to modify the circuit by using one set of filament windings as described above and a second set, connected in the same manner as the high-voltage windings, as a second input, to which either feedback or a separate signal may be applied. Feedback if positive increases the gain, nonlinearity and response time of the circuit, and behaves conversely if negative. To apply feedback of this type it is necessary to rectify the output. Such a connection can be used to produce a bistable circuit or flip-flop or can be used as an oscillator. If the transformers have two high-voltage secondaries, these can be used in the same manner.

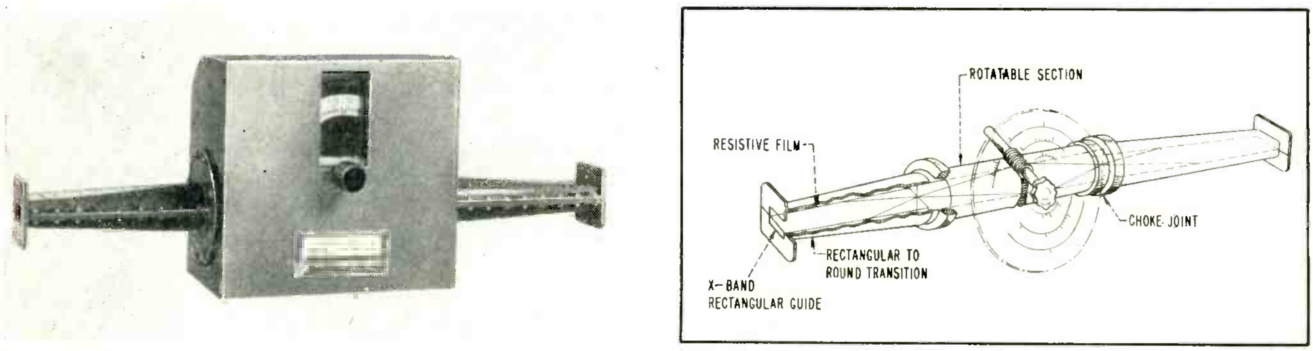
Since the input impedance is the control-loop resistance and inductance in series, it is best to drive the amplifier with a high-impedance source such as a pentode if most rapid response is desired. However, the shape of the control characteristics is dependent upon the internal impedance of the control circuit, as is evident by comparison of Fig. 2C and 2D. In some applications it may be desirable to drive from a low or medium-impedance source.

Applications

One application for this amplifier as a source of controlled filament-heating power for an ionization gage, with the control signal derived from the electron emission from the filament and so applied as to keep the emission constant. The circuit has also been used as a controlled power source for a small oven, deriving the control signal from a resistance thermometer in the oven and thus controlling oven temperature. The circuits also offer a means of introducing students to magnetic amplifiers at reasonable cost.

The author is indebted to many of his co-workers for numerous invaluable discussions during the preparation of this material.

Broadband Rotary



Commercial prototype (left) and cross-section (right) of the rotating waveguide resistive-film attenuator that fits X-band waveguide

By B. P. HAND

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THE ROTARY ATTENUATOR, described by Southworth[1], offers substantial advantages for use at X-band frequencies and above. Although using resistive films, it has a law readily calculable and independent of frequency. Phase shift through the unit is independent of setting. Furthermore, it should be easy to construct for use up to perhaps 50 kmc.

The principle of operation is shown in Fig. 1. The attenuator consists of three sections of round waveguide with a resistive film stretched across a diameter of each. The films at each end are in line with each other and fixed at right angles to the E-field of an incoming wave. The center section is free to rotate axially. When all three films are in line, there is no current flow in the films and no attenuation.

When the center section is rotated through an angle θ, voltage E may be regarded as made up of two components, $E \sin \theta$ in the plane of the film, $E \cos \theta$ at right angles to it. The function of the center film is to attenuate the sine component as completely as possible, leaving at its output only $E \cos \theta$, oriented at an angle θ with respect to the input. The purpose of the output-end film is to restore the original polarization. The component $E \cos \theta$ is again split into two components, with $E \cos \theta \sin \theta$ being absorbed and $E \cos^2 \theta$ emerging. Hence the law of attenuation is db = 40 log cos θ. The input-end film is included to make the unit bilateral.

Signal Leakage

This ideal behavior is modified by inevitable imperfections. The center film cannot be made to have infinite attenuation. Figure 2 shows the effect of a small signal leaking through in the plane of the film. The straight line shows the ideal characteristic, while the curves are typical of what actually happens at different frequencies. Depending upon relative phases and magnitudes, cancellation or addition takes place at high values of attenuation and the curves depart from the ideal. At 90-deg rotation each curve ends up at the value of attenuation the center film has at that frequency. It can be seen that if a sufficiently large margin is left between the maximum attenuation possible and the maximum calibration point, leakage through the center film has negligible effect on the calibration. Furthermore, the resistivity of the film is not required to be extremely stable as in ordinary resistive-film attenuators.

A second imperfection is the effect of reflections from the film ends. Any component in the output due to this cause must be the result of at least two reflections. An analysis of the output signal resulting from multiple reflections within the unit plus some small transmission through the center film yields a series of terms of which only the first few are significant. With typical values for these quantities, the output signal may be expressed very closely by

$$E_{out} \approx E \cos^2 \theta \,(1 \pm 2\, B^2 \sin^2 \theta) \pm EA \sin^2 \theta \qquad (1)$$

where A is the transmission coefficient through the center film, B the reflection coefficient (assumed the same for all points of reflection). The relative phases of these quantities are quite impossible to predict, so only the worst cases are considered, where the spurious signals both add to or substract from the desired signal. The ratio of actual output to ideal output then is

$$\frac{E_{out}}{E \cos^2 \theta} \approx 1 \pm (2B^2 \sin^2 \theta + A \tan^2 \theta) \qquad (2)$$

From this it is seen that the requirements on reflections are not stringent, as this term can attain a maximum value of only $2B^2$. The effect of finite attenuation is much

Waveguide Attenuator

Suitable for secondary standard of attenuation at frequencies up to 50 kilomegacycles, new device employs resistive films. Characteristics are independent of frequency, and phase shift is independent of setting. Error is less than 1 percent up to 50 db

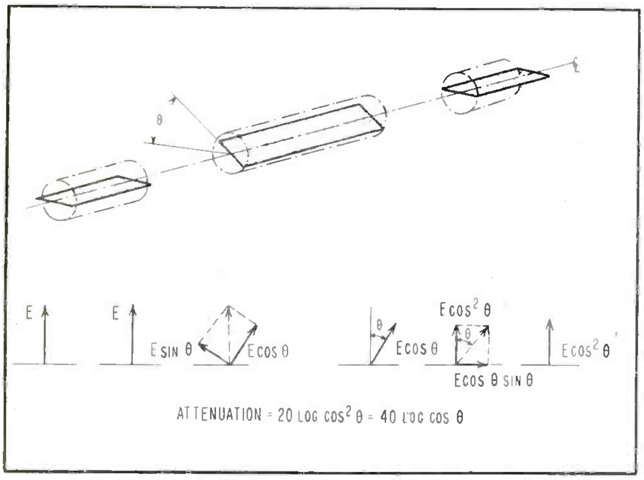

FIG. 1—Principle of operation depends upon three sections of round waveguide with resistive films. Center section rotates to increase attenuation through the system

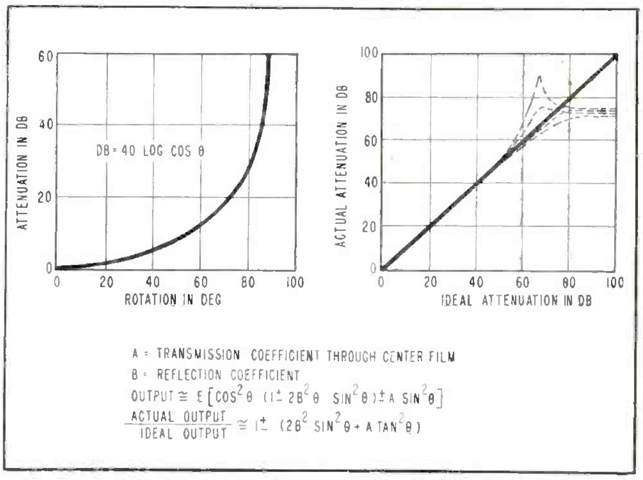

FIG. 2—Attenuation vs center-section rotation (left). Effects of small-signal leakage cause departure from ideal straight-line attenuation (right). Dashed-line humps show possible departures

more serious, as shown by the tangent factor. It turns out that for reasonable accuracy A must be small enough to give about a 20-db margin over the maximum calibration point, as is illustrated in Fig. 2.

An experimental rotary attenuator for X-band embodying these principles is illustrated. The resistive films are evaporated on 2-mil mica, which is clamped between waveguide halves to insure centering. The end sections consist of rectangular-to-round waveguide transitions. Choke joints allow the center section to be rotated. The center-film attenuation is 70 db or more over the entire band from 8.2 to 12.4 kilomegacycles. Reflections are all 5 percent or less.

Performance of this unit is illustrated in Fig. 3A, where the upper and lower limits of the shaded area indicate the maximum positive and negative errors encountered anywhere in the band at each setting.

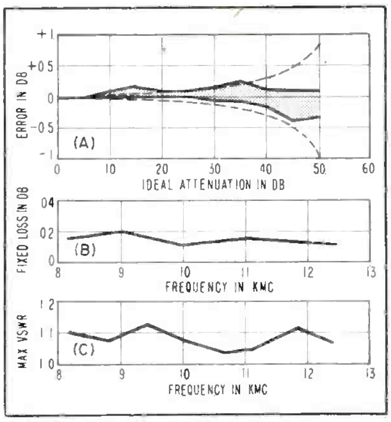

FIG. 3—Maximum errors (A), fixed loss (B) and maximum vswr (C) for rotary attenuator

In terms of db, the error is no greater than 1 percent up to the value of 50 db. It seems likely that calibration can be carried somewhat farther, but eventually accuracy is inherently limited by the fact that successive small increments of angle cause larger and larger increments of attenuation.

Figure 3B shows the fixed loss (loss at zero setting), and Fig. 3C the maximum vswr at any setting. Variation in phase shift is less than one-half degree from zero to 40 db. Undoubtedly it is worse at 50 db, but could not be checked accurately at such a low level.

Reference

(1) G. C. Southworth, "Principles and Applications of Waveguide Transmissions," p 374, D. Van Nostrand, New York. Inventor of this type of attenuator was the late A. E. Bowen, of Bell Telephone Laboratories.

Submerged Repeaters

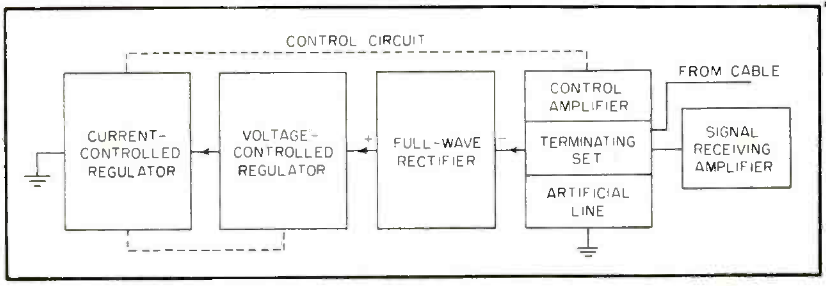

FIG. 1—Block layout of cable-terminating units for submerged repeaters

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VACUUM-TUBE TELEGRAPH REPEATERS have recently been connected into each of a number of transatlantic submarine cables at points on the edge of the continental shelves and are submerged there under many fathoms of sea water. All electric current to each repeater is fed over the cable conductor itself from the end toward which the repeater sends the amplified telegraph signals. Current returns by a ground path to the source.

Joint use of the single cable core for telegraph signals and for power supply offers no great technical difficulty. Geographical location of the cables is such, however, that high differences of potential often occur between remote ground connections. The current path to the repeater is therefore subject to disturbances that may either increase or decrease the source potential needed to maintain a given current.

Current Control

Repeaters require a nearly constant current in their circuits. The potential applied to the cable must remain unaffected by any change of voltage of the power available to the station. It must, at the same time, automatically increase or decrease as earth potentials vary. A special rectifier was found to offer the best solution of the problem. As finally designed, the rectifier and its auxiliary control equipment deliver a current of approximately one-third ampere to the cable with a variation of less than one milliampere throughout wide swings both of primary source voltage and earth-current potentials.

A typical cable from Newfoundland lies at a depth of a few hundred feet for about 150 miles eastward and then the bottom contour falls rather abruptly to a far deeper level. The repeater is placed sufficiently beyond the turning point to lie more than 1,500 feet below sea level. Here the residue of disturbance at signal frequency is very small so that relatively high gains can be utilized.

Signal currents arriving at the repeater, as well as the amplified signal currents leaving it, return by ground paths. Earth potentials normally rise and fall at frequencies so low as not to interfere appreciably with signals at the telegraph frequencies.

At the shore station, a cable-terminating set links the cable to the power source and provides a balancing artificial line. This unit shields sensitive receiving equipment from signal distortions that might result from transient disturbances in the direct voltage applied. In this set is a current measuring tube that initiates a proper correction if the cable current should depart from its normal value.

The repeater requires 0.32 ampere. In the example given, cable resistance to the repeater plus the resistance of the latter totals 700 ohms. It may be assumed that earth potential is normally zero but that differences exceeding 200 volts may arise between the remote ground connections.

The cable-terminal equipment consists of several components shown in Fig. 1. The cable core and an artificial line connect to the terminating set from the line side and the negative pole of the rectifier attaches at the power side. The positive pole of the rectifier leads serially through two banks of control tubes finally making connection to ground. The current-reading electron tube provides continuous grid control to an amplifier.

Output of the amplifier fixes the drop across the bank of current-controlled tubes. This bank of tubes may also adjust the drop across the second bank, designated voltage-controlled tubes. In addition, the latter bank provides automatic compensation for any change of potential across the rectifier itself.

Terminating Set

Employing a circuit similar to that of an impedance bridge, an artificial-line network is used having the same impedance characteristic to direct current and moderately low-frequency transients as does the cable circuit itself. In the terminating set these comprise paired bridge arms of about 500 ohms each.

Assuming that the only potential in the system results from the power source, and that the artificial line is a reasonable simulation of the cable itself, equal currents, whether steady or variant, will appear in both. Potentials at A and B will therefore vary alike and no drop will exist across them.

The signal-receiving amplifier connected across these two points is thus insensitive to any change of voltage at the power source. However, signal currents reaching the terminating set from the cable affect the potential at A far more than at B. The resulting differences of potential appear at the in-

Use Stabilized Power

Remote undersea amplifiers powered from shore obtain current from regulated supply that holds 0.32-amp current constant within less than one ma. Tandem control circuits compensate for earth currents and a-c line variations

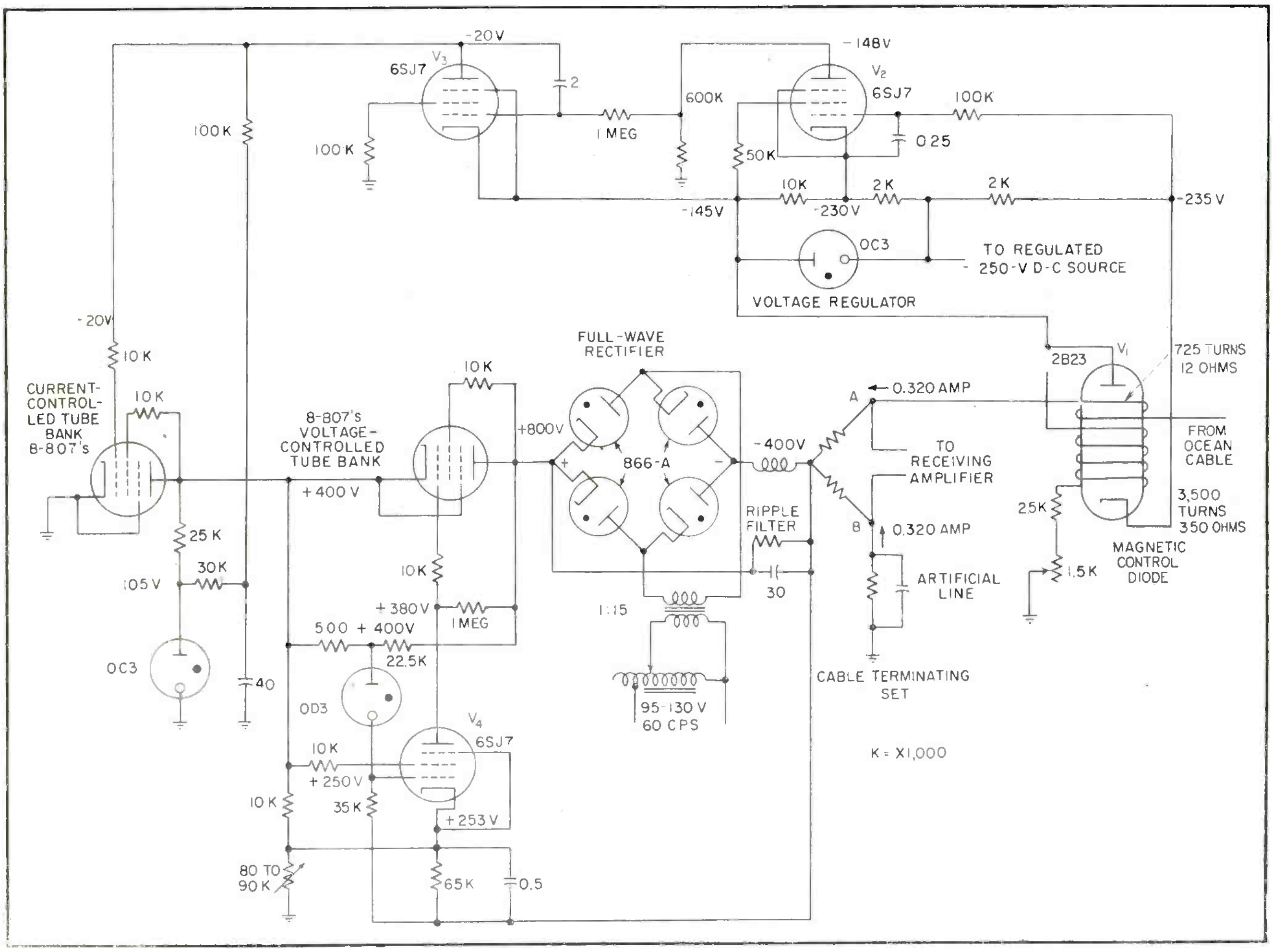

FIG. 2—Combined power source and regulating circuits that hold remote-repeater current stable

put of the signal amplifier. Direct current to line will differ from that to artificial line whenever earth potential exists.

The terminal amplifier is insensitive to the slow drift in these currents and no severe problem is involved on that account.

Current flowing in the cable circuit is carried through one of two coils associated with V_1 shown at the extreme right in Fig. 2. In the glass envelope of this tube, the anode and cathode are mounted on concentric axes and, in the absence of any magnetic field, behavior is similar to that in other diodes. If the lines of a magnetic field parallel the axis of the tube, electrons are forced from their normal radial paths into a spiral trajectory.

When the magnetic field strength is increased sufficiently, this trajectory will be turned back on the cathode to reduce anode-cathode current flow. There is little change of anode current with increasing magnetic field until a critical magnetization is reached. Beyond this, anode current drops off rapidly with increasing fields.

The tube has two coils outside the glass envelope. These are axially concentric with the tube elements and are enclosed in a steel shell that decreases magnetic reluctance and shields the tube from stray magnetic fields. The second coil carries a local current from a constant-voltage source to permit adjustment to the cutoff region.

The cathode-anode path is made part of a potentiometer arrangement that causes the cathode potential to become more negative if the joint ampere-turns in the two coils should increase. Tube V_1 is coupled to V_2 and V_3, which act as a two-stage direct-current amplifier.

A closely regulated 250-volt source supplies current to all circuits. Tube V_1 has the plate-impedance vs ampere-turn curve shown in Fig. 3. The biasing winding provides an adjustment range of some 60 ampere-turns about a normal of 150 ampere-turns. The line winding, with normal current flow, is activated by 230 ampere-turns.

Control Characteristics

Current is directed through the two coils so that the magnetic effects are additive. Plate impedance increases slightly as the ampere-turns increase until a total magnetization equivalent to about 350 ampere-turns is reached. Beyond this, the impedance climbs rapidly. Adjustment provided in the biasing winding is broad enough to ensure that total magnetization can be made just sufficient that a small variation of current in the line coil will produce a large variation of plate resistance.

The drop across the plate-cathode circuit of V_1 and its series 2,000-ohm resistor is held constant by a 105-volt regulator tube. The junction of tube cathode and resistor is used to establish the grid potential of V_2. The cathode potential of the latter is fixed by a voltage divider across the voltage-regulator tube. Grid bias on V_2 is normally about 5 volts.

If the cable current should increase, plate impedance of V_1 will increase and cathode potential will become more negative. This will increase the grid bias of V_2, causing its plate voltage to become less negative. Grid potential of V_3 follows, causing plate potential to fall rapidly in that tube. This latter plate potential determines impedance of the main current-regulating tubes.

The two amplifier tubes together offer a voltage amplification of nearly 1,000. One milliampere of current change in the line coil of V_1 changes the plate current about 0.1 milliampere thus changing the cathode potential approximately 0.2 volt. A change of 25 volts or so at the plate of V_3 is sufficient for all control purposes and actual current change in the line coil of V_1 is therefore not allowed to vary more than a fraction of one milliampere.

Location of repeaters and character of cable affects the potential at which the requisite repeater current can be delivered. A typical case will be assumed in which, under stable conditions, the potential at the apex of the terminating set is 400 volts negative to ground and the current flowing through the set is 0.64 ampere. It is assumed that potentials as high as 300 volts poled either way may arise between the terminal-set ground and the deep-water ground at the repeater. Figure 4 shows the necessary apex potential and current and the total power delivery to the cable system needed to maintain a line current of 0.32 ampere for a wide range of earth potentials. Only those portions of the curves between earth potential limits of plus or minus 300 volts are of interest.

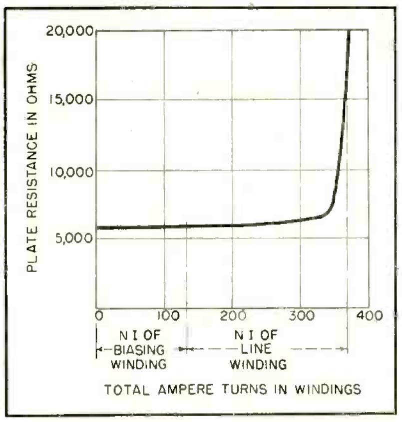

FIG. 3—Plate-impedance versus magnetization curves for magnetically controlled diode in power supply

For this set of conditions, the rectifier voltage would be made approximately 1,200 volts and each of the two regulating tube banks would normally drop this potential by about 400 volts to leave 400 volts available at the apex.

From Fig. 3 it is seen that the plate potential at V_3 is also the grid voltage of the current-controlled tube bank. Under normal conditions about 0.08 ampere flows in the plate circuit of each tube with a consequent drop of 400 volts.

A resistor in series with a voltage-regulator tube is bridged from plates to cathodes of these tubes, the anode of the regulator tube providing a constant-voltage plate-current supply for V_3. The smaller series resistor and the 40-microfarad shunting capacitors avoid rectifier ripple voltage at the plate of V_3 and together with the 100,000-ohm resistor reduce the plate voltage of V_3 to about −20 volts with normal plate current.

This plate voltage is also the grid voltage of the tubes in the regulating bank. As in the amplifier itself, any change in grid voltage will change the drop across the plate-cathode circuit of the current-controlled regulator tubes. In an actual operating case, the drop will be increased or decreased until equilibrium is reached and line current is steady at a value close to the normally correct one.

Additional Regulation

A single regulating bank has sufficient adjustment range to handle 200 volts or less. Because more correction than this may be needed, a second regulating bank is added. Compensation for cable-current change may then be spread over both banks and the second, or voltage-controlled bank, can be used as well to correct for any voltage change that may occur in the primary a-c source to the rectifier.

In Fig. 2 the rectifier is shown operating at 1,200-volt output. The tandem regulator banks maintain the positive pole of the rectifier at 800 volts above ground potential and the negative pole and terminal set apex are held at 400 volts below ground potential. Another amplifier tube V_4 is included together with a 150-volt reference voltage-regulator tube.

The cathode of V_4 connects into a network that links plate and cathode circuit of the current-controlled regulator tube and the negative bus of the rectifier. The cathode potential can be set to any normal value desired and can be made to vary linearly with the plate voltage of the current-controlled tubes. Grid potential of V_4 is maintained at a value nearly 150 volts less positive than plate voltage.

Double Regulation

If a change occurs in the plate voltage of the current-controlled regulator tubes, grid bias of V_4 is altered at the same time. When voltage increases, the grid potential of V_4 rises more than does the cathode potential and grid bias is decreased.

With decreased voltage the bias is increased. The plate of V_4 draws its current through a high resistance from the plate circuit of the voltage-controlled regulator bank. Plate potential of V_4 is used for grid control of that bank.

Any variation of plate voltage in the one regulating bank is, through this linkage, reflected in the other. The drop in the two rise or fall together whenever line current variation changes the control condition. Proper selection of all components permits equalizing the change in the two banks so a required 300-volt change will be made by a 150-volt correction in each.

The voltage-regulator tube through which the grid potential of V_4 is controlled connects to a potentiometer that bridges plates and cathodes of the voltage-controlled tubes. The resistor connected to the plate is of much higher resistance than the other so the anode voltage of the regulator tube is near that of the plates of the current-regulated bank. However, a change in plate voltage of the voltage-controlled tubes makes a proportionate change in the voltage at the grid of V_4. Assuming the drop across the current-controlled regulator remains unchanged, grid bias of V_4 will have been changed. Resistors are chosen so a change of voltage at the plate of the voltage-regulator tube will produce an equal and opposing plate-cathode drop in the bank.

No noticeable current change need occur in rectifier or load circuit. The correction is effected entirely by rectifier voltage and its reflection into the control-amplifier tube V_4. At the worst, any current change that can occur is of short duration.

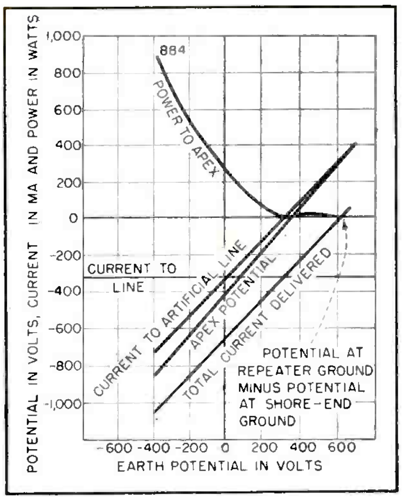

FIG. 4—Potential in volts, current in milliamperes and power in watts as affected by earth potential on undersea cable using remote repeater

Ripple Voltage

The *L-C* filter reduces ripple voltage across the main rectifier to about one percent of the d-c potential (10 volts or more). Actual measurement at the cable-set apex indicates the residual there is about 50 millivolts. The use of a neutralizing artificial line reduces this until the disturbance to incoming signals is negligible.

The general plan by which the voltage-controlled bank compensates for primary voltage changes is employed in the 250-volt direct-current source to the current-control amplifier circuits. There almost perfect voltage stabilization is necessary because of the high-gain requirement in a critical type of amplifier. A small-capacity rectifier together with a single regulating tube, a reference-voltage regulator tube and amplifying tube used as described maintain a dependable 250-volt output at all times.

Power Source

While it is necessary that the power source detect small variations of line current and make automatic voltage compensation, it is equally necessary that incoming cable signals shall not be distorted. Overcompensation and cyclic hunting must be avoided. A number of shunting capacitors helps to make the arrangement less sensitive at signal frequencies but the most effective of these is a fairly large capacitor across plate and control grid of the second-stage amplifier tube V_3. The capacitance coupling at that point acts as a transient negative feedback, making the entire amplifier deliberate in its response. The absorption tubes operate with sufficient slowness to avoid overthrow.

Magnetic Diode Action

The cable current may be stabilized to the exact level desired by adjustment of the steady bias current in the magnetically-controlled diode. If the line current is low, a decrease of bias current will effect an increase; if it is high an increase of bias current will correct the condition.

It was assumed in discussion that the rectifier output potential would be 1,200 volts and that the two absorption tube banks would reduce this to 400 volts at cable-set apex. For an actual installation, that line potential likely would not be correct. Earth-current potentials to be expected might be appreciably lower, or available commercial power might be more or less stable than assumed. If the actual range of variation is less, some advantages are gained by narrowing the range of compensation. The absorption banks will not function correctly if plate-cathode potentials are reduced much below 170 volts. The rectifier voltage must be sufficient to provide the maximum need of the cable equipment plus a minimum of 340 volts.

Network components can be selected for any range needed. For example, if earth potentials in excess of 100 volts are not expected, the nominal drop of each of the absorption banks might be reduced to about 300 volts with the voltage-controlled bank automatically compensating for primary voltage changes up to 15 percent and the current-controlled bank providing all compensation for earth potential. The power required would thereby be reduced and the life of the weaker components would be increased.

Video Amplifier

Optimum transient response analysis yields design curves that permit rapid determination of parameters and evaluation of circuit performance for video amplifiers using conventional types of peaking networks. Typical examples are worked out in detail

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Of the various elements of television systems, the low-pass or video amplifier has probably received the most extensive investigation. The majority of the analytical work[1] has been confined to the determination of the steady-state characteristics of the various coupling networks employed. Only recently has attention been focused on the transient response.[2,3,4]

The purpose of this paper is to show how transient analysis can provide the engineer with a direct, reliable method of resolving circuit limitations and performance specifications into an optimum video amplifier design.

The problem of attaining an optimum design is as follows: certain definite performance criteria are established; that is, gain, maximum rise time and overshoot permissible. Generally, stray circuit capacitances can be evaluated or at least estimated. The problem thus narrows down to determining the type and number of tubes to employ and the best coupling network configuration. Finally, the constants of the various circuit elements must be ascertained.

General Procedure

The general analytical procedure used in preparing the accompanying design curves was as follows: an equivalent circuit was drawn for each video coupling configuration considered, including the effect of inductance losses and distributed capacitances. Then, circuit equations were written in Laplace forms[5,6] and solved for the relative response to an input step function.

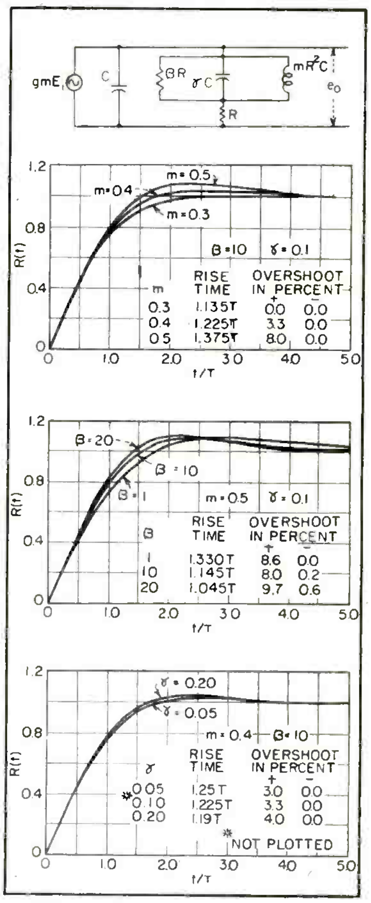

FIG. 1—Pentode shunt peaking

In most cases, the large number of energy storage elements appearing in the circuit resulted in expressions in S of high degree which would not afford a general time solution. Consequently, numerical values for each of the various parameters were chosen, and time solutions obtained and plotted for a large number of numerical cases. From these individual solutions, optimal values of the parameters were deduced and checked not only by trial time solutions but also by experimental work with model circuits. These values are presented in the design curves.

The video coupling circuits considered were those usually described as shunt, series and combination (shunt plus series) peaked. Both triode and pentode equivalent generators were included, and in the case of the triode, families of curves were plotted to study the effect of low plate resistances.

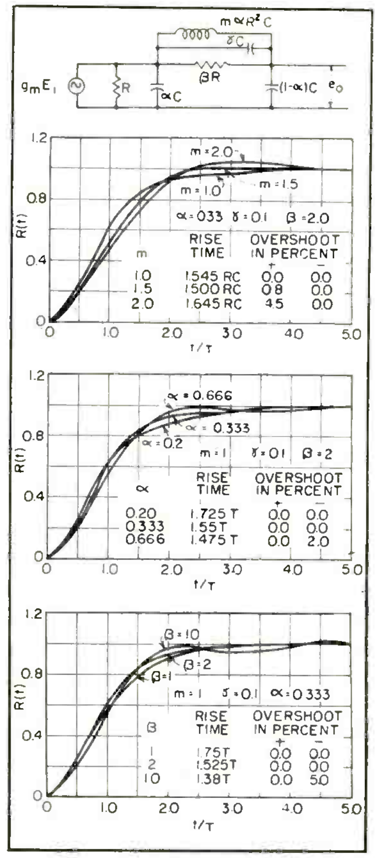

FIG. 2—Pentode series peaking

Pentode Peaking

The simplest case is the shunt-peaked pentode having the equivalent circuit shown in Fig. 1. All circuit elements are expressed in parametric form; for example, the distributed capacitance of the shunt inductance is simply γC. As has been observed by many workers, it can be seen that an optimum value

Design Charts

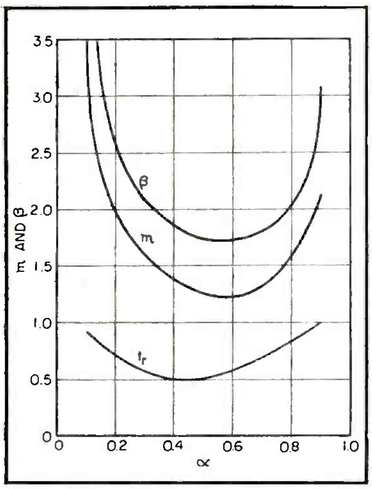

FIG. 3—Design curves for pentode series peaking for optimum m, β and t_r ($\gamma = 0.1$)

of m lies close to 0.4. It can also be seen that distributed capacitance across the inductance causes no difficulty until γ exceeds 0.2. Since β represents the relative loss of the inductance, the effect of coils of low Q can be determined. The curves in Fig. 1 show the effect of varying m, β and γ.

The equivalent circuit for pentode series peaking is shown in Fig. 2. As the value of α is not generally under the control of the designer, optimum values for the various parameters have been obtained and these are plotted in the design curves of Fig. 3. For any value of α, the curves give the values of m and β to produce the minimum rise time for a maximum overshoot of one percent. It should be observed that values of α near 0.4 offer the shortest rise times. From Fig. 2 the effect of varying m, α and β can be determined for use in practical circuit design.

A combination of the shunt and series peaked circuits is shown in Fig. 4. In this case there are six energy storage elements, and as would be expected, this relatively complicated circuit is very sensitive to changes in parameters. However, if the constants are properly chosen, much shorter rise times are possible than can be obtained with the simpler circuits.

Because of the large number of parameters and the difficulty in solving even specific numerical cases of the circuit equation, the attainment of optimum conditions for all values of α is not a simple task. Although further analytical work is still in progress, Fig. 4A shows the effect of varying both the series and shunt inductances while Fig. 4B gives optimum values for the parameters to produce minimum rise times with small overshoot for various values of α.

In all of the cases presented above, the pentode has been considered as a constant-current generator. When it is necessary to consider the effects of low plate resistances, the triode equivalent generator (the constant voltage source with finite series resistance) should be adopted. Although this approach is most valuable for triode representation, it is also useful for the analysis of low-plate-resistance pentodes.

Triode Peaking

The equivalent circuit with the triode plate resistance given parametrically as ρR is shown in Fig. 5 along with relative response for various values of the parameters. The effect of changing ρ is particularly interesting; as may be deduced from these curves and as will be shown later, the performance of the triode is superior to that of the pentode when plate-supply power and peak output voltage become important.

The equivalent triode series peaking circuit is shown in Fig. 6. The circuit has the relative response for various values of the parameters given in the curves of Fig. 6. From the analysis of many such curves, optimum relations of the parameters are obtained and plotted in Fig. 7. When these optimums are utilized, the resulting rise times are those given by Fig. 8. All responses resulting from the use of these values have overshoots of less than one percent.

The triode combination peaked circuit is shown in Fig. 9. Of all the circuits analyzed, the triode combination is by far the most involved. At the present time, insufficient data has been obtained to attain optimum relations as given in other cases. However, typical curves which will permit some understanding and application of this

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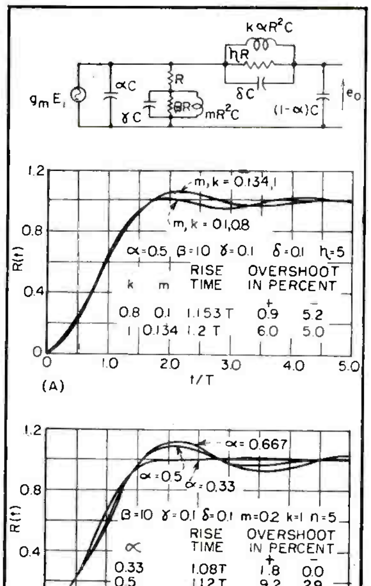

FIG. 4—Pentode combination peaking

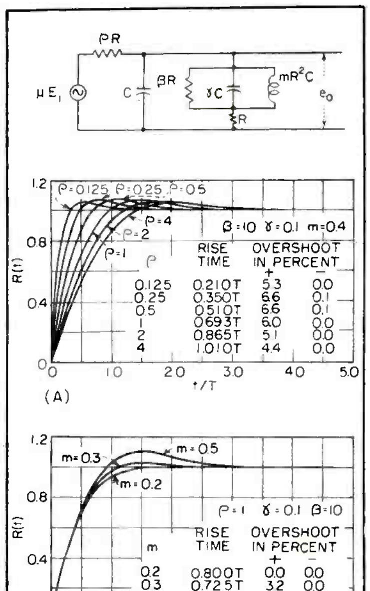

FIG. 5—Triode shunt peaking

Video Amplifier Design Charts

(Continued from p 191)

circuit are given. Figure 9A shows the effect of changing α while the result of varying k is shown in Fig. 9B.

Figures of Merit

When the response of the video coupling circuits is known, the remaining step in formulating the design procedure is to provide some method of selecting the best tube for the particular application. At least from the standpoint of tube performance, this can be done with the aid of figures of merit. From these merit figures contemporary tubes can be evaluated and their figures tabulated for different applications. This has been done but the tabulation is so extensive as to be prohibitive here.[7]

Although a general design procedure applicable to the majority of situations can be outlined, certain limitations are unavoidable. As all of the optimum relations previously described are for very small overshoot cases, the overall response of multistage amplifiers can be determined from the well known rule[4,8] that the overshoot stays practically constant and the rise time is equal to the square root of the sum of the squares of the individual stage rise times.

The procedure that will be described is intended for single-stage design but with consideration of system problems it can be employed with multistage amplifiers. It is clear that no design procedure can take into account all the probabilities of individual problems such as cost, space and maintenance factors, but it can provide a general technical approach which should simplify the organization of the overall design problem.

Typical Problem

To illustrate the design procedure, let it be required to design a single-stage video amplifier having maximum possible voltage gain, less than one percent overshoot and a rise time of 0.1 microsecond. The stage is to work into a load having a total input capacitance of 20 $\mu\mu$f;

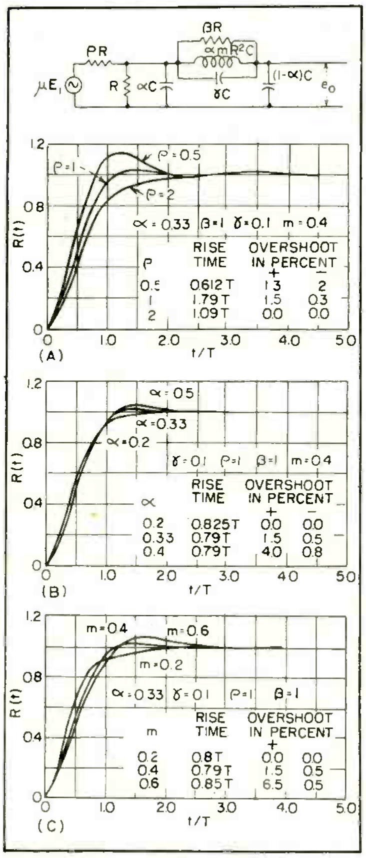

FIG. 6—Triode series peaking

the stray capacitance at the output of the tube itself is estimated to be 8 $\mu\mu$f. The coupling network is to be relatively simple of adjustment.

These performance requirements indicate that series peaking should be used since this configuration yields low rise time and only moderate circuit complication. Calculations will be made for both pentodes and triodes, with the former being considered first.

Reference to the figures of merit for pentodes used for voltage gain indicates that the 6AH6 represents the best choice of tubes for this application. The significant data for this tube are: $g_m = 9{,}000$ μmhos, $C_{out} = 2.0$ $\mu\mu$f, $C = 2.0 + 8.0 + 20.0 = 30.0$ $\mu\mu$f, $\alpha C = 2.0 + 8.0 = 10.0$ $\mu\mu$f and $\alpha = 0.333$. Then, from Fig. 3,: $t_r = 1.51\ RC$, $m = 1.5$ and $\beta = 2.0$.

Therefore $R = 0.1 \times 10^{-6}/1.51 \times 30 \times 10^{-12} = 2{,}210$ ohms
$L = mR^2C = 0.333 \times 1.5 \times (2{,}210)^2 \times 30 \times 10^{-12} = 73.3\ \mu$h
$R = 2.0 \times 2{,}210 = 4{,}420$ ohms
gain $= g_mR = 19.9$

This completes the design of the pentode stage. The triode stage is approached in a similar manner. The 12AV7 is found from the figures of merit to be the best tube and has the following characteristics: $\mu = 41$, $r_p = 4{,}800$ ohms and $C_{out} = 0.45$ $\mu\mu$f so that $C = 0.45 + 8.0 + 20.0 = 28.45$ $\mu\mu$f giving, $\alpha C = 845$ $\mu\mu$f and $\alpha = 0.297$.

From this point, the design procedure for triodes is not quite as straightforward as that for pentodes since t_r is a function of both α and ρ. A rapidly convergent trial and error process can be used to determine ρ and R as follows: assume $\rho = 0.5$. Then $R = r_p/\rho = 9{,}600$ ohms. From Fig. 7 and 8, $t_r = 0.54\ RC$, and $R = 0.1 \times 10^{-6}/0.54 \times 28.45 \times 10^{-12} = 6{,}250$ ohms.

This means the assumed value of ρ is too small: assume $\rho = 1.0$, which requires $R = 4{,}800$ ohms.

Again, from Fig. 7 and 8, $t_r = 0.77\ RC$, and $R = 4{,}570$ ohms. This is still too low. Another trial indicates that a value of $\rho = 1.08$ is probably correct. This is found to be so and yields a value $R = 4{,}450$ ohms. Then, from Fig. 7 and 8, $m = 0.42$ and $\beta = 1.05$. The values

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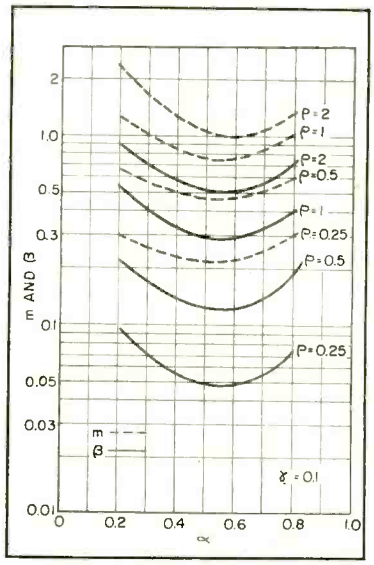

FIG. 7—Triode series peaking curves for determining optimum m and β

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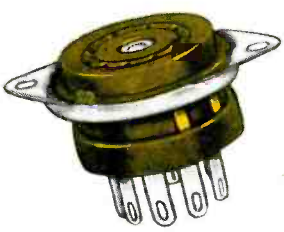

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Video Amplifier Design Charts

(Continued from p 192)

of the actual constants are calculated

$L = mR^2C = 70.5\ \mu h$

$\beta R = 1.05 \times 4{,}450 = 4{,}670$ ohms

gain $= \mu/(1 + \rho) = 41/2.08 = 19.7$

Special Characteristics

Examination of any of the triode response curves showing the results of varying ρ, discloses the fact that as ρ increases so does the rise time. If at the same time reference is made to typical triode characteristic curves, it can be seen that r_p and consequently ρ varies very rapidly with grid voltage, particularly in the region near cutoff. As a result, the rise time of the triode amplifier is a function of its driving voltage; when the grid voltage is far negative, the rise time is long, decreasing as the grid voltage becomes less negative.

Over the normal operating range of typical triodes when used as video amplifiers in class A, this effect is relatively negligible as the variation of ρ is slight.

However, this characteristic of variable rise time can be exploited when triodes are used to amplify an asymmetrical voltage such as a video signal. If a video signal of sufficient amplitude, with the synchronizing signal polarized negative, is applied to the grid of a triode amplifier the rise time of the stage will be longer during synchronizing time than during picture time. It is possible under these circumstances to have the fast rise time necessary to good video amplification and at the same time have a slow rise time, or narrow bandwidth channel, for the synchronizing signal.

As a ratio of maximum to minimum rise time of the order of five is possible, it can be seen that large improvements in signal-to-noise ratio for the synchronizing signal can be obtained. The design of a triode stage to be operated in this manner is made with the same procedure previously described and the rise time and subsequent bandwidth reduction determined from

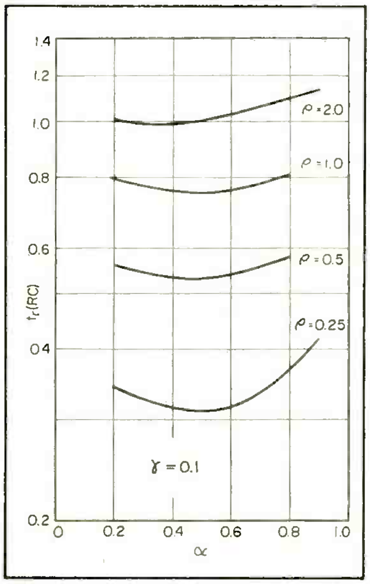

FIG. 8—Triode series peaking curves for determining optimum t_r

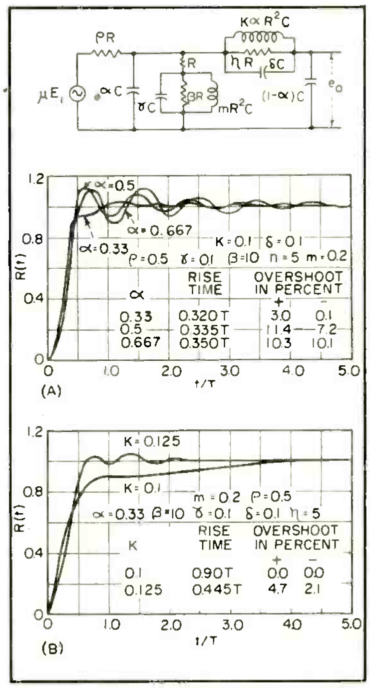

FIG. 9—Triode combination peaking

the optimum curves for the peaking circuit.

From the transient analysis of several video coupling networks, relationships among the various parameters have been obtained to produce optimum transient responses. When these optimum relationships are combined with applicable figures of merit, a design procedure is formulated which permits direct and concise design of both pentode and triode amplifiers.

Summary and Conclusion

From study of the triode response curves and experience with actual circuits, it is clear that the triode amplifier is quite superior to the pentode when the attainment of maximum output voltage is the major criterion. For the same plate supply power and tube dissipation, a triode, properly peaked, can produce from two to three times as much voltage output as a pentode. Of course the problems of cascading and driving the triode are relatively complex, but in many applications the increase in complexity would be a small price to pay for the increase in overall performance. In addition, the triode offers certain advantages in synchronizing signal-to-noise ratio.

From the standpoint of circuit synthesis, the use of the direct solution of circuit equations in terms of their primary functions, in this case reproduction of transients, leads to simple and interpretable design formulation.

The authors are particularly indebted to Karl R. Wendt for his general guidance and criticism and to Laverne H. Hardy for his extensive assistance in the analytical work.

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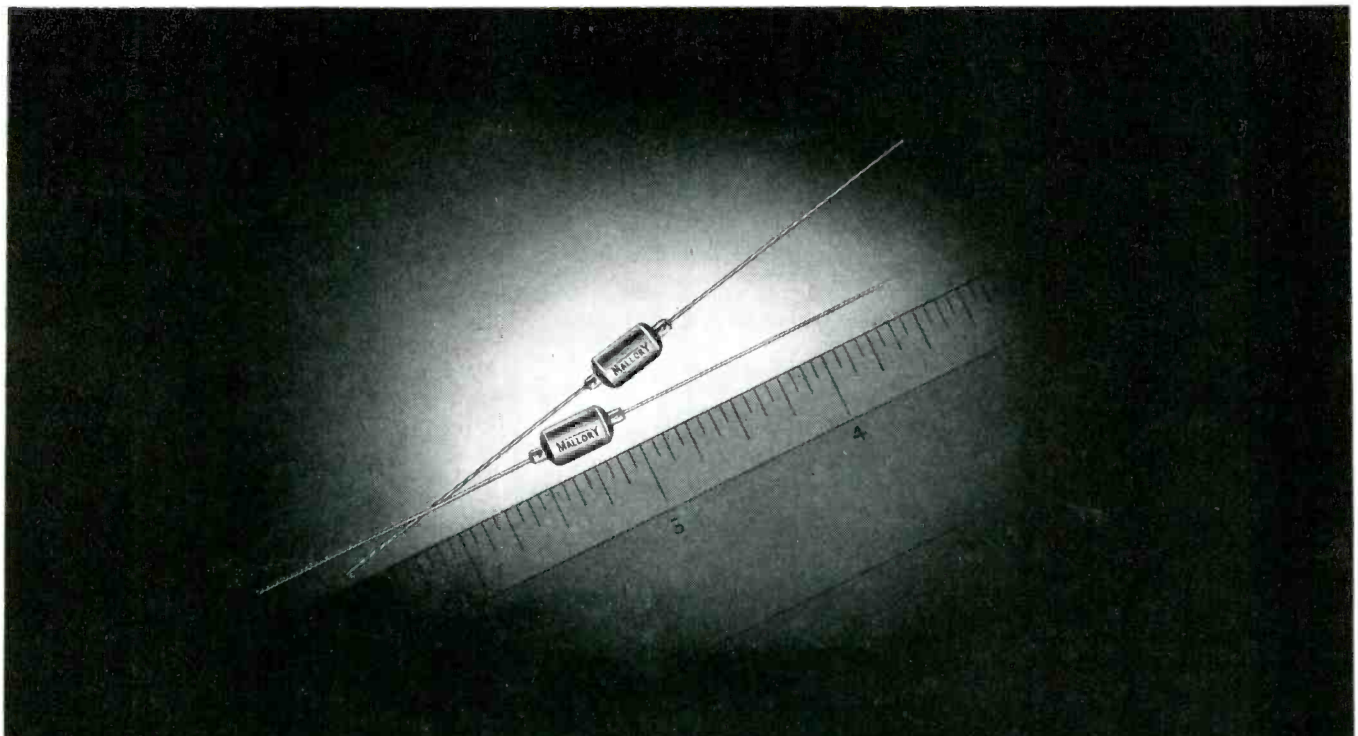

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Save Space in Transistor Circuits

Specifications for Silverlytic Capacitors

Available ratings:

4 mfd.	4 volts DC Max.
2 mfd.	5 volts DC Max.
1 mfd.	10 volts DC Max.
.5 mfd.	10 volts DC Max.
.3 mfd.	10 volts DC Max.
.2 mfd.	10 volts DC Max.
.1 mfd.	10 volts DC Max.

Temperature range: —30° C to +65° C

Capacity tolerance: —10% to + infinity

Max. leakage current: 2 microamps, after 5 min. at rated voltage

In a case smaller than the eraser on a lead pencil, Mallory Silverlytics provide a capacity of up to four microfarads. They're the ideal answer to capacitor problems in transistor circuits and other miniaturized low-voltage applications.

The case is only 7/32 inch in diameter and 3/8 inch long. Axial leads of No. 26 bare tinned wire are furnished for self-supported mounting.

Despite their tiny size, Silverlytics actually exceed the characteristics of their larger predecessors. They embody the years of research and production experience which have made Mallory electrolytic capacitors the leading choice of manufacturers of electronic equipment. Write to Mallory today for complete technical information.

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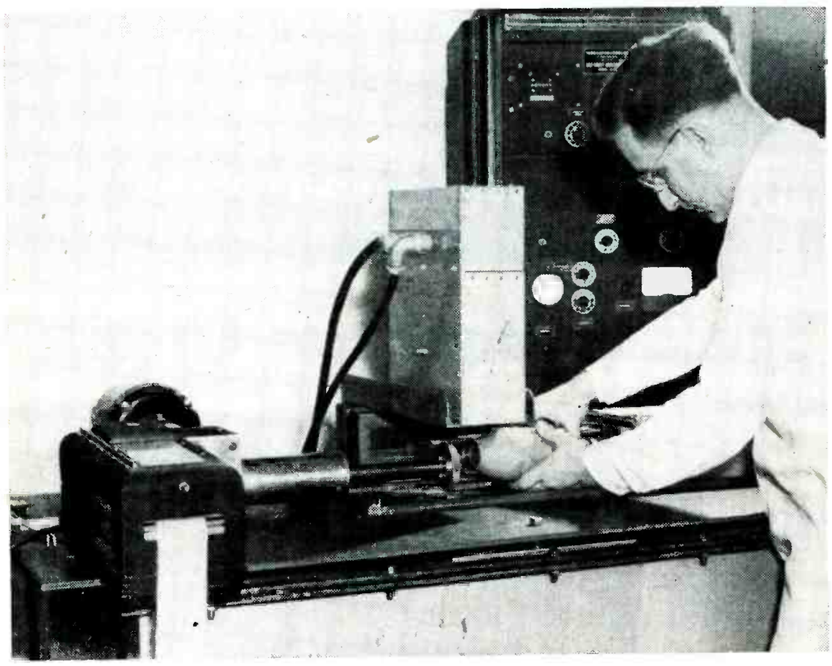
ELECTRONS AT WORK

Edited by ALEXANDER A. McKENZIE

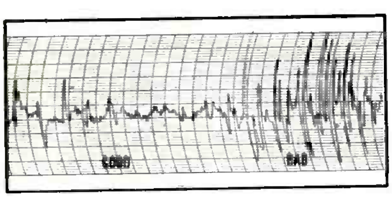
OTHER DEPARTMENTS

featured in this issue:



Shell Gage Draws Graph of Fault

A PHOTOELECTRIC METHOD is employed in a new shell-inspection gage wherein x-rays, after passing through the part under test, strike a pair of potassium iodide scintillation crystals that emit visible light approximately proportional to the x-ray intensity. The light from the crystals is brought to the cathodes of secondary emission phototubes whose output is amplified and applied to a d-c meter and a chart recorder.



Graphic record on tape shows defects

To eliminate variations due to line-voltage changes, the whole system is operated as a self-balancing bridge where output is substantially independent of excitation voltage and varies only when unbalance between the bridge elements is present.

Projectiles of 3.5-inch diameter, having a ⅛-inch steel casing, were to be inspected for the presence of cavities in their filling. To scan the complete volume, it was found desirable to employ a helical scanning method, with two fixed scintillation crystals a small distance apart. A scanning pitch of 3/16 inch was chosen, and the speed of rotation adjusted so that faults 3/16 inch apart would produce signal pulses separated by 0.2 second, which could be handled by an electronic system having a bandwidth greater than 5 cycles per second.

One of the x-ray beams passes through the center of the projectile; the other beam is some distance off center. This arrangement is necessary to avoid a blind spot that exists with symmetrical beams where a small cylindrical volume around the center line is never inspected.

Converted Limousine Aids TV Pickup

BY LAWRENCE WEILAND

Project Engineer
Audio-Video Engineering
National Broadcasting Co.
New York, N. Y.

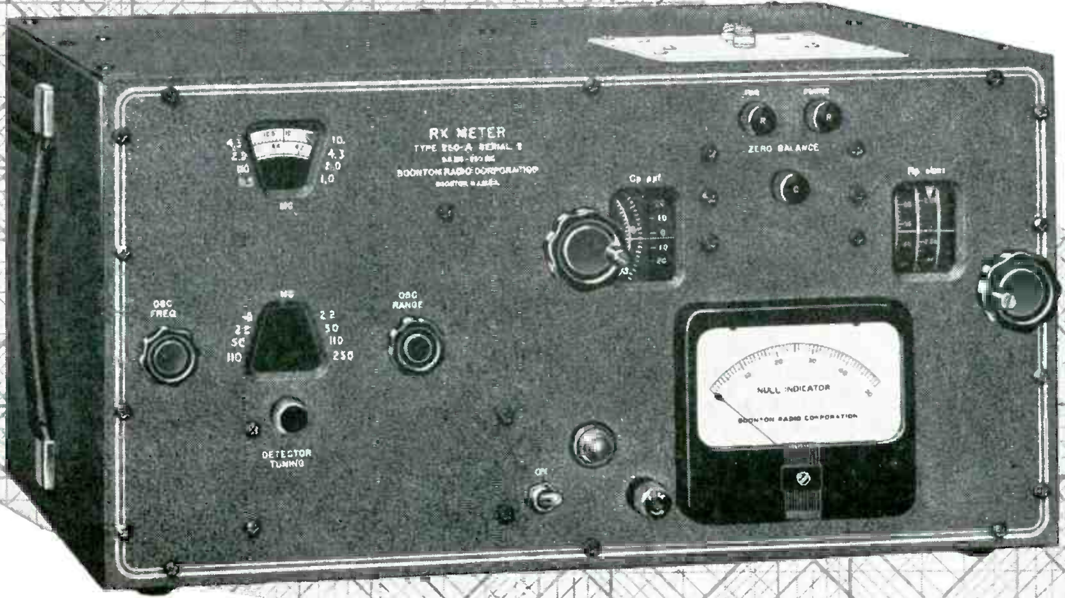
BECAUSE A CONVENTIONAL TV pickup truck is often too bulky to be allowed within convenient viewing distance of a public event, NBC has converted a Cadillac into a mobile pickup. Known as the Traveling Eye, the unit contains a field sync generator, image orthicon camera, modified hand-held vidicon, relay transmitter, diplexer and audio amplifier. In addition, the car carries two-way 450-mc communications equipment, 26-mc program feedback and cueing receiver and 3.5-kw gasoline-driven motor generator.

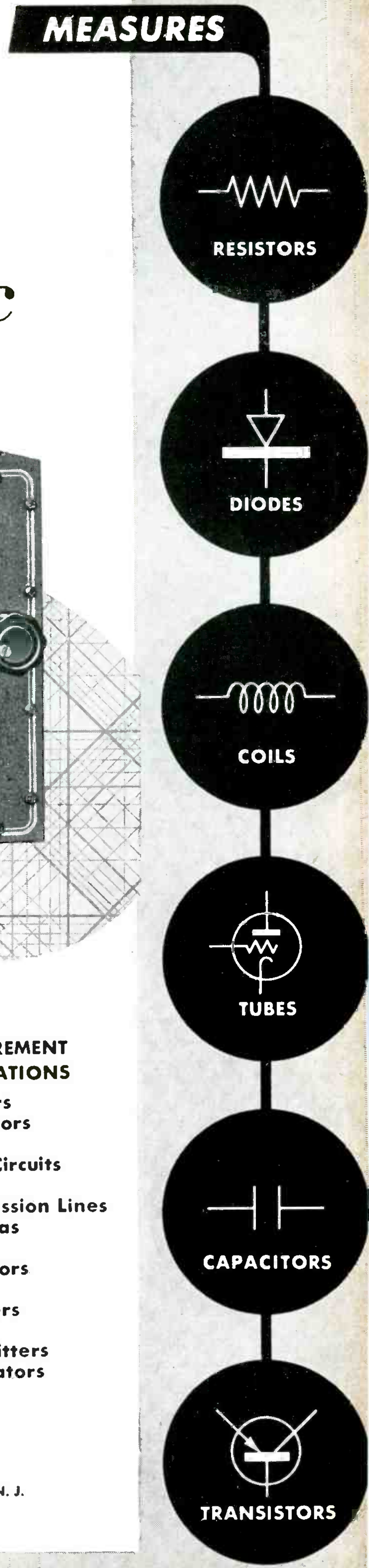
Operating crew includes driver-cameraman, cameraman, operator to point the link transmitter head, announcer and control engineer. The entire equipment was first used

A Completely Self-Contained

RF BRIDGE

500 kc to 250 mc





RX METER TYPE 250-A

- **SAVES** valuable engineering labor: makes RF bridge measurements a "means to an end" rather than an end in themselves.
- **INCLUDES** self-contained test oscillator, local oscillator, Schering bridge, detector, and null indicator.
- **INDICATES** directly equivalent parallel resistance and capacitance (or inductance) of any two-terminal network.
- **MEASURES** dynamic and static systems under actual operating conditions.
- **CONNECTS** to unknown from convenient binding posts or Type N coaxial (with use of accessory adapter).

SPECIFICATIONS

FREQUENCY RANGE: 500 KC to 250 MC in eight ranges.

FREQUENCY ACCURACY: $\pm 1\%$.

RESISTANCE RANGE (Rp): 15 to 100,000 ohms.

RESISTANCE ACCURACY (Rp): $\pm \left\{ 2 + \frac{F_{mc}}{200} + \frac{R_p}{5000} + \frac{Q}{20} \right\} \% \pm 0.2$ ohms.

CAPACITANCE RANGE (Cp): -100 mmf to $+20$ mmf.

CAPACITANCE ACCURACY (Cp): $\pm \left\{ 0.5 + 0.0002\, F^2{}_{mc} \right\} \% \pm 0.15$ mmf.

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).

MEASUREMENT APPLICATIONS

Resistors
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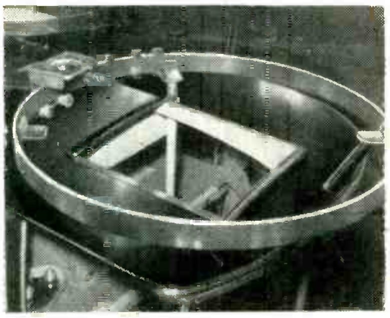
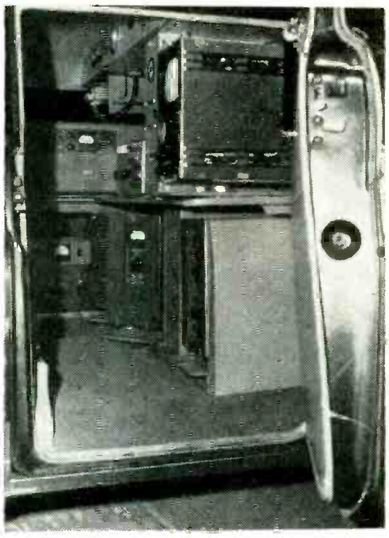


Stainless steel ring and carriage permits aiming camera or transmitter in any desired azimuthal direction



Control section of the telemobile is behind the driver's seat of limousine

to cover the Inaugural parade in Washington. At that time, the microwave relay receiver was located on the Capitol dome, from which point the program was relayed to the tv broadcast transmitter.

Among many structural changes made to the limousine in order to accommodate tv equipment and operating crew, several are of particular interest. Surmounting two waterproof hatches let into the roof of the car are two machined stainless steel rings upon each of which a specially designed carriage rolls.

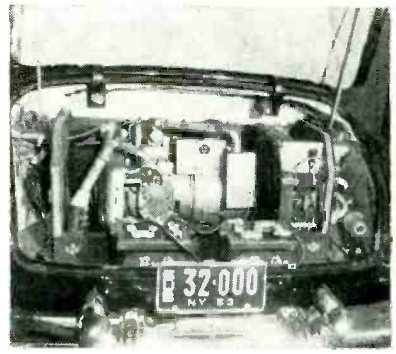
A standard camera panning head mounts on this carriage, which is equipped with a quick-acting lock, enabling the camera man or transmitter man to rotate equipment through a complete circle. Both rings are identical to permit interchange of camera and transmitter positions.

Interior trim is a compromise between ruggedness and sound absorption qualities. An absorbent flannel-like cloth was chosen for the head liner and the space between that and the roof is lined with glass wool.

Noise reduction is effectively increased by use of a newly developed miniature pressure microphone. Noise level is better than 40 db below program, despite the power plant in the rear trunk.

Windows in the rear were replaced with a very heavily tinted green glass to permit the control operator to adjust his kinescopes. Two side windows were equipped

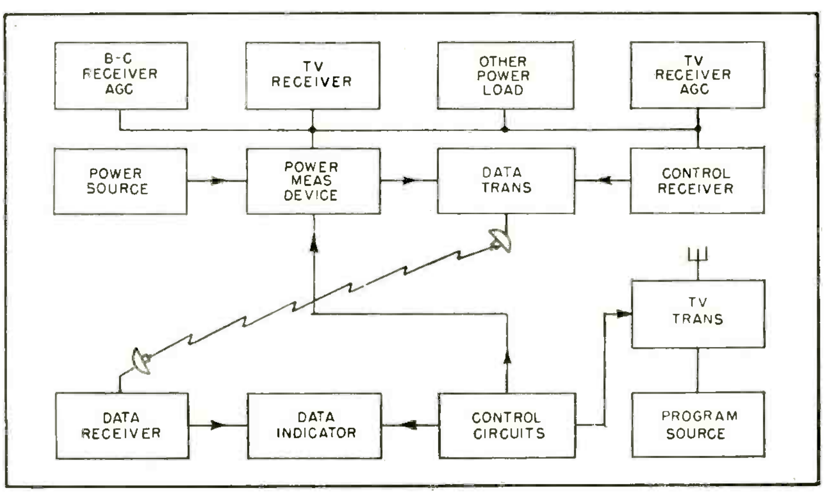
Ambient noise level is effectively reduced with new type microphone



A gas-engine driven 115-volt power supply runs standard video equipment

with black shades.

Because the car is designed to operate at slow speed for long periods, a different ratio axle was used. A five-bladed fan, new drive pulleys for higher fan speed and a shroud on the motor side of the radiator permit adequate engine cooling.



Analyzer Totals Remote Audience Interest

COMMERCIAL ENTERTAINMENT broadcasters must continually seek better means of audience analysis. A means that could provide a broadcast radio or tv station with an indication of the extent of its audience directly and instantaneously is disclosed in patent 2,636,671, issued to R. E. Shelby and assigned to the Radio Corporation of America.

Power Reduction

The simplified block diagram of the invention is shown in Fig. 1. The inventor proposed that each transmitter be momentarily reduced in power, which would result in a change in the agc voltage applied to certain circuits of a tv or voice-modulated broadcast receiver tuned to the broadcast. The resultant difference of plate current drawn by the tubes under the control of the agc bias will result in a small change in the power consumption of the receiver from the

HELIPOT ANNOUNCES NEW DUODIAL SERIES

A number of special features have been designed into the new RB series Duodials made by Helipot Corporation of South Pasadena, California, and Mountainside, New Jersey.

Special Features... Reduced torque and easier reading result from unique jump-action gearing between inner and outer dials. Vibration-proof locking mechanism is provided. RB series Duodials are delivered completely assembled . . . are easily mounted on panel or directly on device. Attractive finish . . . lustrous satin-chrome and polished black nylon . . . adds distinction and quality "feel" wherever used.

Other Series... Other Duodials include the W series ... most often used to drive primary controls; the R series; and the miniature, half-ounce SR101.

General Features... The Duodial consists of two coaxial dials ... and a knob integral with the inner dial. The inner dial is calibrated to count hundredths of each turn...the outer dial is calibrated to count the number of completed turns. The knob and inner dial are fastened directly to the shaft of a rotating device to count its turns ... the critical readings of the inner dial are, therefore, free from backlash. Also...since the Duodial can be rotated by either the knob or the shaft...it will set a device to a desired number of turns ... or will count precisely the full and partial revolutions of a power-driven device.

Duodials are cleanly designed ... attractively finished ... in a variety of types and sizes ... several with locking mechanisms.

Data File... For information and specifications on all Duodials, write for Data File No. 102.

Helipot makes a complete line of single-turn and multi-turn precision potentiometers, and turns-counting Duodials. Many models are regularly carried in stock for immediate shipment.

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centrally located power source.

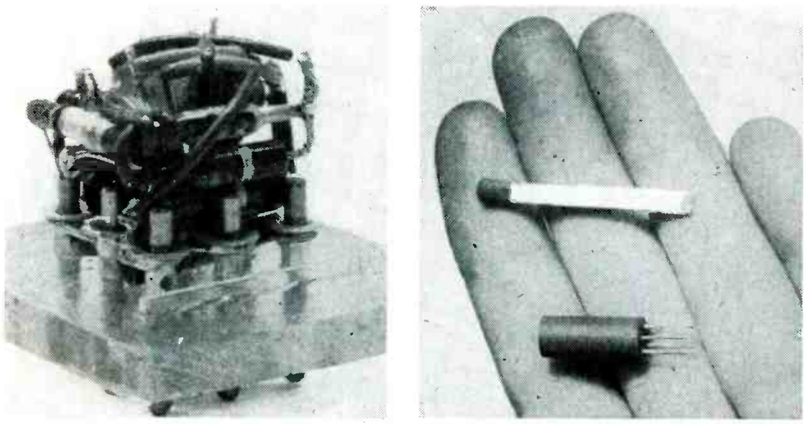
It is claimed that, with sensitive power-measuring equipment in the power stations supplying the area in which the audience measurement is to be made, a measurable difference in the area power consumption will be detected.

It is recognized that the number of receivers affected may not be known but that correlation with other audience measurement survey techniques will give valuable indication. It is further recognized by the inventor that some receivers may be battery operated and a number may not be equipped with agc or avc systems.

Tie-in circuits between the broadcaster and the power stations enable the broadcaster to have a direct indication upon the performance of the audience measurement test and also for the broadcaster to initiate the test. The test would be made in no more than a second and can be initiated during a program lull or station break.

Advantages of the Shelby proposal are that no special devices are required to be installed in the consumer's receiver and that the test can be carried out entirely independent of the receiver—in fact entirely without the knowledge of the audience at any time.

THE FRONT COVER



Decision element is shown before potting (left). New lightweight subminiature element for airborne computers is compared (right) with paper match. Electrical characteristics are described in the article below

Testing Magnetic Decision Elements

By JOHN D. GOODELL
The Minnesota Electronics Corp.
St. Paul, Minnesota

MAGNETIC DECISION ELEMENTS are basic computer building blocks incorporating the functions of logical operators as well as power gain, pulse shaping and temporary storage for synchronization in each element. Using only type A (a mixer) and type S (a negative coincidence circuit), it is possible to construct the arithmetic, program and high-speed memory sections of any digital computer.[1, 2]

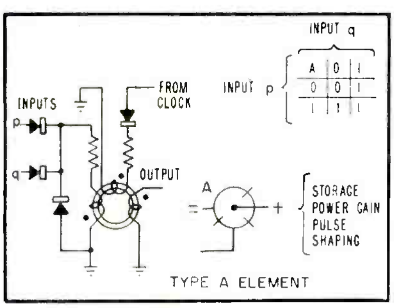


FIG. 1—Circuit of type A element

The basic operation of these elements depends on half-cycle amplifier principles, storage properties of rectangular-hysteresis-loop magnetic materials and cancellation techniques for obtaining logical negation. An input 1 produces an output 0, while an input 0 produces an output 1.

The cover photograph shows a plugboard containing approximately 1,000 magnetic decision elements. These elements are connected in various configurations to form basic computing structures such as shift registers, adders, flip-flop memory sections, delay lines, commutators and recirculating-loop-pattern generators. The element to be tested is inserted in a fixture connected to a switching arrangement that allows it to be substituted for various elements on the board.

Thus, it may be operated rapidly under practically all of the various conditions that may be encountered in practice in order to provide a complete final production check. Decision elements are used to operate sensitive relay circuits directly, thus facilitating simple visual observations of performance.

The yellow elements are the type A and the blue elements type S. The green cubes contain only diodes, for convenience in mixing a multiplicity of inputs when necessary.

Characteristics of Elements

Each decision element may be driven from several sources. Information travel through series chains of elements is at a rate of 100 kc. Average power consumption is approximately 0.5 watt per element.

For special applications, such as airborne computers where weight and size are of primary significance, the cubic volume per decision element has been reduced by a factor of more than ten, with an appropriate reduction in power consumption.

Components consist of diodes, re-

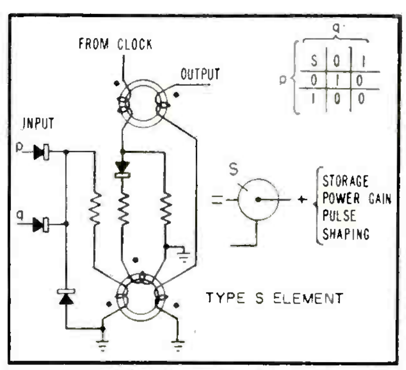
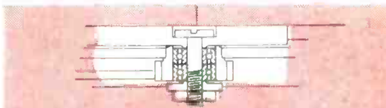


FIG. 2—Circuit of type S element

HERE'S HOW

BENDIX RADIO AND AKELEY CAMERA

cut frictional torque, save space . . . with



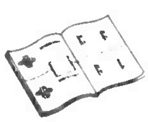
RADAR ANTENNA ROTATOR
Designed by Bendix Radio and manufactured by Akeley Camera. Uses MPB miniature ball bearings.

OPERATING CONDITIONS — low frictional torque at gear speeds of 1065 and 1200 rpm, extremely limited space, plus necessary prevention of radial play and tilting of gears . Resolved by use of 2 ultra-precision MPB bearings, o.d. .3125 in., bore .1250 in.

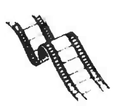
ENGINEERING DRAWING MPB BEARING 518C

Miniature Precision Bearings

MPB bearings can help you



Design engineers, designers of precision equipment of all types — here is the most complete information ever offered on miniature ball bearings. It may help you solve a design problem . . . or spark a new-product-idea. Write on your letterhead for new MPB catalog E 54a.



Also available to qualified groups: the 16mm, sound-color film, "Mighty Miniatures" — the story behind the production of ultra-precise MPB bearings.

Miniature Precision Bearings, Incorporated
Keene MPB New Hampshire

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sistors and inductors. The magnetic cores are toroids wound with $\frac{1}{8}$-mil thick ribbon of grain-oriented, essentially rectangular-hysteresis-loop materials. Power is derived entirely from the clock-type pulse generator that also serves to provide synchronization in two out-of-phase 100-kc strings of 5-microsecond pulses.

Type A Element (Yellow)

The basic operation of a type A unit may be explained with reference to Fig. 1. In this structure, information signals sensed to swing the flux from 0 toward 1 are applied to the input diodes. The diodes function as a mixing circuit. The input stores information in the magnetic material by driving it to saturation in the sense 1 or leaving it in the sense 0 (conventionally the material is assumed initially to be in the zero sense).

Subsequently, a clock pulse is applied through the clock winding sensed to drive the flux in the 0 sense. If there has been no input signal there will be no significant change in flux from the application of the clock winding and the output signal will be 0. If the input signal has driven the material to saturation in the sense 1, then the clock signal will drive it back to 0 and the change of flux will produce an output signal 1.

Power gain in this circuit is obtained by differential loading of the output circuit. The diode in the output circuit is oriented so that the input signal sees an open circuit across the output winding, hence has only to supply energy to move the flux from 0 to 1. When the clock pulse is applied it sees only the forward resistance of this diode and is required not only to move the flux back from 1 to 0 but also to supply current to the load. Pulse shaping is obtained in terms of the integral of the output signal, which is sharply defined and limited by the magnitude of flux it is possible to swing from saturation to saturation.

Type S Element (Blue)

The type S circuit consists essentially of two type A units arranged as shown in Fig. 2 and driven from a common phase of clock source. The input of one A is driven continually from the opposite phase of clock pulse so that this A generates a constant stream of 1's. The output of the two elements are connected in series opposing. Thus, if an output appears from both of them simultaneously, cancellation will take place.

The A with its output winding in opposition to the one that is driven continually at the input from an appropriate source of clock pulses is the one to which the intelligence input is applied. Thus, if there is a 0 (no intelligence pulse) on either of the input lines, the output will be a 1. This may be described as the coincidence of two 0's—or somewhat less accurately as negative coincidence. If there is a pulse on either or both of the input lines, the output will be 0. This satisfies the matrix for the logical factor S.

REFERENCES

(1) John D. Goodell, The Foundations of Computing Machinery, *Journal of Computing Systems*, 1, No. 1, June 1952.

(2) Tenny Lode, A Universal Decision Element, *Journal of Computing Systems*, 1, No. 2, Jan. 1953.

Normalized General Purpose Audio Amplifier

IN TESTING microwave antennas the modulation frequency of the test signal from a transmitter varies from a few hundred cycles to a few thousand cycles, this modulation frequency being fixed for any one test or series of tests. The antenna under test is generally used as a receiving antenna on a rotating mount and the energy picked up goes to a bolometer or crystal. The modulation frequency output is a direct measure of the microwave energy picked up.

This procedure requires a high-gain, linear audio amplifier with good signal-to-noise ratio and preferably with automatic normalization.

The primary purpose of automatic normalization is to compensate for errors introduced by

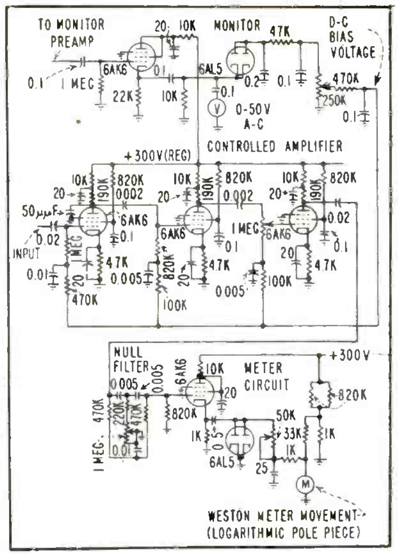

FIG. 1—Monitor circuit controls bias on amplifier to normalize output for transmitted power variations

transmitter power output variation. At present it is necessary to monitor the transmitter and then normalize all readings and graphs from the monitor readings.

If some voltage proportional to transmitted power is used to control the gain of the main amplifier, then automatic normalization is achieved. This was done, in the circuit of Fig. 1, by amplifying and rectifying such a voltage and using the d-c output to vary the bias on a portion of the main amplifier. The monitoring voltage can be obtained directly from the transmitter or be picked up by an auxiliary antenna and bolometer.

This monitoring circuit gives a pure d-c output up to 23 volts, which varies linearly with the a-c input from the monitor preamplifier. Response is uniform from 400 to 5,000 cps with the constants shown. The monitor meter shows when the normalizing range is reached. Adjustment is made by the monitor preamplifier gain control.

Signal Meter Circuits

Since a linear decibel scale was wanted, it was decided to build a linear circuit and use a logarithmic responding meter such as the shaped pole-piece Weston meter movement. The circuit was adapted from the Ballantine voltmeter circuit without the feedback, using a simple cathode follower to give a good linear voltage response. Due to the prevalence of

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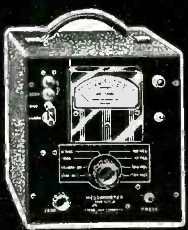
Low Frequency
"Q" Indicator



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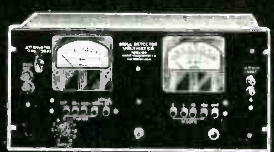
HERMETICALLY SEALED PULSE TRANSFORMERS for use in blocking oscillators, low level interstage coupling, and modulator outputs. Made in accordance with MIL-T-27 specifications. These pulse transformers are designed for maximum power, efficiency and optimum pulse performance. Balanced coil structures permit series or parallel connection of windings for turn ratios other than unity. Pulse characteristics, voltages and impedance levels will depend upon interconnections made.

DM–12 DM–18 DM–8 DM–01

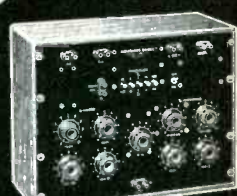
CATALOG NUMBER	APPLICATION	PULSE VOLTAGE KILOVOLTS	PULSE DURATION MICRO-SECONDS	DUTY RATIO	TEST VOLTAGE KV., RMS	CHARAC-TERISTIC IMPEDANCE OHMS	CASE SIZE
MPT-1	Blocking oscillator or interstage coupling	0.25/0.25/0.25	0.2-1.0	.004	0.7	250	DM-12
MPT-2	Blocking oscillator or interstage coupling	0.25/0.25	0.2-1.0	.004	0.7	250	DM-12
MPT-3	Blocking oscillator or interstage coupling	0.5/0.5/0.5	0.2-1.5	.002	1.0	250	DM-18
MPT-4	Blocking oscillator or interstage coupling	0.5/0.5	0.2-1.5	.002	1.0	250	DM-18
MPT-5	Blocking oscillator or interstage coupling	0.5/0.5/0.5	0.5-2.0	.002	1.0	500	DM-12
MPT-6	Blocking oscillator or interstage coupling	0.5/0.5/0.5	0.5-2.0	.002	1.0	500	DM-12
MPT-7	Blocking oscillator, interstage coupling or low power output	0.7/0.7/0.7	0.5-1.5	.002	1.5	200	DM-18
MPT-8	Blocking oscillator, interstage coupling or low power output	0.7/0.7	0.5-1.5	.002	1.5	200	DM-18
MPT-9	Blocking oscillator, interstage coupling or low power output	1.0/1.0/1.0	0.7-3.5	.002	2.0	200	DM-18
MPT-10	Blocking oscillator, interstage coupling or low power output	1.0/1.0	0.7-3.5	.002	2.0	200	DM-18
MPT-11	Blocking oscillator, interstage coupling or low power output	1.0/1.0/1.0	1.0-5.0	.002	2.0	500	DM-01
MPT-12	Blocking oscillator, interstage coupling or low power output	0.15/0.15 0.3/0.3	0.2-1.0	.004	0.7	700	DM-8

SEND FOR COMPLETE CATALOG OF
FREED INSTRUMENTS AND TRANSFORMERS



No. 1210
Null Detector &
Vacuum Tube Voltmeter

No. 1010
Comparison Bridge



No. 1110A
Incremental Inductance
Bridge

FREED TRANSFORMER CO., INC.

1722 WEIRFIELD ST. (RIDGEWOOD) BROOKLYN 27, N.Y.

60-cycle pickup in the Laboratory, a 60-cycle, twin-T, null filter was inserted ahead of the meter circuit.

The material presented was abstracted from NRL Report No. R-3219 by R. P. Lett.

High Sensitivity D-C Breaker Amplifier

By Max D. Liston
*Liston-Becker Instrument Co.
Stamford, Conn.*

Amplification of extremely small d-c voltages by a conventional direct-coupled amplifier is limited by excessive drift and noise. Slight changes in emission or other characteristics of the input tube will produce drift. All tubes have noise that corresponds to several thousand ohms in the grid circuit so the noise level of conventional amplifiers is considerably above that which would be predicted from Johnson noise considerations when working directly from low-impedance input circuits.

To overcome these difficulties the chopper or breaker type amplifier, shown in Fig. 1, is used. A contact interrupter sends the input current through alternate halves of the primary of an input transformer. The alternating voltage produced in the secondary excites the grid of a conventional *RC* coupled amplifier. The output of this amplifier is connected to a similar breaker that synchronously rectifies the output to form a d-c voltage whose voltage and polarity is an amplified function of the input voltage.

Synchronous rectification also has the desirable feature that only signals or noise having components the same as the breaker frequency will add to produce d-c in the output. This results in a high discrimination against noise and induced signals originating in both the input circuit and in the amplifier.

Success of the breaker type amplifier is largely determined by input-circuit design. The zero stability of this type amplifier is no longer limited by the stability of tube characteristics but by thermal potentials, stray currents and electrostatic potentials. At input im-

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pedances below 2,000 ohms the chief difficulty is stray thermal potentials. In the amplifier described here, thermal potentials are reduced to a minimum by eliminating all unnecessary solder junctions. Those that cannot be eliminated are made with a special low-thermal solder designed to match the thermal-electric properties of the copper wire employed in the primary. The breaker contacts are designed to prevent rubbing that would generate heat. The gold contacts are also selected to match the thermal electric properties of the input copper circuits. The en-

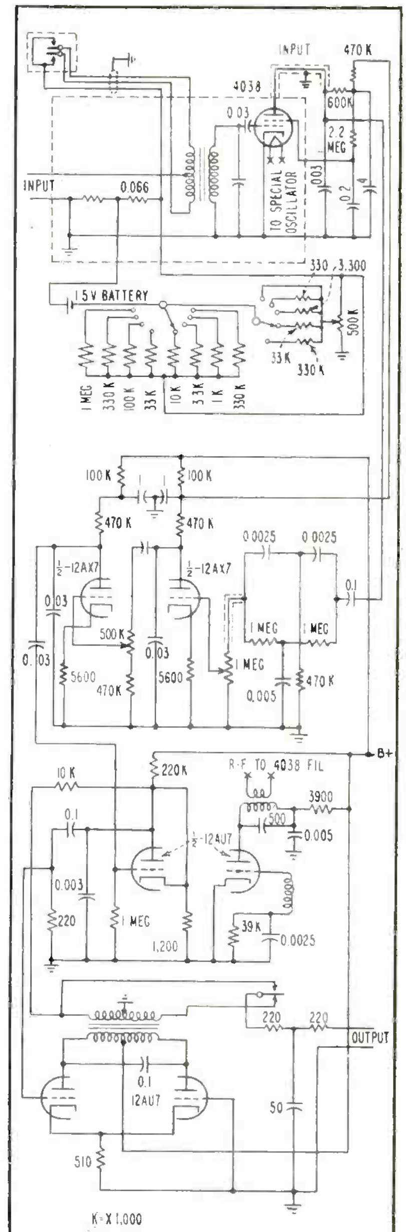

FIG. 1—Sensitive d-c amplifier uses breaker in input to convert low-level d-c into an alternating signal

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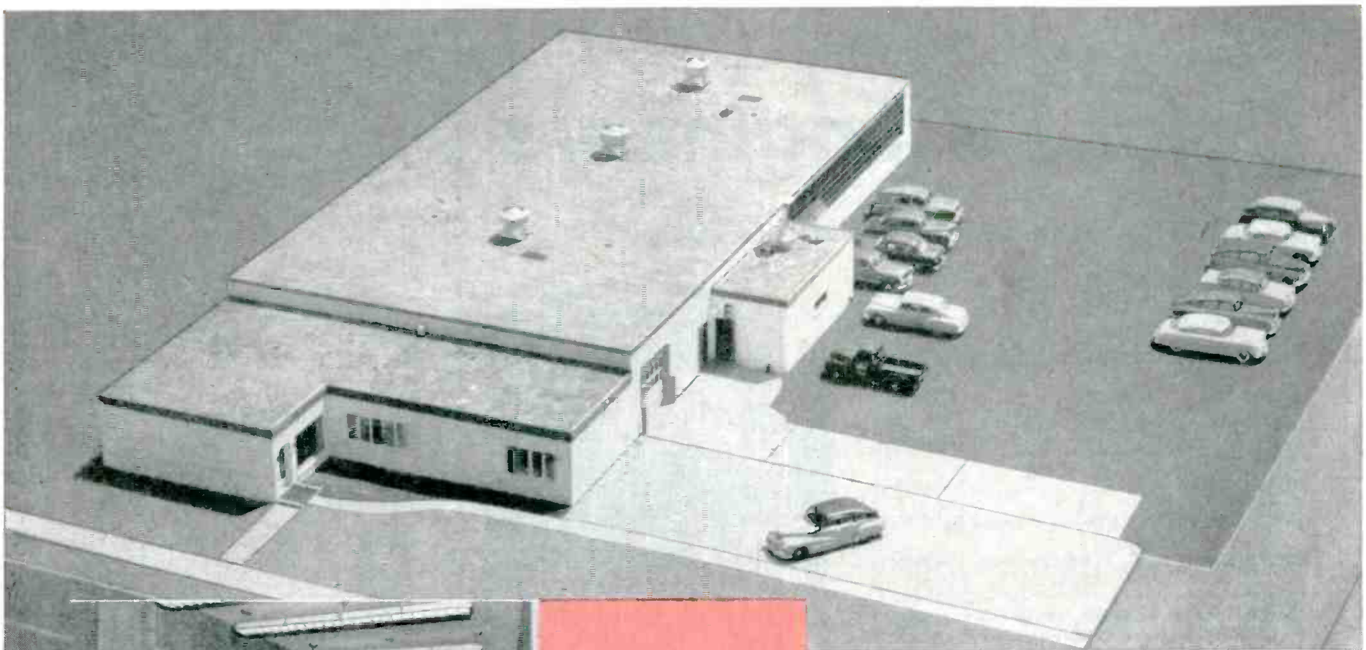

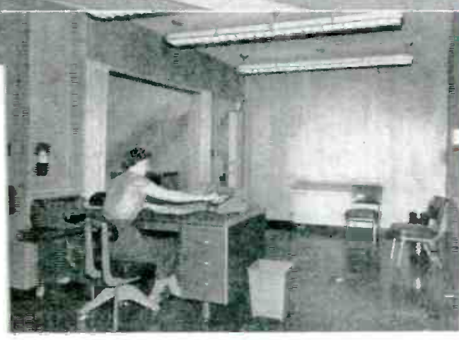

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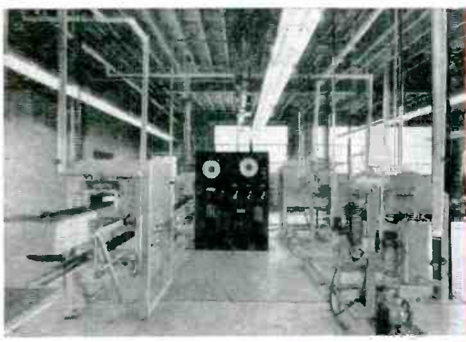

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tire breaker unit is shielded to minimize the effects of temperature change.

The input transformer must have a minimum shunting effect on the input circuit. The effective input circuit impedance must also be increased to a point well above the tube noise. In the breaker amplifier this reflected secondary impedance is always above 10 megohms. This is accomplished in a transformer working at 8 cycles a second.

Noise caused by heater-cathode currents prevents the use of conventional cathode-resistor bias at low frequencies. Battery-fixed bias was employed on the first instruments. This produced satisfactory results, but the batteries became noisy in time and careful selection of tubes was necessary. Also, the life of the preamplifier tube was short since the bias did not adjust for changes in tube characteristics. In an effort to overcome these difficulties a floating grid was tried. This worked satisfactorily since the grid would automatically adjust to the potential which gives no grid current. This is the optimum operating point for this type circuit.

Although the floating grid eliminated the need for preamplifier tube selection and replacement, the system had one bad feature. Severe overloads (1,000 times or greater than the normal signal) would cause the bias to be lost temporarily and as long as 30 minutes were sometimes required for the instrument to recover its normal gain. A 750-megohm resistance was added that does not interfere with the normal self-biasing of the circuit but does reduce the recovery time to a maximum of 10 seconds.

The preamplifier-stage filament is heated by r-f. This has been found cheaper than a d-c supply and more reliable. Tube voltages in the preamplifiers are: 4.5 volts for the heaters, 40 volts on the plate and 20 volts on the screen. This minimizes gas noise and has been found to give more satisfactory operation at this low level than rated operating conditions.

Several considerations influence the choice of the breaker frequency. Where rapid overall response is re-

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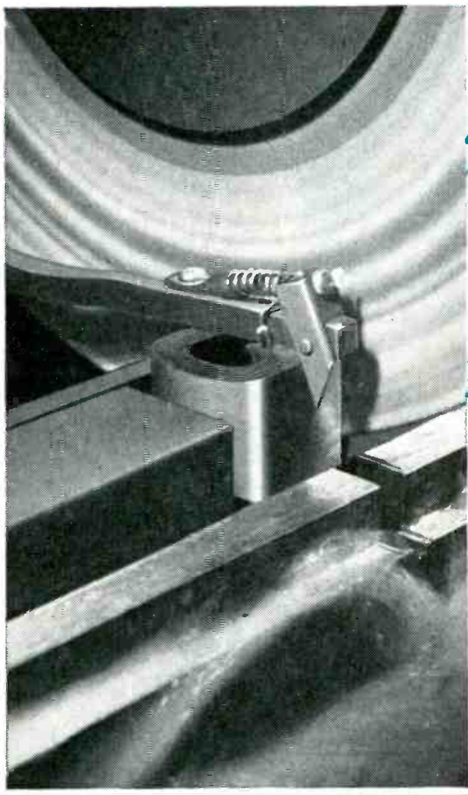

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quired a high breaker speed is required. It is also desirable to avoid frequencies near power-line frequency or its harmonics. At the low levels for which this instrument is designed, induced voltages from power lines are usually many times larger than the signal being measured.

Amplifiers have been built with breaker frequencies from 2,000 to 8 cps. The 8-cps units are definitely superior both from discrimination of induced signals and from the standpoint of breaker life. Discrimination of better than 1,000 to 1 is obtained from this arrangement Eighty cycles is employed where higher speed of response is required. Higher breaker speeds have been found to be short-lived and undependable.

The noise level of this amplifier closely approaches the theoretical limit, 0.003 μv peak to peak. Zero drift is less than 0.005 μv per day. The maximum offset from zero is 0.01 μv.

Variable Balanced D-C With Low Output Impedance

By Herbert Hellerman
Syracuse University
Syracuse, N. Y.

In applications involving d-c analogue computers it is sometimes necessary to obtain a pair of d-c voltages which are equal and opposite in polarity with respect to ground. In many such applications the magnitude of the balanced output must be a function of a potentiometer shaft angle and must be zero for zero shaft angle. Furthermore, it is often necessary to have low output impedances from each of the balanced terminals to ground so that a function potentiometer or other low-impedance device may be connected at the output terminals without destroying the accuracy.

Basically the problem is as shown in Fig. 1A. The input impedance Z_i should be very high so that loading error on the input potentiometer P is small. The output impedances from points b_1 and b_2 should be very low so that R_L need not be very high in resistance.

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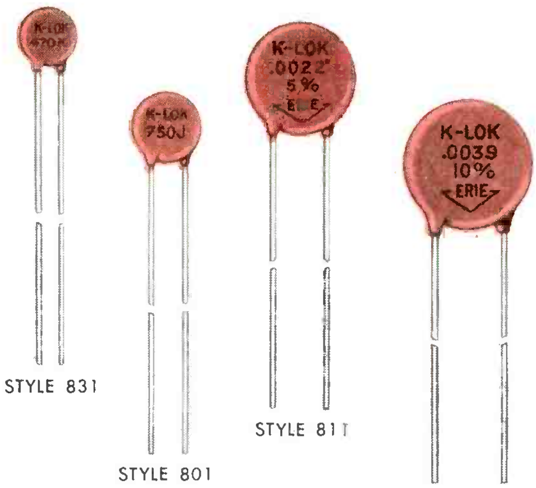

STYLE 831 STYLE 801 STYLE 811 STYLE 821

STYLE	CAPACITANCE RANGE—MMF
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801	530-820
811	820-2400
821	2400-4700

Tolerances: ±5%, ±10%, ±20%.

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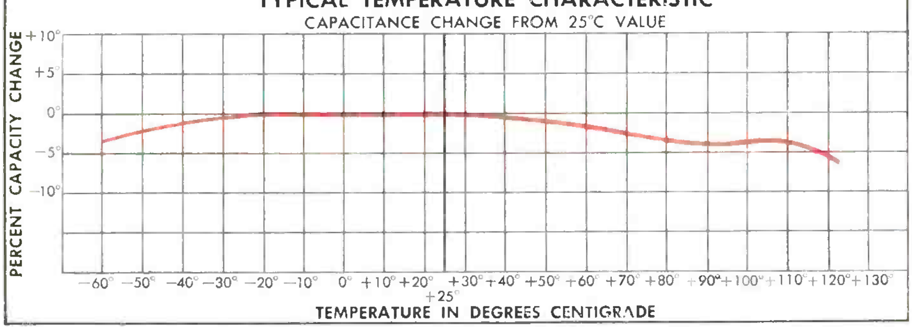

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fairly easy if one or more of the above requirements is relaxed, however, the need for all the above conditions to be satisfied represents an important practical problem.

A circuit based on a simple principle has been developed which meets all of these specifications. The idea is illustrated in Fig. 1B and consists of connecting the potentiometer output to the grid of a cathode follower and the cathode-follower output to a d-c feedback amplifier with a gain of -1. The load R_L is tied between the output of the cathode follower and the output of the feedback amplifier. In this system, potential E_o is sufficiently negative to make E_{b1} zero when $E_p = 0$ (The potentiometer dial at zero) A zero adjustment in the d-c amplifier makes the potential at point b_2 zero when the potential at point b_1 is zero. If K_o the forward gain of the amplifier is very large then

$$\frac{\Delta E_{b2}}{\Delta E_{b1}} = -\frac{R_1}{R_2}$$

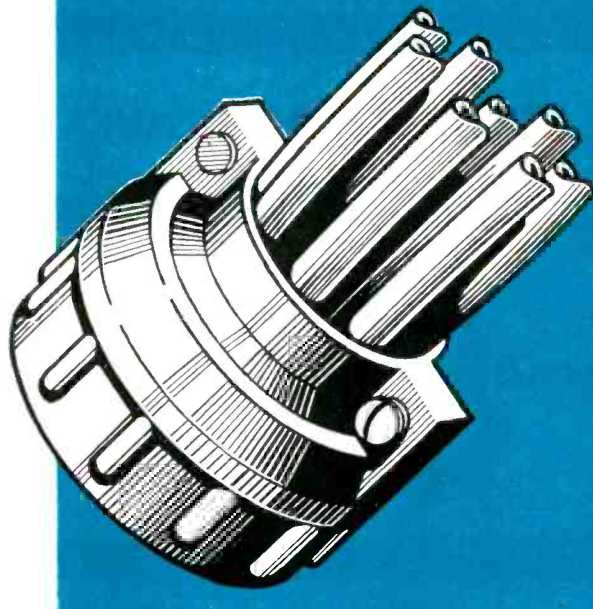
by making $R_1 = R_2$, E_{b2} is equal to $-E_{b1}$. The output impedances from terminals b_1 and b_2 to ground are low. If the gain K_o is very large, the output impedance from b_2 to ground is negligible and it can be shown that

$$E_{b1} = E_p \left[\frac{K_i}{1 + \frac{2Z_{b1}}{R_L} + \frac{Z_{b1}}{R_1}}\right] = -E_{b2}$$

where $K_i = E_{b1} / E_p$ the open-circuit gain of the input circuit, and Z_{b1} is the output impedance from b_1 to ground.

The output potentials are balanced and proportional to the input E_p. The proportionality constant is fairly close to unity in most practical cases. This formula was derived on the basis that $K_o >> 1$. If this condition is satisfied, the balance is substantially independent of R_L or the input circuit feeding the point b_1. However, the magnitude of the output voltage does depend somewhat upon these quantities. Care must be taken in the design of the output stage of K_o so that it can deliver the necessary d-c current to R_L. If desired a small potentiometer

Bendix Builds a Better *cable clamp* — the AN3057B



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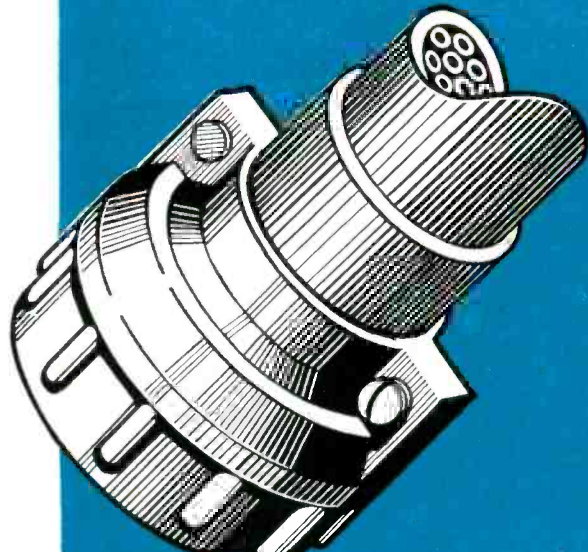

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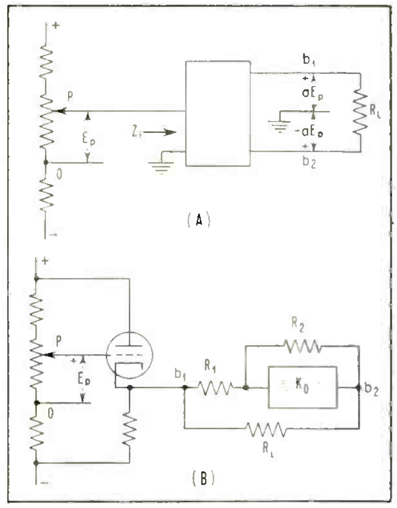


FIG. 1—The problem of obtaining a high input impedance to minimize loading error on potentiometer (A) is solved by use of cathode follower circuit (B) as described in accompanying text

can be placed in the cathode lead of the input cathode follower to do the zeroing of point b_1. If this is done, point O may be grounded. The effect of this resistor on the balance is negligible, and the effect on the magnitude of the output can be calculated by finding the new value of Z_{b1} and K_1 due to the addition of this resistor and substituting in the formula.

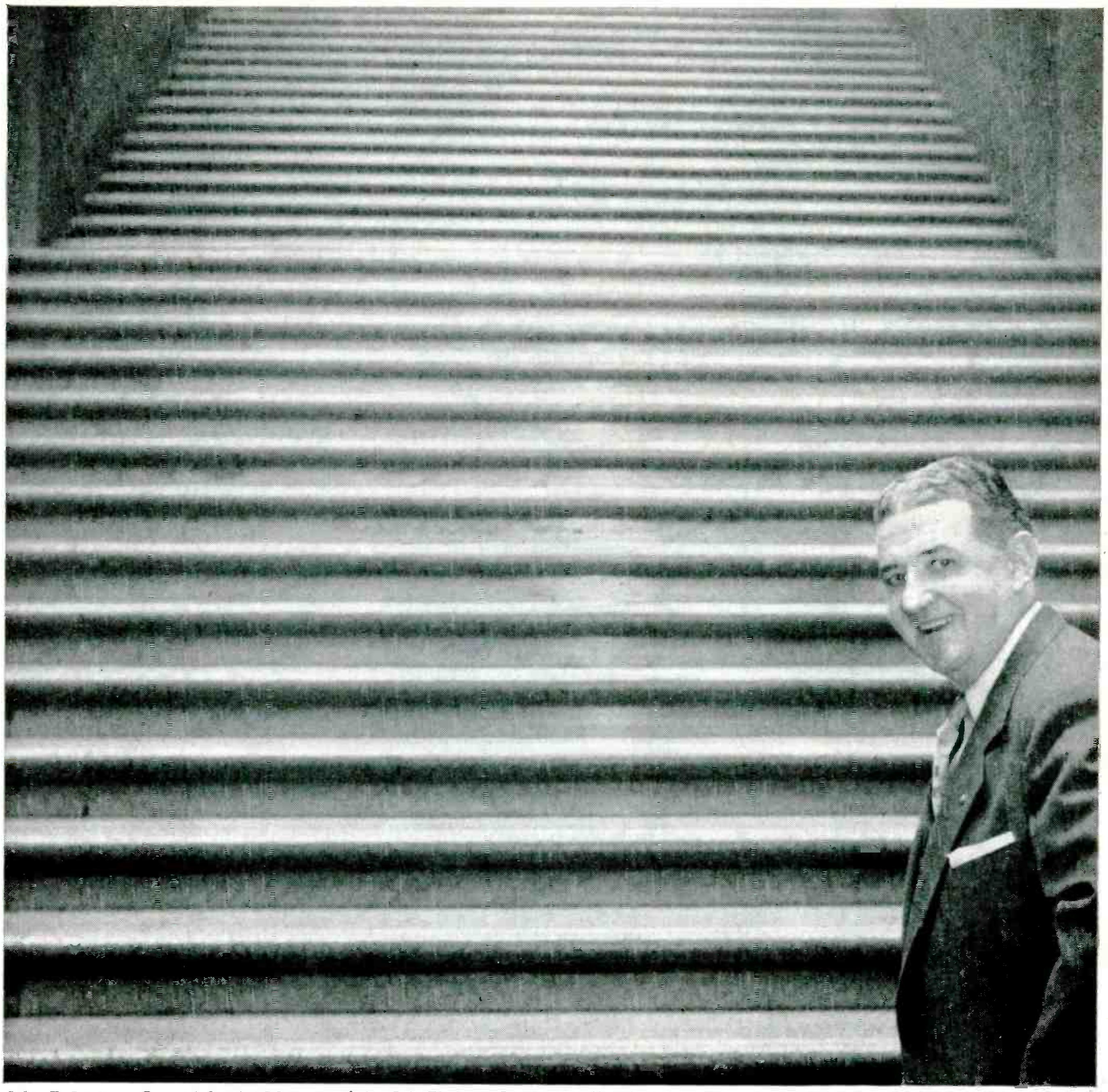
A circuit utilizing these principles was used to obtain balanced outputs from zero to ±50 volts across an R_L that was a 16K sinusoidal potentiometer. Resistors R_1 and R_2 were each 500K 1-percent wire-wound. The amplifier K_0 consisted of a 12AX7 tube and a 12AU7, giving a gain of several thousand.

The total power-supply drain was 20 ma from the positive supply. The unbalance was not greater than 1 percent. The critical values of resistance are R_1 and R_2, the two feedback resistors.

Battery-Powered A-C Voltmeter

By L. Fleming
Falls Church, Virginia

PORTABILITY and complete isolation from power lines are requirements that point to the use of battery-powered instruments. Stability demands the employment of



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negative feedback. Most feedback circuits, however, when applied to filamentary tubes, call for separate A batteries for different stages in the circuit.

A battery-powered electronic a-c voltmeter has been described by the writer[1], which employed a feedback loop extending from the plate of the third stage to the screen of the first stage, thus permitting a common battery supply for all three filaments. Screen feedback, however, has considerable disadvantages. For the best stability of calibration with respect to tube changes, the feedback voltage should be introduced directly in series with the input.

The circuit described here does this, while preserving the simplicity and low battery drain of the earlier design. Figure 1 shows the basic circuit idea, and Fig. 2 the complete circuit.

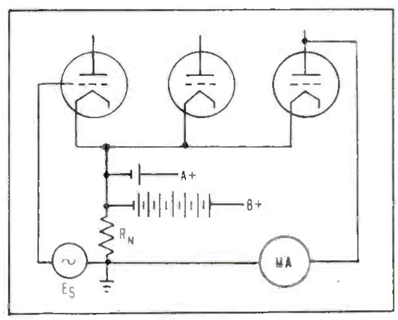
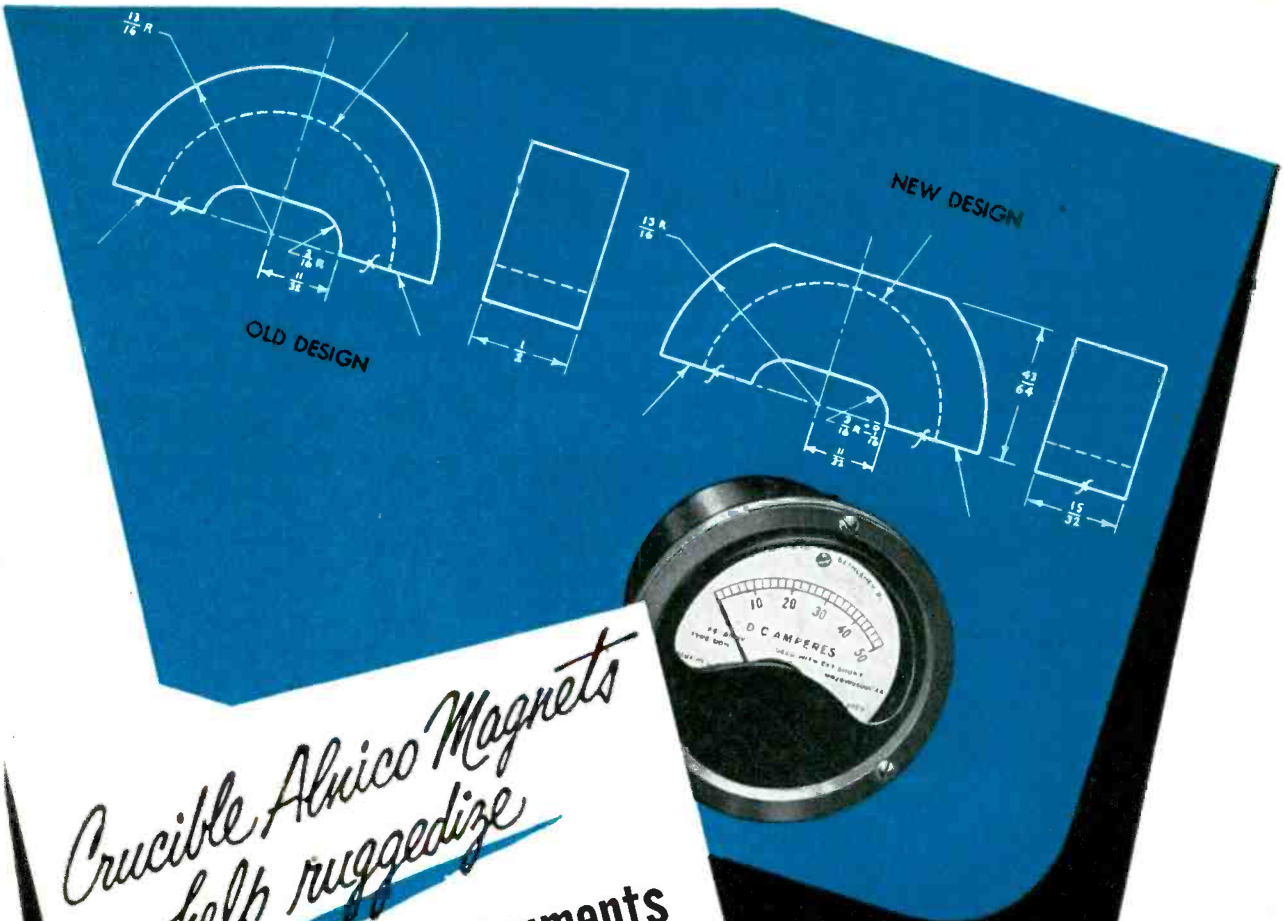


FIG. 1—Elementary feedback circuit for three stages and common A and B batteries described in text

Overall characteristics are: full-scale sensitivity, 4 millivolts to 40 volts in 5 ranges; frequency range (for 5 percent error), 7 cycles to 40 kc; input impedance, 50 megohms shunted by 50 $\mu\mu$f; battery requirements, 1.5 v at 150 ma and 67 v at 0.8 ma. The circuit is designable to a wide variety of characteristics.

In an amplifier having an odd number of stages, a feedback impedance R_n is made common to both the input and the output circuits. The load in the output circuit is a rectifier-type meter and a voltage proportional to the current through the meter is introduced in series with the input. It may be noted that this arrangement is not equivalent to a cathode resistor common to all three stages. The negative



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sides of both the filament and the plate supplies are connected directly together, and the signal voltage across R_n is common only to the input and output circuits.

The input and output both have a common terminal, indicated by the ground sign. Thus this type of feedback can be used in an amplifier as well as in a vtvm.

Whereas in an ordinary amplifier a ground terminal is common to the input, the output, and the power supply, the present circuit is able to ground only two.

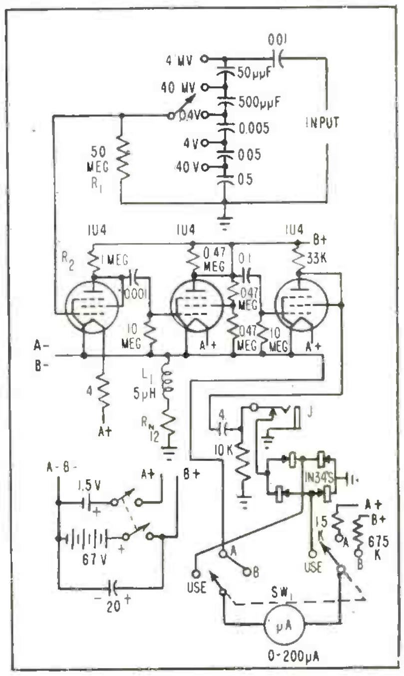

FIG. 2—Capacitive attenuator permits high-resistive input impedance in a-c vtvm using feedback circuit

In a practical three-stage device this is not, however, a serious drawback. The capacitance between an ordinary set of small radio batteries and a metal cabinet is only about 40 $\mu\mu$f at most. The feedback resistor R_n in a three-stage amplifier is generally of the order of a few ohms, so that capacitance effects in a shielded case, or noise pickup in an unshielded case, are not important. An adaptation of this scheme has been used successfully in a single-tube, battery-powered cathode follower[2].

The sensitivity of a vtvm of this type[3] is given by

$$\frac{I}{e} = \frac{A_1 A_2 G_{m3}}{1 + R_n A_1 A_2 G_{m3}}$$

where I = a-c signal current through recti-

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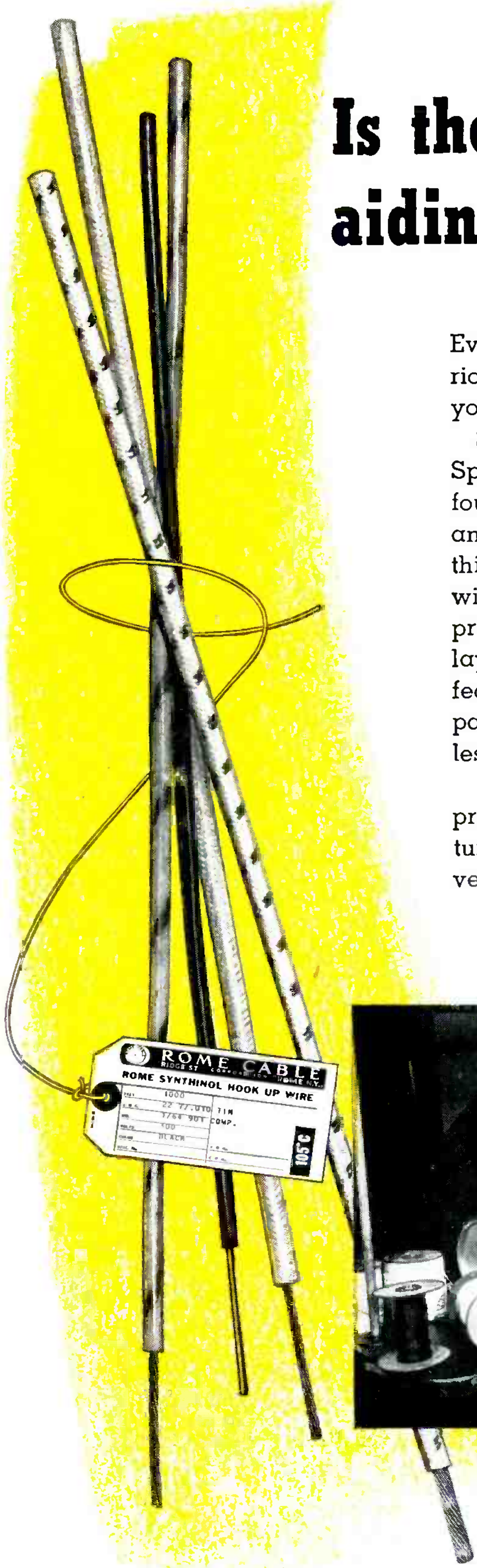

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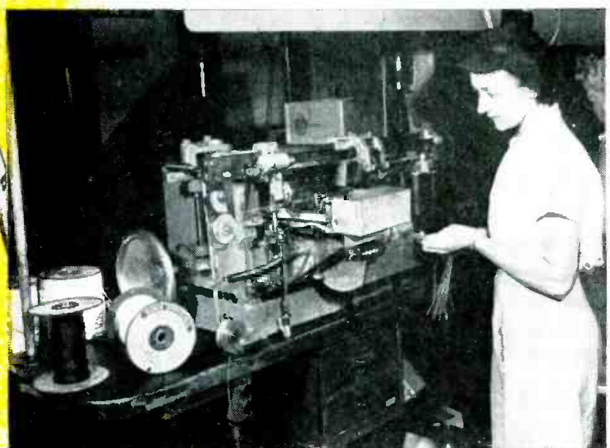

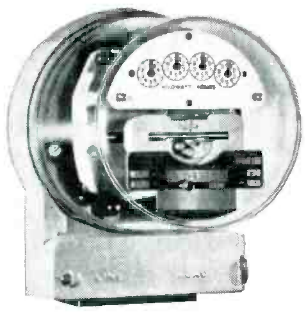

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fier meter used in the device
e = input signal voltage
A_1 = voltage gain of first stage
A_2 = voltage gain of second stage
G_{m3} = transconductance of third stage.

When the gain-transconductance product $A_1 A_2 G_{m3}$ is large, the sensitivity I/e approaches the simple quantity $1/R_n$.

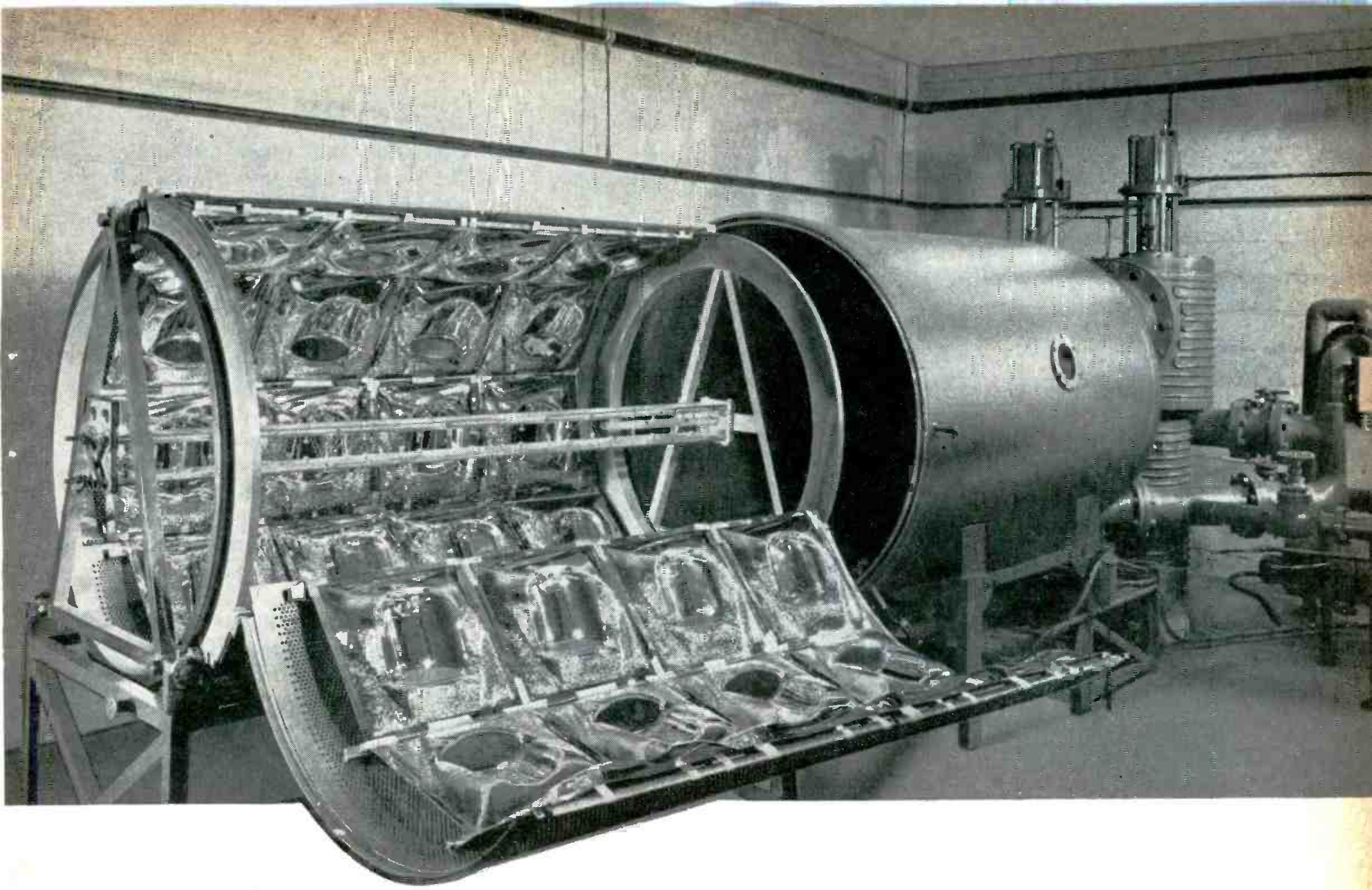
The practical circuit having the specific characteristics listed earlier is shown in Fig. 2. The tubes are the commonest type of filamentary voltage amplifier pentode. Two are triode-connected, the other, the second stage, connected as a pentode with a loose voltage divider supplying the voltage to its screen, so that the operating point does not depend critically on the cutoff characteristic of the tube.

The third stage is triode-connected because it normally operates as a current amplifier into a low-impedance load, the meter. Thus its voltage gain is low, and Miller-effect capacitance is small.

The triode connection of the first stage was dictated by the original application of the instrument, the measurement of the output of piezoelectric accelerometers[4]. These transducers have a capacitive internal impedance of the order of a few hundred μμf. To preserve low-frequency response, the resistive component of the vtvm hence had to be high. That is the reason for the 50-megohm grid resistor R_1. To enhance the stability of this first tube with this high grid resistance, it was operated at a rather low level of plate current.

Low-plate-current operation of tubes reduces ion currents more than proportionately, an expedient long used in electrometer-type circuits. The high plate-load resistance R_2, used to keep the d-c plate current low, unfortunately drops the high-frequency response as well. The droop at high frequencies is not as bad with the tube in triode connection as in pentode connection, because in the former mode the comparatively low dynamic plate resistance of the tube shunts the load R_2.

The high input resistance requirement leads naturally to the consideration of a capacitive input



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attenuator for range switching. The decade steps shown work out satisfactorily. The shunt input capacitance is only 50 $\mu\mu$f, but the lowest capacitance seen by the first grid is 500 $\mu\mu$f. It is interesting to note that a capacitive attenuator is theoretically flat up to infinite frequency. Its errors occur at low frequencies, due to the shunt load resistance across the attenuator.

The feedback impedance in this practical case is a 12-ohm resistor in series with a small inductance. The latter is a phase corrector used to flatten out a peak in the response near 30 kc. The feedback factor is about 15 db.

Regenerative peaks in the low-frequency region are the most common difficulty in circuits of this type. The disparity in the various interstage coupling capacitances indicates a practical solution.

The signal rectifier is a full-wave bridge using four germanium diodes. The cheaper half-bridge is satisfactory where gain and power consumption are not at a premium; its sensitivity approaches half the value of a full bridge.

Midband sensitivity of the complete vtvm is slightly affected by changes in battery voltage due to aging. However, the high internal resistance of an old B battery tends to introduce a regenerative peak at the low frequency limit of the band. This trouble is eliminated by an electrolytic capacitor.

A built-in switch circuit is incorporated to permit checking the battery voltages with the indicating meter. A jack *J* adapts the instrument to use as an amplifier, having an output impedance of 10,000 ohms.

REFERENCES

(1) L. Fleming, Sensitive A-C VTVM, ELECTRONICS, p 122, Dec. 1950.

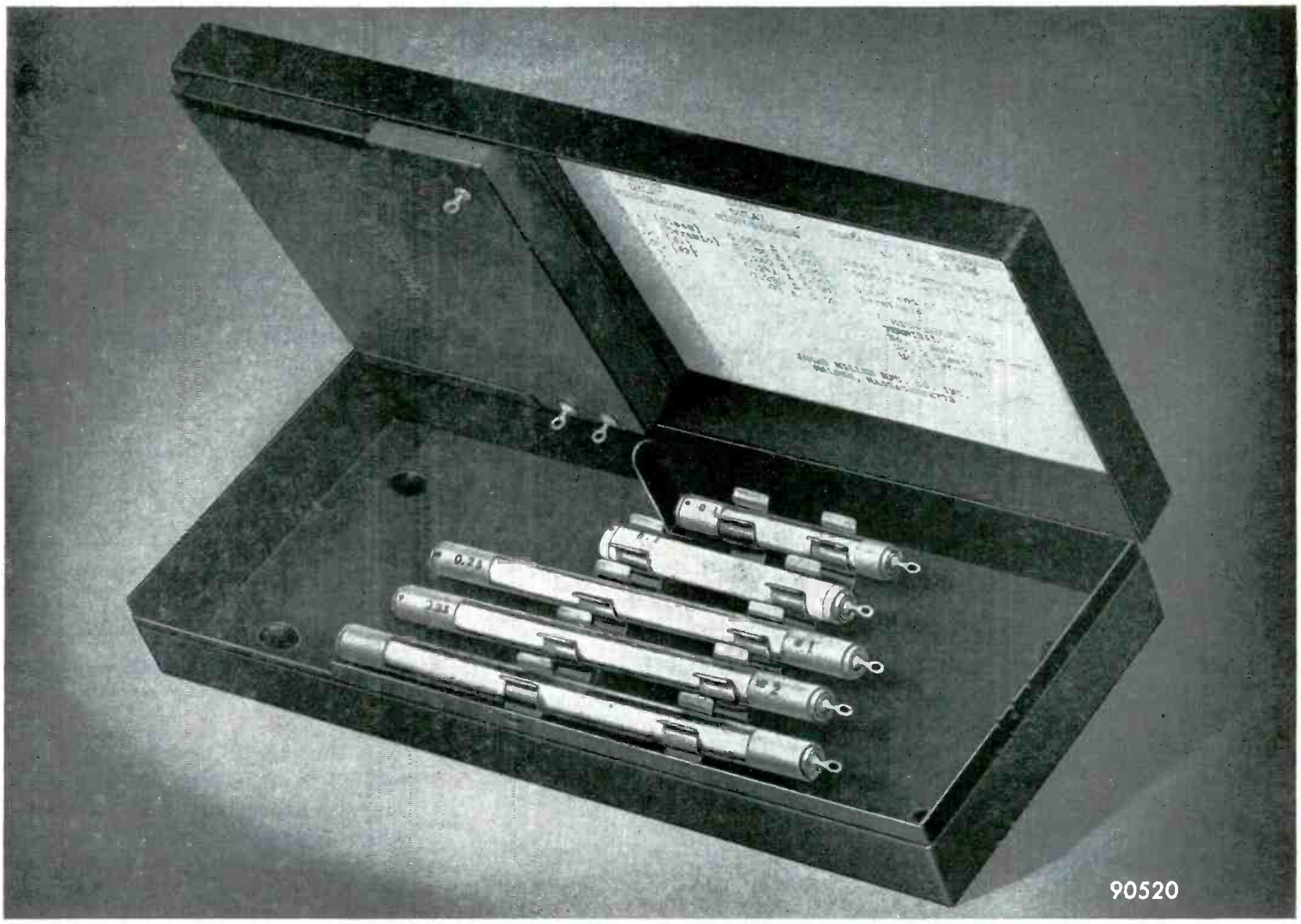
(2) L. Fleming, Battery-Operated Cathode Follower, ELECTRONICS, p 178, May 1950.

(3) L. Fleming, A-C Voltmeter for Built-in Instrumentation, ELECTRONICS, p 152, Sept. 1950.

(4) L. Fleming, A Ceramic Accelerometer of Wide Frequency Range, *Jour Instrument Soc America*, 24, p 968, July 1951.

AGC for Transistor Amplifiers

IN A PAPER entitled "Automatic Gain Control of Junction Transis-



LABORATORY DELAY LINE STANDARDS

The Millen delay line kit effectively provides a means for the development and design engineer to check the affect of various delays in their actual developmental setups without the time loss and expense of producing separate lines for each trial. Increased requirement for time delay circuits in radar, color television and other modern electronic applications has presented a problem to the design and development engineer as it has been both time consuming and expensive to obtain delay lines for developmental work as each line was necessarily cut to the estimated delay and any change in requirements necessitated the fabrication of a new delay line. The Millen delay line kit is designed to provide a ready means of obtaining various delays from .10 microseconds through 2 microseconds in increments of .05 microseconds except at the extreme ends of this range. The lines may be used repeatedly without deterioration as they are hermetically sealed, the smaller lines in glass tubes, the 1 microsecond line in a metal container.

Each set consists of:

NOMINAL DELAY	TOL.	CALIBRATION TOLERANCE
2—0.10 µs.	± 0.01 µs.	± 0.002 µs.
2—0.25 µs.	± 0.025 µs.	± 0.002 µs.
1—0.30 µs.	± 0.03 µs.	± 0.002 µs.
1—1.00 µs.	± 0.05 µs.	± 0.01 µs.

Actual delay as measured by phase shift method are marked on each delay line. The laboratory calibration of each delay line is accurate to ± 0.002 microseconds on all of the .10 microsecond, .25 microsecond and .03 microsecond lines and ± 0.01 microsecond on the 1 microsecond line. Combination of delay lines supplied makes possible the following delays:

0.10 µs.	0.55 µs.	1.10 µs.	1.55 µs.
0.20	0.60	1.20	1.50
0.25	0.65	1.25	1.55
0.30	0.70	1.30	1.70
0.35	0.75	1.35	1.75
0.40	0.80	1.40	1.30
0.45	0.90	1.45	1.90
0.50	1.00	1.50	2.00

Characteristic impedance — 1350 ohms ± 20%.

PHYSICAL DIMENSIONS:

0.1 µs.—15/32" dia. x 4 [illegible]" long
0.25 µs.—15/32" dia. x 7 [illegible]" long
0.30 µs.—15/32" dia. x 7 [illegible]" long
1.00 µs.—4¾" x 4¾" x 1"

All seven lines are mounted in a metal case 9½" x 5" x 1¾" for convenience in storing and safety in handling.

JAMES MILLEN MFG. CO., INC.

MAIN OFFICE AND FACTORY

MALDEN, MASSACHUSETTS, U. S. A.

tor Amplifiers", presented at the National Electronics Conference F. H. Blecher of Bell Labs described a method for applying agc to transistor circuits.

Although the absolute value of emitter resistance varies from transistor to transistor, it was found that in practically all cases it would vary inversely with emitter current. By varying emitter resistance the gain of the transistor can be changed.

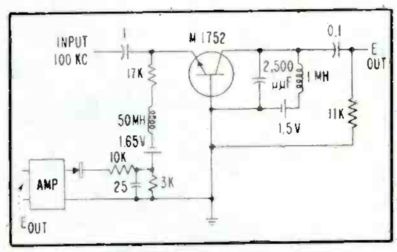


FIG. 1—Amplifier circuit with gain controlled by varying emitter resistance

In the circuit of Fig. 1, agc is applied to an r-f or i-f amplifier. The circuit assumes that the stage will be followed by additional stages of amplification before audio detection. The d-c voltage from the detector is used as the gain-control voltage. The emitter bias circuit is arranged so the emitter current will be decreased when the gain-control voltage is increased.

Since the emitter bias current is decreased when input signal increases, the amplifier tends to distort unless low signal levels are

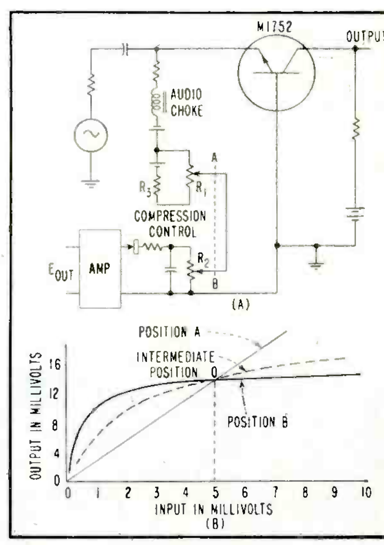
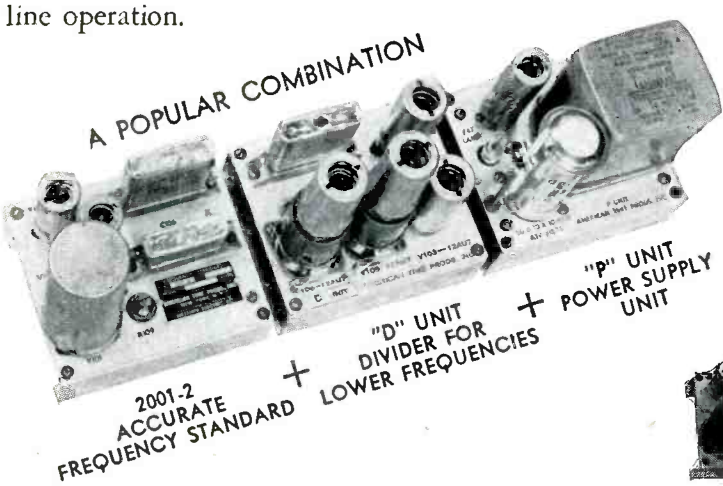


FIG. 2—Audio volume compressor (A) and input-versus-output curves (B) for setting of the control potentiometer

FREQUENCY STANDARDS *Modular*

DESIGNED AS A *system*

The Type 2001-2 series provides frequencies from 30 to 30,000 cycles with an accuracy of .001% (at room temperatures) in units suitable for integration with instruments of your own design — or for panel rack mounting with your own power sources — or for line operation.



WHICH WILL MEET YOUR
CUSTOM NEEDS
FROM A COMBINATION OF
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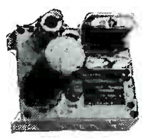
TYPICAL COMBINATIONS

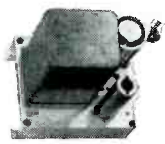
2001-2	2001-2 + M
2001-2 + L	2001-2 + M + P
2001-2 + L + P	2001-2 + L + P + R
2001-2 + H	2001-2 + H + P + R
2001-2 + H + P	2001-2 + M + P + R



TYPE "2001-2"
FREQUENCY STANDARD
Frequencies, 200 to 3,000 cycles. Output, approximate sine wave at 5 volts.

ACCESSORY UNITS

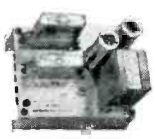
"L" UNIT.
DIVIDER, (MULTI-VIBRATOR TYPE)
Provides frequencies from 30 to 200, controlled by the 2001-2 unit.
Output, approx. 5V. Approx. sine wave.



"M" UNIT
AMPLIFIER
Provides 2 watts at 6 and 110 volts.

"D" UNIT.
DIVIDER, (COUNTER TYPE)
Provides 40 to 200 cycles controlled by the 2001-2 unit. (fail safe)

"P" UNIT
POWER SUPPLY
Provides power for combinations of units illustrated, if other sources are inconvenient or not available.



"H" UNIT
MULTIPLIER
Provides frequencies from 3,000 to 30,000 cycles, controlled by the 2001-2 unit. Output, approximately 5 volts.

"R" UNIT
PANEL MOUNTING
Accommodates up to three units. Standard size is 8¾ inches high, 19 inches long.

For details, please request our "Type 2001-2" Booklet.

American Time Products, Inc.

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

OPERATING UNDER PATENTS OF WESTERN ELECTRIC COMPANY

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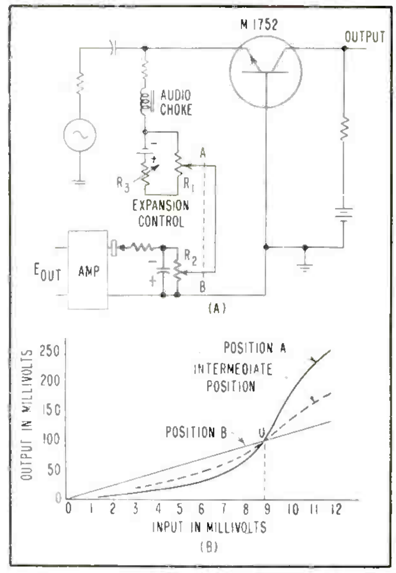

FIG. 3—Volume expander circuit (A) and range of expansion obtainable (B)

used. In the circuit shown, 15 mv is the largest signal that can be handled without raising the distortion above 2 percent.

If the tuned circuit is replaced with a load resistor and a 3-volt collector supply, a compressor amplifier suitable for audio use is obtained. This circuit is shown in Fig. 2A. Compression is controlled by the dual potentiometer R_1R_2 as shown in Fig. 2B. Slope of the operating line can be controlled by potentiometer R_3.

The volume-expander circuit of Fig. 3A is similar to the compressor circuit of Fig. 2 except that the emitter bias circuit is arranged so emitter current will increase as the gain-control voltage is increased. Expansion is controlled by R_1R_2 over the range indicated in Fig. 3B.

British Electronic Developments

By J. H. Jupe
"Rogart", Hillside Road
Chorleywood
Herts., England

Recent new applications of vacuum tubes and other electronic equipment have extended the usefulness of existing devices and made possible new techniques in various scientific fields.

Flying-Spot Microscope

An electronic device attracting attention in Britain is the newly de-

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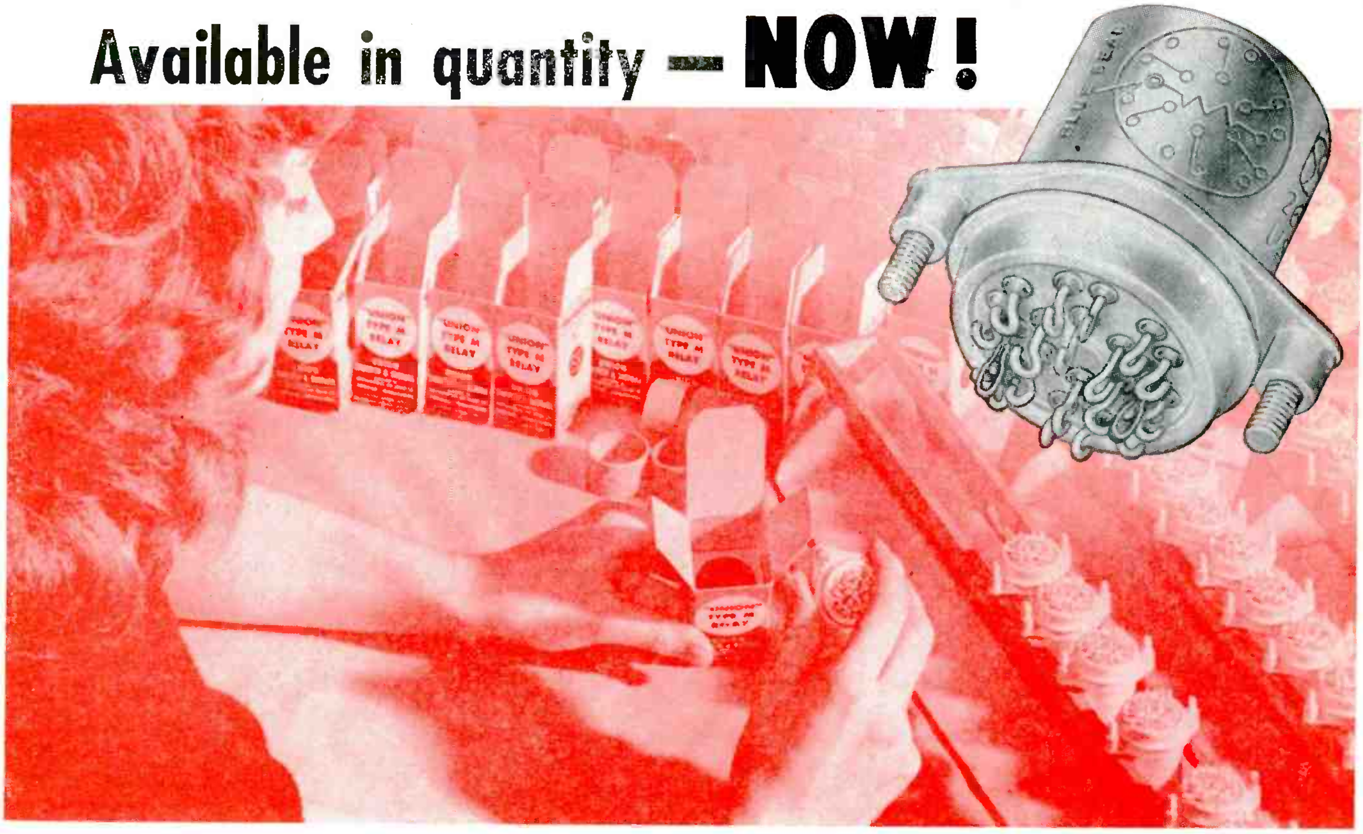

UNION TYPE M MINIATURE RELAYS

MEET ALL REQUIREMENTS OF MILITARY SPECIFICATIONS MIL-R-5757 A & B

TYPICAL PERFORMANCE DATA

Service Temperature	-65°C to 125°C	-55°C to 85°C
Style FM (6-pole)	303125	303085
Style FM (4-pole)	312570	
Coil Resistance	325 ohms	325 ohms
Nominal Voltage	26.5	26.5
Max. Pull-In Voltage at Max. Rated Temperature	18	18
Max. Drop-Out Voltage at Max. Rated Temperature	13	13

Service	Continuous
Shock	40 G's for 10 milliseconds
Vibration	10 to 55 cycles per sec.— 0.060 total excursion
Life Expectancy	1,000,000 operations minimum
Contact Rating	2 amps. at 26.5 Volts— Resistive Load
Breakdown Voltage at Sea Level	1000 volts a.c. between case and contacts or coil

Now, you can buy Union type M miniature relays *in quantity*. And due to our large production facilities, you can expect a delivery date that will meet your needs. Both 6-pole and 4-pole doublethrow models are available. They meet all requirements of Military Specifications MIL-R-5757 A & B.

Here are the facts: shock load rating for the Union type M relay is 40 G's for 10 milliseconds, and this figure is obtained with the relay deenergized. This is an important point to remember, because some relays are shock-rated with the relay energized, resulting in a stiffer assembly with a higher (and non-comparable) G rating.

Breakdown voltage at sea level is 1000 volts between case and coil *or* contacts, a figure unmatched by any known comparable relay. The low 18-volt pull-in voltage is given for *maximum* rated temperature. You do not have to allow for temperature rise when you use this design figure.

This relay, weighing only 3½ ounces, is hermetically sealed containing nitrogen under pressure.

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veloped flying spot microscope. This instrument has been designed to overcome a number of disadvantages inherent in the usual microscope techniques and is capable of presenting a picture of high definition and large magnification to multiple audiences.

Electronically, it is a near relative of modern television systems and consists of a cathode-ray scanning tube with an optically-ground flat face is coated with a blue-violet fluorescent powder. An unmodulated 405-line raster is generated on the screen and this raster, by straightforward optical means, is reduced and made to scan a very small area of the specimen under examination.

The transmitted light, which is modulated according to the light density and the configurations of the specimen, falls upon a sensitive multiplier phototube, the output of which is amplified and is made to modulate another raster on a large, normal cathode-ray tube. The two rasters are synchronized so that the picture built up on the viewing screen is a faithful copy of the specimen scanned.

Advantages of the flying-spot microscope are several. The specimen can be viewed by large audiences.

Contrast of the specimen can be varied by electronic means. This eliminates need for specimens to be stained. For subjects that cannot be stained, satisfactory contrast can be obtained.

In normal microscope work, use of high light intensity can cause the specimen to become damaged or distorted. With the flying-spot instruments, this trouble is eliminated because while the peak intensity of the spot is high, its speed is also high and therefore the average intensity is low.

By using ultraviolet radiation from the scanning tube and a photoelectric tube sensitive to ultraviolet, it is possible to obtain resolution equal to that obtained with photographic emulsions, but with the extra advantage of direct viewing and ease of operation.

The use of a flat-faced viewing tube enables tracings of the specimen image to be made. The appara-

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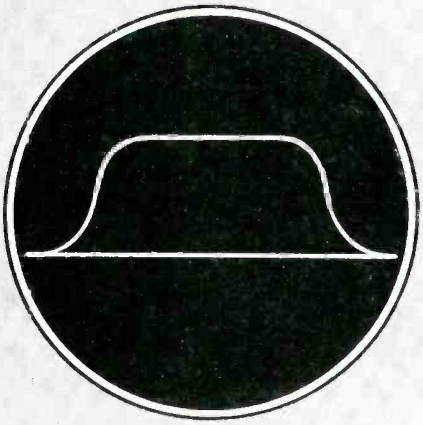
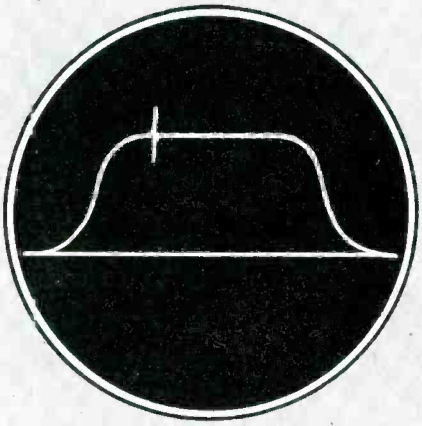
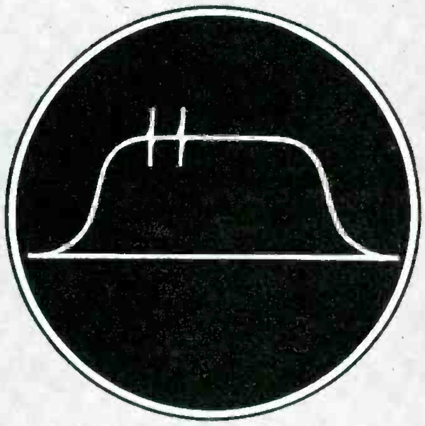


Single Sweep 50 kc to 8 mc



Sweep with Variable OR Crystal-Positioned Marker



Sweep with Variable AND Crystal-Positioned Markers

HIGH LEVEL (1.5 volts) METERED OUTPUT

- **Combines all-electronic sweep covering the whole TV video frequency band with variable marker plus five crystal positioned markers.**
- **Zero level baseline produced on oscilloscope pattern.**

Model Video TTV MARKA-SWEEP

- **CW Oscillator variable from 50 kc to 8 mc, accurate within ½ of 1 per cent.**

SPECIFICATIONS

SWEEP RANGE: 50 kc to 8 mc.

SWEEP: All electronic linear sawtooth. Sweep repetition rate is adjustable around and may be synchronized to the power line.

MARKERS: CW — A continuously variable CW signal covering the frequency range from 50 kc to 8 mc is provided. The frequency dial is calibrated in 0.1 mc divisions and is accurate within ½ of 1%.

Crystal Positioned—Five Crystal positioned marks are provided at 0.20, 0.75, 1.25, 4.0 and 6.0 mc. If desired, special crystal positioned marks may be substituted for standard ones.

DIMENSIONS: Standard rack-mounting panel, 10½" x 19"; depth 16½". (If ordered in cabinet, 11¾" x 22" x 16½")

AMPLITUDE MODULATION WHILE SWEEPING: Less than 0.05 db/mc.

OUTPUT VOLTAGE: Sweep, CW and Crystal frequencies—each 4.2 volts peak-to-peak, into 72 ohms (1.5 volts, r.m.s.). Peak-to-peak reading voltmeter provided at output, accurate within approximately 5%.

OUTPUT ATTENUATORS: Switched: 20 db, 20 db, 10 db, 3 db. Continuous: Approximately 26 db.

MARKER OUTPUT CONTROL: Continuously variable, approx. 5 db.

WEIGHT: 40 pounds. (With cabinet, 65 pounds).

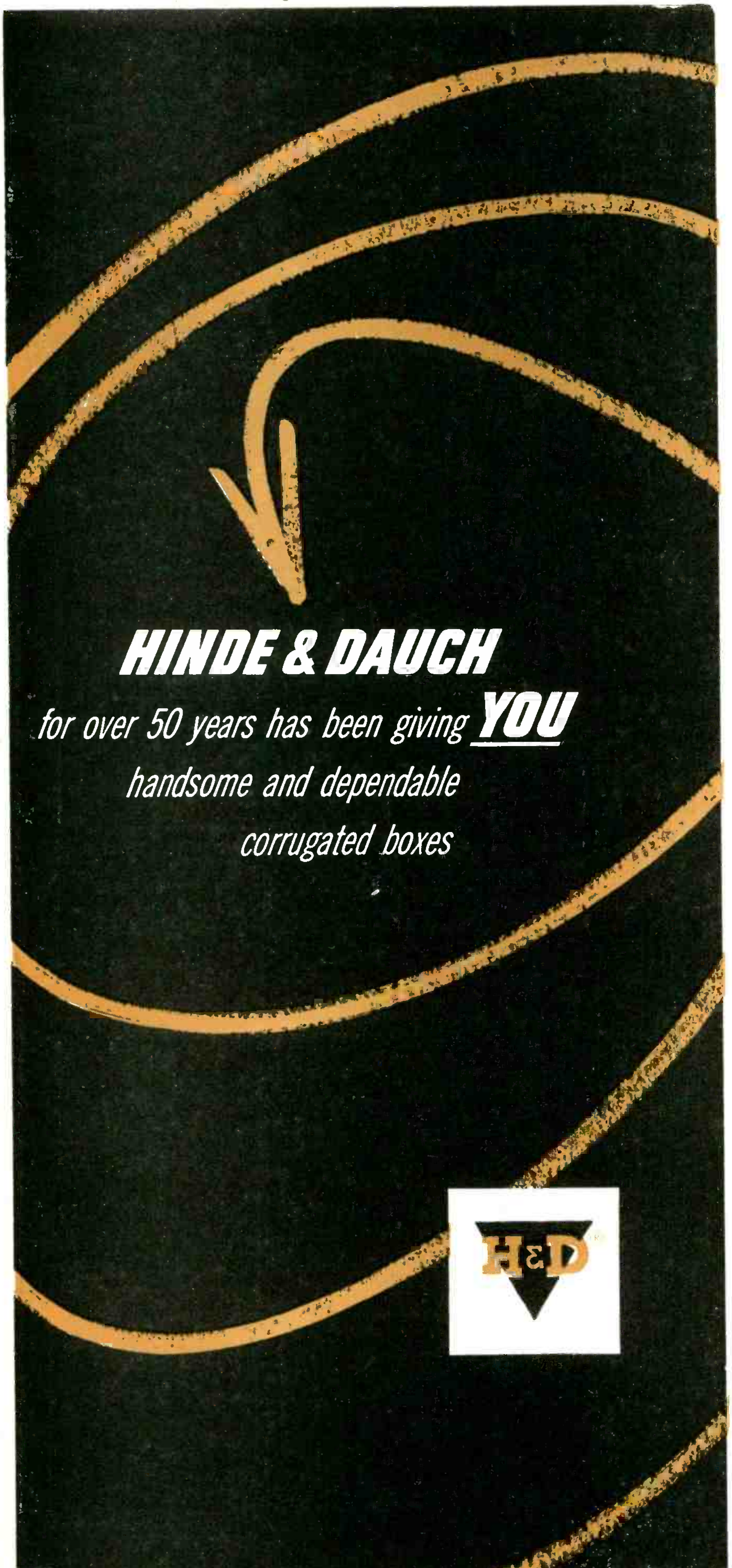
CATALOG NO.: 151-A

PRICE: $695.00 f.o.b. factory, for rack mounting. (Special crystal positioned marks substituted at $10.00 each). Note: Cabinet $35.00 extra.

KAY

KAY ELECTRIC COMPANY

14 Maple Avenue — Phone CAldwell 6-4000 — Pine Brook, New Jersey



tus can also be used for automatic and rapid counting or sorting.

Photocell Smoke Indicators

One of the difficulties in using photoelectric devices for the indication of smoke is that spurious readings can often be obtained due to the gradual build-up of soot and dust on lenses and windows and due to transient conditions caused by fluctuations of line voltage or the momentary passage of relatively large pieces of material through the beam.

In practice, the only indications of importance to the boilerhouse attendant are those caused by a fairly rapid and sustained decrease in the photoelectric current, caused by smoke. A new method of segregating the wanted variation is obtained by applying the input from the cell to the ends of a potential divider composed of two high resistances connected in series.

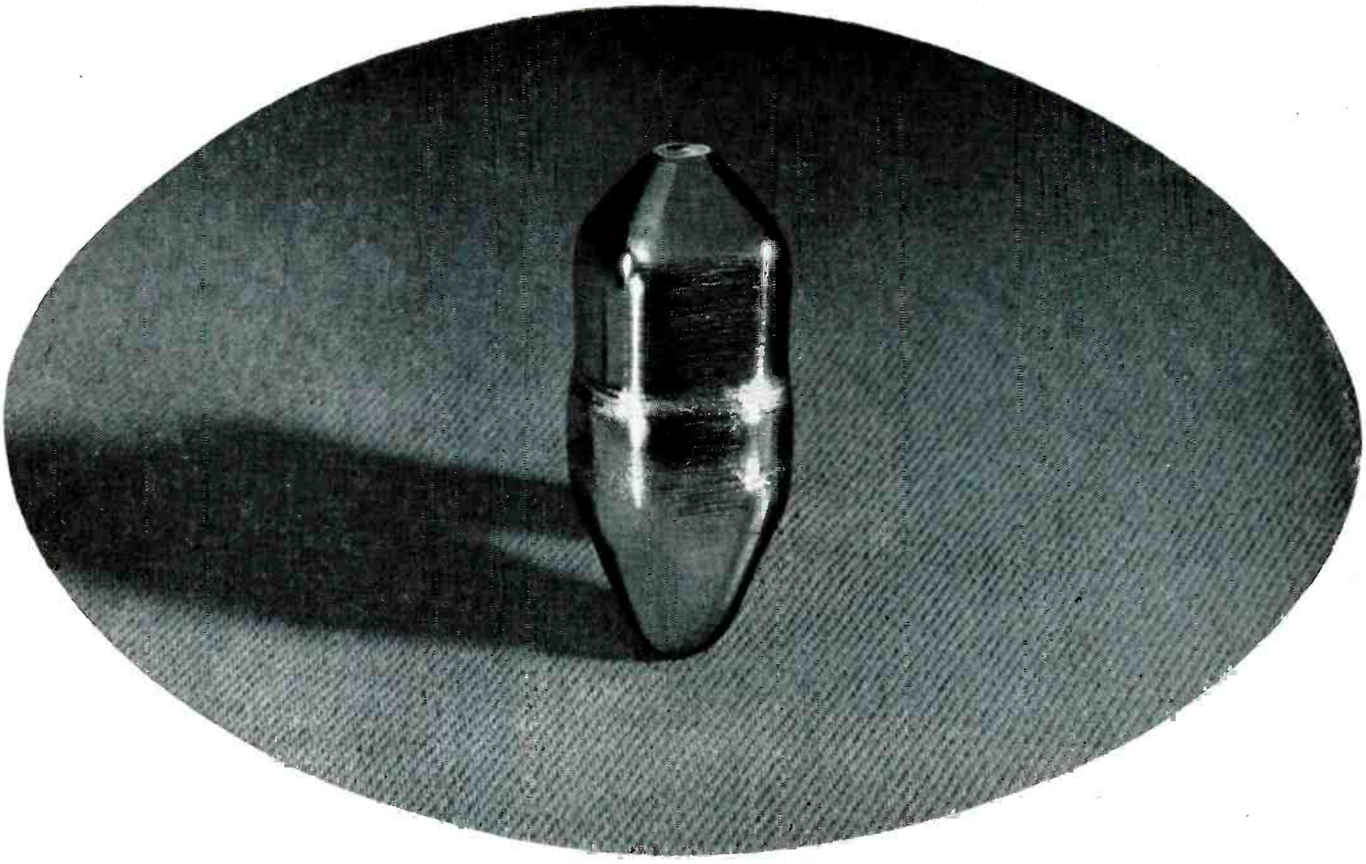
The value of one resistance is chosen to be several times as large as the other and has a capacitor connected in parallel with it. A small capacitor is connected across the whole potential divider and the output is taken from the smaller of the two resistances.

Ionization Manometer

A new method of measuring the degree of vacuum in pumped systems depends on measurement of the changes of current flowing in an ionized gas discharge in the system. The measuring device of glass contains a cylindrical cold-cathode electrode, with a number of metal baffle plates joined to the cathode in such a way that the whole vessel is divided into a number of chambers, which communicate with each other via a central hole in each baffle.

The anode is a fine wire, mounted so as to run centrally through the holes. A d-c voltage between 2,500 and 5,000 v is applied between anode and cathode, depending on the degree of vacuum to be measured. Finally, the whole device is surrounded by a solenoid energized from a d-c source.

The current flowing between the anode and cathode is measured by amplifying the voltage drop across



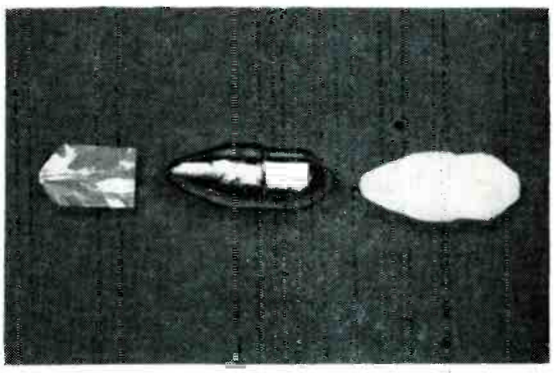
Germanium crystal grown at Bell Telephone Laboratories (life size). It is sliced into hundreds of minute pieces to make *Transistors*. Transistor action depends on the flow of positive current-carriers as well as electrons, which are negative. Arsenic —a few parts per 100,000,000—added to germanium produces prescribed excess of electrons. With gallium added, positive carriers predominate. Latest junction type *Transistor* uses both kinds of germanium in the form of a sandwich.

THEY GREW IT FOR TRANSISTORS

Heart of a ***Transistor*** – Bell Telephone Laboratories' new pea-size amplifier – is a tiny piece of germanium. If ***Transistors*** are to do their many jobs well, this germanium must be of virtually perfect crystalline structure and uniform chemical composition. But it doesn't come that way in nature.

So—Bell scientists devised a new way to *grow* the kind of crystals they need, from a melt made of the natural product. By adding tiny amounts of special alloying substances to the melt, they produce germanium that is precisely tailored for specific uses in the telephone system.

This original technique is another example of the way Bell Laboratories makes basic discoveries – in this case the ***Transistor*** itself – and then follows up with practical ways to make them work for better telephone service.



Section of natural germanium, left, shows varying crystal structure. At right is sectioned single crystal grown at Bell Laboratories.

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a 2-megohm resistor connected in series with the anode.

It is claimed that the above form of construction causes the electrons to follow a helical path in and out of the various chambers, ensuring a large number of collisions with residual gas molecules, a high degree of ionization and thus high sensitivity of vacuum measurement.

Phase Transducer Uses High-Speed Relay

By Desmond E. S. Isle

Late GPO Engineering Dept. London, England

Electronic phase-measuring devices base their comparative action on the output of a limiting amplifier, followed by a gating tube or tubes, which accept the additive component of the limiter square-wave output. This equipment is necessarily complicated inasmuch as it needs all usual ancillary power supplies.

The high-speed relay system described here needs a minimum of attendant equipment. Input frequency may be as low as is practicable with any indicator.

Two high-speed relays with coils rewound to 3,000 ohms are used. The contacts are connected as in Fig. 1 with alternating voltages applied directly across the windings of each relay. This system gives a direct reading of phase on the indicating meter, which is a normal voltmeter calibrated from 180 deg

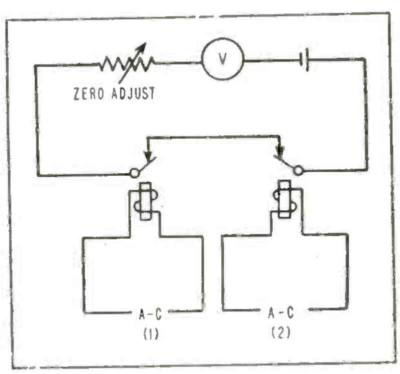
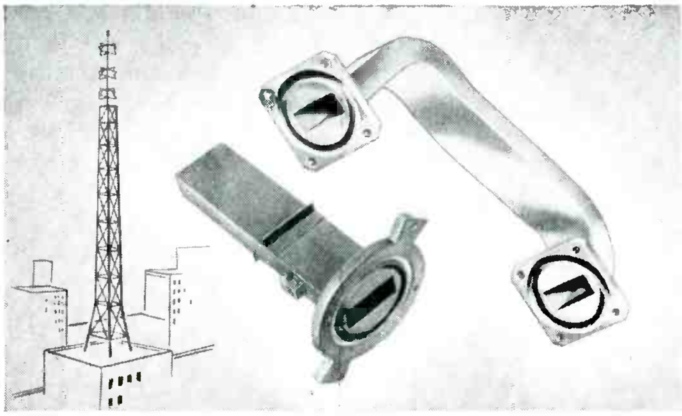
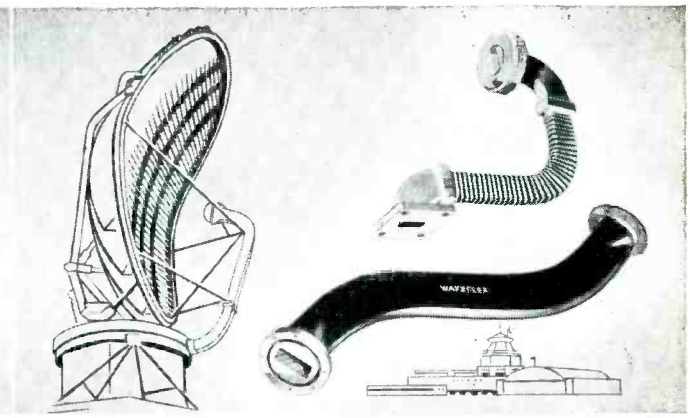


FIG. 1—Phase transducer circuit

to zero. A stable source of d-c feeds the indicator. A potentiometer is adjusted to give zero phase angle with both relays connected to the

All these from one experienced source





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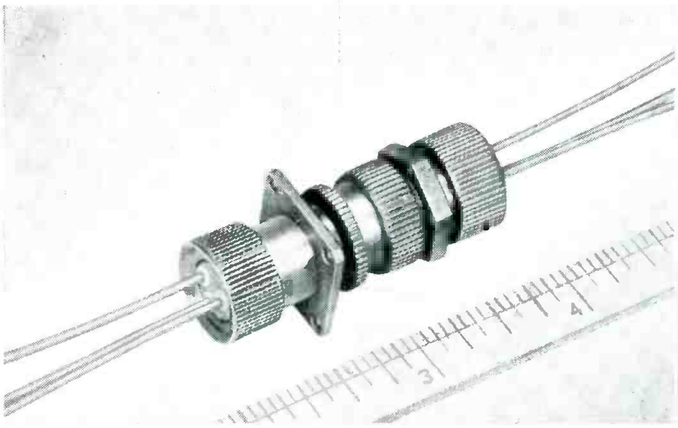
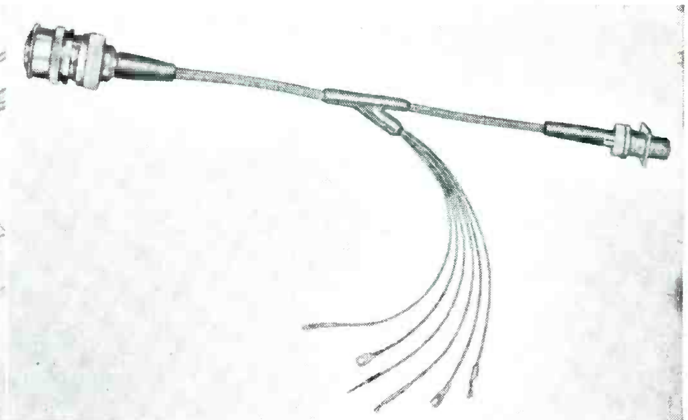
WAVEFLEX® FLEXIBLE WAVEGUIDES are fabricated to retain critical dimensions — regardless of twisting or bending. Waveflex waveguides make assembly easy, improve design, compensate for expansion or movement. Rubber jacketing protects against weather, corrosion, physical abuse.





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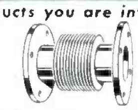

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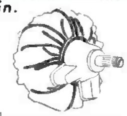

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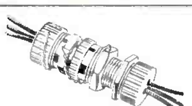
☐ IGNITION SHIELDING



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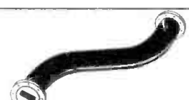

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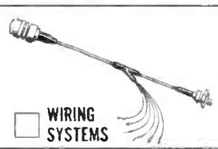

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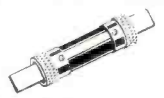

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same supply source of a-c power.

The maximum frequency at which the relays will produce a square-wave output, may be increased by careful adjustment and by removing surplus metal from the armature. This is not necessary below 350 cycles. An optimum frequency for this transducer is 60

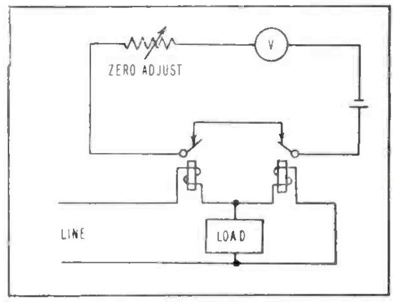

FIG. 2—Power factor indicating circuit

cycles, and therefore it is suitable for use on power supply lines.

A modification to one of the relays, shown in Fig. 2, gives a circuit suitable for power-factor indication by integrating voltage against current over alternate half-cycles of the supply waveform.

One relay winding (of high impedance) is directly across the supply, and the low-impedance winding of the second relay, is in series with the test load. Thus one relay responds to line voltage, and the second responds to the voltage across the relay. As the latter is in phase with the load, due to the winding being of negligible inductance, power factor is indicated.

The relays have proven very reliable in operation, and maintain adjustment over long periods. Contact bounce is avoided by using a contact travel of approximately 4 to 5 thousandths of an inch, thus limiting armature-inertia effects.

PERTINENT PATENTS

A MEANS for microwave modulation is the subject of an invention by S. Freedman and G. Fonda-Bonardi awarded patent 2,640,964.

UHF Frequency Modulator

The invention describes a means of frequency modulating uhf oscil-

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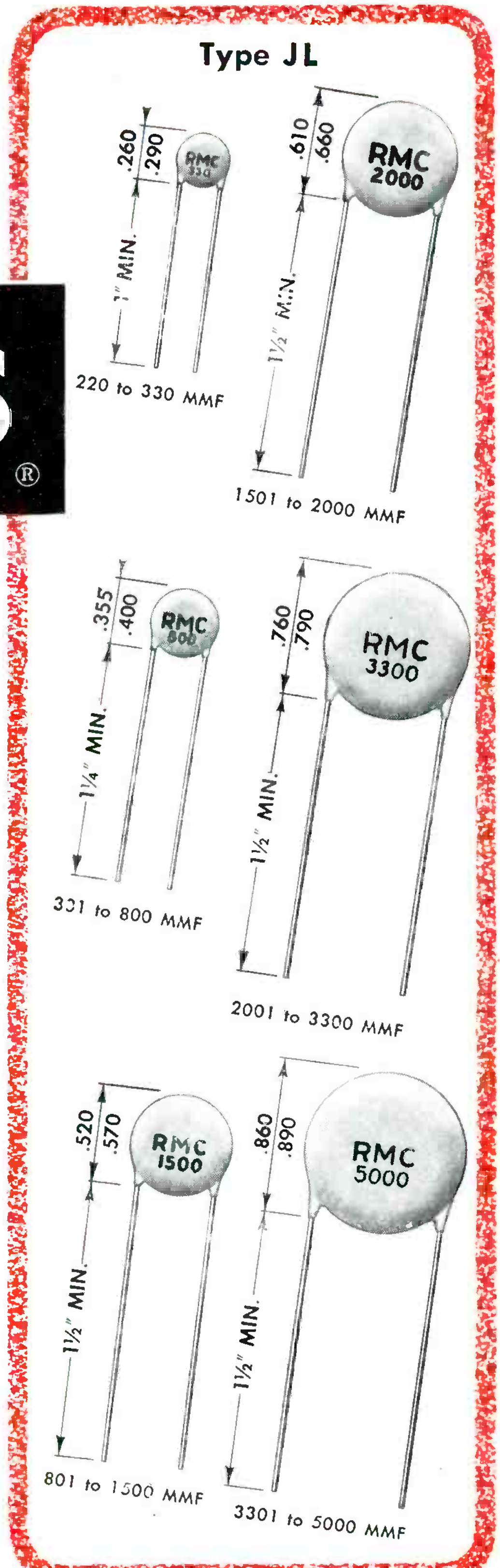
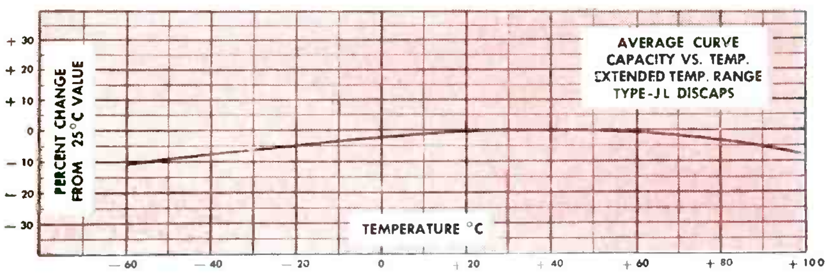


SPECIFICATIONS

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



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lators in which the familiar reactance-tube devices may not be used effectively.

As shown in Fig. 1, an electrodynamic driver reminiscent of the dynamic loudspeaker mechanism is attached to a resonant tank or chamber in a microwave generator. A diaphragm of the electrodynamic modulator varies the chamber dimensions and accordingly varies the frequency transmitted out to

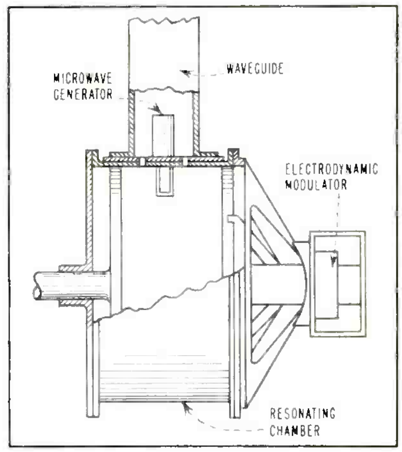

FIG. 1—Cavity is frequency modulated

the load through the waveguide.

Figure 2 illustrates the simple way in which the system may be operated with a telephone unit. Figure 3 shows the structure of the modulator.

Watch Tester

Herald B. Greening of Toronto, Canada, has developed a stroboscopic "Means for Testing the Accuracy of Watches". United States patent 2,640,350 has been granted for the invention.

As can be seen in the diagram of Fig. 4, a standard channel and a test channel are provided, both powered from the same source.

A standard watch is placed on the microphone of the standard channel, and its ticks are amplified in a two-stage amplifier to drive a relay *F* that controls the motion of slotted wheel *Q*.

The test watch is placed on the other microphone. Its ticks are amplified to drive relay *W*, which, in turn, controls the motion of slotted disk *P*, similar to *Q* and on a common shaft with *Q*.

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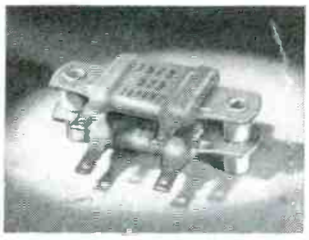

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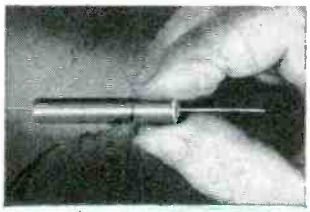

Greenohm Junior or miniature resistor in ceramic casing filled with Greenohm cement.

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placed behind disk Q so that when the slots of Q and slots of P are aligned, the light will be visible

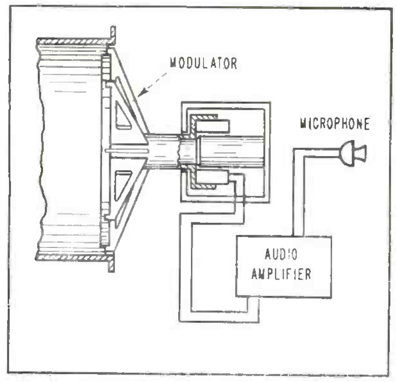


FIG. 2—Simple circuit of uhf voice modulator vibrates cavity

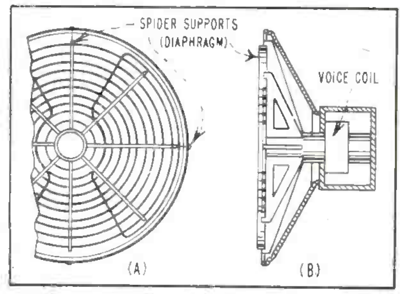


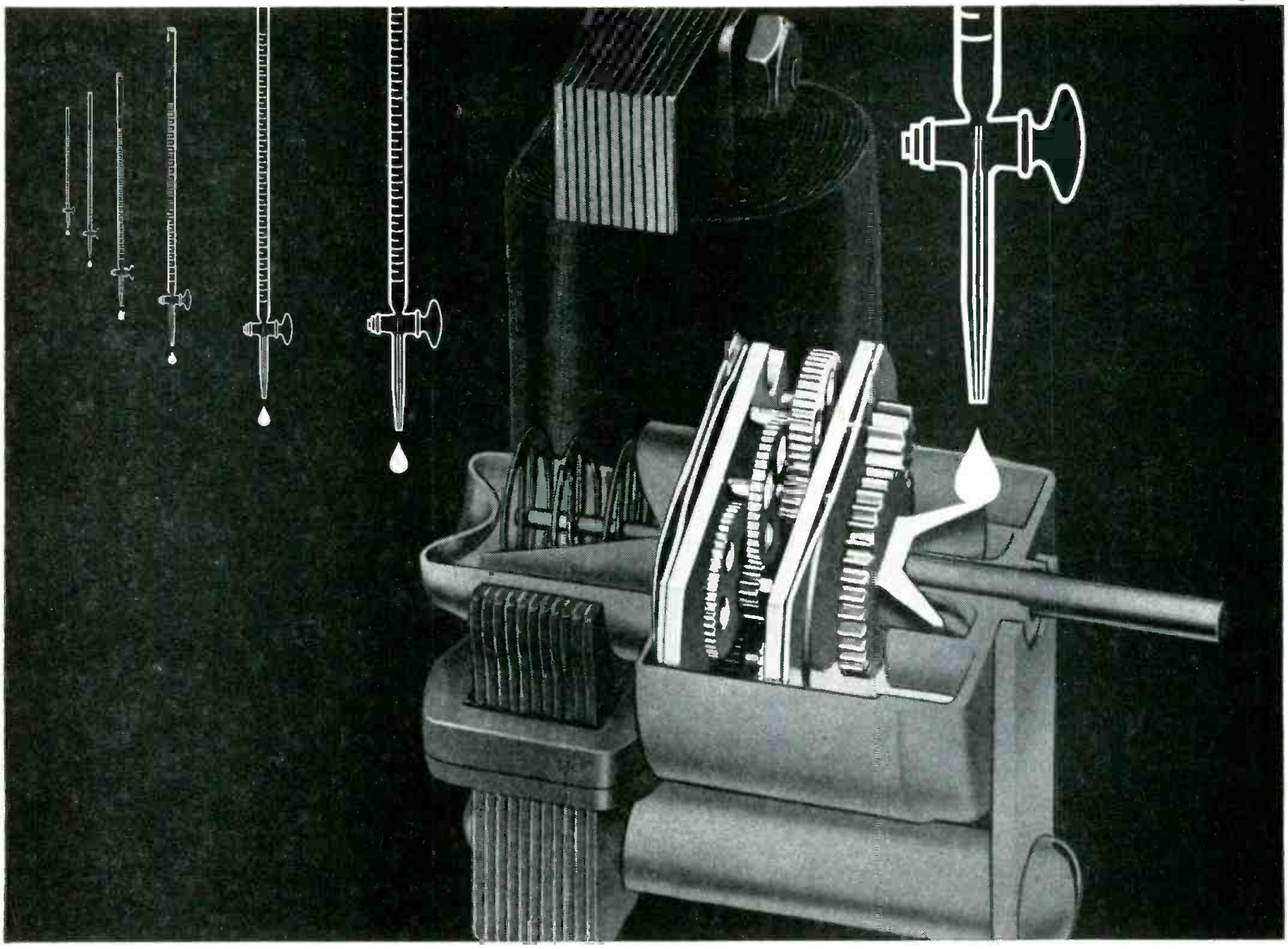
FIG. 3—Structure of the modulator (A) and voice-coil driver (B) used with cavity is similar to loudspeaker

through them. Alternatively, disk P is marked so light through Q slots will show on P at the marks.

A standard watch tick rate is 5 per second, giving a total of 300 per minute. Each of the disks has eight slots, or marks, providing a total of 2,400 possible coincidence flashes per minute where an observer might see the light through two slots aligned at the center of scale X.

If the test watch and standard watch are exactly in synchronism, the light flash coincidences are seen through the disk at the exact center of the scale. If the tick rate of the watch exceeds or is less than the standard, the incorrect rate will result in the coincidence of the two slots to right or left of center on the scale.

As in a stroboscope, the light lines visible will move right or left at a rate determined by the deviation indicated in terms of seconds of error in 24 hours. By permitting



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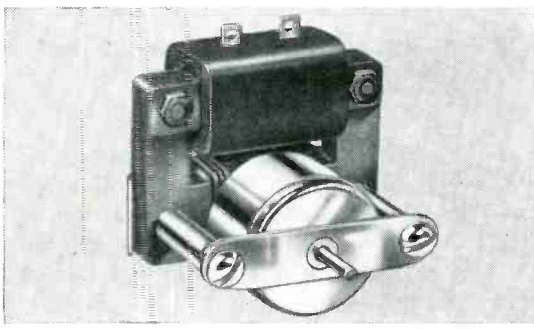

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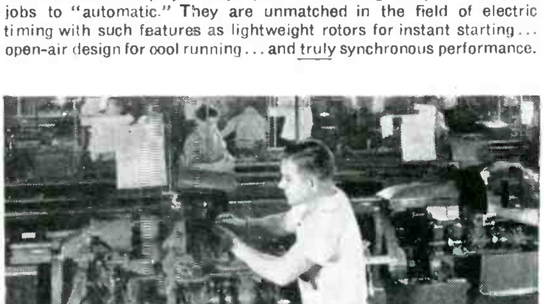

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the test to continue for a minute and counting the number of coincidence lines the drift covers in the period observed, the error in minutes per month may be observed.

Recording Coil Driver

In patent 2,638,401 issued to J. Lukacs for an electrocardiograph, there is shown a novel technique for driving a low-impedance recording coil directly without any transformation means. The patent is as-

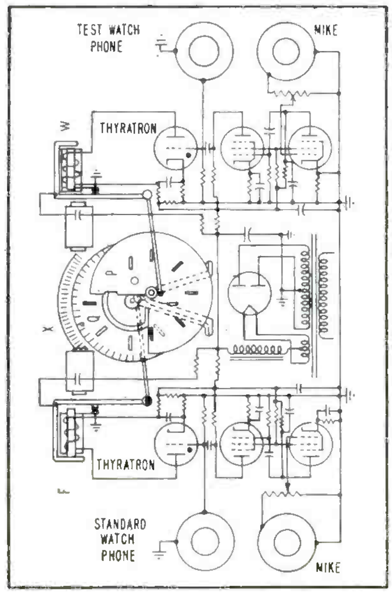


FIG. 4—Circuit and mechanical detail of watch timer using thyratrons

signed to Technicon Cardiograph Corp. of New York. The diagram of Fig. 5 shows the connection of the recording coil between the cathodes of the p-p bridge output network.

The difficulties of properly matching the impedances of the plates of output stages to such devices as recording heads are well known in

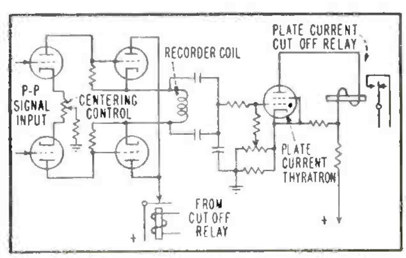
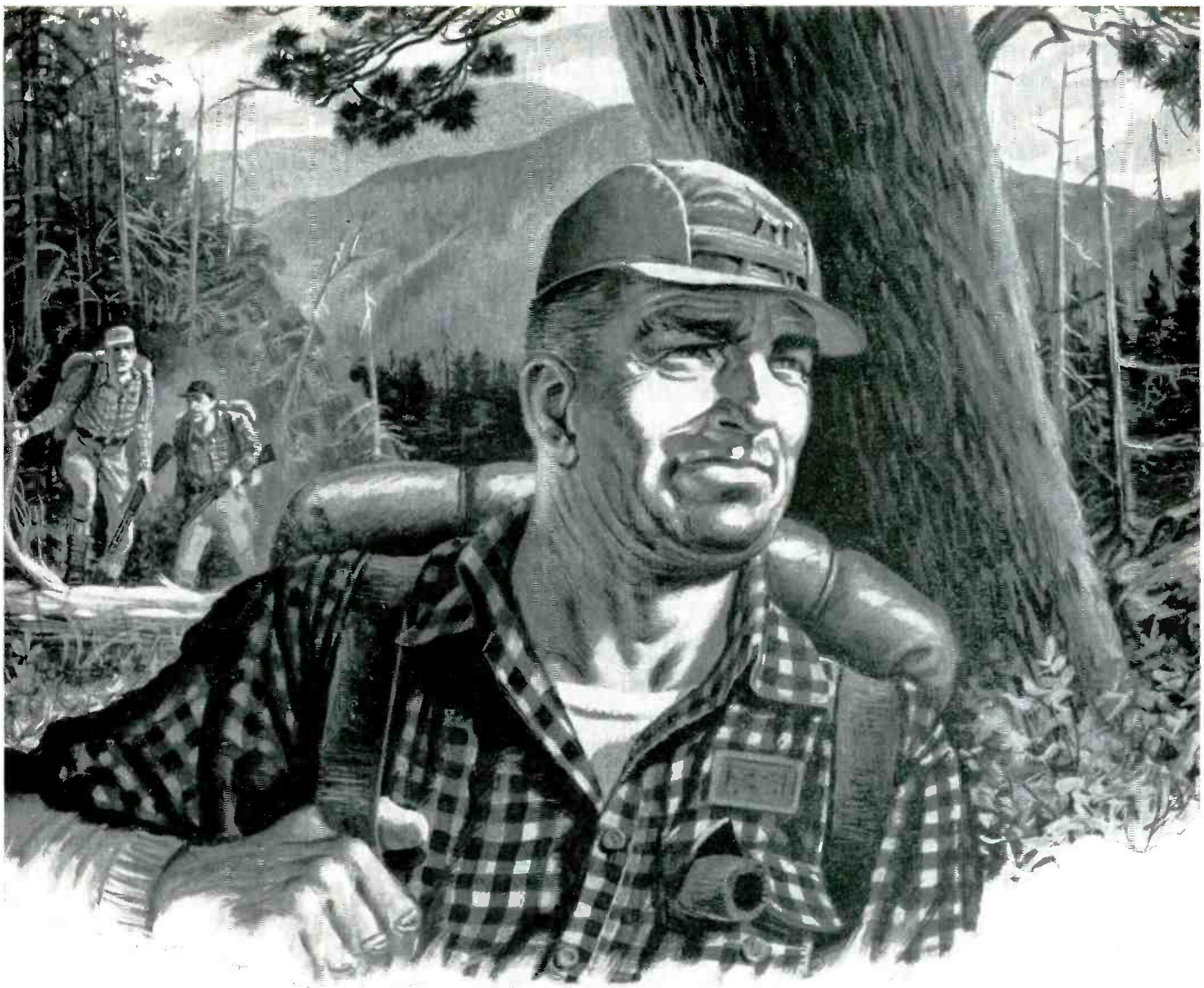


FIG. 5—Low-impedance coil is driven by special circuit for use in recording



the art. In the Lukacs invention this difficulty is overcome by driving the recorder coil directly despite its low impedance.

The circuit at first glance seems to have no d-c return through the cathodes of the output stage. Further examination shows that the d-c amplifier technique is applied here in push-pull and the input push-pull stage is in series with the output push-pull stage, thereby providing the d-c return for the output stage through the input stage. In the quiescent condition there will be a balance in the cross currents through the recorder coil.

In the presence of a signal there is a differential current that deflects the coil or any armature that may be associated with it. The thyratron stage upon the application of too great a signal to the output amplifier will draw an increased plate current beyond a preset value whereupon plate current is removed from the output stage. Time delay means hold off the return of operation for several seconds. Thus the recording stylus is prevented from being too forcibly driven against the limit stops of the recording device.

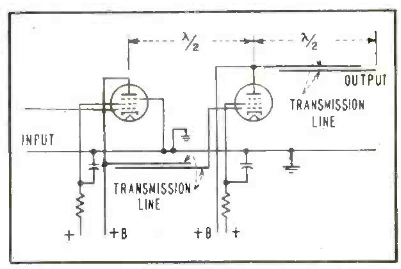
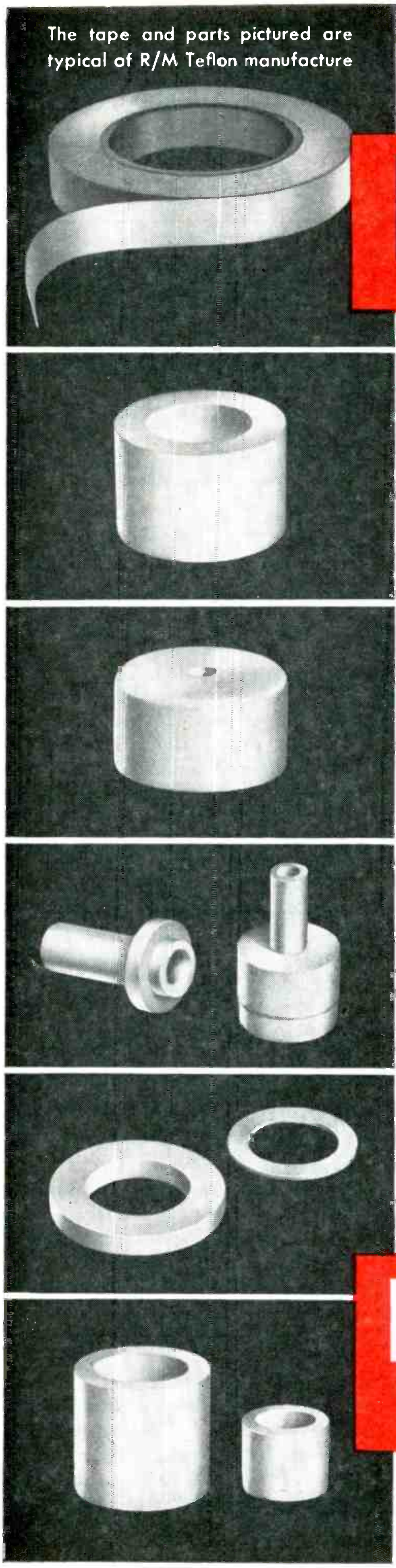


FIG. 6—UHF amplifier uses internal line structure for coupling

UHF Amplifier

Patent 2,639,335 was granted to D. B. Reeves for an "Ultrahigh Frequency Amplifier". The patent is assigned to the National Union Radio Corporation of Orange, N. J.

The invention consists mainly in a novel layout for uhf amplifiers employing vacuum tubes assembled within line structures so that the lengths of the coupling connections between the tubes and the distances between the tubes are dimensionally



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related to the wavelength of the frequencies at which the amplifier operates.

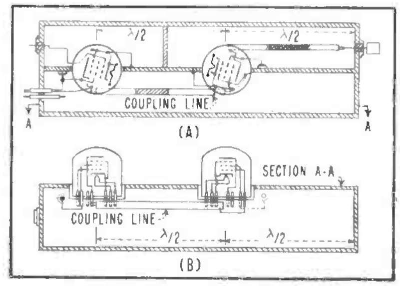

FIG. 7—UHF-line tube for receiver (A) is shown in cross-section (B)

The schematic diagram of Fig. 6 and the assembly drawings of Fig. 7 clearly show the inventor's idea as applied to a two-stage ultrahigh-frequency amplifier.

The inventor claims that his invention provides means of obtaining greater than critical coupling required for wide-band amplifiers in the range above 300 megacycles, such as may be useful for vhf tv receivers.

The assembly technique takes into consideration the terminals, and lead connections at the critical portions of the circuit where the desired resonance would be affected thereby.

Seismic Relay

A radio relay system for "Seismic Surveying" has been awarded patent 2,640,186. The inventor is A. F. Hasbrook. His patent is assigned to Olive S. Petty of San Antonio, Texas.

Seismological technique is used in the oil industry to determine the subsurface structure of an area. Measurements are made by detonating a charge at some point remote from variously placed measuring instruments, which record the characteristics of the shock waves generated by the blast.

For accurate measurement the exact time of the detonation must be known. To bridge the great distances radio has been used to transmit a signal at the instant of detonation. It has been found that noise and static frequently caused

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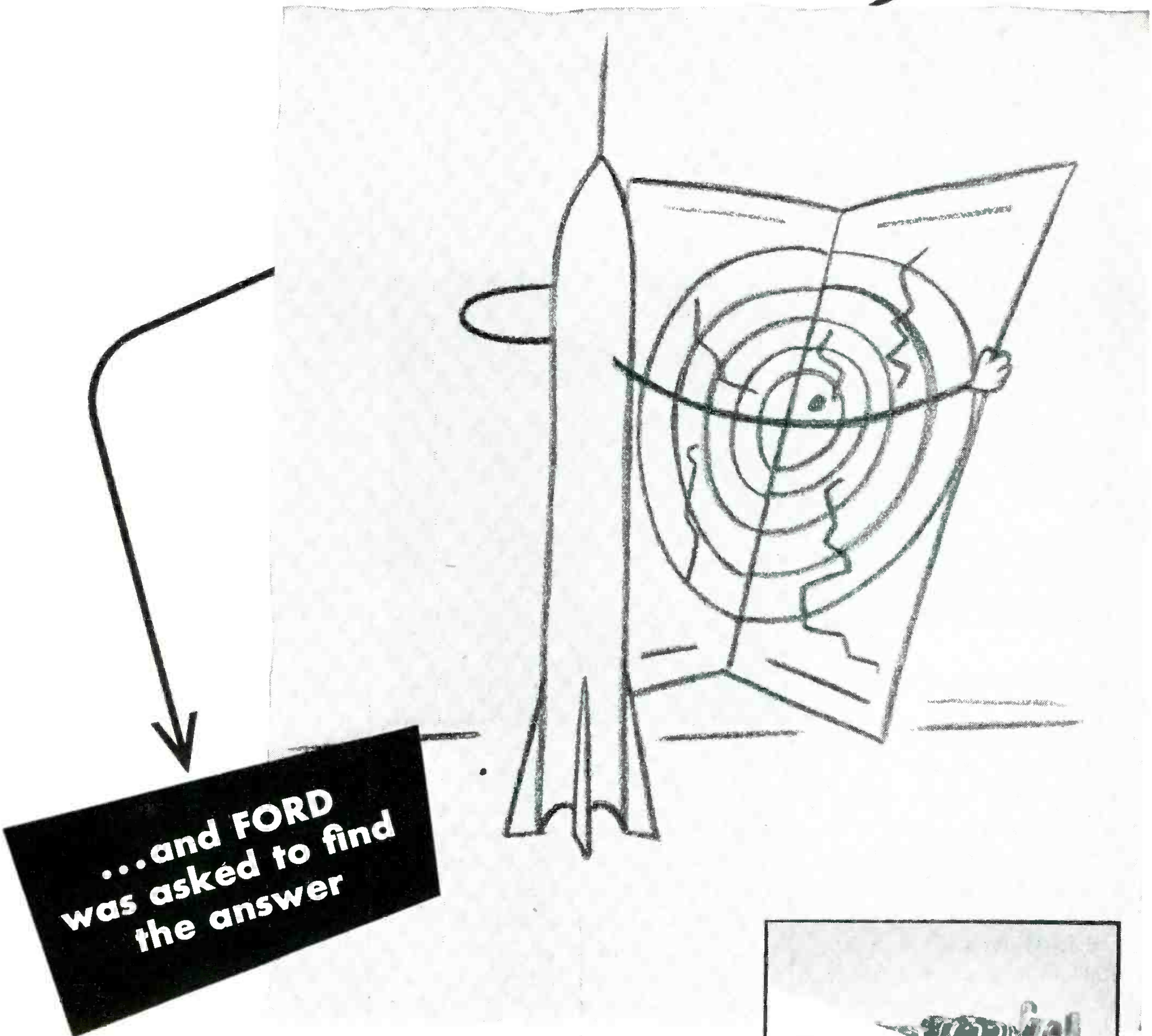

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the signal to be obscured, upsetting the measurement.

The inventor's technique for overcoming the problem is to provide a time-break modulating signal for the transmitter, which is derived from the firing circuit for the detonation of the charge. The signal is in the form of a series of damped waves initiated by the break pulse. The damped waves are acted upon by a pulse shaper and the resulting pulses combined with the time-break pulse so as to distinguish the time break pulse by its polarity.

As a feature of the invention, the transmission to the recording station of the time-break signals produced as above may be effected by applying the series of pulses to a carrier wave, generation or radiation of the carrier being initiated by the original time-break pulse. The following series of damped waves is applied as modulation of the carrier. Thus, the instant of arrival of the carrier wave at the remote recording station denotes the true time break whereas the

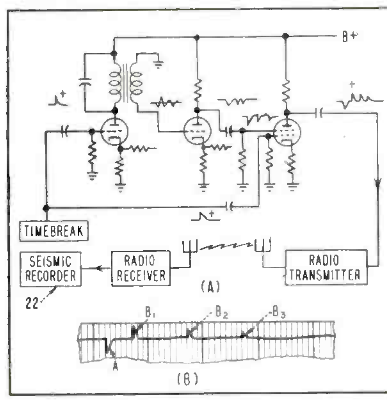

FIG. 8—Ringing circuit provides seismic time signal (A) as recorded (B)

succeeding series of pulses affords an accurate record from which the time break may be determined if static should obscure the carrier at the instant of the time break.

The circuit of the pulse generator of the invention is shown in Fig. 8A. The waves at various parts of the circuit are shown.

In Fig. 8B a chart shows the time-break signal at *A* and the opposite polarity damped pulses at B_1, B_2, and B_3.

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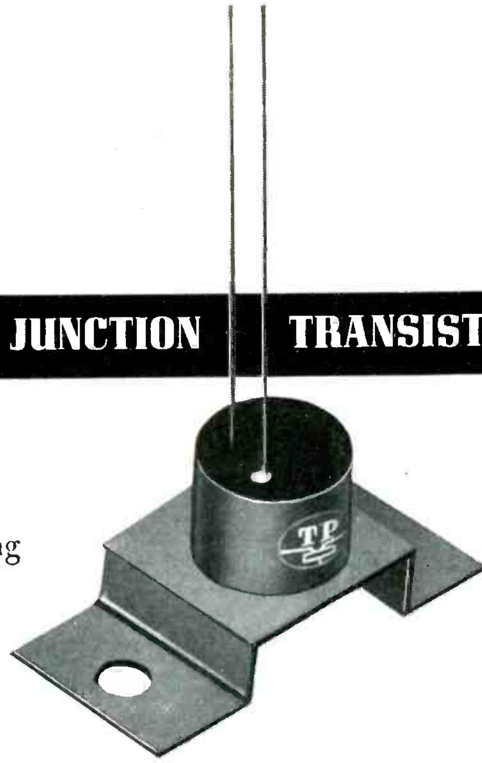

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Collector voltage	45v.
Collector current (no signal)	less than 5 ma.
Collector current (maximum signal)	90 ma.
Emitter control (no signal)	0 ma.
Load impedance (collector-collector)	2000 ohms
Input impedance (base-base) approximately	10 ohms
Driving power	200 mw.
Output power	more than 2 watts
Power gain*	more than 10 db.
Efficiency	more than 50%

*While these units will operate Class B at collector voltages less than 45 V., the power gain drops as the collector voltage is reduced. Operation below 30 volts is not recommended.

Maximum Ratings (in 25°C. free air):

Collector voltage	45v.
Collector current	50 ma. (without heat sink) 100 ma. (with heat sink)
Collector dissipation	2.25 watts (without heat sink) 4.50 watts (with heat sink)
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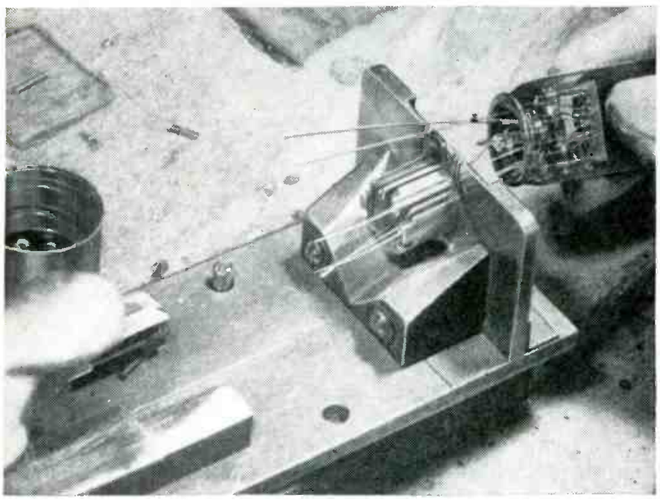
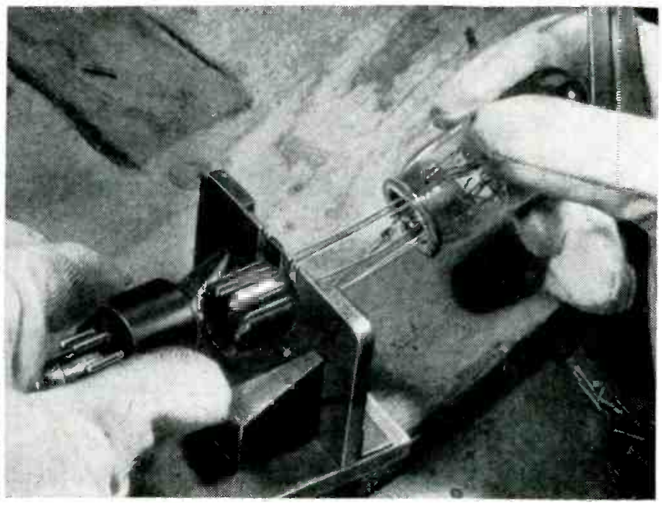


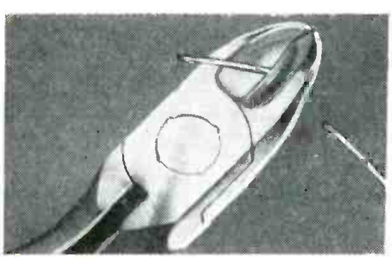


Simple Metal Jig Speeds Insertion Of Tube Leads in Octal Base

THE EQUIVALENT of threading eight needles at a time is achieved in Tung-Sol's Bloomfield, N. J. plant with a metal jig that accurately positions up to eight tube leads so the octal base can be pushed over them in one smooth motion. This automatic base lead wire inserter has greatly speeded up the cementing of bases to tube envelopes and has at the same time reduced rejects due to leads in wrong pins.

Both hands are used for the assembly operation. With her left hand the operator picks up a tube base on which cement has previously been applied in another operation. With her right hand the operator picks up a finished tube envelope, indexes it visually so the electrode structure and leads are in a predetermined correct position, then drops the leads one by one into their correct slots in the jig.

While positioning the leads, the operator inserts the base in a positioning device that is grooved for the aligning key. She now pulls back the tube slightly with her right hand so the ends of the leads do not project beyond the jig, then slides the base up with her left hand and pushes the tube in. The base fixture slides on rails, and the aligning key arrangement insures that the leads enter the correct base pins. Tube and base are now lifted straight up out of the jig and pushed together firmly.



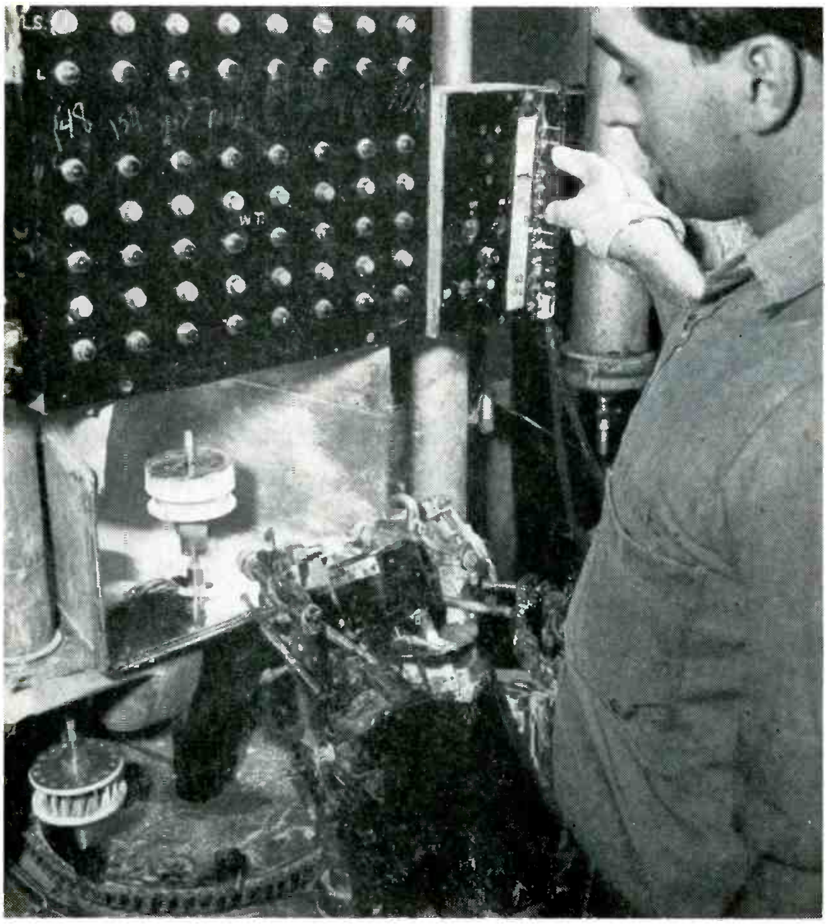
Wire-Holding Pliers Minimize Assembly Rejects

ADDITION of a plastic cushion to the jaws of Utica side-cutting pliers makes these pliers equivalent to a third hand for holding the short end of a lead during and after cutting. This eliminates possible troubles from snips of wires falling into a chassis and becoming lodged there temporarily, to cause short-circuits later.

When cutting springs or hardened steel wire, this cushion-throat

feature keeps the wire from flying off and hitting nearby personnel.

The cushion is tough, rubbery red Plastisol, bonded to the throat areas of the pliers. As the pliers close, the Plastisol cushion grips the short end of the wire tightly, holding it as the cut is made.



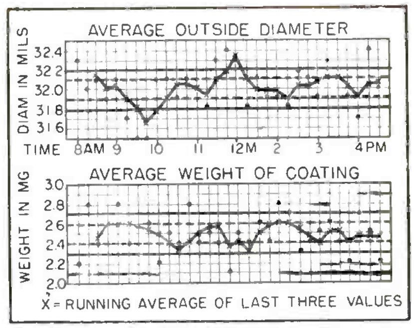
Lamp-and-Switch System Controls Cathode Spraying

PANEL indicator lamps in front of the operator at the cathode spraying position are actuated by quality control inspectors who measure the highly critical diameter and coating weight of finished cathode sleeves in the Bloomfield, N. J. plant of Tung-Sol Electric Inc.

If the average readings are within the dotted lines of the control chart, a green light is given. If the average falls between the dotted and solid lines, the upper or lower yellow warning light is given. If the average falls above or below the area bounded by the solid control limit lines, the upper or lower red light is given, and all spraying on that cathode type must stop until a corrective adjustment in spray time or spray pattern is made.

As many as eight different cathode types may be sprayed at the same time. Each cathode has its own control chart and system of operating lights for both coated diameter and weight, which enables immediate correction to be made at the first sign of excessive variation. The actual quality determination is completed in less than five minutes after the spraying is accomplished. Considerable reduction in material waste and greater uniformity of the product are a direct result of this control system.

Pushbutton switches on a panel at the right of the lamp bank enable the spray operator to vary the spray time in accordance with the

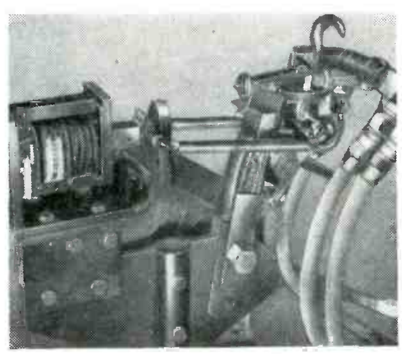


Example of portion of control chart used for plotting result of sampling inspection for outside diameter and coating weight of coated cathodes. Sample size is 3 cathodes, taken every 20 minutes

indications of the lamps. Changes in spray time serve to change both the weight and outside diameter of the finished cathode. The control switches are connected to the various contacts of an electric timer made by Industrial Timer Corp., Newark, N. J. The timer in turn actuates a solenoid that is connected through coil springs to the trigger of the spray gun.

Two solenoid-controlled guns are used, with nozzles adjusted for different spray patterns to get adequate coverage without wasting material while spraying up to eight different sizes and shapes of cathodes in as many different types of masking holders. The holders are cylindrical in shape, and are rotated at 120 rpm by an electric motor during spraying to achieve uniform coating. Pushing the button for a particular type of cathode automatically actuates the proper spray gun through the proper timer.

The spray material employed is a



Method of mounting solenoid to actuate trigger of spray gun. Movement of solenoid armature is transmitted to trigger through two paralleled screen door springs to minimize vibration and shock

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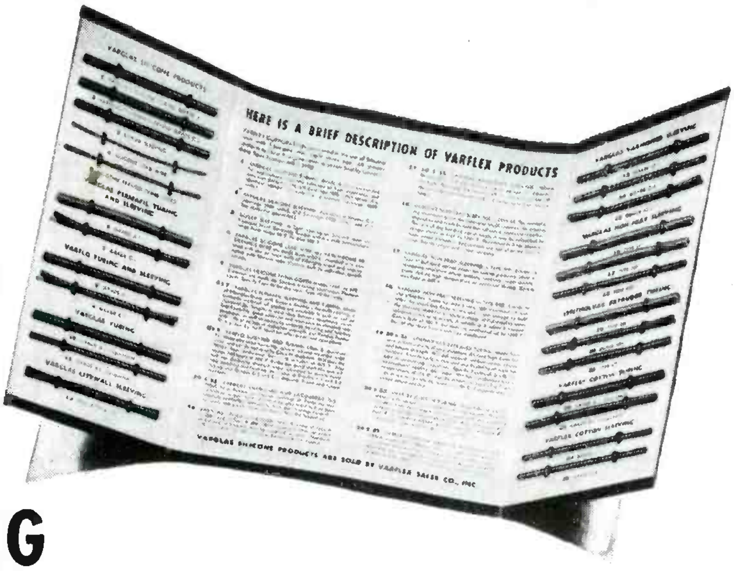
suspension of barium, strontium and calcium carbonates in butyl acetate with a nitric cellulose binder. Both spray guns draw from a common container of this mixture, which is kept stirred continuously by an electric motor with mixing paddles on its shaft.

After spraying, the operator lifts out the holder and places it in an empty position on the chain conveyor that is continually moving through his work position. The holders are designed to take 17 to 75 of the cathodes, depending on their size. Each holder has a vertical shaft which fits into the chuck of the spinning motor during spraying. This shaft drops into the drilled hole in the metal block on the chain conveyor for transport after spraying.

Measuring cathode diameter with micrometer. Weight of coating is measured with precision balance in background. Pushbutton switches above bench control lamps in front of spray operator in background, to give him a continuous visual indication of product quality

The chain conveyor takes freshly sprayed cathodes into an electric oven for drying. Drying temperature is 150-175F, with a circulating

Send for this *Free* SAMPLE FOLDER...



Contains 25 different Test Samples of high-dielectric INSULATING TUBING and SLEEVING

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VARGLAS SILICONE Class H insulating materials were pioneered by our Laboratory. Retain flexibility, electrical properties and mechanical strength in temperatures ranging from —85°F. to 500°F. Available in tubing, sleeving, lead wire, tying cord.

PERMAFIL-IMPREGNATED VARGLAS TUBING Fiberglas braid coated with General Electric's Permafil resin. Extremely tough, resistant to solvents and elevated temperatures, highly flexible. Can be bent or twisted with little or no loss of dielectric strength. Coils and standard 36" lengths.

VARGLAS SLEEVING AND TUBING Numerous types and grades—including synthetic-treated, varnished, lacquered, saturated, litewall and others.

VARGLAS NON-FRAY SLEEVING Fiberglas braid normalized to remove all organic impurities. It will withstand temperatures up to 1200°F. Recommended where dielectric properties are not paramount. Three types available.

VARFLO TUBING AND SLEEVING Vinyl-coated Fiberglas in full range of sizes, colors and grades. Extremely flexible with excellent heat aging qualities. Low priced.

VARFLEX COTTON TUBING AND SLEEVING Varnish or lacquer impregnated — for applications where MIL-I-3190 Class A materials are specified. All NEMA grades.

SYNTHOLVAR EXTRUDED TUBING Made in various standard formulations of vinyl polymers. Has high dielectric and tensile strength—will not support combustion nor absorb moisture. Type EG Approved under MIL-I-631A. Several others to meet special requirements.

NEW! VARGLAS SILICONE RUBBER SLEEVING AND TUBING—the culmination of 5 years of research—for applications requiring extraordinary flexibility. Details on request.

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CORPORATION
Makers of Electrical Insulating Tubing and Sleeving

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Please send me free folder containing samples of your electrical sleeving and tubing.

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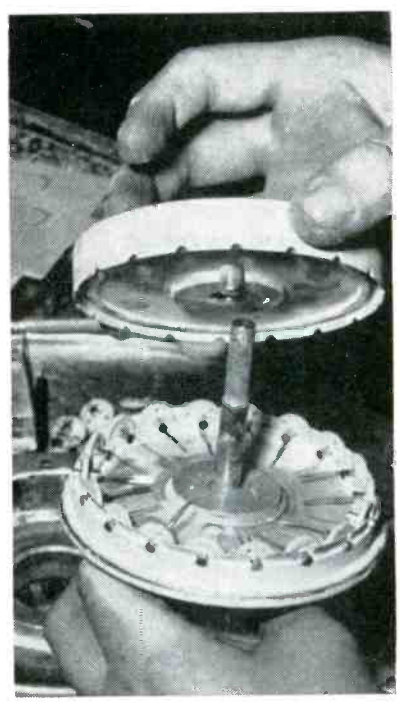
Loading uncoated cathode sleeves in rotary holder preparatory to spraying. Roller chain conveyor brings holders back to operator for unloading after spraying and baking. Finished cathodes are placed in the self-stacking molded plastic trays at rear on bench

air blower to carry off moisture.

After drying, operators take the top plates off the holders and carefully place the finished cathodes in individual compartments of molded plastic trays made especially for the purpose, then reload with uncoated cathodes. Loaded holders are carried to the spray position by the conveyor, where the operator transfers them one by one to the spray booth for application of the cathode coating material.



Combination rotary masking and spraying holder for cathodes of television picture tubes, holding 20 pieces

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INSULATING SPRAY

Higher dielectric strength than any other insulating spray on the market!

Proven by twenty years of use by leading component parts manufacturers!

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Available in clear, aluminum, gloss & flat black

INSL-X E-33 FOR SAFELY HANDLING "HOT" WIRES

Do away with the uncertain protection of taped tool handles. Insl-x E-33, the material used by major utility companies for insulating linesmen's tools, is now available to you! Just dip tool handles—Insl-x E-33 dries to a tough, smooth coating that provides absolute protection. In bright red for quick, positive tool identification.

Insl-x E-26 insulating spray makes it possible to completely insulate electrical equipment, parts and wiring in a matter of minutes. Produced exclusively for the electrical trades, Insl-x sprays a coating one mil thick, with extra high dielectric strength.

Insl-x E-26 is recommended for insulating and reduction of heating on both round and square bus bars; Sealing transformer and coil leads; Spraying motor controllers, starters and switches; Insulating and moisture proofing terminal assemblies;Sealing selenium rectifiers and resistors; Insulating all permanent electrical connections; Spraying finish coat on motor coils; Spraying household master switch and fuse box; Improving arc and moisture resistance of molded and laminated phenolic parts.

Use Insl-x, the material designed to do one specific job—INSULATE.

TECHNICAL DATA

Dielectric strength 800 to 1200 v/m • Drying time, 3 to 5 minutes • Hardness excellent • Adhesion excellent on all conventional assembly surfaces including ceramic, anodized aluminum, and phenolic • Chemical resistance excellent • Water resistance excellent • Flexibility excellent.

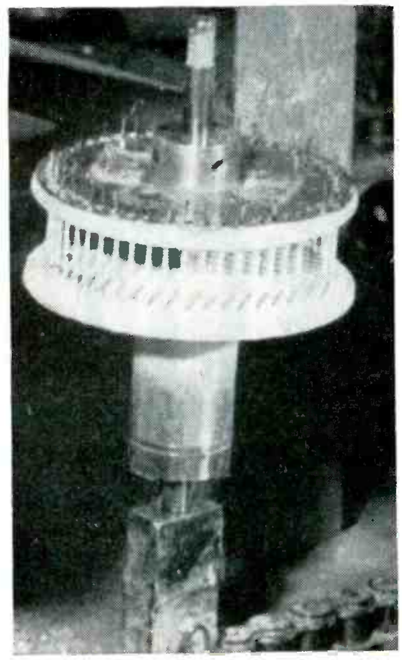
See your jobber, or write for complete technical data, Dept. 401

INSL-X SALES COMPANY, 26 Rittenhouse Place, Ardmore, Pennsylvania

Insl-x Products are available in bulk for spray, dip, and brush application.

Want more information? Use post card on last page.

During unloading of the rotary holders, samples are drawn periodically for measurement of coated diameter and weight. A running average chart is kept by the inspector for both of these characteristics. Each measurement taken is marked on the chart by a point. By visual estimation, this point is then averaged with the last two measured values and the result is plotted as an $\bar{x}$, to form the running average chart. The curve is drawn through the $\bar{x}$'s, rather than through individual points, to guide the operator in punching the pushbutton switches just above her work position. These switches control the lamps on the indicator panel in front of the spray booth operator.



Fifty-cathode rotary holder is moved through drying oven by chain conveyor after spraying cathodes in spray booth

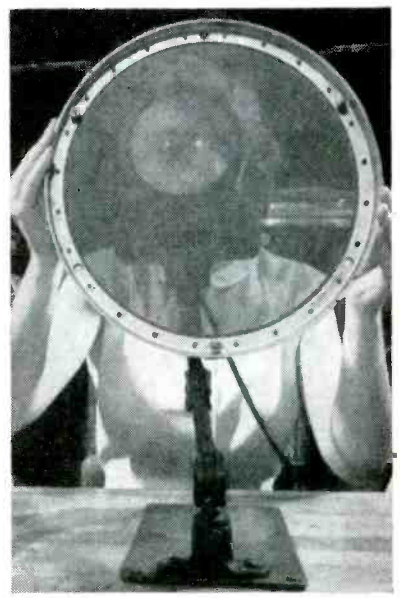
Cathode diameter is measured with a micrometer mounted in its own wood box for cleanliness. Cathode coating weight is determined by weighing the finished cathode with a Roller-Smith precision balance, then brushing off the coating and weighing the cathode sleeve itself. The difference between these values is recorded as the weight of the coating. The scale of the balance is so designed that this differ-

ence can be read directly on a movable accessory scale, the zero of which is set to the reading of the coated cathode.

The balance is mounted on a heavy steel pipe which goes through a large hole in the bench and is embedded in the poured concrete floor. This arrangement prevents bench vibrations from affecting scale readings.

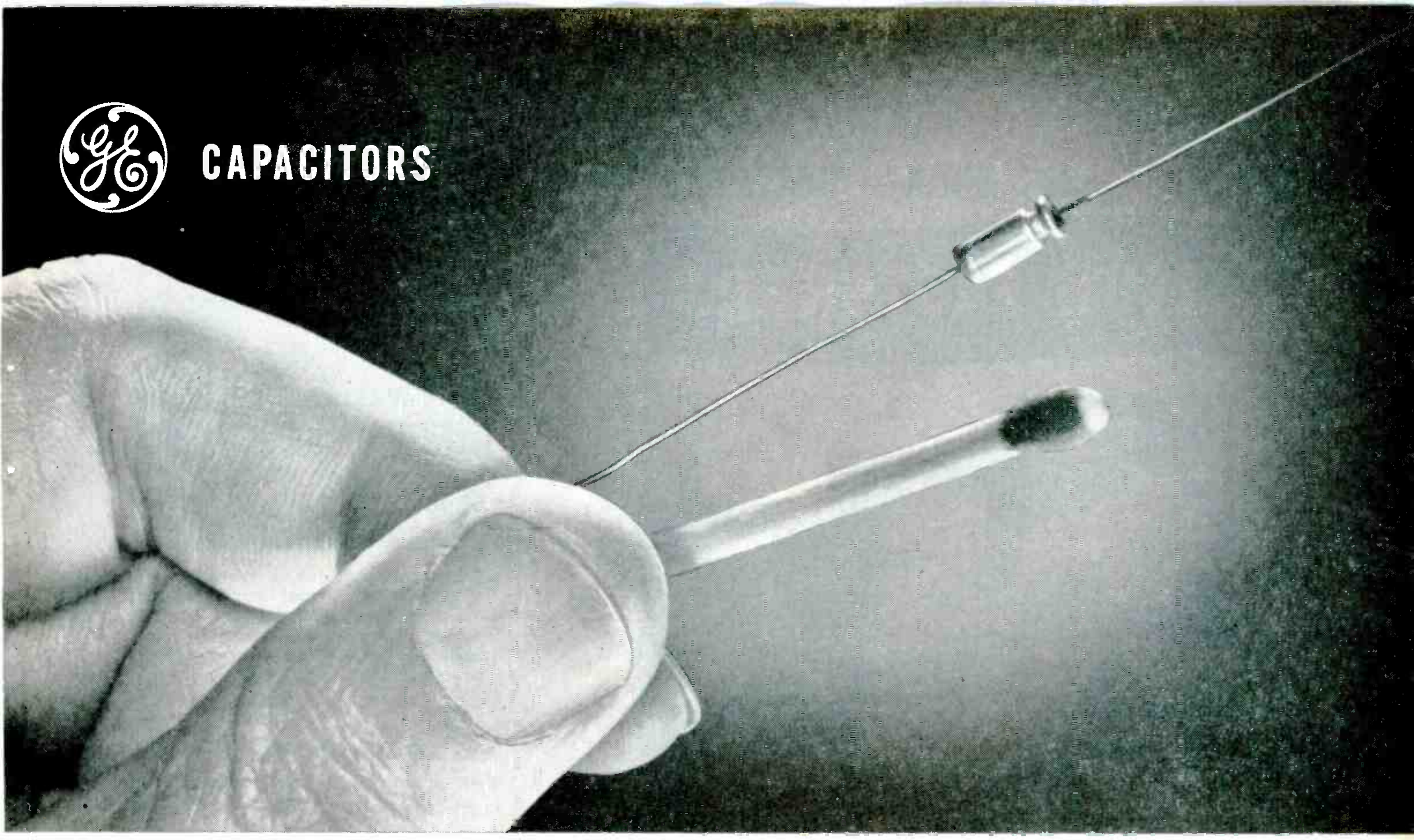
Permanent Time Track for Magnetic Memory Drum

TO ELIMINATE the possibility that the high-precision timing pulse track on a magnetic drum memory might be accidentally wiped out or erased as a result of a connection mistake, a permanent track is used for this purpose by Librascope Inc., Glendale, California. This is achieved by milling precise slots in the circumference of the drum at one end, then filling these slots with magnetic powder.

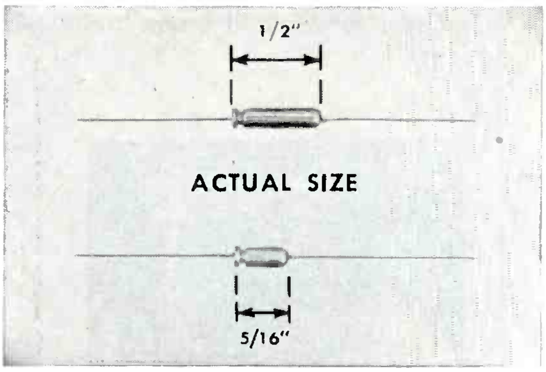


Pilot Production Line Makes Color TV Tubes

SEEMINGLY endless inspections characterize production facilities in RCA's Lancaster, Pa. pilot plant for tricolor television picture tubes. Most critical of all operations is applying the tiny red, blue and green phosphor dots in a highly precise pattern on the screen of the



G. E. ANNOUNCES a new line of Micro-miniature Tantalytic Capacitors



LARGE CAPACITANCE and small size make Micro-miniature Tantalytics valuable where space is at a premium. Diameters are .125 inches.

AVAILABLE RATINGS

Working volts d-c	Maximum muf	
	5/16" Length	1/2" Length
4	2.0	4.0
6	1.5	3.0
8	1.0	2.0
16	.5	1.0

NOTE: Ratings based on −50% +75% tolerance.

For low-voltage d-c applications

General Electric's new *Micro-miniature* Tantalytic capacitors combine *smaller-than-subminiature* size, large capacitance and low leakage current. They permit new design flexibility in low-voltage, d-c circuits . . . particularly transistorized subminiature assemblies where space is at a premium, such as hearing aids.

SUPERIOR PERFORMANCE. *Micro-miniature* Tantalytic capacitors outperform aluminum electrolytics in electrical stability, operating and shelf life, because of the inert characteristics of tantalum metal and the stability of its oxide. They gain added reliability from the use of silver cases, a non-acid electrolyte, and complete sealing that prevents leaking and contamination of the interior.

WIDE TEMPERATURE RANGE. *Micro-miniature* Tantalytics can operate over a −20 C to +50 C range—may be stored at −65 C. With some capacitance derating, they can operate well below −20 C. At −55 C, units rated 10 volts and above will maintain at least 65% of their 25 C value. They also perform satisfactorily above +50 C with some life limitations.

AVAILABILITY. Designed especially for non-resonant, non-critical applications such as coupling, by-pass and filtering, *Micro-miniature* Tantalytics can be obtained in sample lots 2 to 3 weeks after your order is received at the factory. Production lots can be shipped 6 to 8 weeks after your order is received. For more information, see your G-E Apparatus Sales Representative or write for bulletin GEA-6065 to General Electric Company, Section 442-14, Schenectady 5, N. Y.

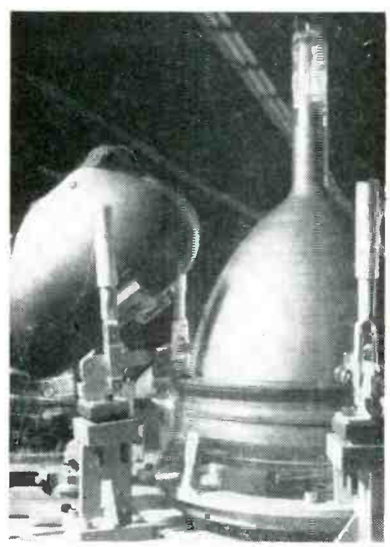
Progress is our most important product

GENERAL ELECTRIC

Tricolor electron gun is assembled on jig immediately in front of operator, and entire jig is then swung forward into flames of torches for fusion of parts while operator rotates gun slowly by turning knurled knobs with hands

tube. A powerful bench-mounted magnifying glass aids operators in checking this screen for mechanical defects such as smears. A similar lens serves for inspecting the mesh of the shadow mask used in conjunction with the color screen.

Simplification of the many highly intricate production processes is the goal at present, pending FCC approval of color television standards for the industry. Duplicate facilities involving different techniques are often set up to com-



Method of joining tricolor television picture tube faceplate to main cone with Heliarc welding. Motor rotates tube automatically past welding arc. Operator who monitors operation is protected from glare of arc welder's mask

New MICROWAVE Associates INCORPORATED Diodes

TYPE	CENTER FREQUENCY (mc)	MAX. CONVER. LOSS (db)	MAX. NOISE RATIO (times)	VSWR (max.)	IF IMPEDANCE (OHMS)
*1N21B	3060	6.5	2.0	–	200–800
*1N21C	3060	5.5	1.5	–	200–800
*1N150	6750	6.0	2.0	1.5	250–500
*1N160	6750	6.5	2.7	–	200–800
*1N23B	9375	6.5	2.7	–	200–800
*1N23C	9375	6.0	2.0	1.5	325–475
1N78	16000	7.5	2.5	–	325–625
1N26	23984	8.5	2.5	–	300–600
1N53	>30000	8.5	2.5	–	400–800

* Also available with reversed polarity

New MICROWAVE silicon diodes insure greatly improved receiver performance throughout the centimeter and millimeter wavelengths.

Lower overall noise figures and broader bandwidth operation are inherent in all of our diode line. The uniformity of the new 1N23C, 1N150, and the reversed polarity, 1N23CR and 1N150R allow their direct use in balanced mixers without pair selection. Overall noise figures of better than 10 db. are typical with these types. The 1N150 and 1N160 are specifically designed for broadband, low noise operation in the popular common carrier frequencies from 6000 to 7000 mcs.

SEND FOR DATA

Write for detailed specifications and catalog literature describing our diodes, magnetrons, TR and ATR tubes and waveguide components.

MICROWAVE ASSOCIATES INCORPORATED
22 Cummington Street, Boston 15, Mass.
Telephone: Copley 7-4441

MICROWAVE Associates INCORPORATED

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Applying blue phosphor mix to screen through gelatin stencil or frame

pare results. These are generally related to production of the screen and mask, since the remainder of the color tube differs little from conventional black-and-white picture tubes.

A silk-screening technique, like that employed in the reproduction of art prints, is used to apply minute phosphor dots to the glass screen. The phosphorous chemical mix, beaten to the consistency of thick cream, is squeegee-squeezed

Use of Veeco mass-spectrometer leak detector (made by Vacuum-Electronic Engineering Co., New Hyde Park, N. Y.) to make certain that weld which joins cone to faceplate of RCA color picture tube is vacuum-tight at al points

Sensitive Controls

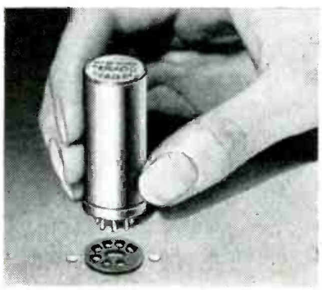
The important components for your thermal, light, vaccum or R.F. actuated control systems are now immediately available at RELAY SALES.

ASSEMBLY PRODUCTS

Contact Meter-Relays

A highly sensitive locking relay for control of chemical processes and mechanical operations through either alarm, automatic shut-off or continuous on and off control. Contact Meters automatically maintain upper and lower limits (or both) of temperature, voltage, current, speed, light or liquid flow rate with extreme accuracy. Applications include their use in electronic circuits for quality control of piezo crystals and other components, switching of standby equipment in micro-wave communications, control of carbon feed in arc furnaces, as warning of bearing temperatures in turbines and generators, and a variety of speed controls for machines.

Contact Meter-Relays are current or voltage sensitive down to 2/10 microampere or 1/10 milliwatt. Contact ratings from 100 mils to 1 ampere. They are available in a wide selection of standard types. Special types engineered to your needs. Phone, write or wire Relay Sales for additional information.



TERADO

Miniature Micro Relay

A hermetically sealed sensitive relay, with particular application to airborne equipment, mounts in a standard 7-pin miniature tube socket. Its S.P.S.T. switch will operate on 60 milliwatts. Insulation: 500 Volts between any terminal and ground. Temperature range: +85°C. to −55°C. Shock 50G. Coil resistance, contact current and other specifications to your requirements. Send us your prints.

RS Phototubes

Phototubes, either gas filled or vacuum type, are available for all photo cell applications. RS Phototubes have superior operating characteristics in high output current, extreme sensitivity to small variations in light intensity, excellent response in infra-red regions, low dark current—all with notably longer tube life. Write for catalog.

CETRON

Grid Controlled Rectifiers

Due to the ever increasing demand for Grid Controlled Rectifiers, which are so closely allied to relay applications, RELAY SALES has arranged for the distribution of these special purpose tubes made by America's oldest and foremost manufacturer.

Write for New 1954 Relay Sales Catalog C-5

JUST OUT!

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You will receive 24 hour shipment on any material in our huge stock of practically any conceivable type of relay, contactor or motor control. Phone or wire your requirements.

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Relay Sales

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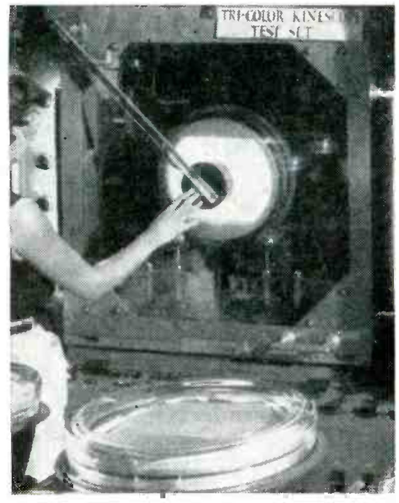


Testing finished tubes for phosphor-dot brightness with photoelectric light meter on swinging arm. Protective square glass window is suspended by counterbalanced chains, to permit easy raising for removing and installing tube

through a gelatin stencil for deposition as precisely formed dots on the screen below. The sequence involves applying one color to a batch of screens at the squeegee position, then putting the batch through two times more for application of the other two colors. The fixture used for screening is designed to give precise positioning of each screen, so that it has exactly the same position all three times. For the second and third colors, micrometer feed adjustments move the gelatin stencil vertically and horizontally a precise small amount, to insure that the red, blue and green dots will be equally spaced in a geometric pattern.

Lead-Coiling Tool

BY P. C. BOIRE
Chief Engineer
Measuring Engineering Ltd.
Arnprior, Ontario

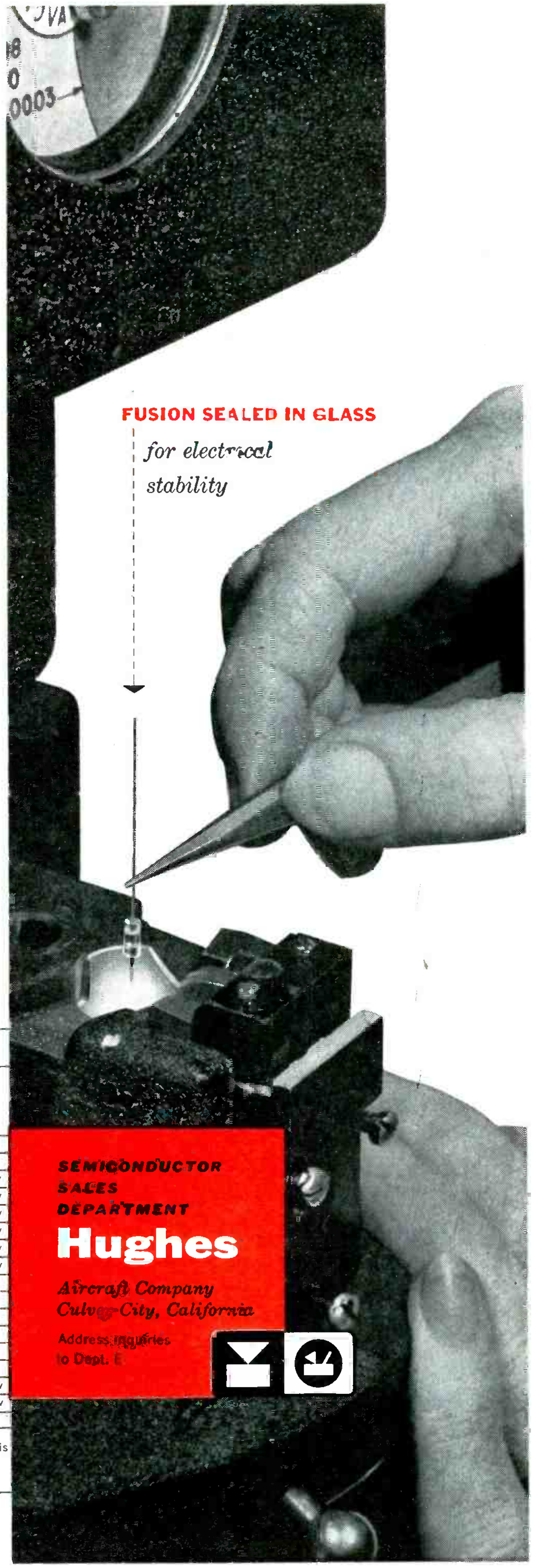
TO MINIMIZE changes in the characteristics of small electronic parts, such as crystal diodes, by heat being conducted along the leads when soldering, the leads are coiled up instead of being cut off.

A special tool was developed to coil the leads of components neatly at high speed. To make this tool, a hole was first drilled in a metal block to match the shape of the

HUGHES DIODES

A New Standard of Reliability

Reliability in a germanium diode is determined principally by permanent freedom from the two major causes of diode failure—moisture penetration of the diode envelope, and electrical instability under extreme operating conditions.



HUGHES GERMANIUM DIODES are designed to prevent such failures through two exclusive features:

1. **Fusion Sealing**—The glass-to-metal seal, proved in billions of vacuum tubes, is incorporated to full advantage in diode manufacture by the Hughes-developed process of fusion sealing at high temperature. The result is a rigid *one-piece* glass envelope impervious to moisture.

2. **100% Testing**—Hughes 100% testing procedures *invite* instabilities to occur prior to shipment, assuring rejection of defective diodes. *Each* **HUGHES DIODE** is humidity-cycled, temperature-cycled, JAN shock-tested, and electrically tested under vibration. This testing procedure insures operation of **HUGHES DIODES** under adverse conditions of moisture, temperature, vibration and severe shock.

Reliability of **HUGHES DIODES** has been proved in advanced airborne military radar and fire control systems, and for guided missiles.

HUGHES GERMANIUM DIODE ELECTRICAL SPECIFICATIONS AT 25° C.

Description	RETMA Type	Test Peak Inverse Voltage* (volts)	Maximum Inverse Working Voltage (volts)	Minimum Forward Current @ +1 v (ma)	Maximum Inverse Current (ma)	
High Peak	1N55B	190	150	5.0	0.500 @ −150 v	
	1N68A	130	100	3.0	0.625 @ −100 v	
High Back Resistance	1N67A	100	80	4.0	0.005 @ −5 v;	0.050 @ −50 v
	1N99	100	80	10.0	0.005 @ −5 v;	0.050 @ −50 v
	1N100	100	80	20.0	0.005 @ −5 v;	0.050 @ −50 v
High Back Resistance	1N89	100	80	3.5	0.008 @ −5 v;	0.100 @ −50 v
	1N97	100	80	10.0	0.008 @ −5 v;	0.100 @ −50 v
	1N98	100	80	20.0	0.008 @ −5 v;	0.100 @ −50 v
High Back Resistance	1N116	75	60	5.0	0.100 @ −50 v	
	1N117	75	60	10.0	0.100 @ −50 v	
	1N118	75	60	20.0	0.100 @ −50 v	
General Purpose	1N90	75	60	5.0	0.800 @ −50 v	
	1N95	75	60	10.0	0.800 @ −50 v	
	1N96	75	60	20.0	0.800 @ −50 v	
JAN Types	1N126**	75	60	5.0	0.050 @ −10 v;	0.850 @ −50 v
	1N127†	125	100	3.0	0.025 @ −10 v;	0.300 @ −50 v
	1N128‡	50	40	3.0	0.010 @ −10 v	

*That voltage at which dynamic resistance is zero under specified conditions. Each Hughes Diode is subjected to a voltage rising linearly at 90 volts per second.
**Formerly 1N69A. †Formerly 1N70A. ‡Formerly 1N81A.

HUGHES DIODES *are also supplied 100% factory-tested to a wide range of customer-specified characteristics, including high-temperature requirements.*

SEMICONDUCTOR SALES DEPARTMENT

Hughes

Aircraft Company
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Address inquiries to Dept. E

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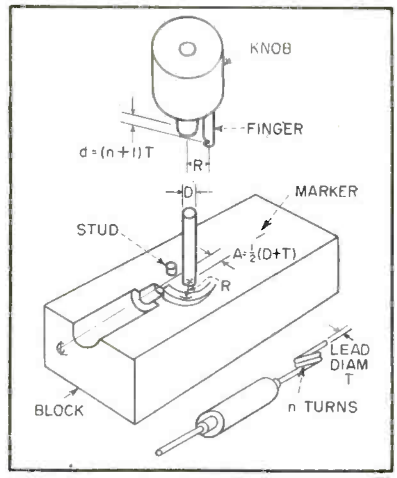


Construction of lead-coiling tool

Using tool for placing heat-blocking coils in leads of a crystal diode

electronic part. The block was then mounted in a lathe and turned down so as to expose the hole and form a recess for the part; turning was carried out to a distance of half the lead diameter below the center line, so that the lead of a part rested on the top of the block when the part was in the recess. During this machining operation, a ridge with an average radius R was left on the surface of the block, as shown in the diagram. The ridge was then filed down so as to leave an inclined plane on one side.

A hole for the winding spindle was drilled at a distance $A = \frac{1}{2}(D + T)$ from the center line of the recess for the part, where D is winding spindle diameter and T is lead diameter. Another hole was drilled for a small stud that is pressed in the block to keep the lead straight at the start.

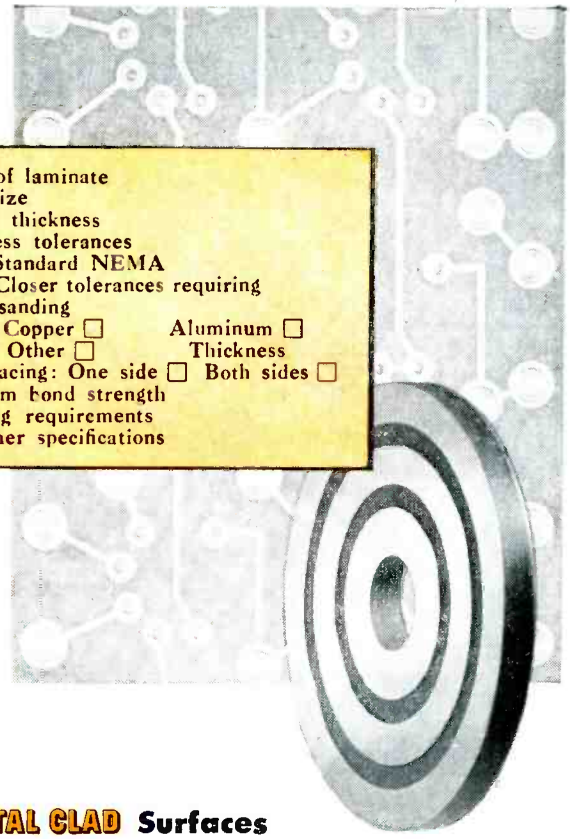
The knob used as the winding

CDF

Information Wanted...

about your uses for

C-D-F METAL CLADS



Grade of laminate
Sheet size
Overall thickness
Thickness tolerances
a. Standard NEMA
b. Closer tolerances requiring sanding
Metal: Copper ☐ Aluminum ☐
Other ☐ Thickness
Metal facing: One side ☐ Both sides ☐
Minimum bond strength
Punching requirements
Any other specifications

Did you know that C-D-F supplies a full range of metal clad laminates in both Dilecto and Teflon grades? With mounting interest in printed circuits it pays to consider the respective advantages of these new C-D-F materials . . . it also pays to line up all the Information Wanted facts and discuss your specific application with your C-D-F sales engineer (Offices in principal cities). He's a good man to know!

Dilecto METAL CLADS

Printed circuits depend upon stable, uniform core material and Dilecto has years of proven insulation service (Dilecto is a laminated thermosetting plastic made only by C-D-F from paper, cotton, glass or asbestos fabric base, or a mat base). Normally phenolic or melamine impregnating resins are used for METAL CLAD sheet stock. There are many grades of Dilecto, but only the better electrical grades are supplied with metal foil surfaces. Outstanding is C-D-F grade XXXP-26, a hot punching grade with high insulation resistance, low and stable dielectric losses and excellent moisture resistance. Green color. New C-D-F Catalog GF-53 gives complete data on Dilecto grades. Write for your copy today.

Teflon* METAL CLADS

Glass fiber cloth is first coated with Teflon resin and laminated into C-D-F GB-112T sheet stock. This base withstands high heat (200°C. maximum operating temperature) with the dissipation factor and dielectric constant extremely low over a wide frequency range. No adhesive film is needed to bond metal to the Teflon laminate, thus the inherently good electrical properties of the core material are maintained. GB-112T has practically zero water absorption, so a METAL CLAD with this core offers consistent high insulation resistance with excellent stability of dielectric loss properties.

METAL CLAD Surfaces

Copper foil (usually .00135″ or .0027″ thick) is bonded on one or both faces of the sheet grade of Dilecto selected. The foil used is a special grade of electrolytic deposition copper particularly adaptable for cementing onto laminated materials. An adhesive film is placed between the metal and the Dilecto, and cemented during the pressing and curing cycle. When closer tolerances are required C-D-F sands the Dilecto to the required thickness before bonding. Aluminum, silver, or other alloys of various metals may be supplied.

Better Bond Strengths

One of the most important physical properties of a metal clad product is its peel strength, the pounds pull required to separate the foil surface from the core material. Working with years of laminating know-how, C-D-F has been successful in obtaining the following average test values for its METAL CLAD sheet stocks:

	Lbs. pull per 1″ width
XXXP-26 plus .00135″ copper	5 to 8
XXXP-26 plus .0027″ copper	7 to 10
XXXP-26 plus .0015″ aluminum ..	9 to 12
GB-112 Teflon plus .00135″ copper ..	6 to 9

Sheet sizes: Dilecto grades — 38 x 38″, 38 x 42″
Teflon grades — 16 x 36″

THE NAME TO REMEMBER . . . FOR PRINTED CIRCUIT METAL CLAD STOCK

Continental-Diamond Fibre Company
NEWARK 16, DELAWARE

*DU PONT TRADE MARK

Write for new C-D-F General Catalog GF-53, new C-D-F Teflon folder T-52, and talk METAL CLADS with your C-D-F sales engineer.

tool has a sleeve and drilled hole that fit over the spindle. A projecting finger on the knob has a groove in its end to guide the lead as it is coiled. The difference d between the height of the groove and the sleeve is equal to $(n + 1)\ T$, where n is the desired number of turns.

In production, the block is mounted in a vise, the part is laid in the hole and the knob is put over the spindle. When the knob is turned clockwise to coil the lead, it is automatically lifted up by the inclined ridge to avoid hitting the part. The finger rides up on the ridge. On the last quarter-turn, the knob must be held down to bring the windings close together. A mark on the surface of the block indicates the end of turning, with the end of the lead acting as pointer.

Installing Thread Inserts in X-Ray Housings

IN THE production of aluminum housings for x-ray tubes, Machlett has found that it costs less to install wire screw thread inserts in every threaded hole than it does to inspect and salvage units having damaged threads. Four equally-

SLANT your requirements to

INSTRUMENT CORP. OF AMERICA

for miniature

SLIP RING AND COMMUTATOR ASSEMBLIES

This Instrument Corporation of America plant contains the most modern and complete facilities available anywhere in the world for the exclusive production of Miniature Slip-Ring and Commutator Assemblies to precision standards. It is now in full scale production to meet your requirements in the fastest possible time at the lowest possible cost.

COMPLETE ENGINEERING AND PRODUCTION FACILITIES AVAILABLE

Our assemblies can be supplied at low cost. Quality is the highest in the industry. Dimensional accuracy and other characteristics are excellent and these units are highly recommended for instruments such as synchros, etc.

ONE PIECE ELECTRO-PLATED TYPES FOR EXTREME ACCURACY

Wherever extreme dimensional precision, accurate concentricity and high dielectric qualities are required, the electro-deposition method is recommended . . . the production of which is licensed under an exclusive arrangement with the Electro Tec Corporation.

TYPICAL SPECIFICATIONS:

Sizes: .035" to 24" Cylindrical or Flat

Cross-sections: .005 to .060" or more

Finish: Polish to 4 Micro-Inches or Better

Breakdown: 1000 V or More Hi-Pot Inter-Circuit

Ring Hardness: 75 to 90 Brinell

Rotation Speeds: To Over 12000 RPM

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Use of Heli-Coil inserting tool for quick seating of wire thread insert in a tapped hole in x-ray tube housing. Cap screws can then be installed conventionally during assembly of the housing, as shown in first photo

spaced holes in the housing are drilled and tapped, then fitted with size 10-32 spiral spring steel inserts made by Heli-Corp., Danbury, Conn. A special inserting tool is used to obtain quick seating of the insert in the tapped hole. Once the insert expands in the hole, it is self-locking and provides much greater resistance to wear than is obtained with the aluminum threads directly.

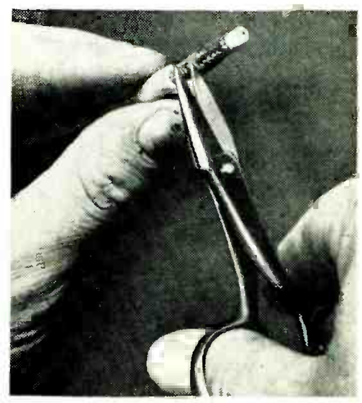
Threaded holes in aluminum housings of x-ray tubes are often damaged as a result of maintenance operations in the field. In order to salvage a housing with damaged threads it became necessary to return it to the factory. Now, with inserts installed in the equipment during manufacture, this condition is eliminated and better customer relations result.

Preparing Teflon Cable

RECOMMENDED procedures for preparing Teflon cable for r-f cables are described and pictured in the booklet "Assembly Procedures,"

available from American Phenolic Corp., Chicago, Ill. These apply to multiple-conductor and single-conductor cables which have an outer covering or jacket of Teflon surrounding the braided-wire shield.

In the knife-and-scissors procedure used for small runs, the first step is rolling the cable under the knife so as to make a cut around the circumference for removing the



Cutting braided shield with scissors after first pushing back the braid

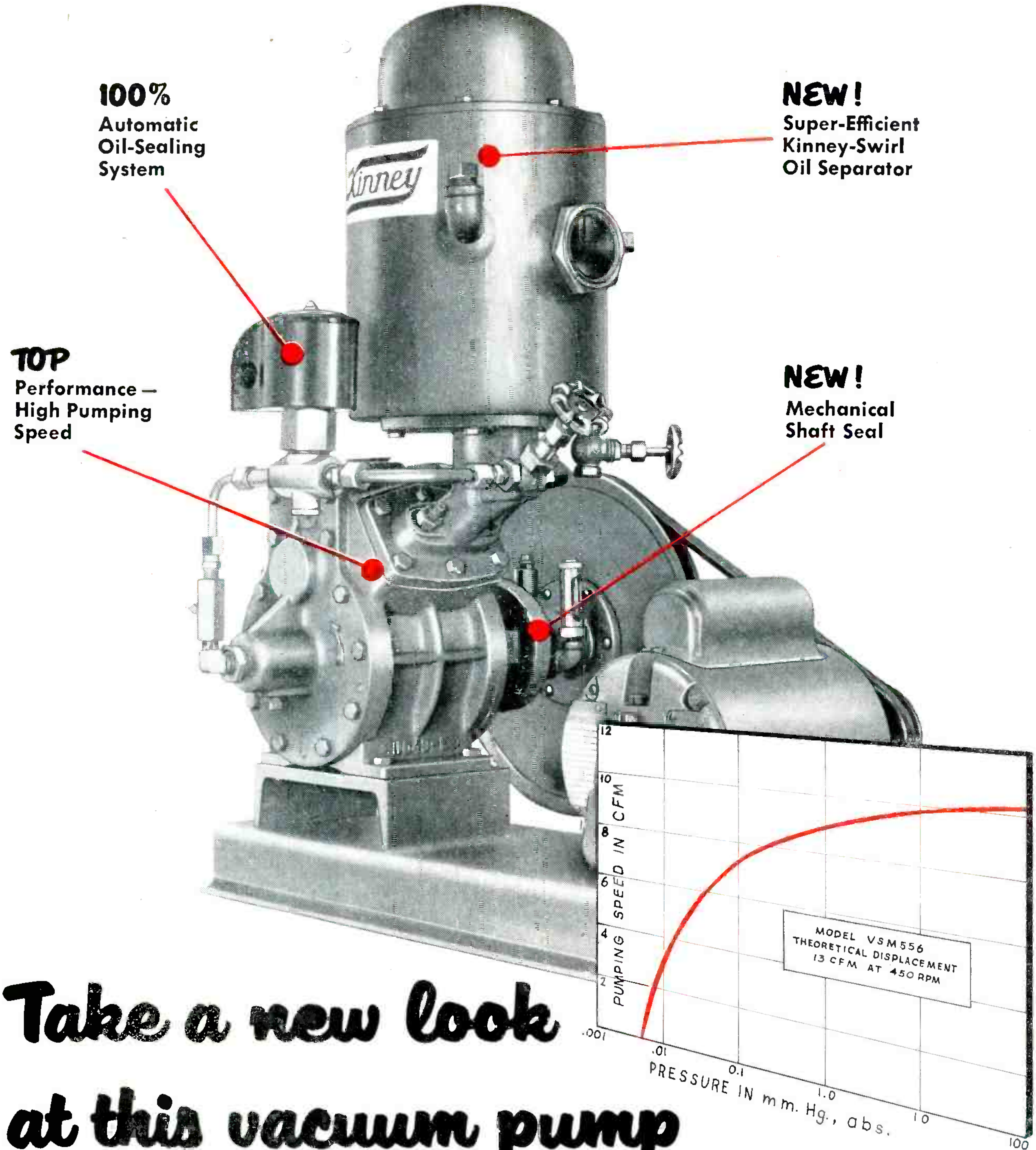
desired length of jacket. The knife is then used to make a lateral cut to the end of the cable, so that the outer covering can be peeled off easily with fingers. When making both cuts, the knife must be carefully controlled so that the cable shield is not damaged. A razor-sharp knife is essential.

To remove a portion of the exposed length of shield, push the shield back to create a bulge so that small pointed scissors can be inserted for snipping the shield wires.

To remove a portion of the exposed dielectric, the knife is then used to make a cut around the circumference, almost but not quite to the conductor. The dielectric can then be pulled off with pliers.

Air-Operated Strippers

For larger production runs of cable, an air-operated stripping device has been made by Amphenol for its own use, to remove jacketing of multiple-conductor cable. It can be adjusted also to remove jacketing, shield and dielectric of coaxial cable. Adjustments are pro-



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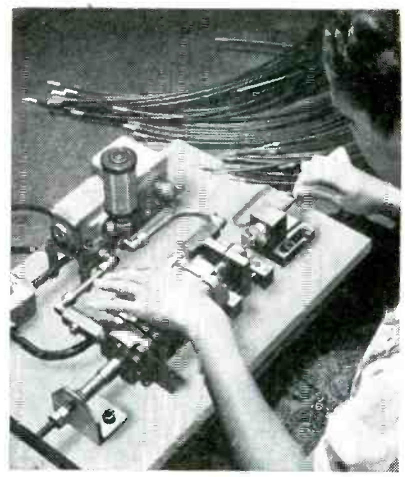
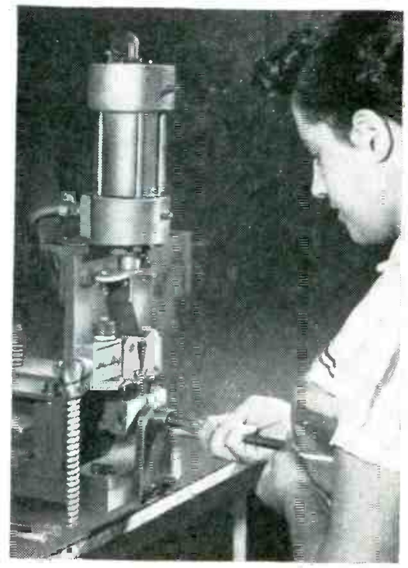


Air-operated automatic jacket stripper for Teflon cable used in radar equipment



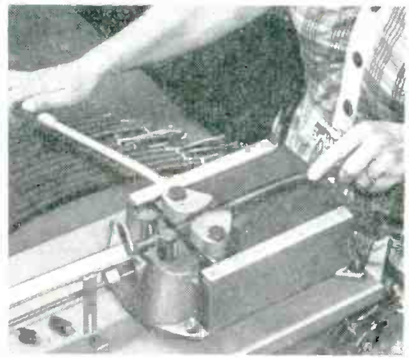
Air-operated braid cutter and stripper

vided for depth of cut as well as length of cut. Once the machine is adjusted, the operator merely inserts the cable and depresses the foot-operated air valve to complete the operation.

Another Amphenol design is an air-operated device that serves for removing the shield from coaxial cables automatically and accurately at high speed. The operator inserts the cable with her right hand and operates the air valve with her left hand. For this machine, the outer jacket must first be removed at another setup.

Manually-Operated Stripper

A manually-operated jacket-stripping device is available from Ideal Industries, Sycamore, Ill. that provides the leverage necessary to



Manually-operated jacket remover for heavy cable having several conductors

remove cable jacketing having a wide range of wall thicknesses. Springs keep the gripping jaws and cutting blades apart in-between operations, so that the operator can push the cable between them up to an adjustable stop in a V trough. When the cable is in position, one pull of the lever makes the cutting jaws dig in the correct distance and then actuates corrugated gripping jaws that pull the cable away from the cutting blade.

Shield Combing and Flaring

Many applications require that the shield of a cable be combed out, so that the strands will be parallel to each other rather than braided. A wire brush on the shaft of an electric motor does this job quickly. For safety, a transparent plastic shield should be mounted over the brush, with a slot cut into it for insertion of the cable. A short length of copper tubing is anchored to a wood block at the bottom of the slot with a pipe clamp, to provide a support for the cable as it is being combed. This pipe also serves to give the optimum angle for effi-

Motor-driven wire-brush setup for combing braided shield on cable

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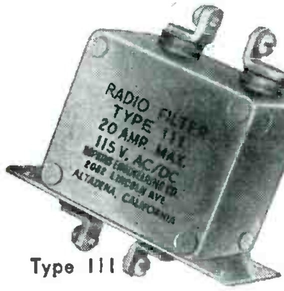

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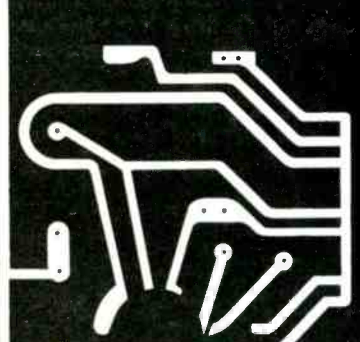

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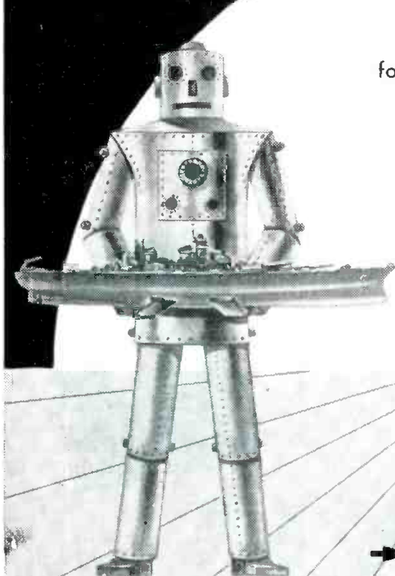

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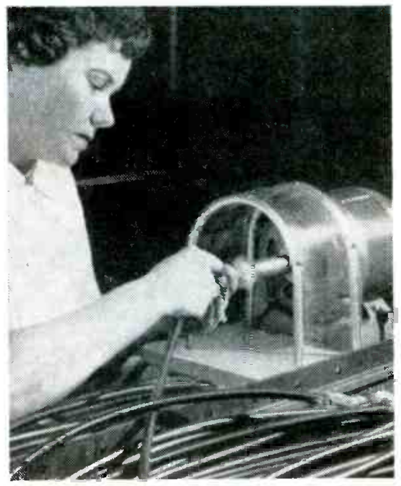


Motor-driven flaring tool for pushing back braided metal shield on cable

Cable-cutting power saw with guard

cient combing of strands.

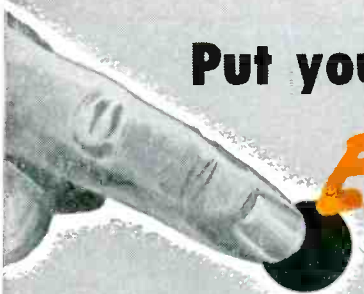
A similar motor setup, having a flaring tool mounted on the end of the shaft, can be used to fold back the shield on a coaxial cable efficiently at high speed. Here a different flaring tool must be used for each size of cable.

Cable-Cutting Saw

Large-diameter cables, as well as flexible aluminum conduit, can be cut effectively with a high-speed fine-tooth power saw. For general production use, a saw like that shown will prove safe as well as satisfactory.

Tube Pin Cutter

THE FASTEST and most practical method that could be found by Raytheon engineers for cutting the leads or pins of subminiature tubes to predetermined short lengths was



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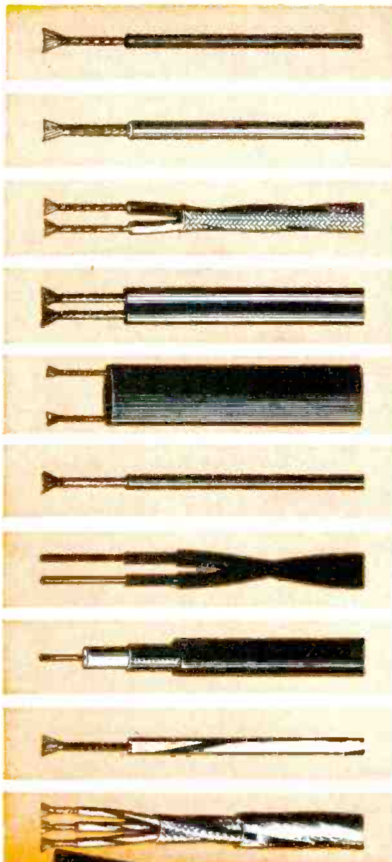

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Setup for trimming tube pins. Operator must have both hands on operating controls of press as shown before shearing blade can come down. Sponge rubber pad set into descending blade mount serves to hold tube in position

use of a heavy-duty bench-type pneumatic press. With an appropriate holding fixture, this snips off the pins with a tolerance of plus or minus 0.0100 inch.

Metal-to-Ceramic Seals for Magnetron Waveguides

BY N. E. PRYSLAK

Tube Department
Radio Corporation of America
Harrison, N. J.

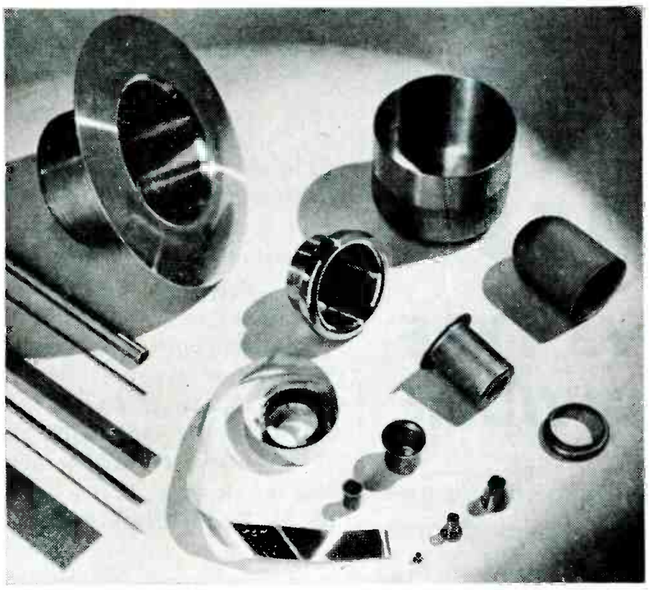
THE TUNGSTEN-IRON metalizing process used in the construction of the sandwich-type metal-to-ceramic seals was developed primarily for use in the construction of vacuum-tight output windows for magnetrons and other microwave electron tubes. Tubes having ceramic windows can be processed during exhaust at higher bakeout temperatures (650 to 700 C), and parts can be brazed to the main section of the tube in a hydrogen furnace with the window in place.

The seal consists of a rectangular ceramic window interposed between two metallic window frames and brazed to the inner walls of a rectangular waveguide. The wave-

Years of experience proves to users . . . the dependability of

KOVAR*

Glass-sealing Alloy



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The ideal alloy for glass sealing, Kovar matches the expansivity of certain hard glasses over the entire working temperature range. It resists mercury attack, has ample mechanical strength and seals readily. A permanent and impervious bond is obtained by a closely controlled thickness of oxide on Kovar alloy interfused with hard glass.

Kovar is a cobalt, nickel, iron alloy, manufactured under very carefully controlled conditions, and supplied by Stupakoff in the form of: SHEET, ROD, WIRE, FOIL, TUBING, EYELETS, LEADS and FABRICATED SHAPES. The prominent users of KOVAR and the length of time they have employed this metal are convincing proof of satisfaction.

Full information on the use of Kovar is given in Stupakoff Bulletin 145, which we will send upon request.

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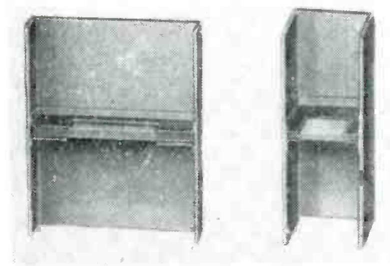


FIG. 1—Typical rectangular output waveguide used with microwave tubes

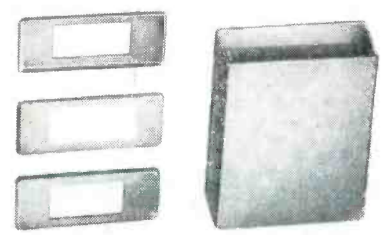


FIG. 2—Component parts of output window assembly for rectangular waveguide section that is brazed to tube

guide shown in Fig. 1 is made of 0.020-inch nickel-iron alloy No. 52, is 1¼ inches long and has internal dimensions of 0.400 inch and 0.900 inch. Alloy No. 52 contains 51-percent nickel and 49-percent iron.

The component parts of the output window assembly used in this waveguide are shown in Fig. 2. The two window frames, also made of No. 52 alloy, are 0.005 inch thick. The outer edge of each frame is flanged to facilitate brazing to the inner wall of the waveguide.

The thickness of the ceramic window has been varied from 0.020 inch to 0.060 inch in experimental assemblies. Both Alsimag 243 ceramic and an RCA developmental forsterite ceramic have been used. The thermal-expansion characteristics of both ceramics and of the nickel-iron alloy No. 52 are shown in Fig. 3. The slight difference between the expansion characteristics of Alsimag 243 and the RCA forsterite is probably due to the use of different materials as fluxing agents. This slight difference did not affect the properties of experimental seals.

The portion of ceramic to be metalized must be free of any contaminating material if an adherent

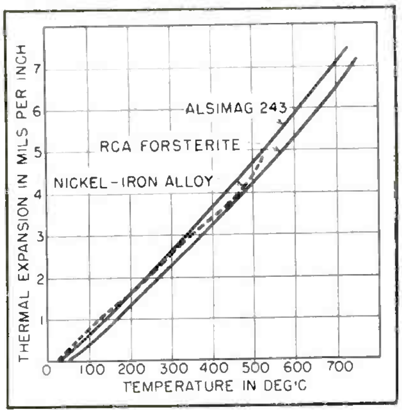


FIG. 3—Thermal expansion characteristics of ceramics and metal used in sandwich-type seal for tubes

bond is to be formed between the metallic powder and the ceramic. The ceramic windows are degreased in an alkaline cleaner, thoroughly rinsed in water, immersed in a dilute solution of 25-percent nitric acid, washed in water again and then dried. After the ceramic is cleaned, the active portion of the window is masked out, and the remaining area is painted with the tungsten-iron mixture.

The tungsten and iron powders used in metalizing the ceramic have particle sizes in the order of one to four microns. The mixture of powder used contains 90-percent tungsten and 10-percent iron by weight. The powder is mixed with a binder composed of nitrocellulose, diatol and diethyl oxalate into a paste having the consistency of paint. This paste is then painted on the ceramic with a camel-hair brush to a thickness of 0.001 to 0.002 inch. Coatings heavier than 0.002 inch often tend to result in peeling of the metallic surface. If desired, the tungsten-iron powder mixture may be diluted to the proper consistency and sprayed on the ceramic.

The coated ceramic is fired in a molybdenum-wound muffle furnace at a temperature of 1,345 C for 15 minutes to form a bond between the tungsten-iron powder and the ceramic. Various atmospheres have been used during the firing process. Forming gas (30-percent hydrogen and 70-percent nitrogen), wet hydrogen and line hydrogen having a dew point of approximately —60 have all given satisfactory results. Reduced temperatures, in the order of 1,200 C, may also be used for sintering provided the firing time is increased.

After the sintering treatment, the metallic surface of the ceramic is polished with a fine wire brush to remove any loose particles and is washed. The metalized area is then plated with nickel or copper to a thickness of about 0.0001 to 0.0002

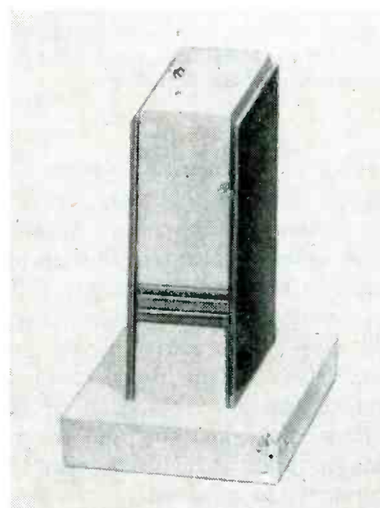


FIG. 4—Parts of output window assembly mounted on jig for brazing

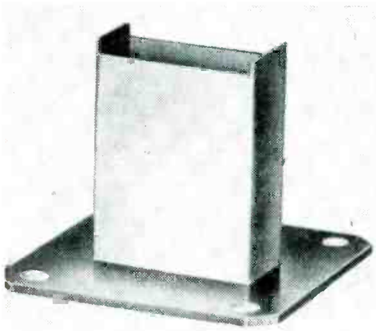
inch to insure better wettability during the brazing process.

Metal-to-Ceramic Brazing

The component parts of the output window assembly are mounted on a suitable jig preparatory to brazing, as shown in Fig. 4. One wall of the waveguide has been cut away in this assembly to show how the parts are stacked in the jig. The mounting jig is made of Nichrome and is lightly sprayed with a coating of alundum to prevent sticking to the inner wall of the waveguide during brazing. The upper portion of the jig serves as a weight to insure intimate contact between the ceramic and the window frames and to prevent warping of the metal parts.

The brazing material used in this seal consists of a piece of oxygen-free high-conductivity copper having a thickness of 0.005 inch, interposed between the ceramic and each window frame. Pure silver and a silver-copper eutectic solder have also been used as the brazing medium with satisfactory results.

The assembly is brazed in a hydrogen muffle furnace at 1,100 C for approximately 10 minutes. The time of brazing may vary depending on the mass of the part being



Finished waveguide window with flange

brazed. The amount of brazing material used as solder is important; too small an amount may cause an incomplete braze, while an excess amount may alter the expansion characteristics of the metal at the braze joint and cause the ceramic to fracture or strip from the metal.

It is desirable that the metalized portion of the ceramic be kept at least 0.020 inch away from the edge of the window-frame opening. If the metalized portion is too close to the opening, solder may creep beyond the edge of the frame, thus altering the window size and changing the electrical properties of the waveguide.

The unflanged end of the completed waveguide is brazed directly to the output connection of a microwave tube. Copper is usually used as the brazing medium in this seal, so that subsequent brazings may be made to the waveguide with solders having lower melting points.

The author wishes to thank D. G. Burnside of the RCA Laboratories at Princeton, N. J. for his guidance in the use of the tungsten-iron metalizing technique.

Wire-Coding Methods

IDENTIFICATION of individual wires in cables, harnesses and in conventionally wired circuits can be achieved in many different ways. There is generally one most efficient

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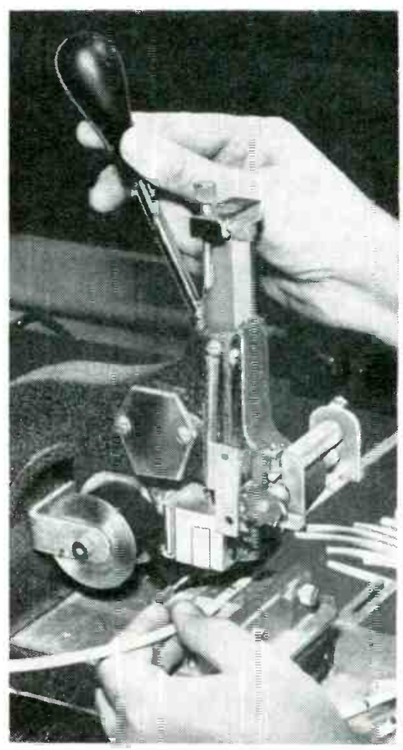
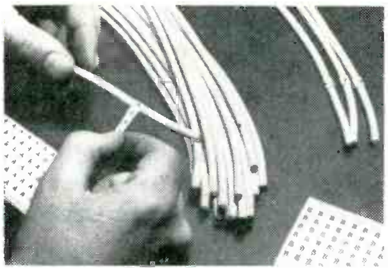
Simple wood block arrangement for holding different colors of wires used in cable plug. Cork sleeve covers almost entire length of pencil-type soldering iron, to give improved grip and minimize accidental burning of hands or fingers

and most economical method for each type of wire covering and each application. Four of the most widely used means of coating electronic wiring are illustrated by



Placing identifying codes directly on wires with Kingsley hot-stamping machine. Ink-bearing tape advances automatically each time lever of machine is actuated by bringing lever arm forward

Use of hot-stamped black vinyl sleeving for identifying correcting wires



Use of imprinted tape for identifying wires during assembly and in field

Amphenol in their recent catalog.

For internal circuits of radio, television and communication equipment, coding is usually accomplished by using differently colored wires. These are generally cut to length and stripped automatically, then placed in holders, bins or racks within easy reach of the operator on the assembly line.

Black or colored vinyl sleeving can readily be hot-stamped with a circuit code number or letter with the Kingsley machine or its equivalent. The stamping can be done on long lengths, and the sleeving then cut or chopped into the required shorter lengths conventionally for application to the leads requiring identification.

Imprinted Scotch tape is widely used for wire coding. Many different types of tape are available, with various dispensing arrangements, and with either standard printing or custom lettering.

Wiring designations can be printed directly on most types of insulation with the Kingsley machine. Different colors of printing tape are available, so that tape with dark ink can be used on light-colored wire and vice-versa.

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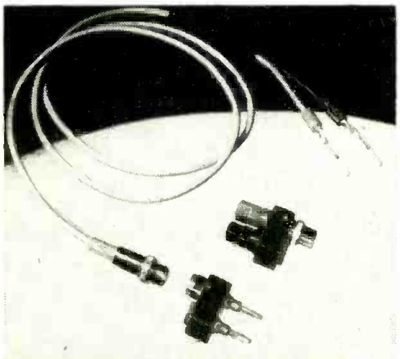
NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered . . . Fifty-Two Bulletins Reviewed

OTHER DEPARTMENTS featured in this issue:

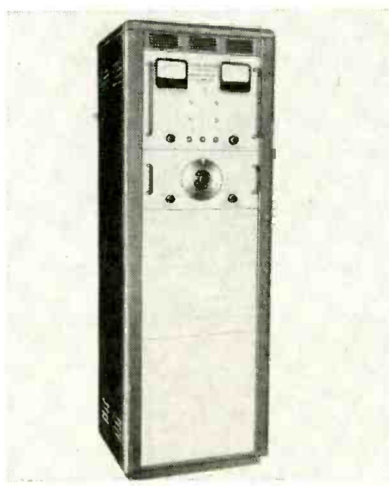


CONVERSION PLUGS
aid interconnections in lab

MILLIVAC INSTRUMENT CORP., 444 Second St., Schenectady 6, N. Y., offers two new conversion plugs to simplify interconnections between measuring instruments and other electronic laboratory equipment having old-style $\frac{3}{4}$-in.-spaced banana plugs, or the corresponding jack-type terminals, with other instruments having new-style concentric Amphenol terminals and plugs. The CP-122 (Amphenol-to-spaced jacks) and CP-221 (spaced-plugs-to-Amphenol) enable users to plug old equipment into new meters and scopes or to use the shielded clip lead, CL-101, for older equipment having spaced terminals. All Millivac instruments are equipped with concentric plugs.

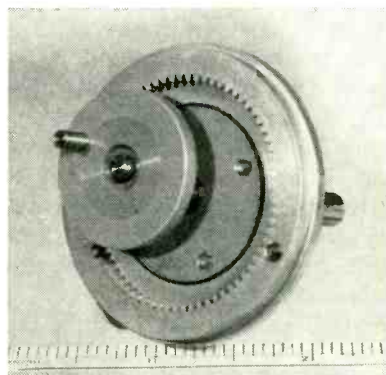
D-C AMPLIFIER
weighs 10 oz

ELECTRO-MECHANICAL RESEARCH, INC., P. O. Box 307, Ridgefield, Conn. Model 55A subminiature stabilized d-c amplifier is designed for telemetering or recording the outputs of thermocouples and d-c excited strain gages. Frequency response is ±2 percent from d-c to 10 kc. Gain is 1,000. Noise is less than 25 μv rms equivalent input signal at normal ambient temperatures. Drift is an output zero offset which does not exceed ±25 μv equivalent input signal. Nominal input range is 0 to ±5 mv. Output impedance is less than 50 ohms. Input and output are referred to ground. Including its nine-pin octal plug, overall dimensions are $5\frac{1}{8}$ in. × $1\frac{7}{16}$ in. × $1\frac{7}{8}$ in.



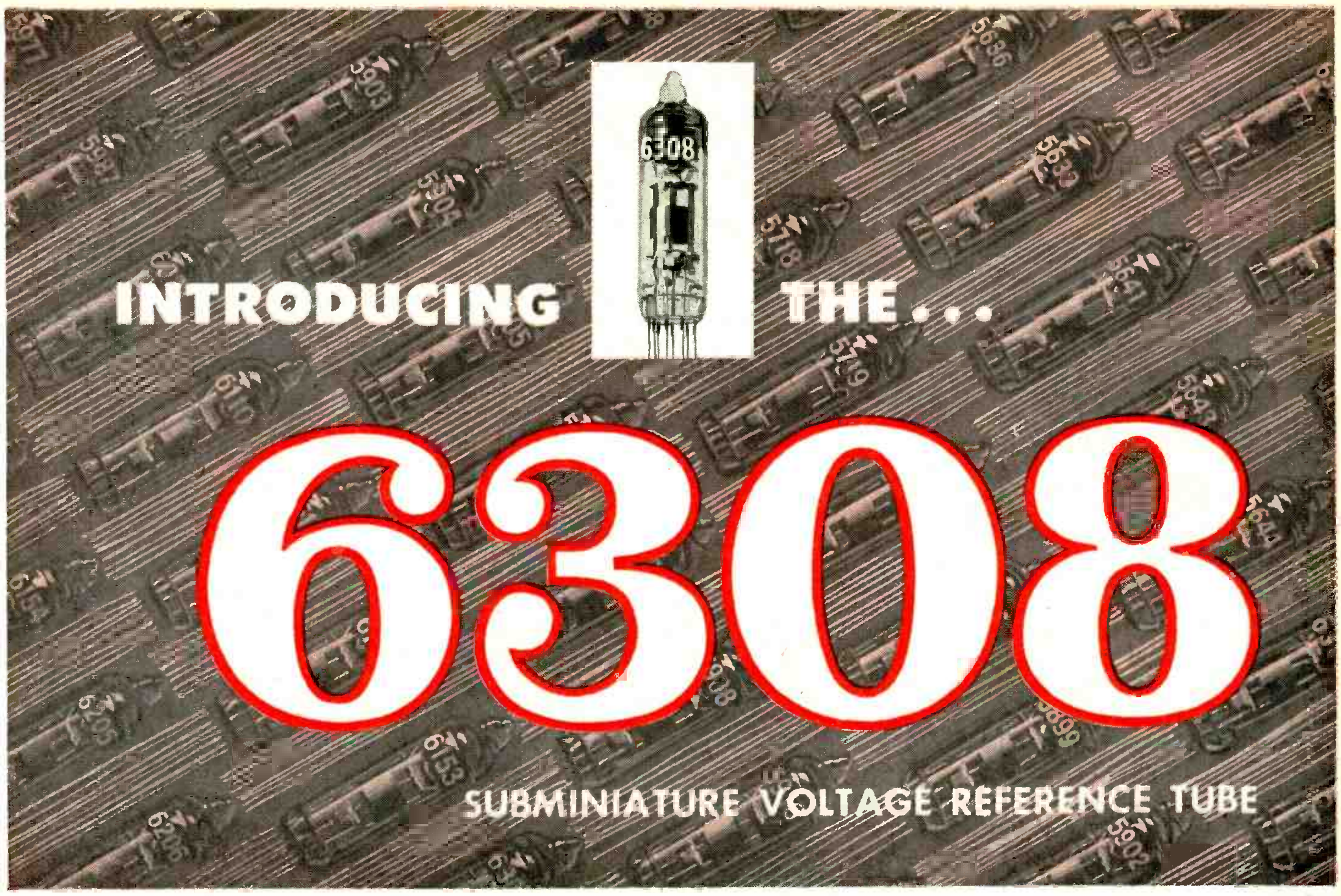
POWER GENERATOR
has 500-va output

INDUSTRONICS, Box 424, Arlington Heights, Ill. Model 1000A variable-frequency power generator will deliver 500 va over a wide portion of the audio spectrum. Excellent voltage regulation is maintained over the entire voltage range of 0 to 250 v. Maximum power is available at any voltage between 25 and 250 v. The system consists of an audio oscillator driving a linear high-power amplifier followed by stabilizing and voltage-control networks. Complete technical specifications and operation data are available in a single-sheet bulletin.



SINE-COSINE DEVICE
for analog computers

LIBRASCOPE, INC., 1607 Flower St., Glendale, Calif., announces the sine-cosine mechanism, a new component for analog computers, which accurately converts angular rotational movements into linear sine or cosine movements. It offers instantaneous solutions to problems of changing variables involving vector components, range and bearing computation, flight computation and many other trigonometric functions. Design features include positive preset indexing (3 position, 90 deg. apart), low friction, high accuracy and simplicity of design in a completely self-contained unit. The mechanism has a conventional 3-lug



Another Sylvania Premium Subminiature Tube!
Type 6308 subminiature is a cold cathode, glow discharge diode . . .
especially designed by Sylvania for voltage reference applications.

Initial reports from engineers who have made comparative tests indicate that such critical performance factors as stability, drift, repeatability and voltage jump have been better attained with the 6308 than with other tube types of this classification.

This tube incorporates the excellent performance features of the Sylvania premium subminiature line and will provide dependable service under severe environmental conditions. Before selecting a voltage reference tube for your particular application, we urge you to check the ratings and controlled characteristics of the Sylvania 6308. For further information, call your Sylvania Sales Engineer or write Dept. 4R-1601 at the address below.

ELECTRICAL DATA

RATINGS—Absolute Values

Maximum Operating Current (dc)	3.5 ma
Minimum Operating Current (dc)	1.5 ma
Maximum Shunting Capacitance	0.02 uf
Maximum Starting Voltage (dc)	115 volts

CHARACTERISTICS

Operating Voltage[1] (dc)	87 volts
Voltage Regulation (max.)	3 volts
Drift[2]	200 mv
Stability[3]	5 mv
Repeatability[4]	150 mv
Voltage Jump[5]	50 mv

Maximum Average Temperature Coefficient of DC Operating Voltage:

−20 °C to +25 °C Ambient	−15 mv/°C
+25 °C to +60 °C Ambient	−5 mv/°C

Notes:

(1) *Anode voltage drop may range between 82 and 92 volts for any tube.*
(2) *Maximum operating voltage change during one hour of operation, at any specific value of current within operating range.*
(3) *Maximum operating voltage fluctuation having a frequency of 10 cps or greater, at any specific value of current within the operating range.*
(4) *Maximum shift in operating voltage between successive firings of tube.*
(5) *Maximum sudden jump in operating voltage when operating current is varied slowly over specified range.*

SYLVANIA

Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg., St. Catherine Street, Montreal, P. Q.

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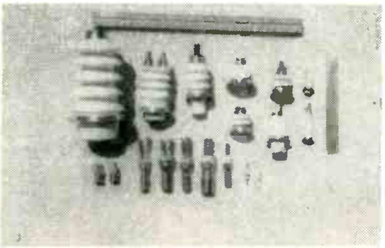
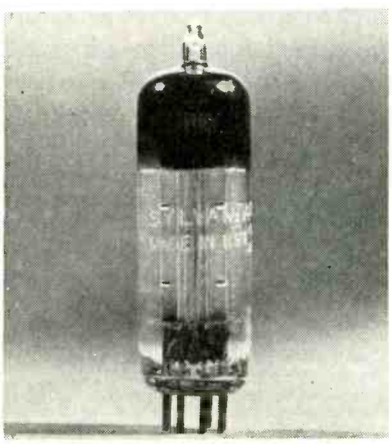
arrangement for mounting, weighs 2 oz and is accurate to 0.2-percent full scale.



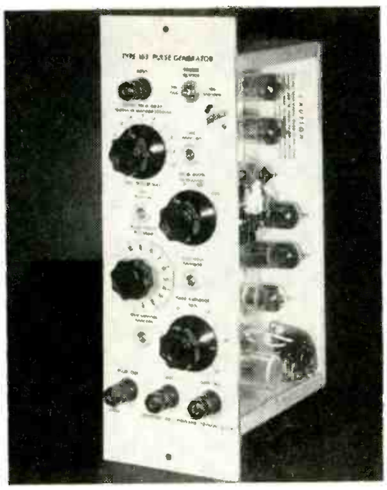
HERMETIC TERMINALS
are high-temperature units

THE CERAMASEAL CO., Box 25, New Lebanon Center, New York, has available hermetic high-temperature terminals, produced by brazing metal members on to high-alumina ceramic, using a new sealing process and using BT as the bonding alloy. They have been used at 350 C and higher temperatures are possible with the use of other alloys. Thermal shock resistance is also high. The size range and general configuration of the terminals are shown. To date, the largest made by the company is about 6 in. tall by about 3 in. in diameter, but larger and longer types are possible.



DISCRIMINATOR TUBE
is gated-beam type

SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y. Type 6BN6 gated-beam discriminator tube performs the function of limiter, discriminator and audio amplifier. The T-5½ miniature is quite different in its characteristics from the usual amplifier pentode. Because of its sharply focused electron beam, the first control grid has a step-shaped control characteristic, the plate current rising abruptly from zero the sharply defined maximum as the grid voltage changes from negative to positive. The second control grid has similar properties, controlling plate current from a cutoff condition at negative bias up to a slightly positive condition. Beyond this point it loses control of the plate current which is limited to a level defined by the first control grid and the electron beam.



PULSE GENERATOR
features fast rise

TEKTRONIX, INC., P. O. Box 831, Portland 7, Oregon. Type 163 pulse generator is a new addition to the type 160 series of special waveform generators. It is designed to supply rectangular pulses of less than 0.2-μsec rise time when triggered by either a positive pulse or a negative-going sawtooth from an external source. A positive pulse of calibrated continuously-variable amplitude from 0 to 25 v peak to peak, and a positive gate of 25 v fixed amplitude are supplied. The pulse and gate are identical in other characteristics. Duration is calibrated and is continuously variable from 1 μsec to 10,000 μsec. When triggered by a sawtooth voltage, the output may be delayed a calibrated interval from 0 to 100 percent of the duration of the sawtooth. Decay time is 0.2 μsec and overshoot can be adjusted to zero.

TINY CAMERA TUBE
for commercial tv

RADIO CORP OF AMERICA, Harrison, N. J. Type 6326 film-pickup Vidicon measures only 1 in. in diameter and 6¼ in. in length. It makes possible simpler, more compact, lower-cost tv film cameras and associated equipment for broadcast film pickup. It has a resolution capability of approximately 600 lines and needs only one-third to one-half the light requirements of an iconoscope for televising motion-picture films. For televising transparencies and opaques, the light requirement is only one-twentieth of that needed for film pickup. It is the first tv film-pickup camera tube to develop a signal-to-noise ratio sufficiently high to allow effective use of aperture correction, an operating technique for increasing the clarity of fine details in the transmitted picture.

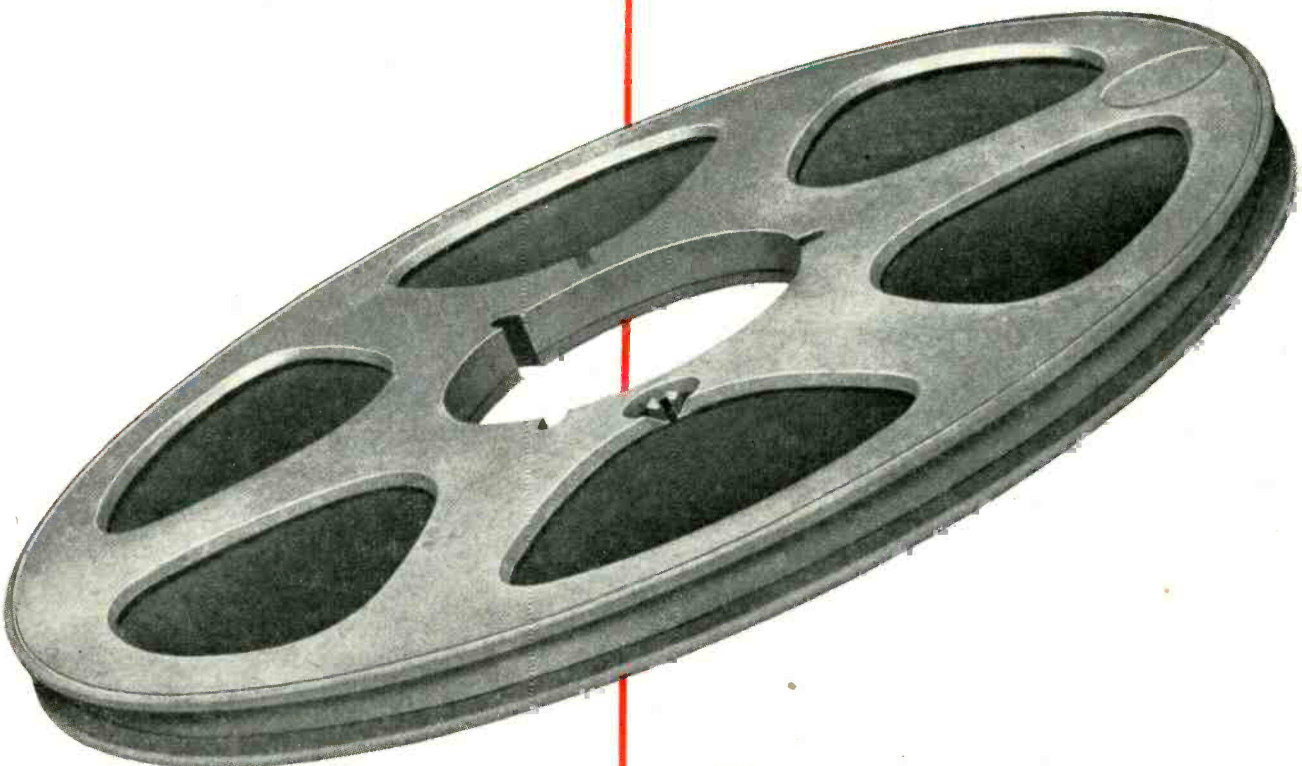
ELECTRONIC COUNTER
has million-count capacity

ATOMIC INSTRUMENT CO., 84 Massachusetts Ave., Cambridge 39, Mass. Model 162A glow-transfer counter has a maximum capacity of 1,000,000 counts with a speed range of 0 to 5,000 counts per sec. All counting, indication and transfer are done within the cold-cathode glow tubes upon which the counter is based. These tubes have bright-red neon glows opposite numbered circular spacings (0 to 9) to show accumulated count. Two units can be run in cascade, with one of the units feeding millions into the other. A

audiotape now available

on new *Fiberglas* 10½″ reel

TRADE MARK



SOLID, ONE-PIECE CONSTRUCTION

STANDARD N.A.B. HUB DIAMETER

25% LIGHTER THAN ALUMINUM REEL

HAS SMOOTHER FLANGE EDGES

WILL NOT BEND

RESISTS WARPING AND DISTORTION

PRACTICALLY INDESTRUCTIBLE

HERE'S A NEW 2500-foot reel with a number of improved design features that will appeal to many tape recordists.

Audiotape can now be supplied on this light-weight Fiberglas reel at *no increase in price*. For a trial order, get in touch with your nearest Audio distributor. If he doesn't have the new reels in stock, have him contact our New York, Chicago or Hollywood office and we'll see that your requirements are promptly filled.

This is another example of how Audiotape gives you *extra value* at no extra cost. Its performance speaks for itself. Output, frequency response, noise level and distortion are correctly proportioned for the most satisfactory end result—with no compromise on quality anywhere along the line.

AUDIO DEVICES, Inc.

444 MADISON AVE., NEW YORK 22, N. Y.

Offices in Hollywood — Chicago

Export Dept., 13 East 40th St., New York 16, N. Y., Cables "ARLAB"

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audiodiscs
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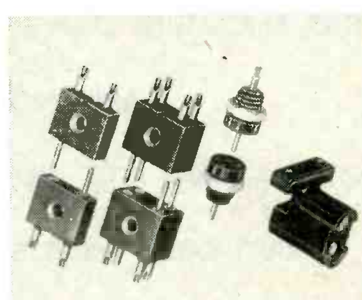
jack in the rear of the chassis provides for remote-control connection. The instrument will accept positive or negative pulses or sine waves of 4 to 60 v, depending on control setting.

RUGGEDIZED TRIODE
is improvement on type 892

AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L. I., N. Y. Incorporating the latest developments in tube design and techniques, the type 6333 fills the requirements of the industrial and communication fields for a tube that is completely interchangeable with the 892 prototype and yet is superior in mechanical construction, performance and shock-resistance qualities. Among the outstanding features of the new tube are a powered glass stem, Kovar grid ring, shorter overall length, internal conical grid support, Kovar anode seal, spiral filament and lower inductance.



CONNECTORS
feature special design

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y., has added four special-design connectors to its Continental line. The miniature rectangular 2 and 4-contact reverse pin and socket connectors are particularly adaptable to small equipment because of their novel countersunk side-mounting arrangement. The one-pin round connector is extremely small and light and completely devoid of excess hardware. The two-contact high-voltage socket has an unusual shape and close mating tolerances. All are available in three different insulating materials: mineral-filled Melamine; Plascon fiber-glass reinforced Alkyd, type 440-A; and Diallyl Phthalate. Contacts are silver and gold plated and normally have solder wells for No. 20 AWG wire.

SILICON DIODES for 6,750 mc

MICROWAVE ASSOCIATES, INC., 22 Cummington St., Boston 15, Mass. Four new cartridge-type silicon diodes have been developed for mixer use in microwave systems utilizing RG 50/U waveguide. These diodes are physically interchangeable with the standard 1N23B and 1N21B but are designed for optimum performance at 6,750 mc in the P-570 mixer. In this mixer the 1N150 diode presents a match of better than 1.5 to 1 at 1 mw level. The 1N150 and its reversed polarity counterpart are manufactured to such narrow limits that they can be used in balanced mixers without selection. In such mixers noise figures of approximately 10 db are obtainable over broader bandwidths than possible with 1N23C diodes at this wavelength. The 1N160

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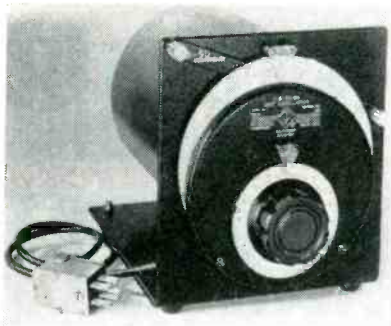
(SD7000) and 1N160R (SD7000R) are similar to the 1N150 but are designed to slightly higher test limits.

MICROPHONES
used with transistor circuits

SHURE BROTHERS, INC., 225 W. Huron St., Chicago 10, Ill., announces the MC series of magnetic microphones with a 1-in. diameter, and immune to varying conditions of heat and humidity. These controlled reluctance microphones were specifically designed for use with transistor circuits; but they are applicable to other devices—such as small, compact amplifiers and transmitters, as well as dictating equipment. Models MC10 and MC11 are similar, but MC11 has a mu-metal shield ring for reducing hum pickup. Both are identical in size: 1 in. in diameter, ⅜ in. in thickness.

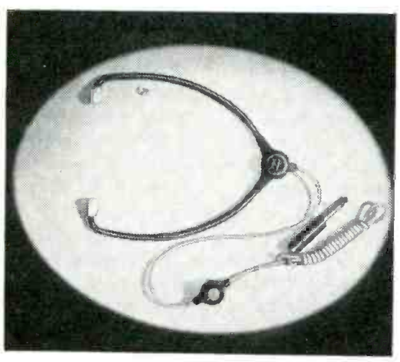
SIGNAL GENERATOR
covers 7 to 11 kmc range

HEWLETT-PACKARD CO., 395 Page Mill Rd., Palo Alto, Calif. Model 620A signal generator offers direct frequency setting and readings from 7 to 11 kmc. It is designed to simplify all shf measurements including sensitivity, selectivity, rejection, signal-to-noise ratio, conversion gain, swr, antenna gain and transmission-line characteristics. It may also be used for slotted lines, waveguide and filter networks. It includes internal or external pulse modulation, internal square-wave modulation, frequency modulation and c-w output. Pulse width is variable from 0.5 to 10 μsec and repetition rate is 40 to 4,000 pps. On internal f-m, the instrument provides a sawtooth sweep variable between 40 and 4,000 cps. For external f-m, capacitive coupling is provided to the repeller of the klystron oscillator.



UNIT OSCILLATOR
spans 0.5 to 50 mc

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1211-A unit oscillator has a frequency span from 0.5 to 50 mc, covered in two 10-to-1 logarithmic ranges. Frequency is read directly from a 6-in. dial, with a slow-motion-drive dial indicating frequency increments of 0.2 percent per division. Output power is well over 1 w over the 0.5-to-5-mc range and is at least 0.2 w over the 5-to-50-mc range. Construction of the unit provides very effective shielding so that the instrument can be used as a power source in bridge measurements.



HEADSET
weighs only 1.2 oz

TELEX, INC., Telex Park, St. Paul, Minn. Designed for professional, business and technical use, the Monoset (under-the-chin headset) is made of tough, durable Tenite and has an exclusive volume control for group-hearing system applications. Weighing only 1.2 oz, it has removable plastic eartips and a miniature, plug-in cord attachment. Sensitiv-

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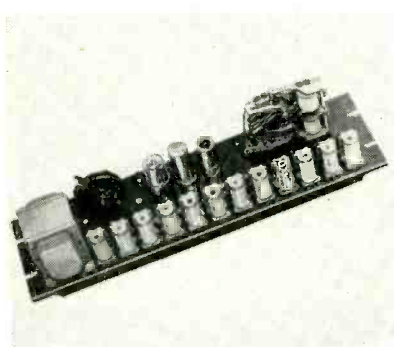
ity is 88 db above 0.000204 dynes per sq cm for 10-μw input. An exclusive feature is the volume control mounted in the lightweight cord that clips to the lapel or pocket and permits use of a series of Monosets on one line. Literature is available.

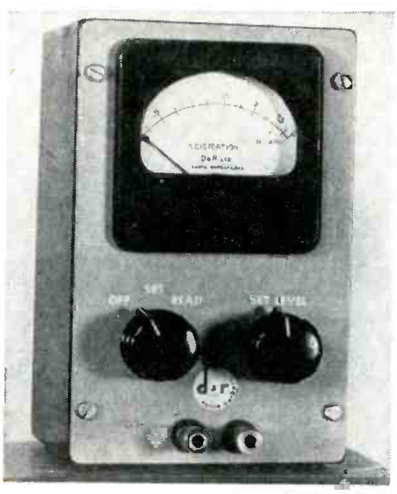
TOROID COIL fits in tiny case

TORWICO ELECTRONICS, INC., 961 Frelinghuysen Ave., Newark, N. J. Extremely fine wire winding now makes it possible to put 18,000 turns of No. 46 AWG wire on the new miniature 20-henry toroid coils so that the coils can be housed in a very small hermetically sealed case, 1⅛ maximum o.d. by ¾ in. high. A 6/32 mounting stud is provided with the terminals that presents a nonturning or locking feature, when mounted in the chassis.



REMOTE SWITCHER is pulse-counting unit

THE HAMMARLUND MFG. CO., INC., 460 W. 34th St., New York 1, N. Y., is producing a remote-control terminal unit that responds to and channelizes telephone-dial-actuated pulses to perform selective switching operations. It is applicable to control and signaling operations by railroads, public utilities, refineries, pipelines and many other industrial organizations. The PCU-2 pulse counting unit is operated from a telephone-type dial at the control center over a transmission media using either audio tone or d-c telegraph signals. A typical application is in its use for selecting any one of 10 telemetering circuits when only one transmission circuit is available for sending metered information. In this case the PCU-2 selects the metering circuit requested from the control point. It may also be used for controlling transmitters, receivers, lights, motors and any other item that can be adapted to electrical control.



DISTORTION METER
is a portable unit

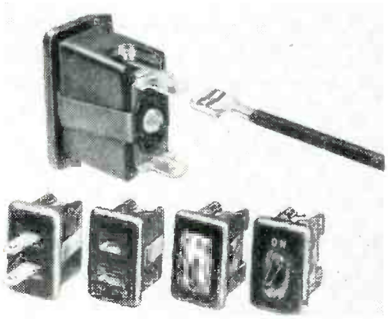
D. & R, LTD., 402 E. Gutierrez St., Santa Barbara, Calif. Model DM-1 portable distortion meter is a precision, self-contained unit, so compact that it can be easily held in one hand. It measures at a single frequency, and differs radically from most distortion measuring equipment in that the filter suppresses a band of frequencies, making it unnecessary to balance for a null. Readings may be taken rapidly and are completely independent of flutter produced by the recording medium. The unit meets all requirements of NARTB tape noise-level measurement. It is especially suited for production and maintenance requirements in radio broadcasting stations, tv stations, recording studios, audio equipment plants and for high-fidelity technicians and enthusiasts.

VARIABLE CAPACITOR
for 500 mc and higher

TRI-POINT MFG. & DEVELOPMENT Co., 401 Grand St., Brooklyn, N. Y., has announced a new uhf Teflon variable capacitor for 500 mc and higher. Advantages include: heat resistance (even soldering will not affect the capacitor); extremely low dielectric loss; nonabsorbency of moisture under all conditions; minimum shrinkage in production; no effect on the Q of any coil or line with which the capacitor is used. Capacitance will not change through vibration once the screw is set. These capacitors come in a wide range of values.

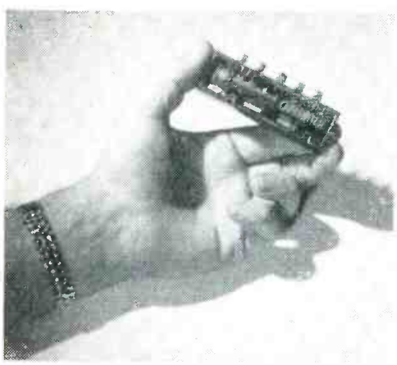
DATA RECORDER
features speed and accuracy

BARNES DEVELOPMENT CO., 213 W. Baltimore Pike, Lansdowne, Pa. A new model data recorder takes 100 identifiable readings on an $8\frac{1}{2} \times 11$ in. chart. The chart may be removed and replaced with accurate indexing. This permits the collection of test data, taken at different times, on a single chart. Simplicity of operation permits a nontechnical operator to take up to 600 bridge readings an hour. The unit can be used for any bridge or potentiometric type measurement. The print drive servo has a sensitivity of 25 μv. Full scale spans as low as 15 mv are practical. A typical use is in production control or acceptance testing of resistors.



SNAP-IN DEVICES with spade terminals

THE HART MFG. CO., 110 Bartholomew Ave., Hartford, Conn. Diamond H snap-in switches, outlets, pilot lights and interconnecting load plugs are now available with spade terminals for A-MP quick-connectors as well as with standard screw terminals. These snap-ins are simply pushed into mounting holes where spring clips hold them firmly in place. Switches are rated at 15 and 20 amperes, 125 v; 10 amperes, 250 v a-c, and also are available with horsepower ratings. Pilots are rated 115 v or 230 v a-c.



NONMAGNETIC RELAY has new operating design

MULLENBACH ELECTRICAL MFG. CO., 2300 E. 27th St., Los Angeles 58, Mass. The Capaswitch is basically an ultrasensitive, nonmagnetic d-c relay with unusual current carrying capacity. An entirely new operating principle is used to provide the mechanical energy to open and close the contacts. Instead of the conventional electromagnetic armature, it uses an electrostrictive capacitive element (0.05 μf), requiring only

0.5 mw-second of operating power (150 v d-c) to close the contacts, and less than 0.1 mw to hold them closed. The present unit weighs only 2 oz and measures 3½ in. long, 1⅜ in. wide including terminals, and $\frac{11}{16}$ in. thick. Model A Capaswitch is a spdt relay, rated at 1 ampere, 110 v a-c noninductive load.

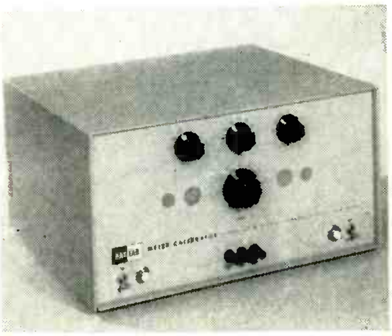
MICROWAVE ANTENNA
for field broadcast use

RADIO CORP. OF AMERICA, Camden, N. J., has announced a 2-ft parabolic reflector designed to meet broadcasting demands for a microwave dish that is readily portable through narrow passages or through small apertures to reach the desired field transmitting point. The MI-26182-51 reflector is a lightweight antenna, easy to manipulate, and especially designed for very short hops within the city such as street to building top, building to building or remote truck to building top. It provides good performance in transmission paths of up to 5 miles.

ROTARY SWITCH
has 8 poles on one deck

THE DAVEN CO., 191 Central Ave., Newark, N. J. Type 87-EM rotary switch has 8 poles on one deck, a feature made possible by the company's knee-action rotor, which gives uniform contact pressure and low contact resistance throughout the life of the switch. The unit measures 2¾ in. in diameter, and is $1\frac{15}{16}$ in. deep. It is available in multiple deck arrangements if required. From 1 to 5 positions per pole are available with shorting-type action;

up to 3 positions per pole with non-shorting action. A 15-deg spacing is used between live positions with the shorting-type action; 30-deg spacing with nonshorting action. Current-carrying capacity of the switch is 15 amperes.



METER CALIBRATORS
available in four models

KALBFELL LABORATORIES, INC., 1090 Morena Blvd., San Diego 10, Calif. Models M30B-1 and M30B-1Z are precision voltage calibrators affording calibrated output voltage from 1 to 300 v variable in 1-volt steps and variable between steps by a calibrated potentiometer. Model M10A-10 is a combination voltage and current calibrator supplying 0 to 100 v at 100 ma maximum, variable in 0.1-v steps; and 0 to 100 ma at 100 v maximum, variable in 0.1-ma steps. Model M100A-20 is a current and voltage calibrator with a voltage range from 0 to 1,000 v at 200 ma maximum and four current ranges. The output current ranges are 0.1, 1.0, 10 and 100 ma with a capacity of 1,000 v maximum. The M10A-10 and M100A-20 employ a special circuit that allows for the adjustment of the output voltage and current down to zero.

SSB FILTERS
for amateur use

BURNELL & Co., 45 Warburton Ave., Yonkers 2, N. Y., has released a single-sideband filter that will appeal to amateur users and manufacturers of low-cost commercial sideband receivers. The type S-15000 consists of stabilized toroids and other high-quality components that will attenuate a 50-kc carrier 20 db and most of the upper sideband, 40 db. Audio response through the

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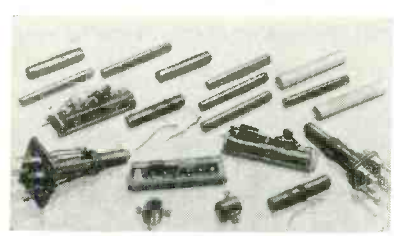
filter would be 300 cycles to 3,300 cycles.

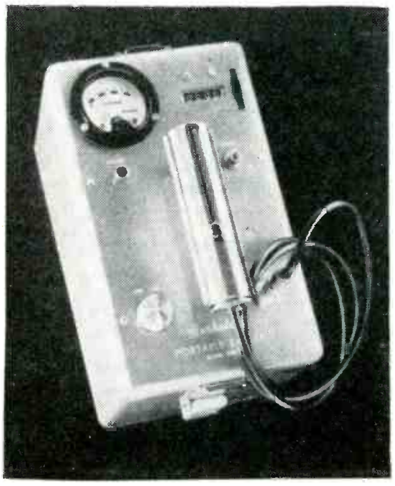
REFLEX KLYSTRON
is thermally tuned

BENDIX AVIATION CORP., Red Bank Div., Eatontown, N. J., has announced a thermally tuned klystron tube designed for K-band operation. The JAN 2K50 will operate over a frequency range of 23,504 mc to 24,464 mc with a minimum power output of 8.5 mw. It will tune this range in 1.2 to 2.6 seconds. The tube is tuned by varying the grid bias voltage of a triode section incorporated in a metal envelope. The plate of the triode section is attached to the klystron structure. Thermal expansion of the plate, caused by variations of plate current, is transmitted to the cavity of the klystron. This results in a change in the gap spacing and consequently the frequency.



COIL FORMS
are resin impregnated

RESINITE CORP., 2035 W. Charleston St., Chicago 47, Ill. Resin-impregnated coil forms are now available in all colors for color-coding of circuits and components. This means to easy identification not only simplifies circuit tracing and repairs but is of material assistance in assembly and production. Known as Resinite AC, the coil forms combine the mechanical and dielectric advantages of phenolics with the high dielectric strength, moisture resistant and noncorrosive properties of cellulose acetate. They are shatterproof and impervious to electrolytic corrosion. Their volume resistivity, power factor and thermal characteristics make them exceptionally adapted to vhf, uhf and other applications involving strenuous operating conditions.



PORTABLE SCALER
is battery operated

BERKELEY, DIVISION OF BECKMAN INSTRUMENTS INC., 2200 Wright Ave., Richmond, Calif. Model 2080 battery-operated portable scaler provides a field instrument for accurate measurement of very low beta or gamma radiation levels where the source-to-background ratio is small. The instrument contains an electronic scale-of-eight and a four-digit resettable register. The electronic scaling binaries use subminiature tubes and are designed for low battery drain and maximum reliability. A meter is used for interpolation of the binary count. The h-v supply is of the vibrator type and is regulated at 900 v by a corona-discharge tube. A selection of Geiger tubes and probes is available for use with the instrument. Hand-operated cabinet latches are used so that batteries can be replaced without tools. The instrument weighs 16 lb and meas-

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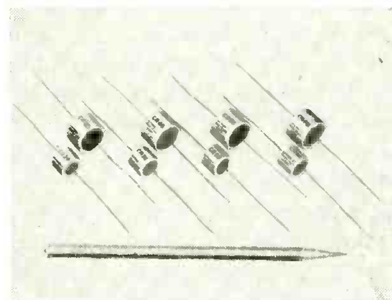
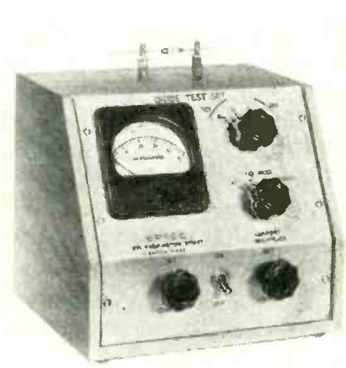
ures 11 in. × 6¼ in. × 8 in. overall size. Maximum counting rate is 100 counts per sec and battery life is 60 hours in intermittent use.



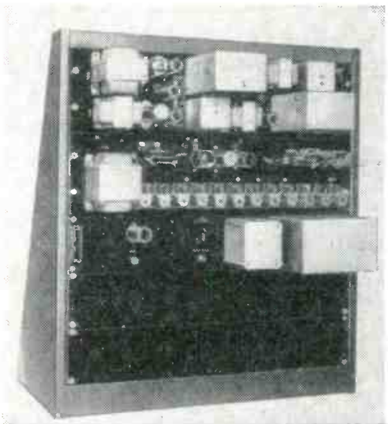
SELENIUM RECTIFIERS are small and compact

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif., has developed a series of miniaturized selenium rectifiers expressly for use in the production of tv boosters and uhf converters for original equipment manufacturers. The CR series selenium rectifiers consist of a number of cells assembled within a cylindrical aluminum tubing and provided with pigtail copper leads for easy wiring into crowded spaces. The smallest unit, type CR-15, is 0.5 in. in diameter and 0.6 in. long, while the largest unit has a diameter of 0.75 in. and is 0.6 in. long. These miniature selenium rectifiers are rated for maximum rms input voltages of 130 and 160 for operation into a capacitive load. Bulletin ER-181 covers both the mechanical and electrical specifications of the line.



DIODE TEST SET operates from 95 to 125 v a-c

ELECTRONICS PRODUCTION SERVICE Co., 871 Washington St., Canton, Mass. Designed to fulfill the varying needs of laboratory development, production quality control and system maintenance, model D102 is a flexible semiconductor test unit. Capable of testing under actual operating conditions, it is useful not only for checking miniature or power, germanium or selenium rectifiers but also for determining transistor parameters. It consists of variable voltage and current sources, a precision metering unit and a versatile switching arrangement which permits rapid selection of any operating-test condition and then high-speed determination of diode forward-backward characteristics.



CONTROL SYSTEM
for aircraft communications

HAMMARLUND MFG. CO., INC., 460 W. 34th St., New York 1, N. Y., is manufacturing a remote-control system using tones in the a-f spectrum, and eliminating the need for d-c circuitry. It is intended for operating airline radio transmitting and receiving equipment located away from control points both at airports and along the air routes. The system requires only a single telephone line having conventional voice characteristics to carry all the standard operations required for rapid switching between transmitter and receiver, and for switching between equipment groups to cover the various frequency channels. A h-f radio signal or a microwave link are equally suitable as transmission media. The dispatcher may select up to 10 transmitter-receiver combinations, any one of which may be operated as a com-

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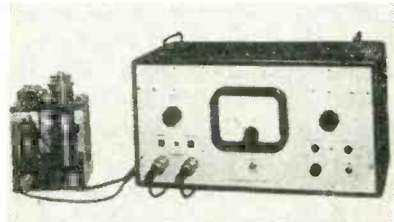
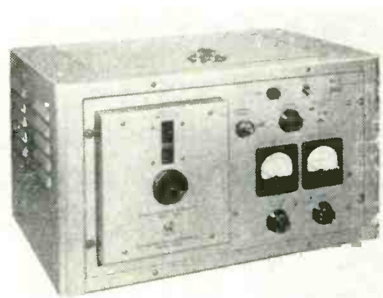
plete communications facility on a press-to-talk basis.



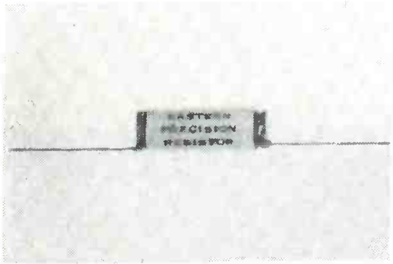
ELECTROMETER
is vibrating-reed type

MARCONI INSTRUMENTS LTD., 25 Beaver St., New York 4, N. Y. The vibrating-reed electrometer is a line-operated instrument for the measurement of small currents and voltages encountered in medical, chemical and allied research. A vibrating-reed transducer of extremely high input impedance converts the d-c signal to a-c. This is then amplified and fed to a phase-sensitive rectifier. Input resistance is greater than 10^{16} ohms. Accuracy is ± 1 percent on all ranges. Ranges are 0 to 1 mv, 0 to 10 mv, 0 to 100 mv and 0 to 1 v. Drift is less than ± 100 μv per day.



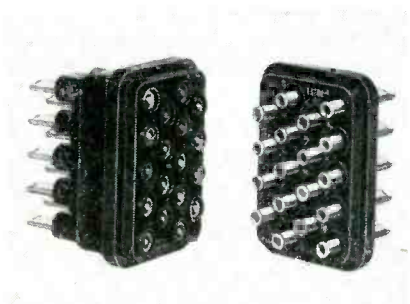
S-BAND OSCILLATOR
is ultrastable unit

LABORATORY FOR ELECTRONICS, INC., 75 Pitts St., Boston 14, Mass. Model 803 ultrastable microwave oscillator features an S-band oscillator stabilized for long-term drift of one part in 10^5. The unit also features a frequency-calibrated dial, means for modulation and a self-contained power supply. Main elements are a klystron oscillator, a stabilizing monitor loop that consists of a calibrated dual-mode reference cavity and a feedback amplifier. Frequency coverage is 2,700 to 2,950 mc. Pulse modulation is possible when stabilization is removed, and 25-percent modulation when stabilized. The attenuator provides 100-db range of control. Power output is 15 mw from a type N output connector. Power consumption is 150 w.



RESISTORS
are precision, wire-wound

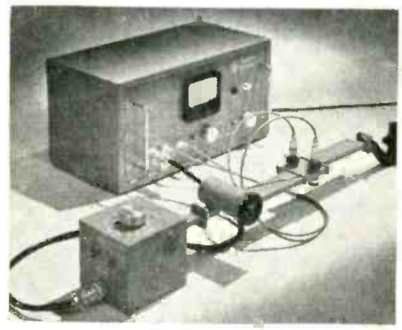
EASTERN PRECISION RESISTOR CORP., 130–11 90th Ave., Richmond Hill 18, N. Y. Type SS-5 low-capacity, precision, wire-wound resistors, with capacitance controlled to 0.5 μμf on a 1.0 megohm resistor, are designed for manufacturers and designers of test equipment, electronic computers, meters and other precision electronic instruments. These units are also being manufactured in matched sets of four to meet capacitance and temperature-coefficient tracking requirements for use in high-frequency bridges and high repetition rate computer circuits.



TINY CONNECTOR
is 18-contact unit

WINCHESTER ELECTRONICS, INC., Glenbrook, Conn. The MAQRE 18 miniaturized quick-disconnecting electrical connector features space and weight saving characteristics without sacrifice of current capacity or voltage breakdown. Particularly suitable for rack and panel mounting, floating contacts have 0.073-in. diameter solder cups for No. 16

AWG and assure proper play for self-alignment. Contact arrangement allows engagement in the correct position only, thus making polarization positive. Spring-loaded contacts provide quick disengagement. Voltage breakdown between contacts at sea level is 5,400 v d-c; at 60,000-ft altitude, 1,350 v d-c. Weight of receptacle is 1.8 oz; plug, 1.1 oz.



VSWR METER
tests waveguide components

COLOR TELEVISION INC., 935 E. San Carlos Ave., San Carlos, Calif. Laboratory or production-line testing of waveguide components is performed rapidly with the model 110A X-band vswr indicator. Covering a frequency band from 8,500 to 9,600 mc, the new unit offers a number of advantages over slotted-line measuring techniques. The instrument includes an oscillator, an accurate wavemeter to supplement the approximate direct-reading dial of the oscillator, a forward and reversed directional coupler with bolometer take-offs for source and reflected power and a direct reading ratiometer having dual scales calibrated directly in vswr—1.06 to 1.3 and 1.3 to 2.5.

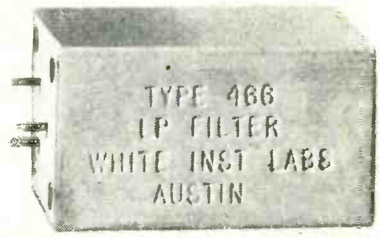
POWER METER
for d-c through X-band

POLARAD ELECTRONICS CORP., 100 Metropolitan Ave., Brooklyn 11, N. Y., announces a new type of power meter that measures rms power over the frequency range of d-c through X-band without the use of frequency limited bolometer mounts. Utilizing a power sensitive element that does not employ a hot wire barretter or other delicate

elements, the meter can withstand 150 percent overload without burnout or other ill effects. The same power sensitive element is used for the entire frequency range, obviating the need for replaceable components. The probe is connected permanently to the meter, while the other side may be fastened directly to the equipment under test, thus avoiding the errors involved in r-f connecting cables.

COMPARATOR
tests component impedances

INDUSTRIAL TEST EQUIPMENT Co., 55 E. 11th St., New York 3, N. Y., has developed impedance comparator model 60. The instrument was designed for production-line testing of resistors, capacitors and inductors. The percentage deviation from a standard component of the component under test is read on a large meter. Four ranges are provided: 1-percent, 5-percent, 10-percent and 20-percent full scale. One simple linear scale serves for all ranges. No zero adjustment is required and the range calibration is readily performed by means of a built-in standard. Component impedances from 1 ohm to 5 megohms at 60 cps may be compared. The built-in regulator permits line-voltage variations from 105 to 125 v, 60 cps.



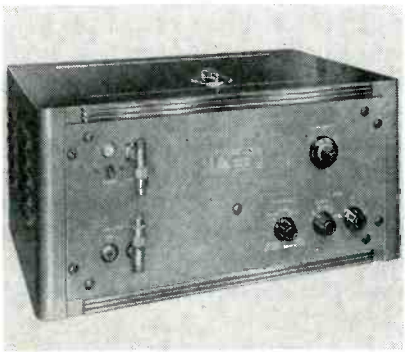
REJECTION NETWORKS
of the twin-T type

WHITE INSTRUMENT LABORATORIES, Austin, Texas. The series 500 networks are R-C rejecting filters of the standard twin-T type. Stable with both temperature and time, they are constructed of low temperature coefficient components, matched for minimum drift. Circuit parameters are selected to give best Q or notch sharpness consistent with adequate output. They are designed especially for circuits having both input and output resistance loading. Standard null frequencies are 60 and 400 cycles, with special null frequencies available. Different impedance levels permit matching to all ordinary electronic circuits. Each network is fully tested and cast in plastic for stability and ease of mounting. Full engineering details are given in bulletin 500.

SIGNAL GENERATOR
for radar testing

POLARAD ELECTRONICS CORP., 100 Metropolitan Ave., Brooklyn 11, N. Y. A new all-purpose KU-band signal generator provides means for the complete testing of radar or associated equipment in the 15.75

to 16.25-kmc range. It consists of a reflex klystron tube and the associated plumbing as well as the necessary attenuating devices and an absorption-type wavemeter. Internal modulation circuitry provides both pulsed and f-m modulation of the klystron oscillator and a temperature-compensated thermistor bridge is incorporated in the unit for measuring both power output of the oscillator and the r-f input for testing of transmitters. Frequency measurements are accurate up to ±10 mc. Power measurements with correction are accurate to ±1.5 db.

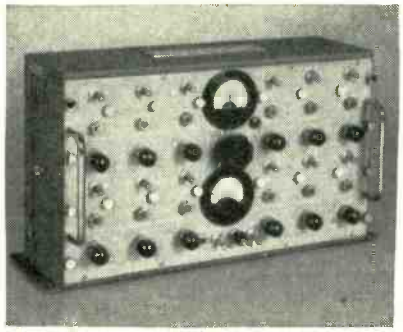


LINEAR AMPLIFIER modifies the Oak Ridge A1

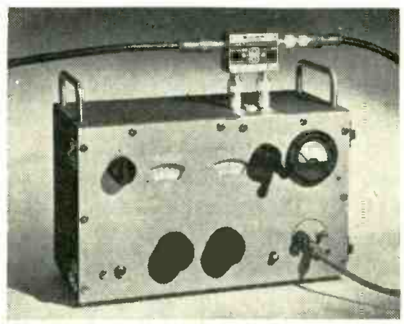
RADIATION COUNTER LABORATORIES, INC., 5122 W. Grove St., Skokie, Ill., is producing the A1C linear amplifier, mark 15, made and tested exactly to ORNL specification Q-1302. It retains the versatile features of the Oak Ridge A1 linear amplifier and is modified for spectrometry applications. Modifications to the amplifier are as follows: (1) Higher counting rate may be achieved in spectrometry applications. (2) There is an improved overload response. (3) The output signal linearity is improved for spectrometry applications. (4) More precise settings may be achieved by a ten-turn pulse height selecting potentiometer. (5) The pulse height selector output is negative, and is 20 or more volts in amplitude.

BRIDGE-BALANCE UNIT is automatic-calibrating

B & F INSTRUMENTS, INC., 4732 N. Broad St., Philadelphia 41, Pa. Model 12-200 adjustable bridge-



balance and calibrating unit was designed in the field for use with recording oscillographs to obtain time histories and dynamic measurements required to test and evaluate present-day aircraft. Aside from flight testing, wherever oscillographs or similar devices are used for the direct recording, without amplifiers, of strains, loads, accelerations, forces, pressures and control positions, the unit can be utilized to provide the means of connecting and adjusting any resistant-type pickup to any oscillograph galvanometer. It is built in units of 12 channels. Two or more units can be used in large installations.

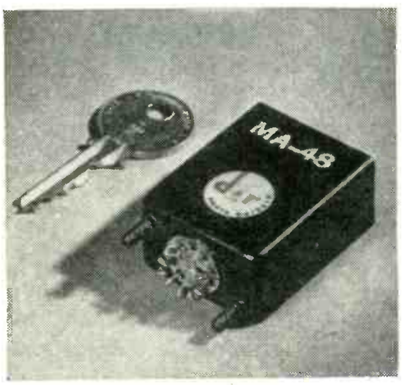


VSWR METER matches loads to line

SIERRA ELECTRONIC CORP., 1050 Brittan Ave., San Carlos 2, Calif. Model 136A reflection coefficient meter is a compact instrument designed for rapid measurement of reflection coefficient and vswr. It provides a convenient method of matching loads to lines to minimize reflected power, and also may be used as a wide-range laboratory receiver for general measurement purposes. The instrument includes a local oscillator continuously tunable from 92 to 355 mc and an i-f amplifier centered at 60 ± 2 mc. Each instrument is supplied with a detachable directional coupler for insertion into the transmission line under test. Reflection coefficient and vswr are read directly on a front panel dial. The unit operates from a 105/120 v 60-cycle power supply.

POTENTIOMETER
permits 2 to 10-unit coupling

MAUREY INSTRUMENT CO., 2452 E. 72nd St., Chicago 49, Ill. Type 2X precision potentiometer is available for servomechanisms, recording or indicating instruments. A new device permits coupling from 2 to 10 units without requiring a special length shaft. It is made for ball bearings or oilite bearings as specified. Linear resistance is 100 to 100,000 ohms with 0.5 linearity. It is also made with adjustable taps for experimental purposes. Nonlinear potentiometers are also available on special requirements.

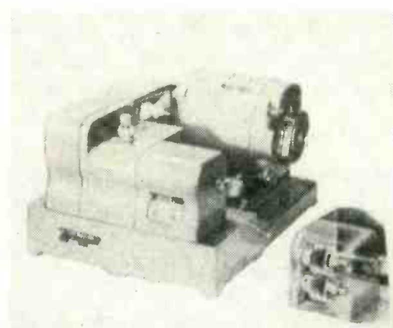


MAGNETIC AMPLIFIER
weighs 3 oz, delivers 25 w

D & R LTD., 402 E. Gutierrez St., Santa Barbara, Calif. Extremely high power handling capability for their size and weight characterize a new line of miniaturized magnetic amplifiers. Through the use of special core materials, winding techniques and mountings coupled with the use of h-f a-c power, it is possible to attain rapid response time and high power handling capability in a very small, lightweight unit. The company now manufactures a line of miniaturized 4,000 and 2,000-cycle magnetic amplifiers, in addition to its standard line of 400 and 60-cycle units. The unit illustrated, model MA-48, weighs only 3 oz, yet delivers a power output conservatively rated at 25 w, with rapid response time and high power gain.

TWIN-WIRE LEAD-IN
eliminates dampness

PLASTOID CORP., Long Island City, N. Y., has introduced Foamline, a tv twin-wire lead-in calculated to eliminate dampness, the chief factor in signal dissipation. The new product is built with millions of tiny, foamlike air cells that protect the wire leads so moisture cannot affect performance. The air dielectric principle is maintained. Foamline also simplifies installation since the ends do not have to be sealed.



WIRE SCRAPER
is a high-speed unit

GEO. STEVENS MFG. CO., INC., Pulaski Road at Peterson, Chicago 30, Ill., has available a high-speed wire scraper with a brush speed of 3,400 rpm. Model 105 is specially designed for rapidly and cleanly stripping textile serving and enamel from multistrand wire up to No. 44 and single-strand wire from 16 B&S to 40 B&S. A new flat belt drive permits quieter operation and greater speed. Wire is cleanly stripped to within $\frac{1}{4}$ in. of the coil by passing through a safety guard between 2 wire brushes. Cleaning pressure is regulated by adjusting the top brush closer to or farther from the lower brush. Wire brushes are available from stock in wire sizes of 0.0025, 0.003, 0.004, 0.006 and 0.008 in., $1\frac{1}{4}$-in. o.d., $\frac{3}{4}$-in. face and $\frac{3}{8}$-in. hole.

Literature

Electronic Test Equipment. Cal-Tronics Corp., 11305 Hindry Ave., Los Angeles 45, Calif. "Electronic Test Equipment" is the title of a new 12-page bulletin that describes the company, its services and facilities, and contains 8 pages of illustrations and description of various types of test equipment built by the company. Included in the equipment shown are a synchronizer test unit, electronic control amplifier test unit, computer systems test unit and signal data converter test unit.

Stainless Steel Fastenings. Star Stainless Screw Co., 190-A Union Ave., Paterson 2, N. J., has released a new catalog itemizing their large, varied inventory in a manner that assures split-second selection. It includes their in-stock inventory of cap screws, nuts, washers, machine screws, sheet metal screws, set screws and pipe fittings for manufacturers of electronic and electrical equipment, measuring instruments, aircraft, as well as the chemical, food and paper industry and general manufacturing. A special page is devoted to suggested short cuts in ordering that help keep costs down. The back cover has a chart that explains AN specifications and a decimal equivalent chart.

General-Purpose Oscillograph. General Electric Co., Schenectady 5, N. Y., has available a new publication, GEC-449B, on the general-purpose oscillograph. For use in investigation, design and testing, the type PM-10 oscillograph described permits simultaneous records to be made of voltage, current, time, speed, pressure, strain and sound. Features and operation of the equip-

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ment are explained in the 12-page bulletin, which also contains descriptive information, pricing data and information on accessory equipment. Other company electric instruments for industrial and central station use also are listed.

Microwave Nomograms and Charts. Airtron, Inc., Linden, N. J., has published a new 20-page booklet of waveguide engineering data and curves. The publication represents practical techniques and approaches developed by the company's engineering staff in designing and using waveguide components such as mixers, duplexers, flexible and rigid waveguides, directional couplers and allied accessories. The charts should prove useful to many communications, broadcast and radar engineers in simplifying their day-to-day handling of microwave problems.

Horizontal Deflection Amplifier. CBS-Hytron, Danvers, Mass. A technical information sheet describing the performance of the 6CU6 horizontal deflection amplifier—a tube designed especially for heavy-duty use—was recently prepared. The 6CU6 described (rated for continuous tv service) is interchangeable with the older type 6BQ6GT. Although it has electrical characteristics identical with those of the 6BQ6GT, it will live much longer, because of its conservative ratings and generous safety factors.

Broadcast Remote Control. Hammarlund Mfg. Co., Inc., 460 W. 34th St., New York 1, N. Y., has available a brochure describing its remote control equipment for broadcast transmitters. The control equipment discussed makes use of audio tones for complete control and metering of the remote transmitter including nine possible control functions and nine telemetering functions. It makes use of recognized principles of telemetering and requires only a single circuit which may be wire, radio or microwave. No d-c line is needed.

Electronic Components. Stackpole Carbon Co., St. Marys, Pa. Catalog RC-9 contains a wealth of helpful information on the complete line of fixed and variable composition resistors, line and slide switches, fixed composition capacitors, powdered iron cores, molded coil forms and Ceramag ferromagnetic cores manufactured by the company. Complete electrical and mechanical specifications, dimensions and application data for all components are given in this 56-page catalog. The section on iron cores alone contains over a dozen informative pages on the selection and use of standard, threaded, sleeve, side-molded and cup cores. Descriptions of several new applications for Ceramag ferromagnetic cores are included.

Comparison Bridge. Southwestern Industrial Electronics Co., Inc., 2831 Post Oak Road, Houston 19, Texas. A 4-page catalog bulletin covers the model E-1 comparison bridge which provides a means of comparing resistors, capacitors and inductances with standard units, indicating percentage deviation directly. Applications, special features, circuit description, electrical and mechanical specifications and a schematic diagram are included.

Connector Bulletin. Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif., has issued a completely revised and redesigned bulletin on its XL series of low-level sound connectors. This 4-page, 2-color bulletin contains detailed technical information and is fully illustrated with dimensional sketches, sectional drawings and exploded views of the plug and receptacle. The connectors described are standard equipment on microphones, amplifiers, tape recorders, data recorders, oscillographs and many other electrical devices. Seventeen different assemblies and two insert arrangements are cataloged.

Microwave and TV Instrumentation. Polarad Electronics Corp., 100 Metropolitan Ave., Brooklyn 11, N. Y. A new brochure covers latest developments in microwave and tv instrumentation. The first section of the catalog deals with microwave test equipment covering frequencies from 10 to 31,000 mc and includes signal sources and generators, spectrum analyzers, microwave receivers and wide-band video amplifiers. The second section of the catalog describes the company's tv studio and test equipment. Technical specifications are set forth for a complete line of picture-generating equipment as well as picture and waveform monitors, both portable and lab type units being available. The radio cue system, used extensively for intrastudio wireless communication, and a complete line of regulated power supplies are also included in the latter section. An up-to-date price list, as well as ordering information, is provided in the catalog.

Watertight Panel Instruments. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y., has available two technical bulletins on its 1½-in. watertight panel instruments. Included are illustrations, schematic drawings, general specifications, tables of standard ranges and approximate resistances, special features and complete ordering information for the round (model 120) and square (model 112) panel instruments.

Radiation Detection Equipment. Radiation Counter Laboratories, Inc., 5122 W. Grove St., Skokie, Ill. Catalog No. 15 is a comprehensive, illustrated guide for selection of radiation-detection equipment. The brochure is divided into three sections. Section I covers electronic equipment, including scalers, special electronic instruments and nuclear-reactor control equipment. Section II is devoted to radiation-counter tubes of all types, scintillation counting equipment, health instruments and accessories. Section III covers glass apparatus, scintillating crystals and liquids, special chemicals and gases and thin films. All items in Section III are products of Wakefield Industries, Inc. General information about the companies and their research facilities are included.

Monoset. Telex, Inc., Telex Park, St. Paul, Minn., has issued new literature on the Monoset (under-the-chin headphone) covering specifications and applications of the unit to professional, commercial and institutional use. The catalog sheet (form 381003) illustrates the equipment and describes exclusive features.

Miniature Gage Pressure Potentiometer. Bourns Laboratories, 6135 Magnolia Ave., Riverside, Calif. A 4-page brochure, No. 3553, describes a new miniature gage-pressure potentiometer in standard ranges from 0 to 100 and 0 to 5,000 psi. Photographs illustrate the method of accurately transmitting the movement of the bourdon tube to the sliding contact of the wire-wound potentiometer. Diagrams, curves, charts and outline drawings provide additional technical information. The detailed specifications include such items as linearity, hysteresis, resolution, life expectancy and the effect of vibration, acceleration and temperature.

Voltmeter. Southwestern Industrial Electronics Co., Inc., 2831 Post Oak Road, Houston 19, Texas. Versatility and accuracy are the outstanding features of the model R-1 voltmeter discussed in a recent 4-page folder. Included in the illustrated bulletin are a complete description, technical specifications, a simplified version of the basic circuit arrangement and a listing of some of the company's other instruments.

Magnet Wire. Hitemp Wires, Inc., 26 Windsor Ave., Mineola, Long Island, N. Y., has available literature announcing its magnet wire that is insulated with Dow Corning's DC-1360 silicone resin in sizes 22 to 42 AWG. The wire described is suitable for continuous service at temperatures ranging up to 200 C and has excellent resistance to scrape abrasion.

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Ceramic Capacitors. Centralab, a division of Glove-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc. Five new and revised catalog sheets covering special types of ceramic capacitors are now available. Each illustrates and gives technical specifications for a particular type. Bulletin 42-4R deals with BC disk capacitors; bulletin 42-101R, ceramic trimmers; bulletin 42-59R, tubular trimmers; bulletin 42-206, feed-through capacitors; and bulletin 42-123R, high-accuracy capacitors.

Punched-Card Computer. Remington Rand Inc., 315 Fourth Ave., New York 10, N. Y. Full details on the electronic punched-card computer are provided in a new, illustrated 6-page brochure. The machine described features universal calculating ability, flexible programming, removable control panels, built-in automatic verification of results, alphabetical reproduction, summarized accumulation, sequence checking, dual-control sorting and high-speed punching of results.

Amplistats. General Electric Co., Schenectady 5, N. Y., has available an 8-page bulletin on amplistats (self-saturating magnetic amplifiers) for high-gain d-c amplification in industrial, educational, and laboratory control and instrumentation circuits. The booklet (GEA-5950) shows typical GE units, explains theory of their operation, defines terms, and describes amplistat characteristics with graphs and charts. Listed are 1-va amplistat, 40-va industrial amplistat, 40-va educational-laboratory amplistat, and 400-cycle plug-in amplistat.

Fiber Catalog. Continental-Diamond Fibre Co., Newark, Del., has available catalog GF-54, a 12-page illustrated booklet, that not only describes the company's products and many of their uses, but also contains detailed technical data in tabular form for quick, easy reference. Technical data include information on tensile, flexural, shearing, Izod impact, compressive and dielectric strengths, water-absorption rates minimum densities, arc resistance, Rockwell hardness, specific gravity, bonding strength, maximum constant-operating temperatures, loss factors and insulation resistance. Many other products are featured in the catalog.

Variable Transformers. Standard Electrical Products Co., 2240 E. Third St., Dayton, Ohio. An 18-page catalog illustrates and describes the full line of Adjust-A-Volt variable transformers. Design and construction details, dimensions and performance characteristics of the various models of auto, isolated and metered variable transformers for built-in and bench applications and for radio and tv servicing are included. The catalog covers the transformers in standard bench or panel mountings, as well as ganged assemblies. Terminal and tap arrangements as well as circuit diagrams are included along with a convenient index of specifications and applications for all single-phase and three-phase transformers covered by the catalog. The many uses for toroidal winding are discussed in a special section.

Glass Catalog. The Lancaster Lens Co., Lancaster, Ohio, has issued an illustrated 8-page catalog showing a wide variety of glass-part applications. To aid the design engineer in taking advantage of the many special characteristics of glass, 21 case histories are recorded. Each includes a photograph of the glass part and a brief explanation of the advantages of the type of glass used for that particular application. Among the items discussed in this section are lenses and reflectors, tv bulb parts and other electronic components, instrument faces and panels, appliance parts, dials and nameplates. Other sections of the catalog outline the physical properties that give glass almost un-

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limited design potential, list the production and finishing processes available at the company, and discuss the basic types of commercial and industrial glass, their general properties and common applications.

Electronic Controls. Barber-Colman Co., Rockford, Ill. Catalog F 6166 describes the flexibility of the company's electronic controls for heating, ventilating and air conditioning. Descriptive information concerning the ultrasensitive microrelay that simplifies the amplifier is also included. The catalog also contains a complete description of the various elements required for system application and illustrates their usage.

Mass Spectrometer. General Electric Co., Schenectady 5, N. Y., has available a new 12-page, two-color bulletin (GEC-587A) on the use of the mass spectrometer for chemical analysis by mass separation. It contains photographs and diagrams of the equipment, describes the component parts, explains operation procedures, and lists range, resolution and system specifications. Sample recorder strip charts show the spectra of various chemical mixtures, and installation, maintenance and modification information is provided.

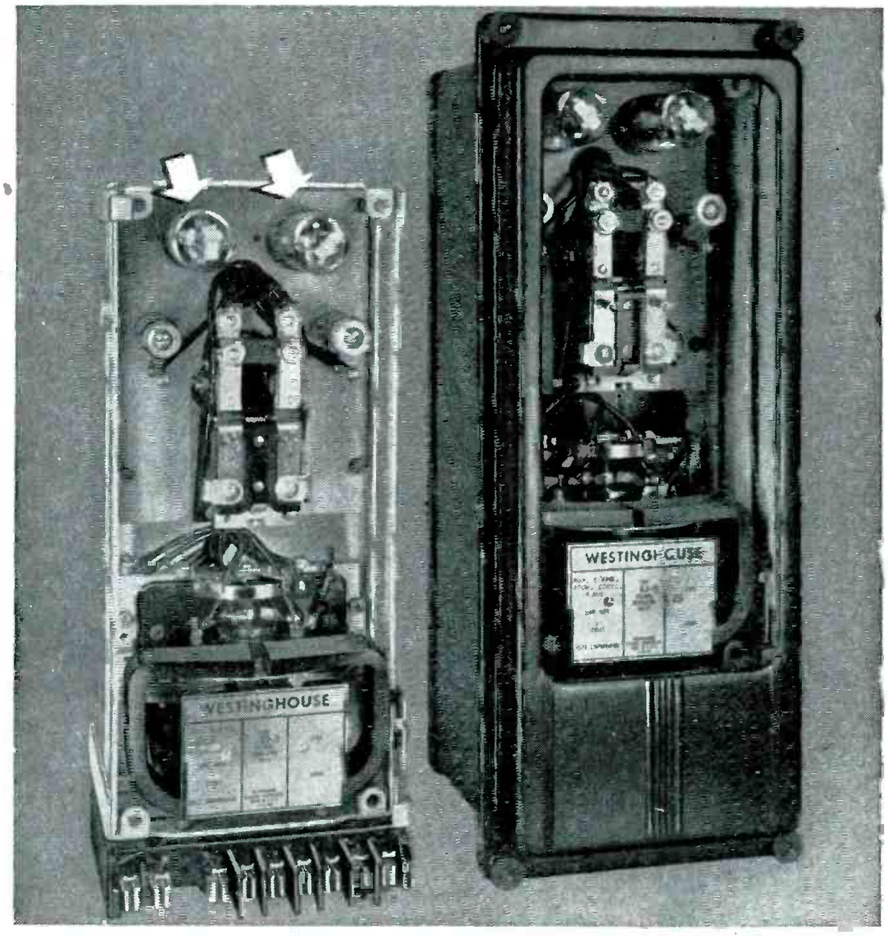
Tube Selection Chart. Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y., has prepared a comprehensive, 3-color chart to make possible the quick selection of rectifiers, thyratrons and ignitrons for practically any condition of service. This 15-in. × 16½-in. chart shows the rating in peak inverse voltage vs maximum average forward current for the tubes in their usual operation. Typical rectifier circuits and associated calculation factors are shown on the chart's reverse side. Once a tube has been chosen from the chart, its special features may be checked on data sheets.

R-F Power and VSWR Equipment. M. C. Jones Electronics Co., Inc., Bristol, Conn. A new 48-page 2-color catalog contains information on the use of each series of r-f power and vswr instruments, absorption-type, r-f wattmeters, r-f load resistors, station guardians and Micro Match accessories. Photographs and typical circuit diagrams are included for each series. The publication contains technical data to guide the engineer in selecting Micro Match equipment to meet his requirements. Ordering information is supplied so that the buyer will be assisted in interpreting engineering requirements in terms of specific models.

Sheet Metal Products & Electronic Components. Bud Radio, Inc., 2118 E. 55th St., Cleveland 3, Ohio, has published a new catalog of sheet metal products and electronic components. The 52-page catalog illustrates and describes the company's complete line. To insure ease of selection and ordering, complete sizing information is given on each product. Suggestions for uses and applications are also included.

Power-Tube Chart. Amperex Electronic Corp., Hicksville, L. I., N. Y., has prepared a 3-color, 15 in. × 16½ in. chart that shows the rating in power output vs frequency for Amperex power tubes in typical operation. The chart includes the FCC frequency allocations and associated applications correlated with tube performance. This comprehensive chart, coded in color, is planned for quick use and easy readability. At a glance, it is possible to find the Amperex tube or tubes that will meet the general requirements for practically any r-f or audio operation. The special features of each tube may then be checked on data sheets, also available from the company.

Solderless Terminals & Connectors. Aircraft-Marine Products, Inc., 2100 Paxton St., Harrisburg, Pa. The "Big Story in the Little Book" is a novel solution to the problem of making technical writing appealing as well as informative. Solderless terminals and connectors are the subject of this story in verse, with the highlights of the company's wire-termination process stressed in an easy-to-read manner. The booklet is amply supplemented with photographs and cartoons picturing the connectors



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and tools as well as the carefully controlled installation process.

Tube Characteristics. Tung-Sol Electric Inc., Newark 4, N. J. The first 166 pages of the 19th edition of the electronic-tube characteristics manual contain all the technical information about receiving and c-r tubes required by engineers and servicemen for every-day use. Six different colored pages are used to separate the many charts, diagrams and technical data for easy reference. In the back of the manual there is a special 20-page section containing basic marketing information.

Data-Reduction Equipment. Clary Multiplier Corp., San Gabriel, Calif. Equipment for the reduction, handling and printing of data in electronic systems for industry, laboratory, business and accounting operations is described in a new 6-page illustrated folder. Products listed in the brochure, with information on equipment features, practical applications and specifications, are the digital readout machine, electrical pulse-data recording combination, analog-to-digital converter, electrical input keyboard, binary-to-decimal conversion machine, printing timer and plug-in units for a number of specific requirements.

Meters & Special Apparatus. Sterling Mfg. Co., 7201 Wentworth Ave., Cleveland 2, Ohio. A file folder of information sheets describes electrical, mechanical and electronic meters and all special apparatus manufactured by the company. In addition to illustrations and listings of the standard line of a-c and d-c voltmeters, ammeters, milliammeters, resistance meters and pocket meters, the folder includes special pages devoted to typical examples of Sterling meters developed for specific adaptations.

Thermistors. Carboloy Department of General Electric Co., Detroit 32, Mich. Latest information on methods of using thermistors, heat-sensitive electrical resistors with negative temperature coefficient, as well as a description of a new physical demonstration of permanent magnet properties, is available in 4 technical data sheets: TH-9, TH-10, TH-11, and PM-116. The reports describe thermistor applications in radio-set surge protection (TH-11), contactless switches in overload protective devices (TH-11), temperature compensation (TH-10), warning signals (TH-9), and controlled automation (TH-9). They each include manufacturing, operating, selection and engineering-assistance data. The report on magnetic principles (PM-116) discusses magnetic suspension, torque control, driving and braking with permanent magnets.

Magnetic-Deflection Yoke. Syntronic Instruments, Inc., 100 Industrial Road, Addison, Ill., has issued a catalog page describing its new Y29 magnetic-deflection yoke for testing c-r tubes. Four types are described, ranging in deflection angle from 50 deg to 90 deg. Complete data include dimensional drawing, mechanical and electrical characteristics, a table listing horizontal-vertical coil inductance combinations and construction details. Additional information includes number of tubes which may be continuously tested without yoke damage or failure and the unconditional one-year guarantee.

Fastening Specialties. Southco Division, South Chester Corp., 1400 Finance Bldg., Philadelphia 2, Pa., has issued a fully-illustrated, 24-page handbook describing fastening specialties. A section is devoted to each of 7 different fastener types: screw fasteners, blind rivets, adjustable-pawl fasteners, door latches, spring-grip fasteners, anchor nuts and door-retaining springs. Each section has photographs, drawings, tables of dimensions and size, and descriptions. Copies of catalog B2 may be obtained for the writing.

Electron Microscope. North American Philips Co., Inc., 750 South Fulton Ave., Mount Vernon, N. Y. A new 4-page folder titled "Some Reasons Why the World's Most Powerful Electron Microscope Deserves Your Consideration" is now available. Forty-four typical applications are listed together with

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design and operating information concerning the viewing screen, accelerating potential, magnification, electron diffraction, focus determination and control, image stability, resolution and other features.

Radio Communication Equipments. General Electric Co., Syracuse, N. Y. Ten new bulletins describe the latest improvements in many of the company's radio communication equipments for industrial and civil defense applications, taxicabs, utilities, police and fire departments. The bulletins cover 6 base-station combinations and 4 mobile combinations. The base stations described are 60-watt units for operation in the 25 to 50-mc band, and 50-watt units for operation in the 152 to 174-mc band. There are three types in each band, designed for floor, desk and pole mounting. The mobile combinations are all for operation in the 152 to 174-mc band. They include two 10-watt units, a 30-watt and a 50-watt unit.

Unitizing Electronic Equipment. Alden Products Co., 117 N. Main St., Brockton 64, Mass. The 1954 edition of the handbook, "Ideas-Techniques-Designs," is packed with new standard components for unitizing electronic equipment. It provides new data and planning sheets on plug-in packages and basic chassis for unitizing equipment and giving it 30-second interchangeability. Further improvements and newer components for indicating and monitoring operation of electronic equipment with tiny tell-tales are described. New models of connectors and interconnecting systems that allow dynamic color-coding for easy circuit tracing have been added. The booklet is available to manufacturers and designers writing on their letterhead.

Installation of Master TV Systems. Blonder-Tongue Laboratories, Inc., 526 North Ave., Westfield, N. J., has released a new manual—"How to Install Master TV Systems." Included are complete instructions and diagrams covering every phase of the planning and installation. Each step is clearly explained and illustrated—antenna installation, choice of transmission lines, signal amplification and distribution to tv sets. Simplified charts show the installer how to calculate transmission-line losses, change decibels to voltage gain and make up all types of attenuation pads. An actual example outlines the calculations of signal level provided to one set in a system. An additional table gives the gain, maximum input level, size and power consumption of all the company's electronic units.

Audio Amplifier. Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa. Bulletin DB85–950 describes the type FG 5 or 10-kw variable-frequency audio amplifier. Applications of the amplifier are suggested. The unit discussed will amplify 30 to 10,000-cycle signals as much as a million times. Design and construction features and operation of the equipment are described. Complete electrical characteristics of the amplifier are included.

Ultrasonic Cleaning for Industry. General Electric Co., Schenectady 5, N. Y. How the ultrasonic generator works, the principles of high-frequency sound cleaning, and examples of present applications are explained in bulletin GEA-6056. The two-color, four-page publication explains how the ultrasonic action of the generator hastens cleaning by as much as 100 times. Photographs and drawings show components of the equipment and the generator in use.

Wire Connector. Ideal Industries, Inc., Sycamore, Ill. A recent catalog sheet gives a complete description and specification on a new all-plastic screw-on wire connector. The connector discussed is designed for low-cost connections of No. 14, 16 and 18 wires, and is available in two sizes, A-1 and A-3. The plastic used has both high impact strength for mechanical security and excellent dielectric properties.

Variable Resistors. Centralab, 900 E. Keefe Ave., Milwaukee 1, Wisc. Catalog form 42-164 covers models 1 and 2 variable resistors. Model 1

Want more information? Use post card on last page.

controls described are subminiature size units, $\frac{5}{8}$ in. in diameter, rated at 0.1 w. They are designed for hearing-aid, subminiature radio and microwave equipment. The model 2 control discussed is a standard $\frac{15}{16}$ in. diameter unit, rated at 0.5 w. This unit is available from 250 ohms to 10 megohms in any of 14 standard tapers.

Products Catalog. General Cement Mfg. Co., 904 Taylor St., Rockford, Ill., recently released catalog No. 156. Printed in two colors, the 64-page catalog gives detailed descriptions, specifications and prices of a complete line of radio, tv and electronic products. All products are listed by types in handy index for quick easy reference. More than 3,000 items in over 150 different classifications are included.

Alloy Data. Cerro de Pasco Corp., 40 Wall St., New York 5, N. Y. Data sheet E-14 describes the use of Cerroseal-35, an alloy of indium and tin that softens at approximately 240 F and is liquid above 260 F. Because of its extremely low vapor pressure, Cerroseal-35 can be used in high-vacuum apparatus requiring a seal between glass and glass or glass and metal. Besides adhering to glass, the alloy described will also adhere to mica, quartz, thermosetting plastics and some glazed ceramics.

Absolute D-C Power Supplies. Kalbfell Laboratories Inc., 1090 Morena Blvd., San Diego, 10, Calif., has available an illustrated mailing piece dealing with its absolute d-c power supplies. Included are a full description of the system's circuit, technical specifications and a list of applications.

Dynamotor Catalog. Carter Motor Co., 2646 N. Maplewood Ave., Chicago 47, Ill. Catalog No. 753 consists of 28 illustrated pages giving complete electrical and mechanical specifications on all the company's dynamotors, including performance and oscillograph charts and dimensional diagrams. A number of newly developed items are shown in the catalog. The new change-a-volt dynamotors are listed with complete mechanical and electrical specifications. Shown also is the recently developed heavy-duty genemotor.

Electronics Equipment. Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa. Booklet B-6093 is a 16-page summary of equipment available for use in the electronics industry. It gives descriptions, applications and operating ranges for such equipment as surge comparison testers, portable balancers and vibrographs, magnetic amplifiers, transistors, capacitors, relays and many others. The booklet also gives information on such semifinished material as transformer cores and magnetic materials and alloys. Designed to give users an idea of what equipment is available, the booklet also gives terse technical data.

Permanent Magnets. Carboloy Department of General Electric Co., Detroit 32, Mich. Latest information on the uses, design, properties and manufacture of Alnico permanent magnets, sintered grade 5, is available in the 6-page technical report PM-111. The report offers charts, graphs and photomicrographs in explanation of magnetic and physical characteristics of the magnets, and a table of tolerances to aid the designer. The company's engineering development and application service is also described.

Sine-Cosine Mechanism. Librascope, Inc., 1607 Flower St., Glendale, Calif. Catalog sheet 304062 covers the hollow shaft differential, a miniaturized precision computer element. Chief features of this sine-cosine mechanism, a precision angle resolver for analog computers, are listed. Application and engineering data are included.

Wide-Band D-C Amplifier. Furst Electronics, 3322 W. Lawrence Ave., Chicago 25, Ill. A single-sheet bulletin contains an illustrated description and outstanding features of the model 220 wide-band d-c amplifier. The unit described was designed specifically to increase the sensitivity of c-r oscilloscopes with extended l-f response. Complete technical specifications are included.

Want more information? Use post card on last page.

PLANTS AND PEOPLE

Edited by WILLIAM G. ARNOLD

Industry and professional associations make new moves . . .
Manufacturers announce new plant and facility expansions . . .
Electronic engineers and executives advance

OTHER DEPARTMENTS
featured in this issue:

Institute of Radio Engineers Elects Officers for 1954

WILLIAM R. HEWLETT, vice-president of Hewlett-Packard Co. of Palo Alto, Calif., was elected president of the IRE for 1954. He succeeds James W. McRae, president of the Sandia Corp. and vice-president of Western Electric, as head of the international society of over 35,000 radio engineers and scientists.

Maurice J. H. Ponte, director of Compagnie Generale de Telegraphie Sans Fil, of Paris, France, will succeed S. R. Kantebet, general manager of the Government of India Overseas Communications, as IRE vice-president in recognition of the international character of the Institute's membership and activities.

Elected as directors for the 1954-1956 term are Axel G. Jensen, director of tv research for Bell Labs and George Rappaport, chief engineer of Counter-measures Branch, Aircraft Radiation Lab. in Dayton.

Regional directors elected for 1954-1955 are as follows: North Atlantic, Lucius E. Parkard, president of Technical Instrument Corp.; Central Atlantic, Harry W. Wells, chairman of Upper Atmosphere Section, Carnegie Institution of Washington, D. C.; Central, Charles J. Marshall, chief scientist, Search Radar Branch, Wright-Patterson Air Force Base; Pacific, Joseph M. Pettit, associate professor of electrical engineering at Stanford University.

William R. Hewlett was engaged in electro-medical research in Palo Alto, Calif., from 1936 to 1938. In 1939 he joined David Packard in organizing Hewlett-Packard.

In 1942 he was called to active duty in the Army and was assigned to the technical division of the Office of the Chief Signal Officer in Washington, D. C. for the next three years. He was then transferred to the new development division of the War Department's Special Staff where he served as

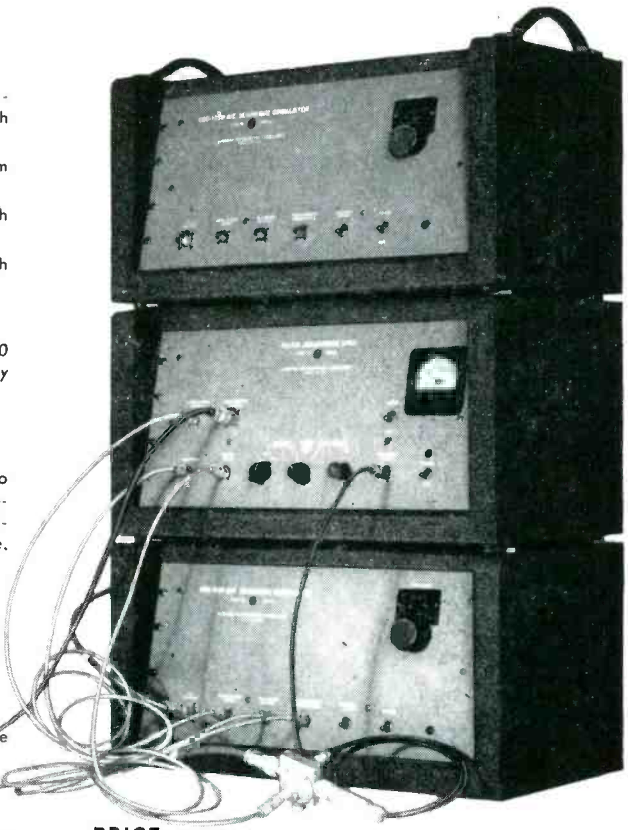
THIRTIETH BOARD OF DIRECTORS AND OFFICERS OF RETMA 1953-54

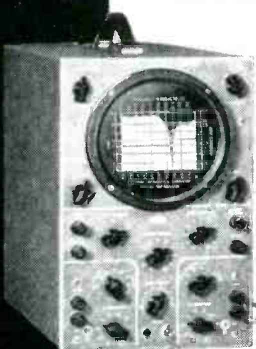
PRECISION ENGINEERING
CUSTOM MANUFACTURING

THE TYPE 20

An Instantaneous Reading BROAD-BAND SWR INDICATOR

The complete SWR Indicator System consists of two separate Scanning Oscillators covering the 400-900 Mc and 900-1350 Mc bands, a Reflectometer with a standard matched 50-ohm load, a Ratio Measuring Unit, interconnecting and power cables. The unknown load is connected to the Reflectometer, and the outputs of the Ratio Measuring Unit are connected to an oscilloscope (not supplied). Frequency is presented on the oscilloscope on the X axis, and SWR over the entire band is presented on the Y axis.





TYPE 20 SYSTEM:

AIL Type 21 Ratio Measuring Unit with self-contained power supply and overlay for 5 inch oscilloscope.

AIL Type 22 Reflectometer with precision 50-ohm reference load.

AIL Type 23 400-900 Mc Scanning Oscillator with self-contained power supply.

AIL Type 24 900-1350 Mc Scanning Oscillator with self-contained power supply.

Complete set of interconnecting cables.

(These units comprise the complete AIL Type 20 Broad-Band SWR Indicator System. Each unit may also be purchased individually as needed.)

SWR INDICATION:

Normal 1.0 to ∞ and, on expanded scale, 1.0 to 6.0. Automatically presented on calibrated oscilloscope scale at 56 presentations per minute. Direct-reading SWR meter for single-frequency manual use.

ACCURACY:

±10% of SWR indication
± 1% of Frequency indication

PRECISION REFERENCE LOAD:

50 ohms having maximum SWR of 1.05 over the two bands.

SIZE:

Each unit in carrying case is 11" high by 22" wide by 11½" deep. The height of the stacked system is 33" high with oscilloscope alongside.

Reflectometer size: 6" x 10" x 4"

All units are designed for rack mounting.

WEIGHT:

Low or high frequency system - 70 pounds.
Complete system - 100 pounds.

PRICE:

TYPE 20 SWR INDICATOR SYSTEM, COMPLETE WITH INTERCONNECTING CABLES less oscilloscope

Low Frequency System	$2,980
High Frequency System	$2,980
Complete High and Low Frequency Systems	$4,200

F.O.B. Mineola

Prices for individual units may be obtained upon request.

- Instantly measures standing-wave ratio over the 400-900 Mc and 900-1350 Mc bands.
- Eliminates tedious point-by-point data taking.
- Adjust antennas, transmission systems, filters, networks, receivers while under test.
- The Scanning Oscillators may be used separately as sources of r-f power, automatically scanned or manually adjusted to the desired frequency, giving 200-milliwatt minimum power output over the band into a 50-ohm resistive load.

Write for complete details

AIRBORNE INSTRUMENTS LABORATORY INCORPORATED

160 OLD COUNTRY ROAD, MINEOLA, L. I., N. Y.

William R. Hewlett

head of the electronics section. In 1945 he was a member of the Compton Mission, which was sent to Japan immediately after surrender to form a quick appraisal of the Japanese scientific war effort. In December of that year he returned to the Hewlett-Packard Co. and has since continued his activities there.

IRE also announced its awards for 1954. Alda V. Bedford of RCA Labs. was awarded the Vladimir K. Zworykin Television Prize Award for 1954 "for his contributions to the principle of mixed highs and its application to color television."

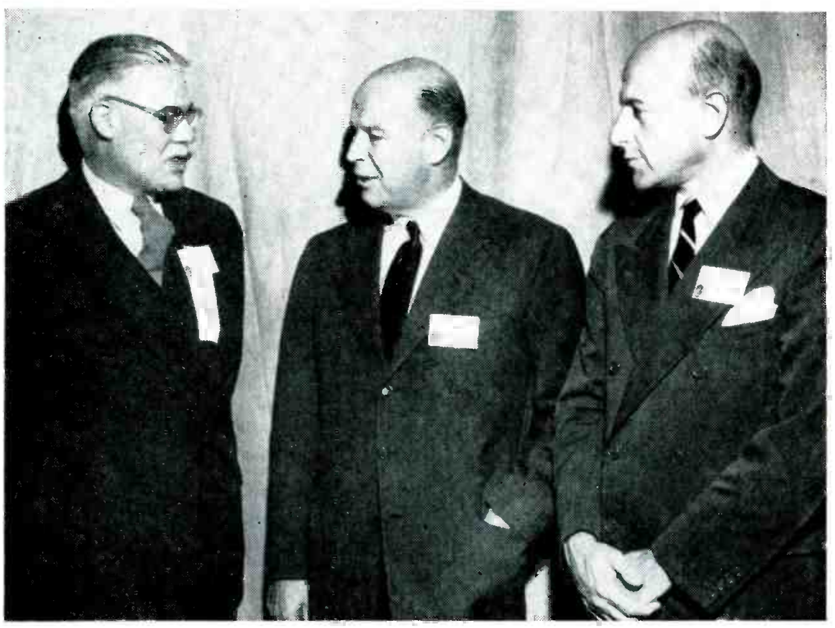
The Institute's Morris Liebmann Memorial Prize was bestowed on Robert R. Warnecke, technical director of Companie Generale de Telegraphie Sans Fil of Paris, France, "for his many valuable contributions and scientific advancements in the field of electron tubes, and in particular, the magnetron class of traveling-wave tubes."

Harold A. Zahl, director of research of the Signal Corps Engineering Labs, Fort Monmouth, N. J., was named to receive the Harry Diamond Memorial Award for 1954 "for his technical contributions, his long service and his leadership in the U. S. Army Signal Corps research program."

Alfred N. Goldsmith, editor of the IRE, was awarded the Founders Award "for outstanding contributions to the radio engineering profession through wise and courageous leadership in the planning and administration of technical developments which have greatly increased the impact of electronics on the public welfare."

The awards will be presented at the Institute's annual banquet.

Electronic Leaders Attend Industrial Council



Among the 200 executives who attended the third session of The Industrial Council at Rensselaer Polytechnic Institute to discuss the Electronics-Electrical industry with the more than 600 social science teachers in attendance were, left to right: Robert Paxton, executive vice-president of GE, Allen B. DuMont, president of DuMont and Charles F. Adams, Jr., president of Raytheon. Objective of the Council is to achieve a wider understanding between industry and education

RETMA Expands Membership Services

AT ITS three-day industry conference in Chicago, RETMA created an international department and authorized the employment of special counsel for the newly-established electronics industry committee.

Discussions of the possible effects of the expected early approval of the NTSC color tv standards by the FCC occupied many of the group meetings.

The board of directors unanimously adopted a resolution commending the work of the NTSC in developing the recommended tv color specifications after W. R. G. Baker, its chairman, reported that the NTSC will be dissolved following the FCC decision on its petition. Whatever further standardization work is required will be carried on by a television systems committee of the RETMA engineering department, Dr. Baker said.

A. Blumenkrantz, chairman of the board of General Instrument, was elected a director by the parts division executive committee, and Louis Hausman, vice-president of CBS-Columbia, was elected to the set division executive committee. Chairman F. R. Lack of the electronics industry committee recently appointed Joseph H. Gillies, a vice-president of Philco, director of the government relations department.

Chairman William M. Adams, of the export committee, said the international department will be governed by an executive committee representing both radio-tv and electronics interests, and will comprise various product sections. An export manager will be employed and stationed at RETMA headquarters.

The electronics industry committee voted to establish a military end equipment section in the technical products division as the first step in its expansion of the association's organizational framework under the EIC.

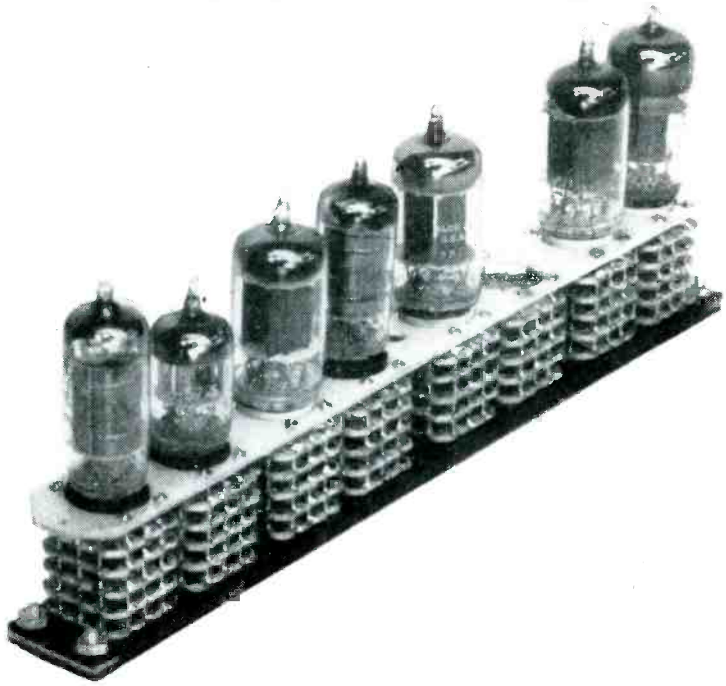
The television committee, under chairman W. R. G. Baker, decided to continue its activities despite the completion of the standardization

"PROJECT TINKERTOY"

MODULAR DESIGN KIT

the key to modular equipment design

Make your own modular assemblies such as the unit shown here, using the CML Type PT-1000 modular design kit. Modules are mounted on etched circuit plates, which are also made with the PT-1000 kit.



CML, a pioneer contractor to the National Bureau of Standards on this Navy sponsored project, is proud to present to the industry our Type PT-1000 Project Tinkertoy Modular Design Kit.

With this kit, you can design and build Project Tinkertoy Modules, complete assemblies, and end items in Project Tinkertoy Modular Form. All you need is the PT-1000 Kit, the conventional test equipment used in design work, and 20 feet of laboratory bench space.

The CML PT-1000 kit contains over 50 different items. You get 26 special tools peculiar to the process, materials to build over 200 modules including wafers, 7 and 9 pin miniature sockets, tape resistors, ceramic condenser bodies, chemicals, screens, etching facilities, drafting aids, etc.

There's nothing else to buy. Just follow the simple detailed instructions and you can start design work the moment the PT-1000 Kit is delivered to you.

Once your designs are completed and tested, the advantages of low-cost, high-quality production, which the Project Tinkertoy Automatic Production and Testing Machines provide, will be available to your company. Several components manufacturers are planning to fill production requirements for modules.

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ON THE CML TYPE PT-1000 KIT

COMMUNICATION MEASUREMENTS LABORATORY, INC.

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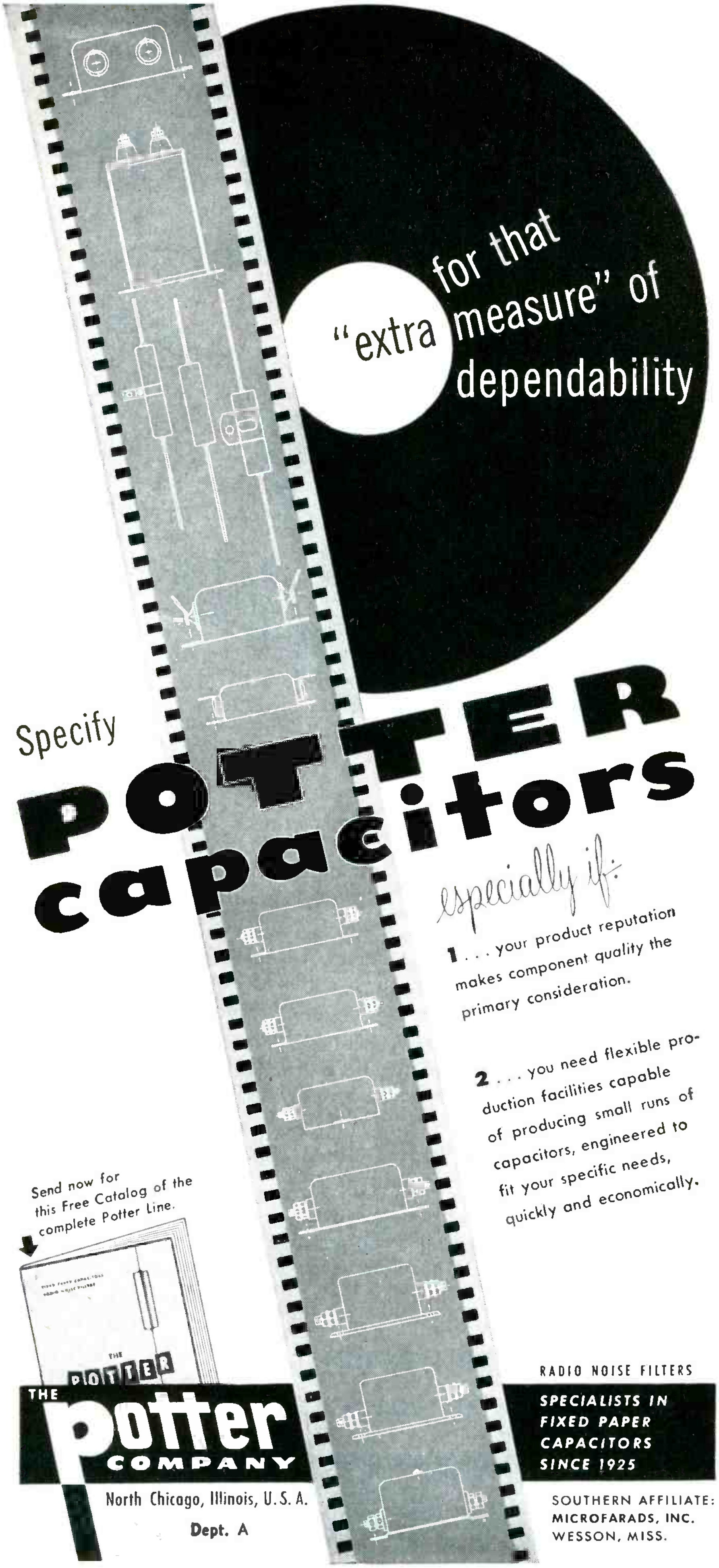

work of the NTSC, and asked Dr. Baker to remain as chairman.

President Glen McDaniel, after discussing controversial portions of the proposed trade practice rules for the radio-tv manufacturing industry, was directed by the set division executive committee to renew the Association's opposition to several of the recommended rules at the FTC hearings.

The parts division executive committee, under chairman Matt Little, approved a recommendation of the phonograph cartridge and pickup section that RETMA undertake an investigation of subsidies and other benefits accorded phonograph equipment and accessory manufacturers in foreign countries now competing with American manufacturers in the domestic market. Six sections and the newly established jobber relations committee held meetings. Under chairman J. A. Milling, the jobber committee's objective is to deal with problems and develop programs to effect a better understanding between parts manufacturers and distributors.

High Fidelity

Floyd Bell, chairman of the executive committee of the amplifier and sound equipment division, reported to the RETMA board that the high-fidelity equipment section and an engineering department committee had been unable to develop a recommended definition of high-fidelity as requested by the FTC for inclusion in the pending trade practice rules. The engineering department will continue its efforts, however, to develop technical standards for high-fidelity components.

Early dissemination of technical information on the servicing of color receivers was planned by the service committee under chairman H. J. Schulman. A three-week "Teacher Training Seminar" for tv service instructors was planned for the summer of 1954.

Robert C. Sprague, board chairman of RETMA, announced the reappointment of Fred D. Wilson of the DuKane Corp. as chairman of the school equipment committee.

At its annual fall meeting in Toronto, Canada, RETMA honored

Mrs. Martha E. Kinzie of GE, secretary for NTSC, "for her untiring efforts on behalf of the NTSC in the formulation of a successful compatible standard for color tv."

Executives Advance At Du Mont

THREE new vice-presidents were appointed at Allen B. Du Mont Laboratories. They are Thomas T. Goldsmith, Jr., vice-president of research; Irving G. Rosenberg, vice-president of tubes and government and C. Edwin Williams, vice-president of instruments and transmitters.

Dr. Goldsmith, who joined Du Mont in 1936 as director of research, is a member of the board of directors and is also president and a director of Du Mont of Canada, the company's wholly-owned Canadian subsidiary.

Thomas T. Goldsmith, Jr.

I. G. Rosenberg, former director of operations for the receiver and cathode-ray tube divisions, joined the company in 1942 as a production-control specialist. He became manager of the cathode-ray tube division in 1946. In 1950, when the tube plant was moved, he supervised the planning and layout of production facilities capable of producing 1 million cathode-ray tubes a year.

C. E. Williams, who was formerly director of operations for the com-

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Irving G. Rosenberg

pany's instrument and transmitter divisions as well as director of government and special contracts, joined Du Mont in 1945 as general manager of the company. Prior to that he had four years war service in Washington, D. C. as staff member of the radio and radar division of the War Production Board.

Promotion of P. S. Christaldi from assistant manager to manager of the instrument division of Du Mont, replacing Rudolf Feldt who has resigned, was also announced by A. B. Du Mont, president.

Dr. Christaldi has been associated with Du Mont since 1936. His first duties were in the field of cathode-ray tube and cathode-ray oscillograph development. He was appointed chief engineer of the company in 1941, and in 1947 became engineering manager of the instrument division. He was made

C. Edwin Williams

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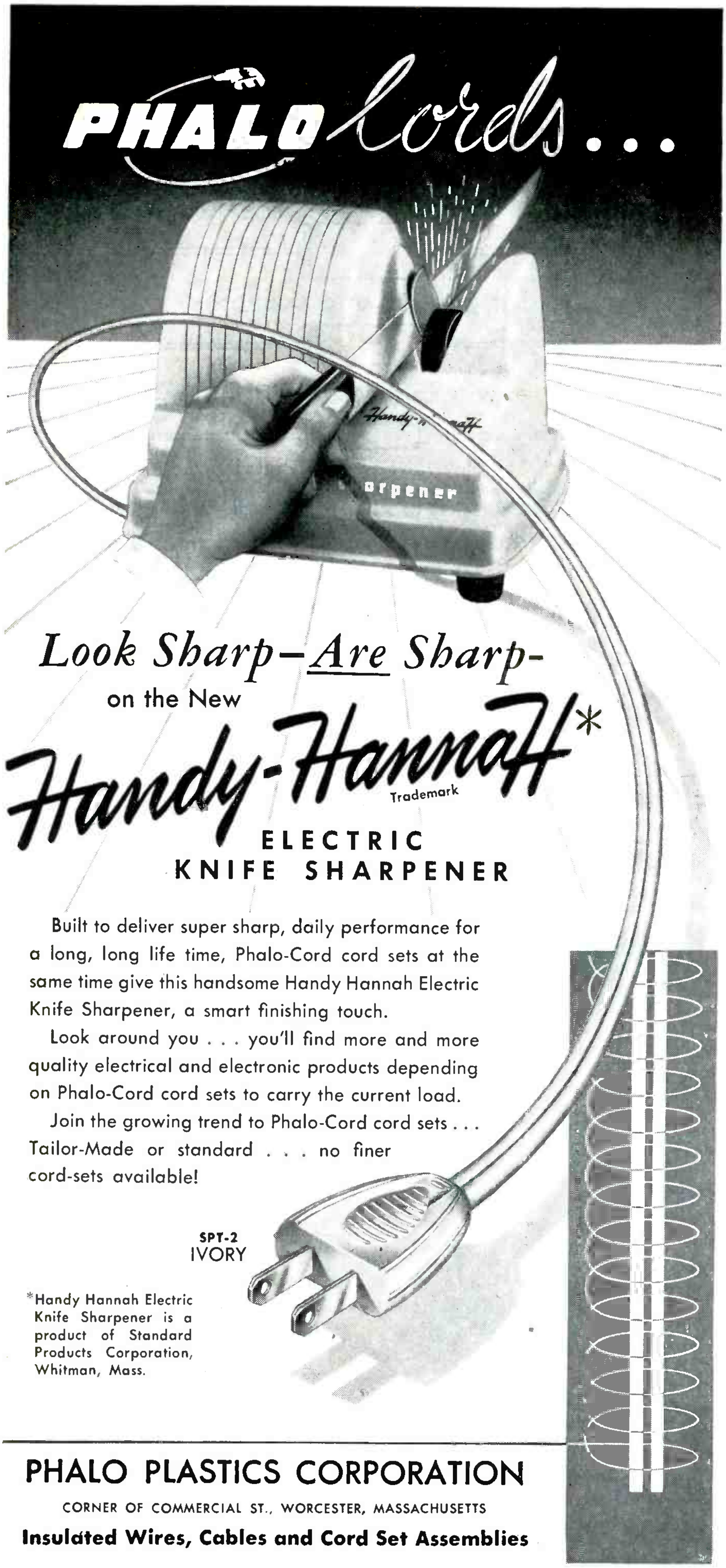


P. S. Christaldi

assistant manager of the division in 1952.

In the broadcasting division of the company, Dr. Du Mont announced the appointment of Ted Bergmann as director of broadcasting succeeding Chris J. Witting who has resigned from that position to become president of Westinghouse Radio Stations on January 1, 1954. Bergmann is a veteran member of the Du Mont organization and for the past six months has been general manager of the network.

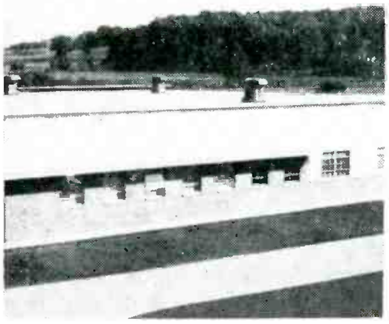
As chairman of the contract standardization committee of the National Association of Radio and Television Broadcasters, he was instrumental in helping to standardize tv time contracts for the industry, a system currently being used by most tv stations in the U. S.

Sylvania Makes Expansion Moves

SYLVANIA will undertake studies, laboratory experiments and field tests of electronic equipment under a contract with the Army Signal Corps at its electronics defense laboratory now under construction in Mountain View, Calif.

When in full operation, the 60,000 sq ft lab will employ approximately 250 persons, most of whom will be scientists and engineers.

The firm also announced that construction of a 200,000 sq ft plant extension for the manufacture of large size (24 and 27-inch) tv picture tubes and for pilot-line production of color tubes is nearing



Sylvania's electronics defense lab

completion in Seneca Falls, N. Y. The new extension will bring the company's picture tube manufacturing space to 687,000 sq ft.

Although 82,000 sq ft of the new addition is planned for color screen work, production of color tv tubes, equipment development and storage, W. H. Lamb, general manager of the tv picture tube division, said that it is too early to predict just when the company will fully equip and operate this section of the plant for complete color work. At the present time the company intends only to continue its experimentation and operation of a pilot production line for color tubes and color screens. The Seneca Falls plant is the only Sylvania plant at which color work is being developed. At present, Sylvania employs 1,400 employees there with a monthly payroll of $570,000.

A. W. Keen has been appointed as commercial engineering manager of the tv picture tube division, according to R. K. Gessford, Sr., chief engineer of the division. He has been with Sylvania since 1933 and previously was manager of the application coordination section at the company's research center in Bayside, L. I., N. Y. Prior to this, he was assistant manager of the product development lab.

American Research Forms New Company

AMERICAN RESEARCH AND DEVELOPMENT CORP. has formed the Product Development Corp. in Boston. Merrill Griswold, chairman of the executive committee and a director of American Research, was elected

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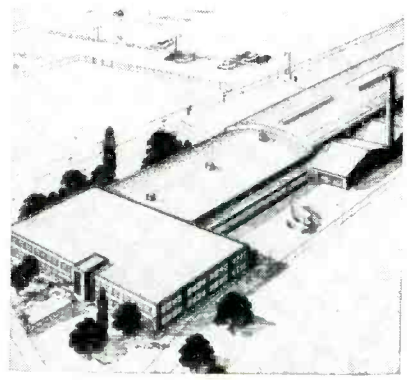
chairman and John F. Rockett, Jr. was named president.

The new firm will offer a product consulting service. Processes, products and existing enterprises will be referred to companies for acquisition.

Griswold is chairman of the board of trustees of Massachusetts Investors Trust and chairman of the board of directors of Massachusetts Investors Growth Stock Fund.

Rockett is former head of commercial research at the electronics division of American Machine and Foundry Company.



Magnetics Readies New Plant

THE NEW plant of Magnetics, Inc. just outside of Butler, Pa., is scheduled to be in full operation early in January, 1954.

Research and development laboratories as well as its engineering and general offices will be housed in the administration-building section of the new plant. Assembly and fabrication shops, a heat treatment room, and a rolling mill for high-permeability steels are included in the new facilities.

Tape wound cores, permalloy-dust cores, magnetic laminations, shields, magnetic amplifiers and magnetometers will be produced in the new plant and facilities are included for dry hydrogen annealing of components on an industrial contract basis.

The company also announced that Thomas G. Wilson has joined the engineering development staff. He was previously with the U. S. Naval Research Lab. in Washington, D. C. where he spent over four years on

basic and applied research on magnetic amplifiers. Prior to this he worked on equipment design for supersonic wind tunnel measurements for the Naval Ordnance Lab.

Servomechanisms Makes Expansion Moves

A NEW component division in Westbury, Long Island, N. Y. has been formed by Servomechanisms. It will produce miniature servo and instrument motors, mechanical development apparatus and various other products associated with the electronic and instrument industries.

R. F. Redemske, vice-president of the company, has been appointed division manager. Other appointments include: H. W. Brede, customer liaison director; S. Davis, development engineer; W. Berg, production manager; E. Kares, chief accountant and R. J. Corby, purchasing agent.

The company also acquired Industrial Electronics of Canada. The new subsidiary will continue to operate under its own name and to produce its line of electronic equipment. The engineering department of Industrial and its manufacturing facilities will be expanded. It will merchandise Servomechanism products in Canada along with products of other U. S. and European companies.

Alexander S. Mackie will continue as president of Industrial as will Donald L. Stewart as treasurer with the added duties of secretary. Croydon H. Hartley, sales director of Servomechanisms, has been appointed vice-president.

Norden Laboratories Appoints Thompson

L. T. E. THOMPSON has been appointed executive vice-president in charge of Norden Laboratories' three operating divisions. Dr. Thompson has just resumed full-time duties with Norden after serving as vice-chairman of the Research and Development Board of the Department of Defense and recently as consultant to the Assistant Secretary of Defense for Research and Development.

Prior to his appointment as executive vice-president, he served as vice-president of Norden in charge of its research and development division in White Plains, N. Y. His new duties will extend his responsibilities to the product engineering division and the manufacturing division.

Before joining Norden, he was technical director of the Naval Ordnance Test Station at Inyokern, Calif.

Dutch Firm Plans Latin Subsidiary

THE 27-year-old Dutch firm, Van der Heen, manufacturers of "Erres" radios and television sets, plans to establish a subsidiary plant in Latin America. President Cornelius Kroon, who has made a tour of 17 countries to investigate the prospective market, said his firm regards Venezuela favorably and feels it has a great future.

Kelly Honored by Industrial Research

MERVIN J. KELLY, president of Bell Telephone Laboratories, was named to receive the Industrial Research Institute Medal for 1954.

The medal, awarded annually since 1945, is given for "outstanding accomplishment in leadership in or management of industrial research which contributes broadly

Want more information? Use post card on last page.

to the development of industry or the public welfare."

Announcement of the award was made by Allen Abrams, president of the Institute and vice-president of the Marathon Corp. of Rothschild, Wis., at the Institute's fall meeting in Detroit, Mich. Official presentation of the medal will be made at an Institute dinner to be held April 22, 1954 in San Francisco.

Dr. Kelly began his Bell System career as a research physicist with the Western Electric Co. in 1918 and became associated with Bell Labs when it was incorporated in 1925. He later served as development director of transmission instruments and electronics and in 1936 was appointed director of research. In 1944 he was appointed executive vice-president, and in 1951, president of the laboratories.

RCA Consolidates Tube Sales Activities

THE Tube Department of RCA Victor has organized an overall marketing operation that unifies all sales and commercial activities.

Four new marketing divisions have been established. They are: receiving tube and transistor marketing; cathode-ray and power tube marketing; electronic components marketing and parts and equipment marketing.

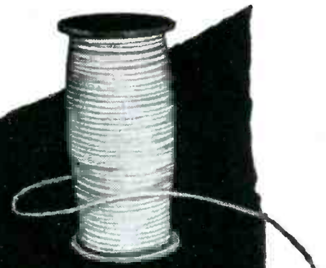
Lawrence S. Thees, formerly general sales manager, has been elevated to the post of general commercial manager. A veteran of 37 years sales experience, he will now be responsible for the RCA Tube

Lawrence S. Thees

for lacings that stay put!

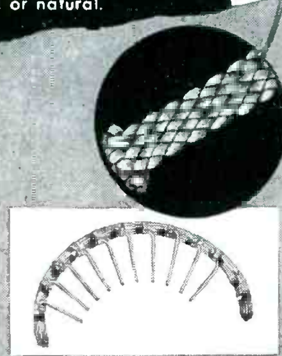
GUDELACE

BRAIDED NYLON LACING TAPE*



Style 18 (Medium), 500 yd. spools, black or natural.

A New and Revolutionary Type of Lacing



- Saves time, saves money, greatly reduces the number of rejects
- Won't "bite through" insulation
- Won't cut wiremen's fingers or cause dermatitis
- Ties easier, ties tighter and cuts down on slipping of knots

Let GUDELACE answer your lacing problems.

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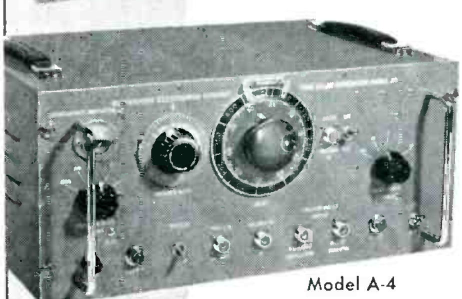
Rutherford ELECTRONICS CO. MAKES PRECISION TIMING INSTRUMENTS

Model A-2



Model A-4

Our TIME DELAY GENERATORS:

Each provides accurate and variable time intervals in five ranges. They feature low jitter (.008%), linear scales, built-in calibration indicator, 1,000-division dial, small repetition rate effects, blocking oscillator output and wide pulse output.

A-2 — Range: .8 μs to 100,000 μs
Get complete data: our Bulletin E-A-2

A-4 — Range: .00001 to 10 secs.
Get complete data: our Bulletin E-A-4

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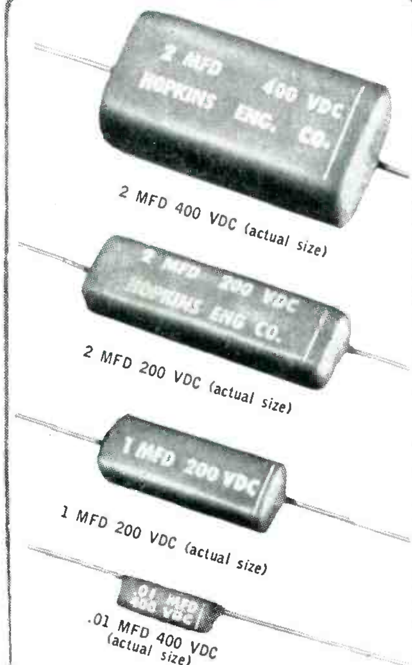

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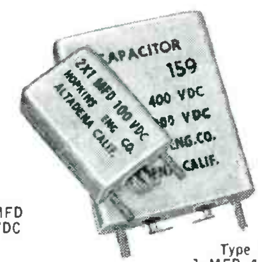

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Type 159, 1 MFD 400 VDC; 2 MFD 400 VDC

A multiplicity of sizes is available in either plastic encased or hermetically sealed capacitors. Special designed units also made to your exact specifications.

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Douglas Y. Smith

Department's overall commercial viewpoint and policies and for developing long-range planning.

Direct marketing operations will be under the supervision of Douglas Y. Smith, formerly manager of sales operations, who has been advanced to the new post of general marketing manager.

He will have direct administrative responsibility for the four marketing divisions, a separate sales division and two sales-service divisions. Smith has been with RCA for nearly 25 years.

Kenneth G. Bucklin, formerly product administration manager for receiving tubes, has been promoted to manager of the new receiving tube and transistor marketing division. Michael J. Carroll, for the past four years equipment sales manager for electronic components, now becomes manager of the electronic components marketing division. Leonard J. Battaglia, formerly manager of the renewal sales field force, has been promoted to manager of the parts and equipment marketing division.

Raytheon Appoints New Personnel

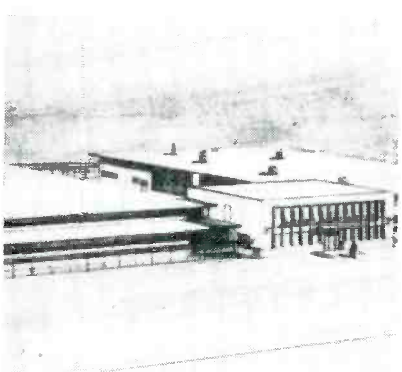
WILLIAM C. BROWN, manager of Raytheon's magnetron research and development laboratories, and William T. Welsh, sales manager of the power tube division, have been appointed assistant vice-presidents.

Brown joined Raytheon in 1940, working first in the small tube section of the receiving tube division. Subsequently he worked on high frequency triodes, which were used in radiosonde balloon transmitters. In 1941 he was transferred to the equipment division to work on microwave components. The following year he worked for the power tube division and eventually was in charge of the magnetron research and development facilities still under his direction.

Welsh joined Raytheon in 1941 at its receiving tube plant in Newton, Mass. Then he joined the sales staff of the power tube group which shortly gained the status of a separate division of the company. After war service, he returned to Raytheon in 1945 as a junior engineer in the quality check department. He has been on the road as a sales representative introducing the "Microtherm" diathermy machine and has been sales manager for that product. He was appointed sales manager of the power tube division in September, 1952.

In the television and radio division of the company, Stanley S. Crane was appointed director of engineering and research for the special products group, according to Raul H. Frye, general manager of special products. Crane has been with the company since 1944 and had previously been chief engineer of the special products radar division.

Also in the tv and radio division, David Bell was appointed manager of the quality control department. He was associated with the Capehart-Farnsworth Co. as manager of quality control.



Diamond Power Opens New Laboratory

THE ELECTRONICS division of the Diamond Power Specialty Corp. has moved into its new electronics laboratory in Lancaster, Ohio. The new building, which has approximately 30,000 sq ft of floor space, is being used for the continuing development and construction of the Diamond "Utiliscope" and for the development of other electronic instruments and controls. Problems relating to the application of this equipment in various basic industries are also carried through preliminary stages. Another important activity is electronic-tube development.

A mass-spectrometer type of leak detector, which will detect leakage at the rate of 1 cc in 31 years, is part of the lab's new equipment.

Kaiser and Willys Electronics Combine

CONSOLIDATION of the electronics research and production facilities formerly operated as separate Kaiser and Willys divisions was announced by Edgar F. Kaiser, president of Kaiser and Willys Motors.

He also announced the appointment of Clay P. Bedford as vice-president in charge of the new division, which includes Willys electronics plants at Toledo, Ohio and Anderson, Ind., and Kaiser facilities at Nashua, N. H. and Arlington, Va.

John W. McGee, who has been manager of Willys electronics operations, will be general manager of the new expanded division. McGee has a background of 15 years in radio and electronics engineering, including service with the Air Material Command at Wright Field, Ohio and Lear, Inc.

Bedford has been associated with various Kaiser enterprises for some time. During the war he was engaged in shipbuilding activities on the west coast and, in 1945, he joined Kaiser-Frazer Corp. as vice-president in charge of manufacturing. He served as a special assistant to the director of defense mobilization and the Secretary of Defense, in Washington, from the spring of 1951 until the summer of 1952. Upon leaving Washington, he became president and director of Chase Aircraft Co., a position he still holds.

It is expected that the combining of the engineering and research departments will permit under-

taking over-all electronics projects for both civilian and military purposes, according to Bedford, and will provide an opportunity to make maximum use of the Tinker-toy development on which Kaiser electronics has been engaged for the Bureau of Standards and the U. S. Navy.

Pacific Bendix Builds New Plant

CONSTRUCTION of a new engineering building at Bendix Aviation's Pacific division plant in North Hollywood, Calif. was recently started. The building will be two stories high, providing 23,000 sq ft of floor space. Its design facilitates future additions to the building. The Pacific division airborne radar and hydraulic engineering departments will be housed in the building which is slated for completion in February, 1954.

Lewis Named Vice-President of Prodelin

ROBERT F. LEWIS, formerly technical director of Prodelin, designers and manufacturers of telephone and tv antennas and transmission lines, located in Kearney, N. J., has been appointed vice-president of the company.

He joined RCA in 1933 and later transferred to their research division where he was engaged in antenna studies until 1939. He worked for CBS on tv problems associated with antennas and radio-frequency filters. While serving as a member of the Harvard Radio Research Laboratories, he was commissioned a Major and was placed in charge of the antenna activities of the American-British Laboratories in England and on the Continent during World War II. He also was a member of the engineering staff of Federal Telephone and Radio, later transferring to Federal Telecommunications Labs.

Triad Transformer Appoints Graham

GRANT GRAHAM, previously in jobber sales for Triad Transformer Corp. of Venice, Calif., has been selected to fill the newly-created post in the firm of product applications engineer. In his new position he will work in an advisory capacity with design engineers, assisting them in transformer application problems.

Triad inaugurated the plan when it was learned that manufacturers and engineers would welcome assistance in their design and application problems as they affected transformers.

Armour Research Appoints Wachowski

HILLARD M. WACHOWSKI, former assistant professor of electrical engineering at Northwestern University, has been appointed an electrical engineer at Armour Research Foundation of the Illinois Institute of Technology.

He will work with the communications and radio-frequency applications section of the electrical engineering department.

Stanford University Sets Microwave Plans

A STEPPED-UP program of microwave research sparked by construction of a new \$200,000 microwave laboratory with 15,000 sq ft of space was announced by Stanford University. It is hoped the new lab will be completed by the spring of 1954.

The staff of the new lab will number about 75. The present building will be used for full-time nuclear research and will be known as the High Energy Physics Laboratory, directed by W. K. H. Panofsky.

An underground radiation vault will be built for the new lab. Lab director E. L. Ginzton said a 70-million-volt linear accelerator is planned. The accelerator will be located in a trench inside the building with its electron beam piped into the subterranean chamber, located at an outside corner. Dr. Ginzton emphasized that medical use of the vault for radiation therapy of cancer and other diseases is unlikely for several years. However, a six-million-volt medical linear accelerator being built at the Stanford School of Medicine is expected to provide such treatment by the end of 1954.

Hull Named Capehart Research Head

HARVARD L. HULL has been appointed vice-president and general manager of the research and development division of Capehart-Farnsworth. Philo T. Farnsworth, vice-president and technical director, will continue to be in charge of special research activities.

Dr. Hull, who has been active in atomic energy research since 1943, was director of the Argonne National Laboratory's division of remote control engineering before joining Capehart. While at Argonne, he took an active part in the organization of the lab on a postwar basis. Earlier he was director of process improvement for Tennessee Eastman. From 1933 to 1943 he was associated with Sperry in a variety of positions including those of project engineer, research engineer and director of remote control development. He was responsible for the development of a wide variety of remote control equipment for gyro-compasses, searchlights, anti-aircraft guns and bombsights.

American Research Names Augustyn

AMERICAN RESEARCH CORP. of Bristol, Conn., announced the appointment of Thaddeus Augustyn as vice-president. He will supervise production and engineering for the company.

He resigned as works manager of Bowser Technical Refrigeration, where he has been one of the

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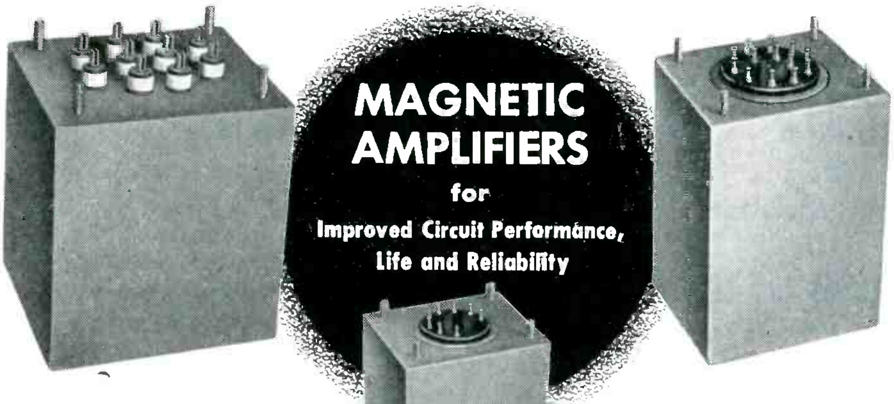

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pioneers in the development of environmental test equipment since 1946. His background in the industry has also included the posts of chief draftsman, coordinating engineer and production manager.

Minneapolis-Honeywell Adds Factory Space

MINNEAPOLIS-HONEYWELL REGULATOR CO. has taken a six-month lease on manufacturing space at Tucson Municipal Airport in Tucson, Ariz.

The company plans to use the facilities to insure uninterrupted work on its jet fighter electronic equipment during the winter months. Increased volume of jet work has taxed the company's main flight center in Minneapolis.

Stevens Doubles Plant Area

GEO. STEVENS MANUFACTURING CO. of Chicago has completed an addition which doubles the area of the present plant. The new space is being used for manufacturing high-speed coil winders and for an enlarged engineering and design department.

Gray Research Names Winlund

EDMOND S. WINLUND has been appointed chief engineer of Gray Research and Development Co.

He was formerly associated with RCA and Westinghouse and is experienced in the design and application of radio broadcast transmitters, marine radar devices and dielectric and other industrial heating equipment. He is a specialist in radio and microwave equipment for railroads.

Stanford Research Acquires Microwave

STANFORD RESEARCH INSTITUTE has acquired the facilities of the Microwave Engineering Co. of Los Angeles, located at the top of Mount Lee in the Hollywood district.

The new facility will be integrated as part of SRI's Engineering Division's Radio Systems Laboratory, and will be known as the Mount Lee Laboratory of Stanford

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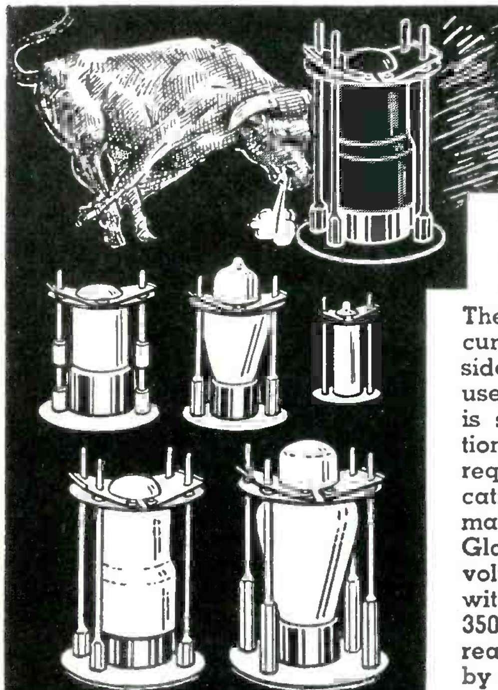

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VACUUM TUBE RETAINERS

These retainers are used to secure Vacuum Tubes and to resist side motion of Vacuum Tubes used in radio equipment which is subject to shock and vibrations. These retainers meet the requirement of all JAN specifications. The insulated portion is made of a melamine base Fibre Glass Phenol which provides 300 volts insulation to ground and withstands a temperature of 350 F. The insulated plate can readily be fastened or released by hand.

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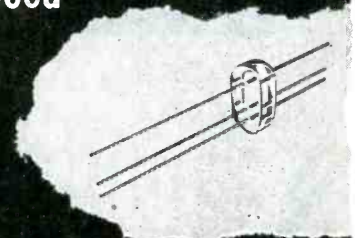
BUTTON STEM MACHINERY

for all tube sizes... in any production speed



You can produce button stems for sub-miniature, miniature, standard, cathode ray and power tubes (as well as crystal diodes and transistors), at any rate you specify on one of Kahle's machines.

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Kahle has contributed to the electronics and glass industries for more than 40 years . . . today serves all the major electronic tube producers in this country as well as those in many other nations.

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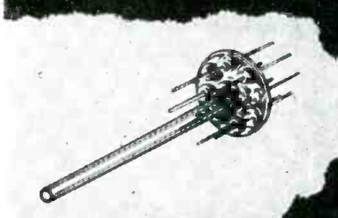

Kahle
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1310 SEVENTH STREET
NORTH BERGEN, N. J.

Research Institute.

Present laboratory facilities will be augmented for additional work on radomes and antenna systems for guided missiles. Also contemplated is fuller use of the antenna measuring range to take advantage of the favorable geographical location.

Robert Krausz, former vice-president and chief engineer of Microwave, has been appointed to head the operation. Microwave's engineering staff of 15 also has been retained.

Ampex Organizes Loudspeaker Firm

THE AMPEX CORP. has organized a wholly-owned subsidiary, the Ampex Loudspeaker Co.

With manufacturing facilities in North Hollywood, Calif., the new firm's initial output will consist solely of theatrical loudspeakers. The company was formed to fulfill commitments to equip theaters with integrated multidirectional sound systems used with the new 3-D and wide-screen techniques.

Ampex loudspeakers are being built under license from the James B. Lansing Sound Corp. Thomas L. Taggart, comptroller, has been temporarily reassigned as manager of the loudspeaker subsidiary.

More Companies Become RETMA Members

FOURTEEN new members, 13 active and one associate, were admitted to RETMA membership by the board of directors bringing total membership to 362, the highest in RETMA history. New members are:

The Alton Co. of Union City, N. J. (Associate); Andrews Tower Co. of Fort Worth, Texas; Avionex Electronics Corp. of Burbank, Calif.; Cal-Tronics of Los Angeles, Calif.; Chromatic Television Laboratories of New York, N. Y.; Don Good of South Pasadena, Calif.; R. L. Drake Co. of Dayton, Ohio; International Instruments of West Haven, Conn.; Olympic Radio & Television of Long Island City, N. Y.; Rek-O-Kut of Long Island City, N. Y.; Swett & Sibley of Cambridge, Mass.; T. J. Mfg. Corp. of Martinsville, Ind.; Transistor

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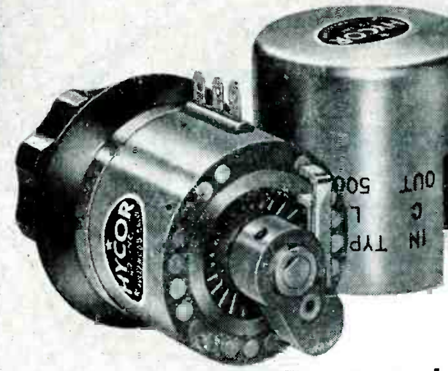

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NEMA Elects New Officers

J. H. JEWELL, vice-president of Westinghouse, was elected president of the National Electrical Manufacturers Association at their annual meeting to succeed L. G. Hall, president of Stackpole Carbon Co.

Vice-presidents named by meeting delegates are: J. L. Busey, vice-president of GE; J. W. Corey, president of Reliance Electric; W. A. Elliott, president of Elliott Co.; F. F. Loock, president of Allen-Bradley Co. and Hoyt Post Steele, executive vice-president of Benjamin Electric. Re-elected as treasurer is A. F. Metz, president of Okonite.

Radio Condenser Appoints Chiefs

JOSEPH S. ROBB has been appointed director of engineering in charge of all engineering functions at Radio Condenser Co. of Camden, N. J.

Melvin V. Weiss has been named chief engineer of special apparatus and tv and Jack Teaf has been named chief engineer of the auto tuner division.

Pentron Increases Production Facilities

ADDITIONAL manufacturing facilities have been leased by Pentron Corp. in Chicago for assembly operations devoted to manufacturing magnetic recording heads, amplifiers and related components.

The extra capacity will supplement the facilities of Pentron's main plant. The two locations provide floor space of 47,000 sq ft.

GE Organizes New Groups, Opens Tube Warehouse

REORGANIZATION of government electronics activities of the GE Electronics Division was announced by W. R. G. Baker, vice-president and general manager of the division.

Two new departments have been

created to handle engineering and manufacturing functions of the division's government business. All marketing functions will continue to be handled by the division's government equipment marketing section.

J. J. Farrell

John J. Farrell, who joined GE in 1913 and has been in charge of heavy military electronic equipment since 1952, was appointed general manager of the new heavy military electronic equipment department.

Herman F. Konig, who joined GE in 1932 and has headed light military electronic equipment activities since 1952, was named general manager of the new light military electronic equipment department.

Venard M. Lucas will continue as manager of the government equipment marketing section, with headquarters at Syracuse.

The three units were previously part of the division's government equipment department, which has been discontinued. George R. Metcalf, who was general manager of that department, has joined the company's engineering services division in New York as a consultant to C. H. Linder, vice-president of engineering.

The newly formed germanium products unit of the GE Electronics Division's commercial equipment department set up its marketing organization under James H.

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INFRA *Electronic Corp.*
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Manufacturers of Precision Synchros

Herman F. Konig

Sweeney, manager of marketing for germanium products.

Richard H. Rudolph was appointed manager of sales. He has been sales manager for precision and laboratory test instruments since 1948.

Edwin O. Vandeven was named manager of marketing administration. He has been commercial engineer for germanium products since 1951.

Guy O. Whelchel was appointed manager of marketing administration and research. He has been engaged in marketing administration for the commercial equipment department since 1951.

Samuel R. Tedford, who has been a section leader in the advertising section of the commercial equipment department since 1950, was named manager of advertising and sales promotion.

In other activities, GE opened its new tube warehouse in Los Angeles. A prediction that the future growth of the electronics industry in the West Coast region may be "several times the growth of the rest of the country," was made by J. Milton Lang, general manager of the GE tube department, at the opening of the new 25,000 sq ft building.

The new warehouse, under the management of W. E. Morrison, was built in accord with GE specifications and will be occupied by the company under long-term

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INPUT AND OUTPUT VSWR
1.1 to 1000 mc at 50 ohms

Quick delivery on Standard Models. Prompt attention given to special requirements.

*PAT. PENDING

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lease. The building also houses GE western sales offices as well as commercial service offices and a commercial engineering laboratory.

NYU Expands Electronics Curriculum

A BROADENED program at NYU's College of Engineering consists of fall and spring courses in amplifier coupling networks and vacuum tube and transistor circuits, and a fall course in theory of fractional horsepower and servo motors. Courses are designed particularly for electronics engineers engaged in radar circuitry, servomechanism component design and allied fields.

CBS-Columbia Becomes Division of CBS

WILLIAM S. PALEY, chairman of the board of the Columbia Broadcasting System, announced that the activities previously carried on by CBS-Columbia as a subsidiary will be carried on by the organization as a division of CBS under the designation of CBS-Columbia. He stated that the organizational change was made to simplify the over-all corporate structure and to permit greater integration of activities of CBS-Columbia with CBS.

In the new division Frank R. Day has been named production engineer in the industrial engineering department. He has had more than 30 years experience in the radio-tv field and has been plant and production manager for U.S. Television Corp. and also headed production testing for Pilot.

In the special products unit of the division, Robert G. Horner, George Wass and Harold Metter all have been named to color tv receiver design and production engineering assignments.

I-T-E Moves Special Products Division

THE SPECIAL products division of the I-T-E Circuit Breaker Co. of Philadelphia moved from the company's main plant to a separate plant in the city.

The new plant houses not only the offices of the special products

Want more information? Use post card on last page.

division but also the company's facilities for assembling jet engine components. With other buildings of the division, a total of 185,000 sq ft for manufacturing and 16,000 sq ft for office area is now used.

Photo Chemical Opens California Company

Photo Chemical products of New York City opened an affiliate, Photo Chemical Products of California, in Santa Monica. According to Henry G. Renaud, president, the California operation will concentrate its activities in printed electronic circuit applications and development of phosphor screens for color tv kinescopes. The West Coast operation will also continue the manufacture of aircraft instrument dials and electronic panels using their "Wrinlay" process.

John Lesser, formerly production manager of Multi-Metal Wire Cloth Co. of New York City, has been elected vice-president and general manager of the California plant.

Superex Operates Rayburne Corp.

SUPEREX ELECTRONICS CORP. of Yonkers, N. Y. is operating Rayburne Corp. (formerly Grayburne) also at Yonkers, and will market the combined lines of electronic components and equipment under the Superex name.

Headed by Daniel Schulman and Marvin Buchalter, Superex has been engaged in the manufacture of electronic equipment for the civilian and military fields.

Electronic Engineers Needed By Navy

THERE are current research vacancies at the Naval Research Laboratory in grades GS-5 to GS-12 with basic entrance salaries from \$3,410 to \$7,040 per year. A Bachelor's degree in an appropriate field is required and applicants with graduate degrees are particularly desired. Post graduate research experience in electronics will be given

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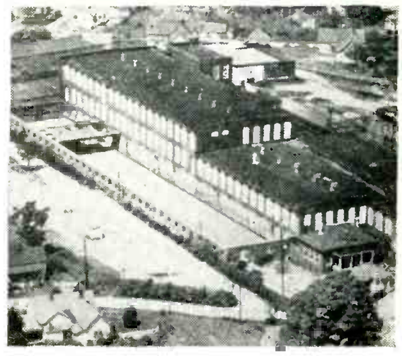
credit toward qualifying for a higher grade, depending upon the kind and amount of experience. Persons who have these qualifications and are interested in a government career in electronics research are urged to complete an application for Federal employment, Standard Form 57, and mail it to the Personnel Officer, Naval Research Lab Washington 25, D. C.



Pyramid Acquires Southern Plant

A PLANT in Gastonia, N. C. has been taken over by Pyramid Electric of North Bergen, N. J. as part of its current expansion program. The factory consists of 160,000 sq ft of floor space. It is now in process of renovation and will begin operation in January, 1954 employing approximately 1,000 persons in the manufacture of paper, motor starting and ceramic capacitors.

Packard-Bell Names Michaels

EDWARD L. MICHAELS has been appointed supervisor of Packard-Bell's advance development group which is engaged in research and development of color tv and the possible applications of transistors and printed circuits to radio and tv receivers.

He comes to the company from the Pomona division of Convair where he was supervisor of the control system design group engaged in research on the application of transistors. Prior to that he was a member of the research staffs of the Rauland Corp. and Cook Research Labs in Chicago.

While with Rauland he engaged principally in development of the color tv picture tube. At Cook he was senior project engineer in charge of Aerobee rocket instrumentation.

Texas Instruments Officials Open New Plant

J. E. JONSSON and Eugene McDermott, president and chairman of the board of Texas Instruments, congratulate each other during the ceremonies which marked the completion of the firm's recent plant expansion. Located in Dallas, Texas, the company now has nearly 200,000 sq ft of plant area, including the new 90,000 sq ft addition, devoted to the manufacture of precision electronic, electro-mechanical and geophysical equipment.

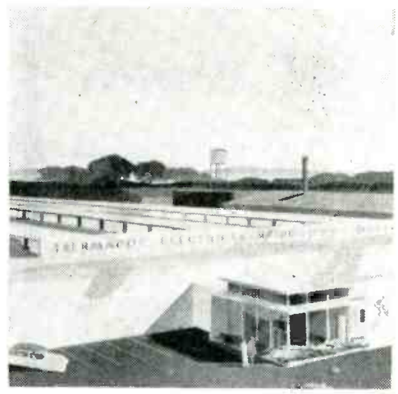
Net sales of the company have climbed from under $5 million in 1948 to an estimated $30 million for 1953. Employees now number over 2,000.

Raymond Engineering Appoints Thompson

HORACE H. RAYMOND, president and founder of Raymond Engineering Laboratory of Middletown, Conn., announced the appointment of Lincoln Thompson as a vice-president of the company. The appointment will permit Raymond to devote full time to inventive projects.

Thompson joined the research department of Victor Talking Machine Co. in 1923 and in 1925 left to become assistant to W. H. Bristol, president of the Bristol Co., where he was instrumental in developing talking pictures and electronic devices.

In 1932 he made the first practical talking book records for the blind and also founded a small company to develop and manufacture sound recording devices. By 1940 he had perfected an electronic disc dictating machine and The Sound Scriber Corp. was begun to manufacture and market it. He served as president of the company from 1940 to 1950. He developed the recently announced Sound Scriber 24-hour recorder. He has received nearly forty patents in the electronic and sound recording field.



Production Underway At Thermador Plant

THE NEWLY occupied 77,000 sq ft plant of the electronics division of Thermador Electrical Manufacturing of Los Angeles is now in full operation according to Robert Singleton, plant manager.

Built on an 8-acre site, the new plant has 5,000 sq ft devoted to offices and engineering staff rooms. Other facilities are complete die and tool shops, a battery of high-speed automatic presses for lamination stamping, heat treating and annealing ovens, vacuum impregnation equipment and laboratory testing facilities that can simulate varying climatic, humidity and temperature conditions that might be encountered anywhere.

Thor Corp. Buys Phillips Control

THOR CORP., major appliance manufacturer, has purchased the Phillips Control Corp. of Joliet, Ill., maker of components for the elec-

tronics industry.

Raymond J. Hurley, Thor board chairman, said Phillips would be operated as a wholly-owned subsidiary of Thor. John E. Moseman, Phillips founder and president, will remain as president of the subsidiary, and all other members of the Phillips organization will retain their present positions.

Phillips Control represents Thor's third major acquisition in the past 12 months. The company earlier had purchased Century Vitreous Enamel and Leeson Steel Products.

Hurley said that with its new subsidiary, Thor will enter the industrial field for the first time. Its present customers are retail customers.

He said that the Phillips research program would be expanded as a result of the availability of additional working capital.

Varo Names Wible

PAUL E. WIBLE has joined Varo Manufacturing Co. as a project engineer conducting research and development in electronics.

Previously he was associated with the Naval Ordnance plant at Indianapolis. He has worked in the field of closed loop devices and on transistor applications in that field.

Waltham Watch Names Sverre Johannesen

COMMANDER SVERRE JOHANNESEN has been named assistant to the president of Watham Watch Co. to head up servicing and development of military and industrial contracts for the instrument division of the company, it was announced by Teviah Sachs, Waltham president.

Just released from active duty in the U. S. Navy after being recalled during the Korean emergency, Johannesen represented the military on critical production problems of precision instruments and other components affecting aircraft production schedules while assigned to the Aircraft Production Resources Agency and the Navy Bureau of Aeronautics. He has previously been associated with U. S. Gauge and Bendix Aviation.

DuBois Elected Mycalex Director

J. HARRY DUBOIS, Mycalex vice-president of engineering, was elected a director of the corporation, it was announced by president Jerome Taishoff. His election fills the vacancy left by the recent retirement of James L. Robertson, director, after 22 years of continuous service.

During his earlier career, DuBois held various engineering and executive positions with GE, later was vice-president of Shaw Insulator and manager of new-product development of Plax Corp. He has been vice-president of Mycalex since the beginning of 1952.

Superior Tube Acquires Fine Tubes of England

SUPERIOR TUBE CO. of Norristown, Pa. has purchased a controlling interest in Fine Tubes of Surrey, England.

Founded in 1943, Fine Tubes has grown rapidly and is considered to be one of the U. K.'s largest producers of seamless nickel cathodes and other electronic parts.

Superior expects to gain from the purchase an entree to foreign markets that cannot be served from the U. S.

Malcolm A. Rowe, who has been managing director of Fine Tubes for several years, will continue to serve the company in that capacity.

Cuckler Named Engineering Head

LEE E. CUCKLER has been appointed manager of the engineering department at Fielden Instrument Division of the Robertshaw-Fulton Controls Company and is responsible for all application engineering and technical services. Prior to joining Fielden, he was head of the textile and paper group of the application engineering department at Brown Instrument Division, Minneapolis-Honeywell from 1943 to 1952.

King Appointed By Hydro-Aire

LESLIE E. KING has been named a project engineer at Hydro-Aire, west-coast transistor manufacturer, according to H. H. Rhoads, president of the company, and will be in charge of transistor research and development.

King served as a Commander with the U. S. Navy during World War II. Among other assignments, he was executive officer of the electronic field service group of the Naval Research Laboratory in Washington, D. C. More recently he has been associated with the Glenn L. Martin Co. and Consolidated Vultee in research and development work on guided missiles.

Caltech Appoints Lester M. Field

LESTER M. FIELD of Stanford University has been appointed professor of electrical engineering at the California Institute of Technology, where he has been a visiting professor since January, 1953.

At Caltech he has set up an electron tube and microwave laboratory, with support from private industry and the Office of Naval Research, and is continuing his re-

search on microwave amplification and interaction processes.

Dr. Field, 35, worked at the Bell Telephone Laboratories from 1945 to 1947 in the field of magnetron development and electron dynamics. With Dr. J. H. Pierce, he developed the practical traveling-wave tubes.

He joined the Stanford faculty in 1946 and four years later became its youngest full professor when he was promoted from the rank of associated professor of electrical engineering at the age of 32.

Lear Appoints Chief Engineer

J. C. OWEN has been appointed chief engineer of instrument products for Lear's Grand Rapids division.

Prior to joining the company, Owen was with Bendix Aviation for a period of 12 years. There he was senior engineer in charge of systems engineering activities.

In his capacity as chief engineer, he will direct all engineering activities involving instrument products and will concentrate on the development of new products and the broadening of the current line.

In effect, Owen's activities and responsibilities will parallel those of T. K. Greenlee, chief engineer of electromechanical products. Greenlee was previously chief engineer of Barber-Colman in charge of actuator and controls development.

American Machine Makes New Moves

RALPH H. ANDERSON has been appointed staff engineer at Sterling Engineering in Laconia, N. H., electrical relay subsidiary of American Machine and Foundry.

Formerly associated with Crystal Research and Cambridge Thermionic Corp., Anderson was a technologist for 8 years working with piezoelectric gauges for measuring large transient pressures. Prior to working for these companys, he did analytical work at MIT Labs.

In other actions AMF moved the battery section of its Raleigh, N. C. engineering labs into new quarters there representing twice the area it formerly occupied. The new lab of 3,600 sq ft is engaged in work on $900,000 worth of governmental and commercial contracts involving research and development of special purpose power sources for use in such military items as guided missiles, torpedoes and jet aircraft.

Measurements Names Chief Engineer

MARTIAL A. HONNELL has been elected a vice-president and chief engineer of Measurements Corp. of Boonton, N. J. He will be in charge of engineering design and development.

As professor of electrical engineering at Georgia Institute of Technology from 1937 to 1953, he was in charge of communications and electronics and has acted as consulting engineer to industry, broadcasting stations and government sponsored projects.

New Metals Company Formed

P. W. BLACKBURN, formerly with North American Philips, has announced the formation of his own company, The Rembar Co. in Dobbs

Ferry, N. Y. The firm will specialize in molybdenum and tungsten sheet, ribbon and foil plus other basic metals and fine wires for the electronic and allied industries.

Burroughs Research Center Progresses

JOHN S. COLEMAN, President of Burroughs Corporation of Detroit, laid the cornerstone of the new $2,000,000 Burroughs Research Center in suburban Philadelphia. The building is scheduled for completion by Spring, 1954. Construction of the 105,000 sq ft structure was begun in July 1952.

The Burroughs Research Center will continue basic research and development in electronics, electromechanics, magnetics and related fields. Research activities are now being carried on in downtown Philadelphia.

Approximately 350 employees will be on the staff in the new air-conditioned laboratory at Paoli. It is expected that some units will begin occupying the Research Center early in 1954.

Consolidated Makes Executive Promotions

CONSOLIDATED ENGINEERING CORPORATION took steps to raise its electronic computer development group to company divisional status.

James R. Bradburn, who will become vice-president in charge of Consolidated's computer division, was selected to head the development, production and research activities of the company's electronic digital computer and to introduce it to industry for general industrial and commercial use.

Joseph H. Lancor, Jr., will succeed Bradburn as vice-president in charge of engineering and Walter B. Claus will move into the post vacated by Lancor as director of Consolidated's transducer division.

Bradburn joined Consolidated Engineering in 1945 as treasurer and assistant to the president. He has served as vice-president in charge of engineering since 1948. Prior to World War II service as a major in Army ordnance, Bradburn served in engineering and ex-

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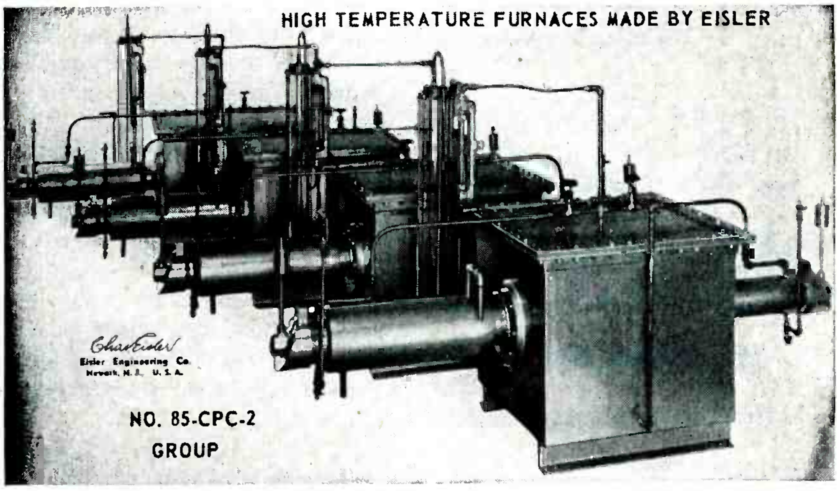

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BIWAX CORPORATION 3445 HOWARD STREET SKOKIE, ILLINOIS ecutive posts with GE and the Eastman Kodak Company.

Joining Consolidated in 1951 to head activities of the company's transducer group, Joseph Lancor, Jr., was later named director of the transducer division. He has held executive and research posts with Lancor Electric and Sperry.

New Parts Firm Organized

THE Permonite Manufacturing Company has been organized by Morris Perlman, who recently resigned as president of General Laminated Products Company of Chicago.

The new company will manufacture and sell terminal strips, tube sockets, kinescope sockets, pin plugs and connectors, special assemblies and fabricated parts for the electronic, radio, television, general electrical and automotive parts industries.

A new Permonite factory is under construction on two and a half acres of land bought by the company approximately 70 miles southeast of Chicago. Completion of the building, containing approximately 16,000 sq ft of floor space, and installation of machinery and equipment was scheduled for November.

Buggie Promotes Engineers

ADVANCEMENTS of top engineering and production personnel were made by H. H. Buggie, Inc. of Toledo, Ohio.

C. H. Sharp has been promoted to general manager of the company. Previously he was production manager and has been associated with the company since 1934.

C. R. Thorpe has been assigned the post of chief engineer. He has been with the company since 1933 in development, engineering and production capacities. More recently he has been sales manager.

R. J. Melcher is now special project engineer coordinating the development of electronic components of advanced design for special application. He has been with the company since 1934 and most recently served as chief engineer.

NEW BOOKS

Electronic Organs

BY ROBERT L. EBY, *Technical Director, House of Organs, Hollywood, California. Van Kampen Press, Inc., Wheaton, Illinois,* 213 *pages,* 1953, $5.00.

IT IS probably true that "in the last 15 years many more electronic organs have been produced in the United States than all the pipe organs ever built in this country." But at least a few musicians will argue the statement that these organs are "rapidly being accepted as true musical instruments."

This book will be useful to anyone considering buying an electric organ. It has extensive data (155 pages) taken from sales and service literature of six well-known makes as well as briefer mention (18 pages) of lesser known and discontinued types, plus a few foreign makes. The Table of Contents (4 pages) covers, for each of the major types: General Description, Consoles, Registration, Tone Generators, Mixers, Couplers, Amplifiers, Loudspeaker Systems, Installation, Care and Maintenance, and Models Summary Chart. The List of Illustrations is also complete (6 pages). There is no topical index.

The first and last chapters, though short, are outstanding: "I. History of Electronic Organs" (4 pages), and "IX. Selecting an Electronic Organ" (3 pages). The last page of the last chapter is a "Comprehensive Reference Chart of Leading Electronic Organs." This is concentrated and valuable information.

One major fault of the book is that it has no criticism of any electronic organ. For instance, an item of considerable interest is the attack and decay time of the electronic organ tone as contrasted with that of the wind-blown pipe. Undoubtedly the electronic organ can be made to equal the pipe with suitable circuits, and oscillograms of both the electronic and regular pipe will prove the similarity. However, a typical statement (page 36 of the Allen organ) is "the oscillator components are so designed that they have a finite build-up and decay time that is characteristic of actual organ pipes." A more helpful statement, though not specific enough (page 58) is "in order to prevent a sudden explosive tonal attack when the output circuits of the continuous generator are closed, the Baldwin uses gradual contact switches." Further description, and a figure of the switch, is supplemented by the statement that these are variable 250,000-ohm conductive-coating contacts in which "the rubbing action of the switch contact makes it self-cleaning."

Nothing is said about the amount of tuning required. For the organ which is perhaps the least troublesome in this respect, the author merely says that it has a synchronous motor. As a trivial item, to be left out in future editions "the mounting hardware in a cloth bag . . . and installation instructions are included." (page 67).

This book is not for the engineer who wants to construct his own electronic organ, as no circuit constants are given, and few complete circuits shown. Two partial exceptions are (page 88) "One Note Organ Schematic" of the Connsonata, and (page 38) "Tone Generator of Allen Organ." Several block diagrams are included. Electronic engineers will be interested in some terms said to be used by those familiar with organs. For example, in explaining the Gyrophonic action (trade name of vibrato used by Allen organ): a baffle rotates 7 cps in front of the manual speakers, producing a volume change which is *mild and dignified.*

A glossary of terms (5 pages) is helpful. Some definitions may surprise an electronic specialist. As examples: "Diode, a small dry rectifier used in some tone circuits to filter out unwanted harmonics," and "Expression, that which pertains to the control of loudness." Another term, "Registration," which "is the stop list on the console", occupies a large place in some of the chapters, for the Allen organ pages 29 through 36. The "stops are the switches which control the various voices of the organ."

Installation data varies from 6 pages (Baldwin) and 4 pages

(Wurlitzer) to a ¼-page single paragraph (Minshall-Estey). This information, if segregated in a comprehensive chapter covering all types, would be of value to all users of loudspeakers, not necessarily restricted to organs.

Most of the figures are clear and interesting. In a few cases the extreme reduction in size requires a magnifying glass for reading. Both figures on page 130 have capital letters less than $\frac{1}{32}$ inch high.

If this book is to have a new edition, this reviewer would make an earnest plea (1) to examine all figures for too-small-to-read print, (2) to include a comprehensive index, and (3) to expand Chapter IX with a critical appraisal, indicating what is good, and what is less desirable in each type of electronic organ.—RICHARD C. HITCHCOCK, *Buhl Planetarium, Pittsburgh, Pa.*

An Introduction To Scientific Research

BY E. BRIGHT WILSON, JR. *McGraw-Hill Book Co., Inc., New York*, 1952, 375 + *xi pages*, $6.00.

THE RESEARCH WORKER in the physical sciences is apt to be an individualist. Well trained in his speciality but comparatively ignorant of others, he tends to distrust books confined to the generalities of science as being too abstract to aid him in his everyday problems. This attitude has been reinforced by the recent appearance of several books on research organization which, for lack of a better phrase, can be tagged as "teacher's college" books, excessively taken up with the form, as against the substance, of science.

Professor Wilson's book is an outstanding exception. Drawing on his concrete experience of professor of chemistry at Harvard, (his special interests according to "American Men of Science" are quantum mechanics in chemistry, molecular dynamics, infrared, microwave and Raman spectroscopy, and the physics of explosives), the author has larded his book with a great variety of examples which dispel the academic atmosphere of "research in general."

Aside from this refreshing display of specific applications of broad principles, Professor Wilson has done a masterful job of selecting those topics which are possessed in common by research projects. The chapter headings confirm this judgment: choice of statement of a research problem, searching the literature, elementary scientific method, the design of experiments, the design of apparatus, the execution of experiments, classification, sampling and measurement, the analysis of experimental data, errors of measurements, probability, randomness and logic, mathematical work, numerical computations, and reporting the results.

A Human Book

Mathematical symbolism is used when necessary, but only then. As a result the book can be read without difficulty by college seniors. But it is much more likely to be appreciated by the research worker in his first year or two of professional work. Such novitiates will take much comfort in the many ways (cited as concrete examples in the book) in which research data can be misinterpreted by experts. The advice in the direction of assistants is definite. For example, on page 136, the author says "If you want Jones to clean the muck out of the vacuum pump, don't just politely hint that it might be a good idea if someone did it." (This from Harvard!) In this, and in countless other manifestations, the book is "human", and a pleasure to read.

As is usually the case when a really outstanding book appears (this one rates with the classics), the need for it has existed for some time. The vast increase in the number of young people taking up research as a career, the steadily growing support of industrial research by companies who once disdained it, not to mention the apparently permanent assignment of large public funds in support of pure and applied research—all these indicate that practitioners of the art must be carefully selected, and broadly trained to make the most of every hour and every dollar.

The selection process is still too haphazard. Professor Kubie of Yale, addressing himself to the problems of a scientific career from the viewpoint of a psychiatrist

(*American Scientist*, October 1953, p 596), points out that many young men enter scientific life because they are unable to compete in early youth in social and athletic pursuits. This situation will no doubt be remedied as the financial and social rewards of devotion to scientific research fall more in line with those of the business executive or the individual professional man.

However selected, students of research science need the broad point of view and wide range of abilities implicit in Professor Wilson's program of study. His book should be read by every graduate student in the physical sciences who plans to make a living in research work, by every young worker in the field, and by their supervisors. As much as any book can, it will take the place of having been inspired by direct, personal association with a great teacher.—DONALD G. FINK, *Philco Corporation, Phila., Pa.*

Luminescence and the Scintillation Counter

BY S. C. CURRAN, *Academic Press, Inc., New York*, 219 *pages*, 1953, $5.80.

Scintillation Counters

BY J. B. BIRKS, *McGraw-Hill Book Co., New York*, 1953, 148 *pages*, $4.50.

AFTER a period of several years, in which the worker in nuclear science who wished to take advantage of the exceptional capabilities of the scintillation counter in his research had to depend on gossip and the widely scattered periodical literature for his information, it is a pleasure to report that there are now available two very useful books on the subject. The first of these, "Luminescence and the Scintillation Counter", is by S. C. Curran, who has also published extensively on other types of counters, and the second, "Scintillation Counters", is by J. B. Birks, and is the second volume in the "Electrons and Waves" series of monographs under the editorship of D. W. Fry.

After a short introductory chapter covering the history and general features of the scintillation counter, Professor Curran discusses the various types of radiation and their interaction with matter. Chapter

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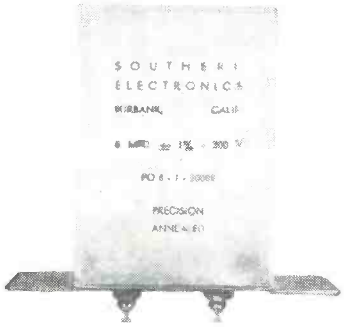

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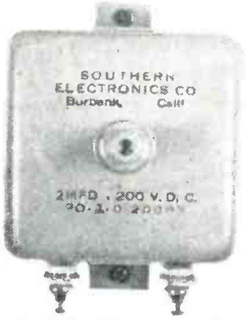

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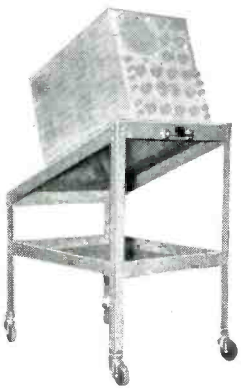

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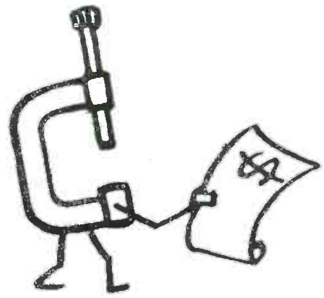

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CONRAD & MOSER · ESTABLISHED 1925 · APPLIED PRECISION three is devoted to secondary emission, chapter four to the electron multiplier and chapter five to the characteristics of commercial multiplier phototubes. The next four chapters are concerned with the luminescence of solids, the fluorescence of organic solids and liquids, the preparation of scintillating crystals and liquids, and the properties of crystals and liquids. Chapter ten covers the various typical applications of scintillation counters with remarks on miscellaneous special techniques which have been found useful. Next comes a short discussion of the applications of multiplier tubes (as distinct from scintillation counter assemblies), and at the end a chapter on circuitry for scintillation counters.

In his introduction Professor Birks devotes a very little space to the general methods of radiation detection and to scintillation counter history, and proceeds directly to discuss the modern scintillation counter. Next comes a chapter on scintillation counter principles, ranging from absorption of the incident radiation to the multiplication process, followed by a discussion of multiplier phototubes. In Chapter four the topics of pulse height and time resolution are treated briefly. Next comes a discussion of inorganic phosphors followed by organic crystalline phosphors and organic plastic and solution phosphors. The final chapter covers the applications of scintillation counters in such fields as particle detection, spectrometry of gamma radiation and studies of isomers and mesons.

Both books contain extensive bibliographies and, as might be expected when an attempt is made to treat such a complex subject in a small volume, the reader must be prepared to consult the periodical literature for complete information on most topics. Probably the chief value of these books is that they offer in convenient form a critical guide to the literature. However, the reader should not get the impression that this is all they comprise. Birks' book, for example, contains considerable material on the problem of energy transfer in organic crystals, including much previously unpublished work by the author. Curran, on the other hand, has stuck less rigorously to the subject of the scintillation process and has provided more collateral information which might be most helpful to the reader with little background in nuclear science.

Although the reviewer sympathizes with the authors in their attempts to cover so much material in little space, he cannot refrain from remarking that more on the circuitry required in scintillation counting would have been helpful. While it is obvious that the phosphor and multiplier phototube are the most important components of a counting system, it is also evident that one cannot achieve a good result unless the electronics is right. And in many respects the scintillation counter imposes far more stringent requirements on the circuitry than does the more familiar Geiger-Müller tube. Apart from this understandable shortcoming, both books appear to be remarkably complete and up-to-date. Professor Birks' publishers in particular are to be congratulated on their speed in getting out his book, which compares favorably with journal publication in many cases.—J. B. HORNER KUPER, *Brookhaven National Laboratory.*

Principles of Transistor Circuits

EDITED BY RICHARD F. SHEA, *John Wiley & Sons, New York,* **535 *pages,* 1953, $11.00.**

UNTIL about a year ago, literature on transistor circuits and applications was almost as scarce as the transistors themselves. Then, gradually, good technical information began to flow into periodicals; now, completing the last phase, a good circuits book is available.

This long-awaited book is the result of the collective efforts of R. F. Shea and nine of his Electronics Park associates. The adage of too many cooks definitely does not apply to this project, for virtually no duplication or confusion is evident.

In fact, the organization of material is exceptional, and the easy-to-read writing style is maintained throughout the 22 chapters of the book. An excellent balance between words and mathematics has been employed; where both become unwieldy or difficult to interpret, curves are provided. The latter technique is especially helpful in describing effects of changes in transistor parameters on circuit performance. Instead of having to try high, medium and low values of parameters in transistor equations to determine trends, the reader simply consults the appropriate curve for the entire picture. This technique is, of course, not original with this book, but its generous use is one of the factors that makes the book so valuable.

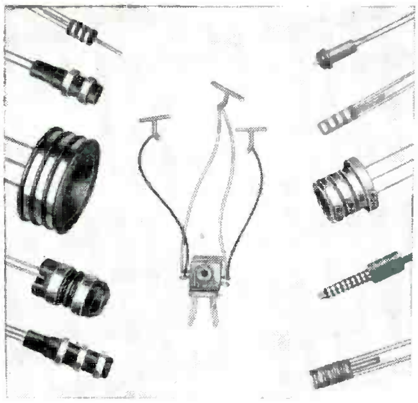
In each discussion, practical aspects are emphasized. In comparing types and combinations of circuits, consideration is given to power-supply simplicity, most efficient use of transistor characteristics and reduction in number of components. Typical examples are used to illustrate validity of design techniques discussed. Each chapter includes a series of excellent problems ideally suited for ensuring thorough understanding of the material presented.

The subjects discussed are best described by listing chapter headings. They are as follows:

Chapter Heading	Number of Pages
Semiconductor Principles	22
Forms, Types and Characteristics of Transistors	4
Transistors as Low-Frequency Circuit Elements	36
Basic Principles of the Amplifier Stage	29
Junction Transistor Multistage Amplifiers	16
Bias Stabilization	33
Power Amplifiers	31
Direct-Current Amplifiers	18
Transistors as High-Frequency Circuit Elements	19
Basic Principles of High-Frequency Operation	29
High-Frequency Circuit Design	22
Video Amplifiers	17
Oscillators	15
Circuit Design by Duality	10
Matrix Methods of Circuit Analysis	39
Feedback Amplifiers	24
Transient Analysis	30
Large-Signal Operation	14
Computer Circuits	24
Noise in Transistors	6
Associated Semiconductor Devices	30
Small-Signal Parameter Measurement	22
Appendix	
Matrix Algebra	6
Definitions of Terms	4
Bibliography	8

The book is not without faults. It is unfortunate that only ten lines of text and one small drawing are devoted to describing the important techniques made possible by the symmetrical properties of *pnp* and *npn* transistors. The section "De-

Miniature and Sub-Miniature



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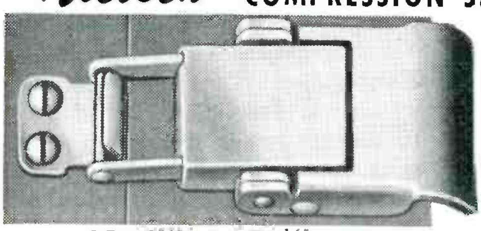

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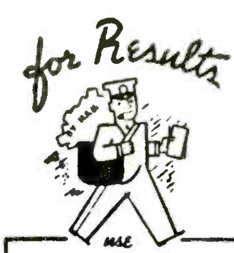

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finition of Terms" is rather sketchy, and the Chapter entitled, "Associated Semiconductor Devices" reads somewhat like a catalog.

However, such derogatory remarks should be followed rapidly with a statement that, with the exception of the first criticism mentioned, the faults are minor. The book will prove extremely useful to the practicing engineer seeking to employ transistors and to design circuits around them. The book will unquestionably find extensive use in colleges and universities in both graduate and undergraduate courses in transistor electronics—in this role it has no rival.—J.D.F.

Mikrowellenbandfiltern Im Hohlleiter

BY VON DR. SC. TECHN. FUAD SURIAL ATIYA, *Dipl. Elektroingenieur, B. Sc. Hons. Mitteilungen Aus Dem Institut Für Hochfrequenztechnik An Der Eidgenössischen Technischen Hochschule in Zürich, Herausgegeben von Prof. Dr. F. Tank, Nr.* 17, 99 *pages* + 14 *pages of tables (Curves), date of printing not stated (probably* 1952), *but analysis developed during* 1949-50; *Verlag Leemann Zürich; price* 12.50 *Swiss francs.*

THIS is an interesting monograph. It reports the work of an Egyptian study at the Eidgenössischen Technischen Hochschule in Zürich, Switzerland. The subject matter, which received its earliest elaboration at the hands of English physicists, has achieved its highest development here in the United States.

Since the treatment consists for the most part of an analysis or extension of published work, it is not elementary. The reader will require familiarity with the material in "Wave Guides*" by H. R. L. Lamont, or an equivalent introductory survey to be able to readily appreciate the content. The citations of published work, parts of which are referred to as background for each topic in the monograph, have been selected carefully. These reveal a striking pattern; nine are American texts, seven on microwaves and two slighty more general; three are German texts on electrical circuit theory, with three references to circuit theory articles in the *Journal of Mathematics and Phys-*

*"Wave Guides", by H. R. L. Lamont, 118 p. Third Edition, Methuen and Co., Ltd., London, 1950.

ics. The remaining references, ten from the *Proceedings Institute of Radio Engineers,* five from the *Journal Institution of Electrical Engineers* (British), four from the *Bell System Technical Journal* and a few scattered are, for the most part, published technical developments in the field. Two references to the work of F. Staub at Zürich represent stages in the development of which this report is a part. In forty-two citations we have nine German and thirty-three English.

It is probable that the actual progress in waveguide research and development is, to a degree greater than this bibliography suggests, a United States project. However, it is highly desirable that the development within this country be appraised by someone outside our national boundary. The choice of an Egyptian in a Swiss University is most fortunate, because Switzerland in the center of Western Europe is tending to become a communication exchange, as Egypt no doubt will be between Asia and Africa.

This text seeks to collate and organize material connected with waveguide band-pass filters. The work, proceeding from a short introduction, summarizes the necessary definitions and terminology of microwave circuits. Next, the properties of waveguides and cavity resonators are considered. Frequency and reactance transformations are then reviewed and applied to cavity resonator circuits which with direct or λ/4 coupling form microwave filters.

Four-terminal network synthesis for a prescribed attenuation function, which is taken up on page 37, describes the essential problem of the whole monograph in terms of Cauer's methods. To further its application a general separation of filters into classes is made, and the forms of the formulas for each class are stated. Examples of filters in these various classes are then taken up, and the possibilities of variable band width with fixed mid-band frequency are discussed. Measurement methods and results are mentioned.

The two developments which are the special project of this publication are the presentation of general design curves computed for filters made up of two to six resonators. There are fourteen tables (actually curve sets) which present this data. The filter here under consideration is really a group of resonators directly in tandem or coupled by $\lambda/4$ elements. The second microwave filter type of novelty utilizes T-circuits to produce series and parallel circuits.

The effort here, as is usual in microwave network theory, is to relate input and output quantities for microwave networks without, at every step in the process, using the electromagnetic field equations; that is, develop a circuit analysis for microwave structures and a set of appropriate theorems. The result is certainly interesting and should be useful to American designers.—B. A. KINGSBURY, *Bell Telephone Laboratories, Inc.*

THUMBNAIL REVIEWS

Storage Battery Technical Service Manual. Association of American Battery Manufacturers, 2706 First National Tower, Akron, Ohio. 44 pages 1953, $0.30. Third edition of a widely distributed manual telling how a battery is constructed, how it works, how to maintain it, how to make certain repairs, plus a section on car generator systems.

Synchro Systems Manual. Aeronautical Radio, Inc., 1523 L Street, N. W., Washington, 5 D. C., 1953, $3.00 single copies, $1.00 in lots of 50 or more. Fourth printing of what is known as the "Bible of navigation synchro instrumentation".

Statistical Quality Control and Acceptance Sampling. U. S. Ordnance Corps, Office of Technical Service, U. S. Department of Commerce, Washington 25, D. C., 103 pages, 1952, $2.00. This is Ordnance Inspection Handbook ORD-M 608-9 and reviews the fundamentals of governing sampling procedures, gives a study of statistical methods with tables showing how to tabulate and classify measurements. Useful anyone having jobs requiring sampling or statistical methods.

Natural Logarithms, 0 to 5, to 16 Places. National Bureau of Standards Applied Mathematics Series 31 (revision of MT10), 501 pages, 1953, $3.25 from Government Printing Office, Washington 25, D. C. A reissue of Volume III of a 4-volume table published in 1941. The intervals are 0.0001 and the tables are useful to mathematician, physicist and engineer.

Radio's Master 1953. (18th) Edition, 1,370 pages, 8¾ x 10¾, 1953, $6.50 from the publishers or $1.95 from certain distributors. United Catalog Publish-

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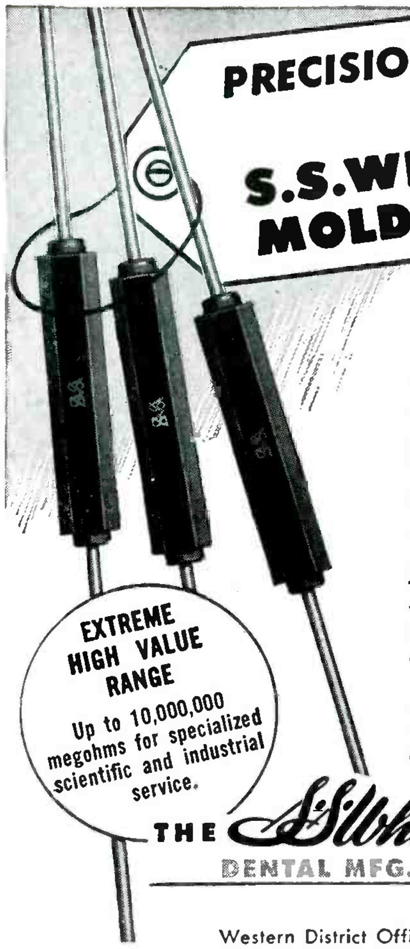

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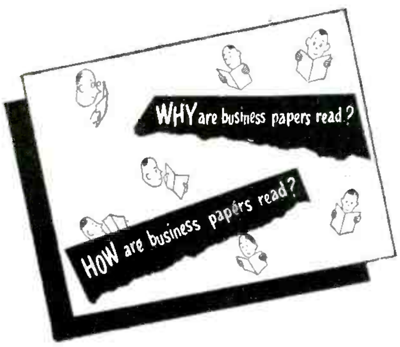

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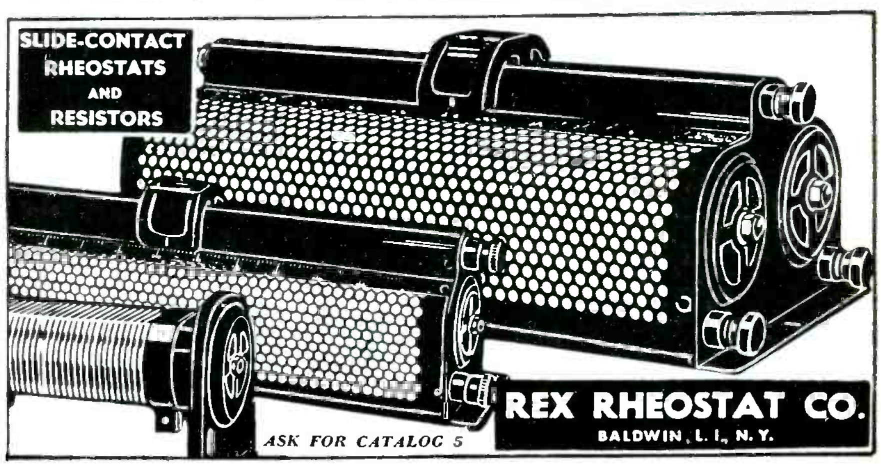

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Fundamental Mathematics. By Virgil S. Mallory and Kenneth C. Skeen. Prentice-Hall, Inc., New York, N. Y., 1953, 128 pages, paper bound, large format, $1.95. An interesting practice-book with hundreds of problems in the fundamental operations of addition, multiplication, measuring angles, fractions, decimals, reading and drawing graphs, areas and volumes. Useful for vocational and junior-high schools. The problems are practical in nature, some involving home budgets, figuring insurance, and depreciation.

Die Laplace-Transformation und ihre Anwendung. By Paul Funk, Hans Sagen and Franz Selig, Technischen Hochschule, Vienna. Franz Deuticke, Vienna, 106 pages, $2.40, 1953. A paper-bound treatise, in German, on the theory and applications of the now-familiar Laplace transform.

Temperature Measurement in Engineering. By H. Dean Baker, E. A. Ryder and N. H. Baker. John Wiley & Sons, Inc., New York, N. Y., 1953, 179 pages, $3.75. The first of a two-volume series on the theoretical and practical problems of temperature measurement. Volume I covers the general introduction to the subject and then deals with the details of measurement by means of thermocouples. The book is non-mathematical and practical. Volume II will cover the measurement of very high and very low temperatures where the thermocouple does not have the superiority it possesses for measuring the internal temperature of solids discussed in Volume I.

How to Troubleshoot a TV Receiver. By J. Richard Johnson. John F. Rider Publisher, Inc., 480 Canal Street, New York 3, N. Y., 128 pages, $5\frac{1}{2} \times 8\frac{1}{2}$, 1953, $1.80. How to interpret circuit symbols, how to use servicing information, how to set up a shop and get started.

How to Use Signal & Sweep Generators. By J. Richard Johnson. John F. Rider Publisher, Inc., 480 Canal St., New York 13, N. Y., 137 pages, 1953, $2.10. Types of equipment available, principles of operation, functions of controls, setting up and adjusting generators for various applications, and maintenance of generators.

Fundamental Processes of Electrical Contact Phenomena. By F. Llewellyn Jones, Professor of Physics, University of Wales. Radio Research Special Report No. 24, HMSO, London, 1953, 66 pages, 3 shillings. Serious and useful study dealing with contact phenomena, arcs, approach and separation of contacts, sealed contacts and measurements. Some mathematics.

TV Repair Techniques. Gernsback Publications, Inc., 25 W. Broadway, New York 7, N. Y., 128 pages, $1.50. Compilation of television troubleshooting articles culled from *Radio-Electronics* magazine.

BACKTALK

Untried Ideas

DEAR SIRS:

I AM enclosing for your consideration a number of electronic techniques. As they are all purely theoretical in nature (no practical examples, etc.), I am submitting them as an aid to the art.

D. SACHS
Hollywood, California

(Editor's Note: It is contrary to the policy of ELECTRONICS to publish untried ideas. However, several of those suggested by Mr. Sachs seemed worthy of being brought to the attention of our readers, and we are printing these herewith. We invite comments from readers. We will also consider publication of other such ideas in this department if these appear to meet with approval.)

Modulation Method. The circuit appearing in Fig. 1 illustrates a possible means of modulating a transmitter on the transmission line

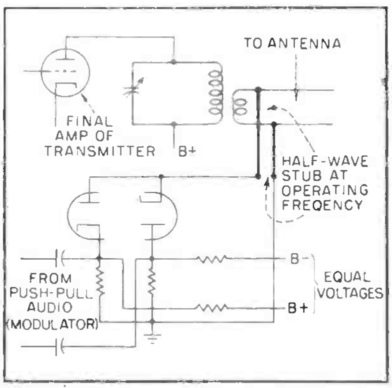


FIG. 1—Transmission-line modulation

itself. At an appropriate place on the line, a half-wavelength stub connects to the line and is terminated at the other end in the circuit as shown. Both diodes act as a variable short across the stub, the impedance of which varies at the modulating voltage rate. Diodes are biased (B+ and B−) so that with no modulation, medium conduction occurs.

Cutting Plastic Sheet. The technique illustrated in Fig. 2 is an electronic means of forming patterns or holes in sheets of plastic

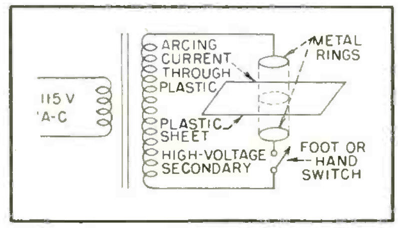


FIG. 2—Electronic cutting method

or similar material. A very high voltage forces an arcing current through the material. Spaced closely on either side of the material is a pair of rings (for round holes) or any other pattern shape. High voltage will cause arcing and the pattern will literally be burned out of the material. A foot or hand switch operates the unit, which could be similar in shape and size to a drill press.

Counter Circuit. Figure 3 shows a different technique for a counting circuit. It is essentially the same as the conventional diode counter

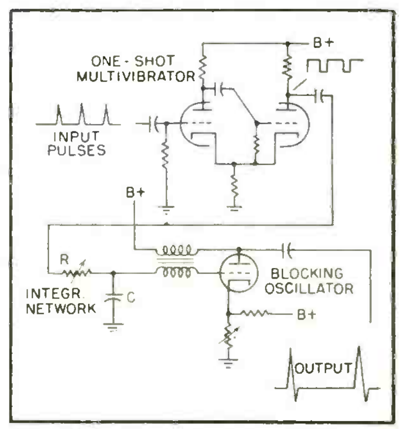


FIG. 3—Counter circuit proposal

circuit, except that the diodes are replaced by an *R-C* integrating network. Also, the input pulses are used to trigger a one-shot multivibrator to provide the pulses shown for integration. The *R-C* time constant may be varied, according to the frequency required, with the variable *R*. Essentially, the function is similar to a tv vertical integrating network, except in this case a counting system is employed.

AFC System. An electromechanical automatic-frequency-control system is illustrated in Fig. 4. If the frequency increases, the output of the discriminator becomes posi-

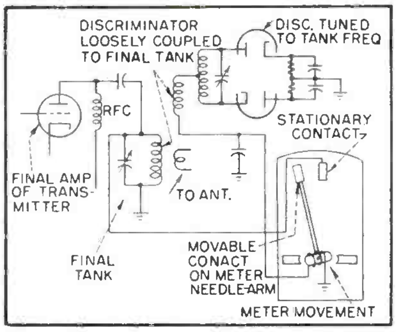


FIG. 4—Electromechanical afc system

tive. This will move the meter needle and contact closer to the stationary contact, thus throwing more capacitance across the tank circuit which tends to offset the drift. A frequency decrease will cause the opposite effect and will balance the tank.

Mixed Feedback

DEAR SIRS:

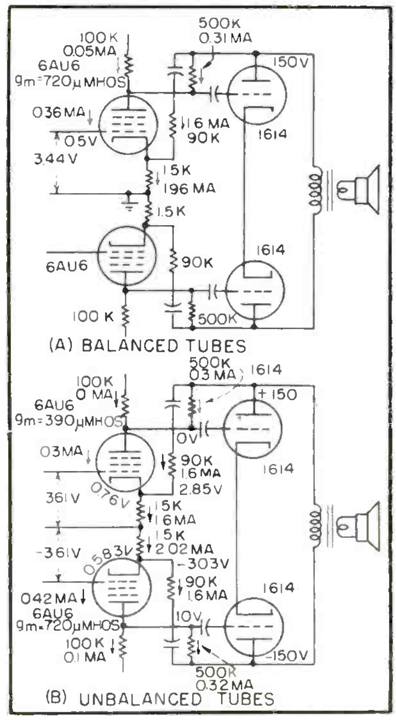
I WOULD like to comment on the article "Multiple Feedback Audio Amplifier" appearing in ELECTRONICS for November 1953, on page 148. First, the statement that a tetrode output stage requires more feedback to equal the distortion performance of a triode stage is not borne out by a study of the curves in the tube manuals or by experience. This, however, is a minor point compared to the other one which is in reference to the plate-to-grid feedback.

It should be noted that plate-to-grid feedback does not reduce the gain of the stage around which it is connected, but rather it reduces the gain of the preceding stage by reducing the load impedance into which it works. This puts serious limitations on the places where such a feedback system may be used.

In the circuit shown in the article, the plate load on the 6AU6 tubes is less than 15,000 ohms if the two sides of the system are balanced. Since at least 15 volts peak are necessary to drive the 1614's, a rather large plate current excursion is required of the 6AU6's. Thus it is quite possible that the feedback adds more distortion than it removes.

As mentioned in Mr. Good's letter

in the *Backtalk* department of the October 1952 issue of ELECTRONICS, the coupling between the halves of the output transformer requires that any push-pull feedback from



Circuits illustrating W. B. Bernard's letter. Voltages and currents shown are signal components only; in balanced case they are identical in the two halves of the circuit

the output tube plate be very accurately balanced to preserve balanced drive to the two output tubes. This is fairly difficult when the elements of the feedback network are fixed resistors, which are reasonably stable, but when tubes are included as part of the network the problem becomes impossible.

Because the plate signal of an output tube in a push-pull stage is to the first approximation independent of the drive to the output tube, a 45-percent change in the characteristics of one of the 6AU6's will totally cut off the drive to one of the output tubes.

A Kirchhoff's law analysis of one side of the circuit shows that where a 6AU6 g_m of 700 micromhos might give normal operation, a g_m of 400 micromhos will give a zero signal to the grid of the associated output tube, considering that in both cases the other 6AU6 has a g_m of 700 mi-

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cromhos and that the circuits are otherwise balanced (see the accompanying circuit diagram). While this effect is counteracted to some extent by the increased drive to the 6AU6 grids, because of the overall feedback loop, the effect is emphasized by the lowering of the effective plate load resistance on the weaker tube and the raising of the plate load resistance on the stronger tube. Any stabilizing effect of the unbypassed 6AU6 cathode resistors is minimized by the plate-to-cathode feedback path.

To put it briefly, I am still waiting to see something which is an improvement over a pentode voltage amplifier direct-coupled to a split-load phase inverter driving two 6L6 tetrodes or four 6V6 tetrodes, with about 20 db of feedback from the voice coil tap in use to the cathode of the voltage amplifier. I have tested a number of fancier ones but I think I'll keep on using the ones I have.

W. B. BERNARD
San Diego, California

Fitting Title

DEAR SIRS:

IT IS UNUSUAL to find an article in a wholly technical magazine which would be of interest to any *man* in any field.

Such an article is found in your October 1953 issue of ELECTRONICS.

I refer specifically to the item by John J. Dougherty, Lt. USN on page 232 of that issue, entitled "Shape Factor as a Criterion of Skirt Selectivity."

WILLIAM R. MURPHY,
Philadelphia, Penna.

(Editor's Note: Normally, we prefer short titles for articles, but we couldn't resist leaving this one just as it came from the author.)

Erratum

ON PAGE 348 of the November issue a statement appeared to the effect that the new Amperex twin tetrode type 6252 "works efficiently with a power output of 112 watts at 600 mc." This rating appears to have been somewhat optimistic; it should have read 12 watts.

CONTACTS

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To be informed—and reminded—on modern aids to economical operation, maintenance and production, check "Contacts" advertising regularly . . . every issue.

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supplements other advertising in this issue with these additional announcements of products essential to efficient and economical production and maintenance. Make a habit of checking this page, each issue.

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITIONS VACANT

PHYSICIST—SPECIALIZING in antenna design and analysis. Writing ability desirable. Permanent position in excellent location. Advancement commensurate with ability and results. State qualifications, salary desired, and availability in first letter. Telrex, Inc., Box 879, Asbury Park, New Jersey.

ENGINEER OR Physicist for Instrumentation on experimental projects involving measurement of dynamic and transient phenomena. Good knowledge of theory of instruments and three years of instrument experience required. Some military work (U. S. Citizens only.) Mobility handicaps acceptable. Write Engineering Mechanics Department, Southwest Research Institute, P. O. Box 2296, San Antonio, Texas.

A RESEARCH Scientist, Canadian citizen or British Subject, is required for a Laboratory in Toronto, Ontario, engaged in voice communications. Audiology Acoustics research, M.A., MSC, or Ph.D. in Speech, Speech Science and Psychology with experience and training in Speech, Audiology, Acoustics and Experimental Psychology is required. Salary to be commensurate with Qualifications, experience and ability. Replies should refer to competition 53-DRML-5 and should be addressed to P. O. Box 62, Postal Station "K" Toronto, Ontario.

TRANSFORMER PLANT or Production Manager, N. Y. Metropolitan area. An excellent opportunity for a man familiar with transformer winding and manufacture with a growing company of approx. 35 people. P-1093, Electronics.

SELLING OPPORTUNITIES OFFERED

MANUFACTURERS' REPRESENTATIVES wanted by young progressive component manufacturer (toroidal transformers and filters). Write stating present line and territory. RW-1046, Electronics.

MANUFACTURER OF Graphite Interior Cathode-Ray Tube Coatings wants representative now regularly calling on tube manufacturers to handle these products as sideline. RW-1029, Electronics.

POSITIONS WANTED

ELECTRONICS PROJECT Engineer; BEE, MEE, BBA; 10 years comprehensive experience planning, development, application electronic automatic control systems involving computers, data handling, processing, displays; creative and administrative ability; seeks non-defense opportunity. PW-1038, Electronics.

M.S. IN Electronics, microwave and computer experience, seeks non-military sales, applications, or production engineering position. PW-1021, Electronics.

ARMY OFFICER, release in Feb. 1954, seeking position as engineering rep., sales eng., etc. Foreign assignment preferred. 5 years military and civilian experience in electronics, including supervision. PW-1010, Electronics.

ELECTRONIC ENGINEER, BEE, MSEE. Single. Age 30. Looking for responsible position in R & D or administrative engineering. Five years experience cover test equipment, microwave measurements, vhf transmitters, contract monitoring etc. PW-1006, Electronics.

ELECTRONIC ENGINEER: Ten years experience with servo mechanisms, analogue computors, automatic test equipment, and general electronic applications. Broad knowledge of guided missile systems. Desires a semi-administrative or supervisory position with a progressive organization. PW-9878, Electronics.

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INDUSTRIAL BUILDING, Gastonia, N. C.—52,500 sq. ft., mill construction, wired, sprinklered, steam heat, rail siding. For lease. Write Gastonia Industrial Diversification Commission, Box 823-E, Gastonia, N. C.

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PRIVATE TUTORING: Technical upgrading for technicians, engineering assistants, junior and operating engineers. New methods, simplified systems, fast arithmetic routines, economical cost. "Superior Procedures" Douglas Matthews, 72 Vendola Drive, San Rafael, Calif.

OFFICIAL PROPOSAL
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SEARCHLIGHT SECTION

(Classified Advertising)

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RA-9985, Electronics
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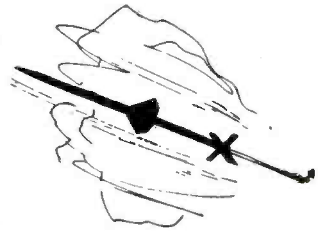

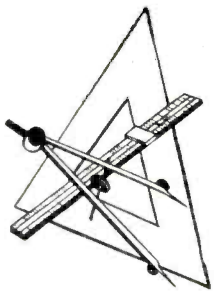

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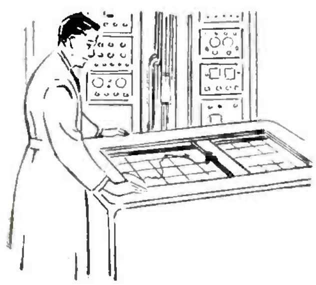

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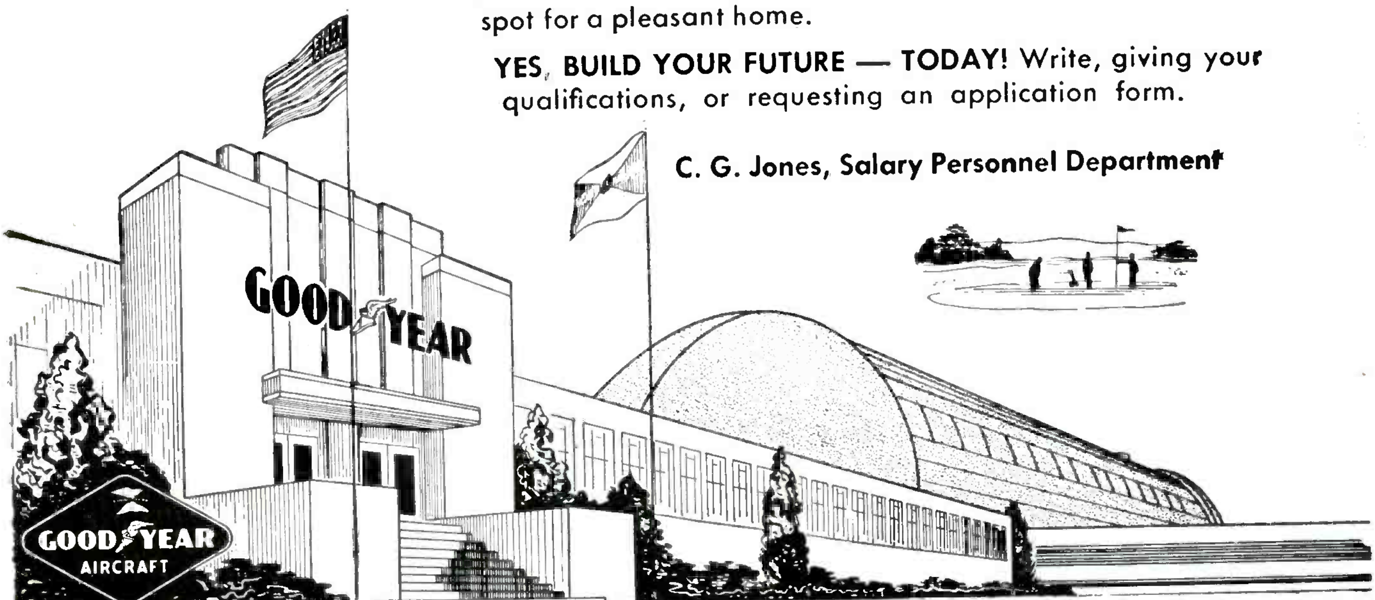


GOODYEAR AIRCRAFT CORPORATION, 1210 MASSILLON RD., AKRON 15, OHIO

Want more information? Use post card on last page.

OFFICIAL PROPOSALS

Bids: January 7, 1954

OHIO TURNPIKE COMMISSION
139 East Gay Street
Columbus 15, Ohio

Contracts RC-1A and RC-1B

Sealed Proposals will be received by the Ohio Turnpike Commission for the designing, furnishing, installation, and maintenance for a period of seven years, of a radio-communication system, consisting essentially of nine microwave communication stations, eight very-high-frequency communication base stations, seventeen very-high-frequency communication fixed stations, and approximately seventy-five very-high-frequency mobile stations, for Ohio Turnpike Project No. 1.

Contract RC-1A provides for the sale of the completed radio-communication system to the Ohio Turnpike Commission and for maintenance services for a period of seven years.

Contract RC-1B provides for the rental of the completed radio-communication system to the Ohio Turnpike Commission for a fixed monthly rental and for maintenance services, all for a period of seven years.

Copies of the Special Provisions and accompanying profiles, drawings, maps, and copies of the General Specifications for Contracts RC-1A and RC-1B will be available on or about November 6, 1953, and thereafter (and in any event no later than November 10, 1953) for public inspection or purchase at the office of the Chief Engineer, Ohio Turnpike Commission, 139 East Gay Street, Columbus 15, Ohio. These documents may be purchased from said Chief Engineer for the following sums per set, which sums are non-returnable:

General Specifications for Ohio Turnpike Project No. 1	$5.00
Proposal and Affidavits for Contracts RC-1A and RC-1B, and attached Notice to Bidders, Instructions to Bidders, Special Provisions applying to said Contracts, form of Contract, form of Performance Bond, form of Maintenance Bond, and Schedule of Wage Rates for Contract RC-1A	$5.00
Profiles, drawings, and maps.....	$2.00

All Proposals must be on the form prescribed by the Commission, must be accompanied by the required supporting technical data, and must comply with the terms and conditions set forth in the Contract Documents.

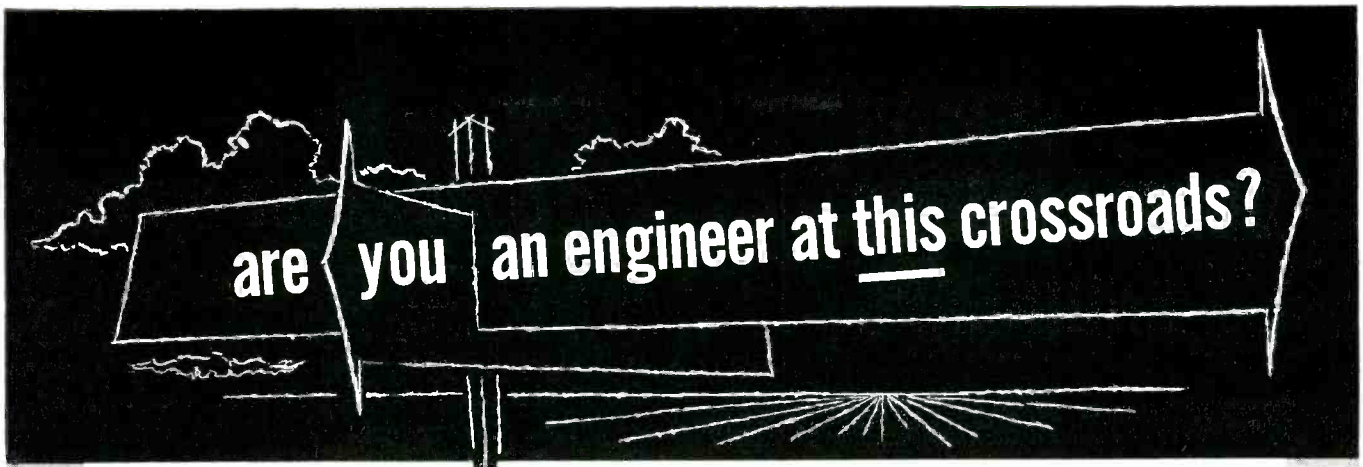
Each Proposal must be accompanied by a Proposal Guaranty in the form of a certified check or checks on a solvent bank or banks, payable to the order of the Ohio Turnpike Commission, in the amount of $40,000.00.

If a Bidder bids on both Contracts RC-1A and RC-1B, one certified check in the amount of $40,000.00 will suffice. The Commission may at any time cash any such check. Each such check, or the proceeds thereof, will be held by the Commission as a guaranty that, if any Proposal guaranteed thereby is accepted, a Contract will be entered into and the performance of the Proposal secured. Each such check, or the proceeds thereof, will be returned or forfeited as provided in G-3.03 and G-3.06 of the General Specifications.

All bids must be received on or before 10:00 A.M., Eastern Standard Time, January 7, 1954, in the office of the Ohio Turnpike Commission, 139 East Gay Street, Columbus 15, Ohio. At said hour, all Proposals will be publicly opened and read at said office.

Contracts RC-1A and RC-1B are alternate contracts and only one will be awarded. The award of the Contract, if any award be made, will be to the lowest and best Bidder whose Proposal complies with all the prescribed requirements. In determining which bid is lowest and best, especially as such determination involves any decision as between awarding Contract RC-1A and awarding Contract RC-1B, the Commission may consider the possible benefits and detriments of ownership of equipment versus the rental thereof. The Commission reserves the right to reject any or all Proposals and to waive technicalities.

OHIO TURNPIKE COMMISSION



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Duties: Design, development, and application of electronic circuitry including vacuum tubes and magnetic amplifiers as applied to the control of nuclear reactors.

Requirements: Three or more years experience and a B.S. degree in Electrical Engineering or in Physics.

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Duties: Applied research, development, and design of advanced radar, fire control and missile guidance equipment. Openings exist in the fields of local oscillators and associated circuitry, indicators, feed-back problems (closed-loop electronic circuits), pulsed circuits, video, simulators, i.f. strips, and in analysis of complex radar.

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SENIOR COMMUNICATIONS ENGINEERS

Duties: Applied research, development, and design of advanced communications equipment and systems. Openings exist in the fields of automatic transmitters and communications circuitry.

Requirements: Three or more years experience and a B. S. degree in Electrical Engineering or in Physics.

TRANSFORMER DESIGN ENGINEER

Duties: The applied research, development and design of audio transformers, modulation transformers and reactors, electric-wave filters, iron-core radio frequency transformers, radio frequency chokes, etc.

Requirements: Three or more years experience and a B. S. degree in Electrical Engineering or in Physics.

OR if you have experience in the fields of antennas, rf plumbing, magnetic amplifiers, technical writing, or in high frequency heating design and application, please apply.

To apply send resume of education and experience to
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Write or phone

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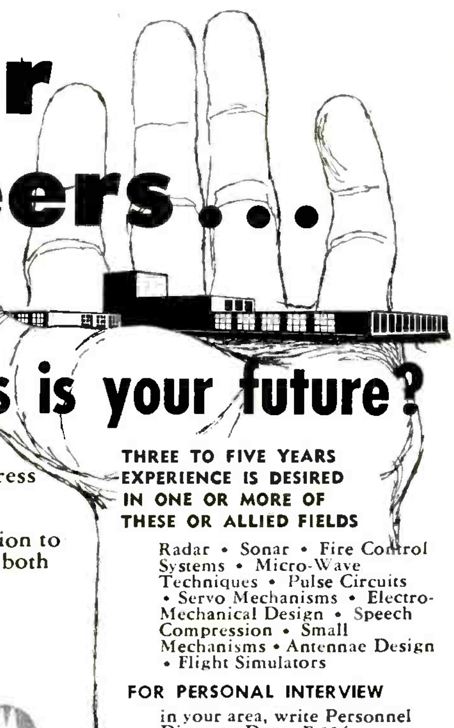

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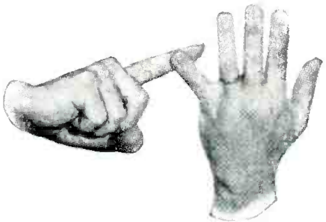

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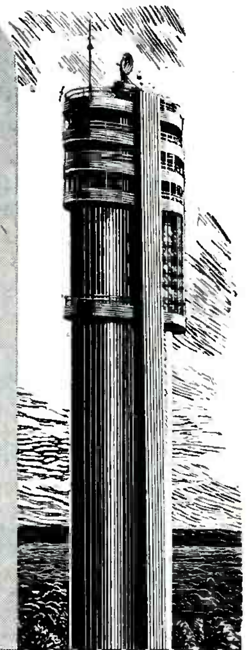

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Personnel Department

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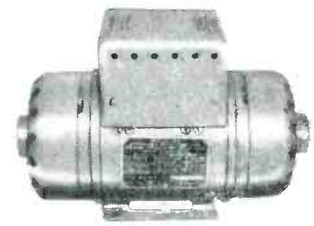

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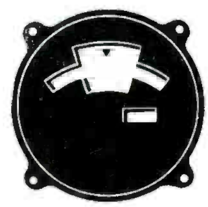

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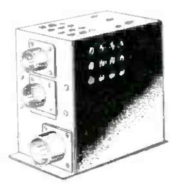

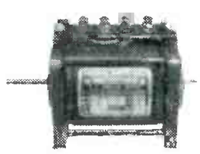

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YJ and YG for shipboard use
AN/CPN-6 3 cm.

TEST SETS

TS-3A/AP
TS-10AandB
TS-12/AP
TS-13/AP
TS-16/AP
TS-35/AP
TS-36/AP
TS-62/AP
TS-69A
TS-74/UPM
TS-89/AP
TS-100/AP
TS-101/AP
TS-125/AP
TS-173/UR
TS-278
TS-323
OAA
OAP
OBU
LAE
LM
LU
IE-19
I-46
1-56
I-208
I-222
SCR-211
and others

FIELD TRANSMITTERS

SCR-284—The famous mobile and ground equipment station for field use, complete with all accessories. Range 3.8—5.8 mcs; 20 watts cw, 5 watts phone.

SCR-510—Mobile, portable **FM** radio station. Operates from 6, 12, or 24 volt dc supply. Frequency range: 20.0 to 27.9 mcs.

SCR-610—Same as SCR-510, but with built-in speaker and range of 27.0-38.9 mcs.

SCR-508, 528—Mobile **FM** radio station, operates from 12 or 24 volt dc. Frequency range: 20.0-27.9 mcs.

SCR-608, 628—Same as SCR-528, but with range: 27.0 to 38.9 mcs.

BC-325—400 watts c.w., 100 watts new or voice operates from 110 or 220 volts ac. Freq. range: 1.5-18.0 mcs. Master oscillator or crystal control.

14C—400 watts phone or 800 watts c.w. Operates from 220 volts ac. Freq. range: 2.0-18.1 mcs. Has automatic dial selection of anyone of ten preset channels. Mfr. Western Electric.

MARINE TRANSMITTERS

TCS—Collins mfd. Navy radiotelephones for shipboard and mobile use, complete with all accessories for operation from 12, 24, 110, 230 volts d.c. and 110 or 220 volts a.c.

TDE—Navy or commercial marine transmitters, complete 110 & 220 volts d.c. and a.c.

TBK—Navy high frequency transmitter, 2-20 mcs; 500 watts output. Supplied complete with m/g and starter for d.c. or a.c. operation.

TBM—same transmitter but with speech input equipment to give 350 watts phone.

TBL—Navy all-wave transmitter; 350 watts output; CW and phone. Supplied complete with m/g and starter for d.c. or a.c. operation.

TAJ—Navy intermediate freq. transmitter, 175-550 kcs; 500 watts output. Supplied complete with m/g and starter for a.c. or d.c. operation.

TBN—200-3,000 kcs, complete with 220/440 volt, 3 ph. 50-60c power supply—conservatively rated at 1 kw. output.

MARINE TRANSMITTERS

TAJ
TAQ
TBL
TBK
TBM
TBN
TCE
TCP
TDE
TDQ
TDO

MARINE RADAR

SA	SG
SC	SJ
SD	SK
SF	SL
SN	
SO-1, 8, and	13
SQ	YJ
VG	BG
VJ	BM
YG	BN

393 GREENWICH STREET **NEW YORK 13, N.Y.**

***All Phones:* BEEKMAN 3-6509** ***Cable Address:* COMPRADIO, N. Y.**

SPECIAL ATTENTION TO OVERSEAS INQUIRIES

SPECIAL NOTICE

Because too large a percentage of our new building is employed in the storage of articles which we have not had time to merchandise and because we need the same space for the installation of a sheet metal shop and a transformer shop we are listing below articles of general interest priced way beneath the competitive market. Quantities are limited so those whose orders reach us first will be served first.

RECEIVERS

Description	Frequency Range	Unit Price
CW-3	to be adjusted	39.00
Hammerlund Super Pros	200KC—20 MC	150.00 to 250.00
RBZ	5.7—13 MC	29.00
BC-1206	75 MC	12.50
BC-1333	75 MC	19.00
BC-1033	75 MC	19.00
BC-1023-A	75 MC	21.00
NC100RSD	2—30 MC	120.00
BC-652-A	2—6 MC	69.00
RCF	.2—30 MC	135.00
Mackay Model 128A	15—660 KC	105.00
RU-17	187—455 KC	15.00
NC-44	.6-30 MC	50.00
NC-110	20—500 MC	40.00
NC-100XA	.3—17 MC	105.00
National HRO-50-T	100—155 MC	145.00
BC-639 with RA 42 Power Supply	100 KC—155 MC	240.00
BC-923A	27—39 MC	79.00
R-100	90—1500 KC	240.00
BC-348		100.00
AN/SPR-2A	1000—3000 MC	500.00
AN/APR-4	30—4000 MC	2,225.00
RT-7/APN-1		59.00
BC-1269	144—600 MC	920.00

SIGNAL GENERATORS

Description	Frequency Range	Unit Price
TS-47/APR	40—500 MC	160.00
BR-102A	S-Band	440.00
LAE	520—1300 MC	970.00
LAF	900—600 MC	780.00
BC-277A	2700—3400 MC	275.00
TS-418	400—1000 MC	1,450.00
P-500A	175 KC—50 MC	660.00
Federal Model 605CS	9.5 KC—50 MC	440.00
TS-13	X-Band	1,275.00
TS-45	X-Band	440.00
TS-14	S-Band	575.00
I-208	1.9-4.5 MC/19-46 MC	990.00

SLOTTED LINES

Description	Frequency Range	Unit Price
TS-56 (50 ohm input)	325—625 MC	220.00
TS-12 (plumbing & amplifier)	X-Band	550.00
OAK	S-Band	720.00

FREQUENCY METERS

Description	Frequency Range	Unit Price
TS-173/UR	90—450 MC	575.00
TS-174	20—250 MC	435.00
TS-175	80—1000 MC	435.00
BC-221	200 KC—20 MC	125.00 and up

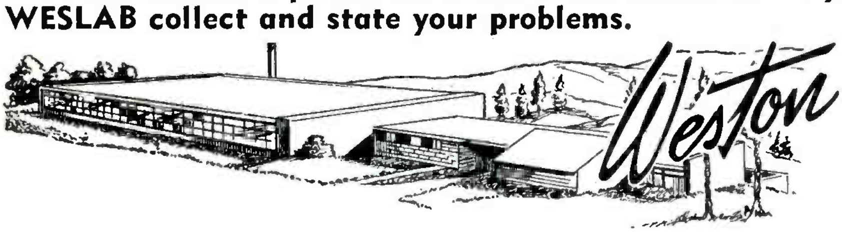
SYNCHROSCOPES

Description	Unit Price
TS-143/CPM-1	490.00
Sylvania P-4	240.00
Browning P-4	240.00
TS-34	350.00
TS-34A	450.00
TS-64A	450.00
TS-170	330.00
Raytheon Lab WX-4718	190.00
TS-100	550.00
BC-1060	360.00
DuMont Type 247	460.00
DuMont Type 224	175.00

SPECIAL TEST SETS

Description	Unit Price
I-203	210.00
TS-170	210.00
BC-376H	205.00
TS-15	190.00
I-86 A	140.00
BE-67	24.00
I-225	40.00
TS-8/U	39.00
TS-32-A	21.00
I-222	105.00

Plus hundreds of pieces too numerous to mention. If you are test equipment minded call WESLAB collect and state your problems.



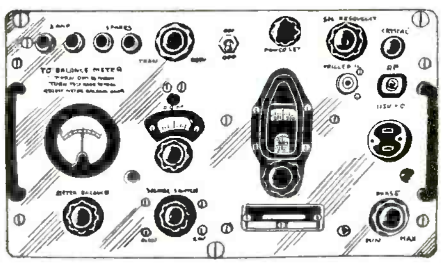
Weston LABORATORIES, INC.
HARVARD, MASS.
Tel: HARVARD 250—AYER 300—TWX HARV 193
Cable: WESLAB

Want more information? Use post card on last page.

NEW YORK'S RADIO TUBE EXCHANGE

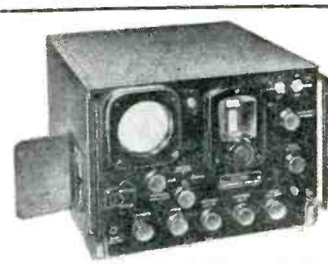
TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
OA2	$1.40	2J26	27.75	3GP1	5.50	15R	.95	385A	4.95	801A	1.00	956	.89
OA3	1.10	2J27	29.95	4B26	6.95	NE16	.66	388A	2.95	802	4.25	957	.29
OB2	1.35	2J31	29.95	4C27	25.00	FG17	6.95	394A	5.00	803	7.95	958A	.69
OC3	1.25	2J32	69.95	4C28	35.00	KY21A	8.75	MX408U	.75	805	5.95	991	.65
OD3	1.25	2J33	69.95	4E27	17.50	FG33	12.95	417A	17.95	807	1.69	F1148	.35
C1B	3.95	2J34	69.95	4J25	199.00	35T	3.50	434A	19.95	808	3.50	1280	1.25
1B21A	2.75	2J36	105.00	4J26	199.00	45 Special	.35	446A	1.95	810	11.00	1611	1.95
1B22	3.95	2J38	17.95	4J27	199.00	RK39	2.95	446B	5.40	811A	3.95	1613	1.38
1B23	9.95	2J39	12.50	4J28	199.00	HF50	1.75	450TL	45.00	813	9.95	1616	2.95
1B24	15.00	2J40	35.00	4J29	199.00	VT52	.25	464A	9.95	814	3.95	1619	.89
1B26	2.95	2J42	150.00	4J30	199.00	RK72	1.10	471A	2.75	815	3.50	1622	1.75
1B27	13.50	2J49	109.00	4J31	199.00	RK-73	1.95	527	25.00	816	1.45	1624	2.00
1B32	4.10	2J50	95.00	4J32	199.00	100TH	9.95	WL530	3.50	829	12.95	1625	.45
1B42	19.95	2J61	45.00	4J33	199.00	FG95	24.95	WL531	22.50	829A	13.95	1851	1.85
1B50	25.00	2J62	45.00	4J34	199.00	FG105	24.00	WL533	17.50	829B	15.95	2050	1.85
1B51	9.95	2K25	29.50	4J35	199.00	203A	8.95	700A/D	25.00	830B	2.50	2051	1.80
1B56	49.95	2K28	37.50	4J36	199.00	211	.95	701A	7.50	832	7.95	8012	4.25
1B60	69.95	2K29	37.50	4J37	199.00	217C	18.00	703A	5.00	832A	9.95	8013	2.95
1N21	1.35	2K39	150.00	4J38	189.00	242C	10.00	705A	3.95	833A	49.95	8013A	5.95
1N21A	1.75	2K41	150.00	4J39	199.00	244A	12.95	706AY/FY	45.00	834	7.95	8014A	89.00
1N21B	4.25	2K45	149.50	4J40	199.00	249C	4.95	707A	17.95	836	4.95	8019	1.75
1N21C	23.00	2K48	170.00	4J41	199.00	250TH	22.50	707B	17.95	837	2.95	8020	3.50
1N22	1.75	2K50	350.00	4J42	250.00	250TL	19.95	714AY	17.95	838	6.95	8025	6.95
1N23	2.00	2K54	200.00	4J51	350.00	274A	3.00	715A	7.95	845	5.59	PD8365	99.00
1N23A	2.75	2K55	200.00	4J53	350.00	274B	3.00	715B	12.00	849	52.50	9001	1.75
1N23B	4.25	2K56	180.00	C5B	3.95	304TH	10.00	715C	25.00	860	4.95	9002	.95
1N34A	.96	2V3G	2.10	5BP1	6.95	304TL	12.00	717A	1.95	861	29.50	9003	1.75
1N43	2.50	3BP1	7.50	5BP4	6.95	307A	4.95	718AY/EY	48.05	866A	1.79	9004	1.75
2B4	1.50	3B24	5.50	5CP1	6.95	310A	5.95	719A	29.50	869B	69.00	9005	2.90
2B22	1.95	3B24W	7.50	5D21	21.00	310B	6.75	721A	3.95	869BX	50.00	9006	.35
2B26	3.75	EL3C	5.95	5JP1	27.50	311A	6.95	722A	3.95	872A	3.95		
2C34	.35	3C22	120.00	5JP2	19.50	312A	3.95	723A/B	24.95	878	1.95		
2C40	10.00	3C24	1.95	5JP4	27.50	323A	15.00	724A	4.95	880	300.00		
2C43	16.00	3C31	3.95	WE6AK5	2.50	327A	3.95	724B	6.95	884	1.95		
2C44	.90	3DP1A	10.95	C6A	12.50	328A	6.95	725A	9.95	885	1.75		
2C46	12.00	3DP1-52	12.00	C6J	10.95	350A	10.00	726A	24.00	889R	199.50		
2D21	1.75	3EP1	7.50	7BP7	7.95	350B	5.95	726B	56.00	914	75.00		
2E22	2.25	3E29	15.50	7DP4	10.00	352A	3.00	726C	69.00	931A	5.00		
2E30	2.75	3FP7	7.50	12AP4	55.00	357A	15.00	728AY/GY	27.00	954	.35		
2J21A	17.95	3HP7	7.50	12DP7	25.00	368AS	5.00	730A	24.00	955	.55		
2J22	17.95	4A21	2.75	15E	1.95	371B	1.95						

Thousands of other tubes



TS-147 C/UP TEST SET
Hard-to-get X-Band SIGNAL GENERATOR Now Available

Test Set TS 147 C/UP is a portable Microwave Signal Generator designed for testing and adjusting beacon equipment and radar systems which operate within the frequency range of 8500 MC to 9600 MC.



MICROWAVE TEST EQUIPMENT TS148/UP SPECTRUM ANALYZER

Field type X Band Spectrum Analyzer, Band 8430-9580 Megacycles.

Will check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q or resonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available new complete with all accessories, in carrying case.

Other test equipment, used checked out, surplus.

TSK1/SE K Band Spectrum Analyzer
TS3A/AP Frequency and power meter S Band
RF4A/AP Phantom Target S Band
TS12/AP VSWR Test Set for X Band
TS13/AP X Band Signal Generator
TS14/AP Signal Generator
TS33/AP X Band Power and Frequency Meter
TS34/AP Western El Synchroscope
T35/AP X Band Signal Generator
TS36/AP X Band Power Meter
1-96A Signal Generator
TS45 X Band Signal Generator
TS47/APR 40-400 MC Signal Generator
TS69/AP Frequency Meter 400-1000 MC
TS100 Scope
TS102A/AP Range Calibrator
TS108 Power Load
TS110/AP S Band Echo Box
TS125/AP S Band Power Meter
TS126/AP Synchroscope
TS147 X Band Signal Generator
TS270 S Band Echo Box
TS174/AP Signal Generator
TS175/AP Signal Generator
TS226 Power Meter
TS239A Synchroscope
TS239C Synshroscope

SURPLUS EQUIPMENT

APA10 Oscilloscope and panoramic receiver
APA38 Panoramic Receiver
APS 3 and APS 4 Radar
APR4 Receiver
APR5A Microwave Receiver
APT2 Radar Jamming Transmitter
APT5 Radar Jamming Transmitter

MINIMUM ORDER 25 Dollars

YOU CAN REACH US ON TWX NY1-3235

Cables: TELSERSUP

SPECIAL

Wide Band S Band Signal Generator 2700/3400MC using 2K41 or PD 8365 Klystron, Internal Cavity Attenuator, Precision individually calibrated Frequency measuring Cavity. CW or Pulse Modulated, externally or internally.

Large quantities of quartz crystals mounted and unmounted.
Crystal Holders: FT243, FT171B others.
Quartz Crystal Comparators.
North American Philips Fluoroscopes Type 80.
Large quantity of Polystyrene beaded coaxial Cable.

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GUARANTEED BRAND NEW

LECTRONIC RESEARCH TUBE SPECIALS

STANDARD BRANDS ONLY

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Receiving Tubes

Type No	Price
0OA	$1.50
01A	.67
0Z4	.59
0Z4A	.63
1A3	.71
1A5GT	.72
1A7GT	.79
1AB5	1.30
1B3GT	.99
1B4P	.79
1B5	.74
1C5GT	.85
1C6	.69
1C7G	.69
1D5GP	.69
1D8GT	.99
1E5GP	.71
1F4	.69
1F5G	.69
1F6	.71
1G4GT	.69
1G5G	.69
1G6GT	.69
1H4G	.89
1H5GT	.69
1H6G	.75
1H6GT	.79
1J5G	.74
1J6G	.69
1L4	.69
1LA4	.87
1LA6	.99
1LB4	1.01
1LC5	.81
1LC6	.93
1LD5	.93
1LE3	.93
1LH4	.82
1LN5	.74
1N5GT	.83
1N6G	.75
1P5GT	.69
1Q5GT	.99
1Q6	.99
1R4	.69
1R5	.79
1S4	.71
1S5	.69
1T4	.71
1T5GT	.71
1U4	.73
1U5	.77
1V	.65
1X2A	.93
2A3	1.28
2A5	.79
2B7	.79
2E5	.94
2X2	.50
2X2A	1.85
3A4	.65
3A5	.95
3A8GT	1.50
3B7	.57
3C6	1.15
3D6	.57
3Q4	.77
3Q5GT	.83
3S4	.77
3V4	.79
5AZ4	.54
5R4GY	1.59
5T4	1.91
5U4G	.59
5V4G	.98
5W4	.82
5X4G	.79
5Y3GT	.47
5Y4G	.71
5Z3	.87
5Z4	1.40
6A3	1.28
6A6	.82
6A7	1.05
6A8	.95
6AB4	.83
6AB7	.98
6AC5GT	1.19

Type No.	Price
6AC7	.85
6AC7W	3.25
6AD6G	.98
6AD7G	1.29
6AE6G	.89
6AF6G	.89
6AG5	.79
6AG7	1.45
6AH6	1.29
6AJ5	1.95
6AK5	.84
WE-6AK5	1.85
6AK5W	2.95
6AK6	.99
6AL5	.59
6AL5W	2.65
6AQ5	.72
6AQ6	.79
6AQ7GT	1.26
6AR5	.79
6AS5	.99
6AS6	2.25
6AS7G	4.25
6AT6	.63
6AU5GT	1.21
6AU6	.65
6AV6	.55
6B4G	1.25
6B5	1.20
6B7	.95
6B8	.75
6B8G	.75
6BA6	.65
6BA7	1.28
6BC5	.88
6BC7	1.10
6BD5GT	1.60
6BD6	.85
6BE6	.65
6BF5	1.10
6BF6	.83
6BG6G	1.89
6BH6	.95
6BJ6	.95
6BK7	1.60
6BL7GT	1.45
6BN6	1.59
6BQ6GT	1.26
6C4	.55
6C5	.70
6CB6	.79
6C6	.73
6C8G	.96
6CD6G	2.21
6CL6	1.50
6D6	.88
6D8G	.83
6E5	1.19
6F5GT	.83
6F6	.99
6F6G	.87
6F7	1.05
6F8G	.91
6G6G	.99
6H6	.66
6H6GT	.66
6J5	.59
6J5G	.61
6J5GT	.55
6J6	.95
6J6W	1.75
6J7	.99
6J7GT	.79
6J8G	1.28
6K5GT	.99
6K6GT	.65
6K7	.79
6K7G	.86
6L5G	1.06
6L6	1.87
6L6G	1.49
6L6GA	1.39
6L7	.99
6L7G	.85
6N7	.99
6N7GT	.89
6P5GT	.96
6Q7	.89
6R7	.79
6S4	.72
6S7	1.06

Type No.	Price
6S7G	.99
6SA7	.71
6SA7GT	.67
6SB7Y	1.04
6SC7	.93
6SD7GT	.94
6SF5	.83
6SF5GT	.80
6SF7	.75
6SG7	.75
6SH7	.75
6SH7GT	.75
6SJ7	.71
6SJ7GT	.69
6SJ7Y	.85
6SK7	.72
6SK7GT	.72
6SL7GT	.81
6SN7GT	.73
6SN7-WGT	2.10
6SQ7	.65
6SQ7GT	.65
6SR7	.63
6SS7	.99
6ST7	1.05
6T7G	1.23
6T8	.98
6U5	.98
6U7G	.65
6V6	1.49
6V6G	.89
6V6GT	.67
6W4GT	.64
6W6GT	.88
6X4	.59
6X5GT	.59
6Y6G	.89
6ZY5G	.89
7A4	.76
7A5	.79
7A6	.75
7A7	.76
7A8	.78
7AD7	1.44
7AH7	1.08
7B4	.79
7B5	.79
7B6	.79
7B7	.79
7B8	.78
7C4	.45
7C5	.79
7C6	.79
7C7	.79
7E5	.79
7E6	.59
7E7	.83
7F7	.99
7F8	1.35
7G7	.89
7H7	.79
7J7	1.10
7K7	1.10
7L7	.97
7N7	.97
7Q7	.79
7R7	.94
7S7	1.11
7V7	1.11
7W7	1.11
7Y4	.73
7Z4	.79
10	.39
12A	.65
12A6	.64
12A6GT	.64
12A7	1.16
12A8GT	.77
12AH7GT	1.32
12AL5	.79
12AT6	.55
12AT7	.99
12AU6	.71
12AU7	.86
12AV6	.54
12AV7	.99
12AW6	1.20
12AX7	.99
12BA6	.69
12BA7	.95
12BD6	.99

Type No.	Price
12BE6	.66
12C8	.65
12F5GT	.79
12H6	.69
12J5GT	.55
12K8	.70
12Q7GT	.67
12SA7	.69
12SA7GT	.69
12SC7	.90
12SF5	.79
12SF5GT	.79
12SF7	.85
12SG7	.85
12SH7	.73
12SJ7	.71
12SJ7GT	.65
12SK7	.69
12SL7GT	.93
12SN7GT	.89
12SQ7	.69
12SQ7GT	.68
12SR7	.79
12SR7GT	.79
12X3	.89
12Z3	.89
14A4	.97
14A7	.74
14B6	.74
14B8	.89
14C5	1.10
14C7	.93
14E6	.99
14E7	1.09
14F7	.89
14H7	.89
14J7	.89
14N7	.89
14R7	.89
14S7	.89
14W7	.89
14X7	.89
19	.89
19T8	.99
22	1.16
24A	.89
25A6	1.16
25L6GT	.69
25Z5	.79
26	.79
27	.69
28D7	1.95
30	.70
30 Spec.	.45
31	.54
32	.69
32L7GT	.87
33	.69
34	.69
35/51	.59
35A5	.72
35B5	.75
35L6GT	.67
35W4	.55
35Y4	.72
35Z4GT	.69
35Z5GT	.55
36	.64
37	.69
38	.69
39/44	.59
41	.71
42	.79
43	.79
45	.79
45Z5GT	.89
46	.81
47	.99
50	1.09
50A5	.89
50B5	.69
50C5	.69
50L6GT	.63
50Y6GT	.92
55	.99
L55B	.32
56	.69
57	.69
58	.69
59	1.24
70L7GT	1.29
71A	.79

Type No.	Price
75	.85
76	.69
77	.69
78	.79
79	.89
80	.59
81	1.41
82	1.19
83	1.11
83V	1.25
84/6Z4	.75
85	.79
89Y	.55
117P7GT	1.89
117Z3	.65
117Z6GT	.97
FM-1000	1.59

Transmitting and special Purpose Tubes

Type No.	Price
0A2	$ .95
0A3	1.15
0A4G	1.25
0B2	1.10
0B3	1.19
0C3	1.10
0D3	.95
1B21A	2.65
1B22	2.50
1B23	9.60
1B24 West.	12.95
1B24 Sylv.	18.95
1B24A	39.50
1B26	3.73
1B27	14.95
1B29	2.75
1B32	3.75
1B35	11.00
1B36	12.50
1B37	14.70
1B38	32.50
1B40	4.95
1B41	51.94
1B42	9.80
1B49	50.33
1H20	.88
1P21	35.00
1P23	4.10
1P24	1.27
1P28	10.00
1P29	2.89
1P30	2.85
1Q23	122.50
1S21	9.50
1Z2	3.75
2A4G	1.22
2AP1	8.95
2AP5	8.95
2B4	2.10
2B22	2.20
2C21	.65
2C22	.45
2C26	.39
2C26A	.49
2C33A	4.95
2C34	.49
2C39	22.00
2C39A	29.00
2C40	12.00
2C42	23.75
2C43	17.75
2C44	1.20
2C46	21.50
2C51	5.75
2C53	11.75
2D21	1.55
2E22	1.85
2E24	4.10
2E26	3.79
2J21	8.75
2J22	8.95
2J26	24.75
2J27	22.95
2J31	27.00

Type No.	Price
2J32	36.50
2J33	39.50
2J34	27.00
2J37	13.70
2J38	17.50
2J39	36.50
2J40	34.50
2J48	49.50
2J49	65.00
2J50	39.50
2J54	67.50
2J56	148.50
2J61	45.25
2J66	165.00
2K23	37.50
2K25	28.50
2K26	78.50
2K28	29.50
2K29	27.50
2K33	185.00
2K33A	195.00
2K39	135.00
2K45	129.50
2K55	135.00
3AP1	8.95
3AP4	10.25
3B22/EL-1C	2.60
3B24	5.20
3B24W	7.50
3B25	4.50
3B26	3.75
3B27	4.20
3B28	7.75
3BP1	5.75
3C22	89.50
3C23	9.65
3C24	1.85
3C27	6.95
3C31/EL-C1B	3.95
3C37	32.50
3C45	12.95
3CP1	2.25
3D21	2.98
3DP1	4.85
3DP1A	6.75
3E29	13.75
3EP1	4.75
3FP7	2.90
3FP7A	6.95
3GP1	3.95
3HP7	3.95
3J31	145.00
4-125A	29.50
4-250A/5D22	35.00
4A1	1.18
4AP10	4.40
4B22/EL-5B	8.95
4B24	5.75
4B25/EL-6CF	8.95
4B32	10.50
4C27	17.50
4C35	27.00
4E27	21.50
4J36	150.00
4J38	120.00
4J52	275.00
4X150A	36.00
4X500A	118.50
4X1000A	129.36
5AP1	5.95
5AP4	4.75
EL-C5B	3.95
5BP1	5.50
5BP4	5.50
5C22	47.75
5CP1	4.95
5CP7	9.50
5D21	19.50
5D22/4-250A	35.00
5FP7	1.95
5HP1	5.50
5HP4	5.75
5J26	325.00
5J29	18.50
5JP1	26.50

Type No.	Price
5JP2	26.50
5JP4	26.50
5LP1	21.75
5LP5	19.75
5MP1	10.50
6-8B	.85
C6A	6.75
6AN5	3.30
6AR6	3.25
6C21	27.50
6C24	52.50
6F4	5.95
C6J	9.95
6J4	6.85
C6L/5528	12.50
7-7-11	1.19
7BP1	8.65
7BP7	6.50
7BP12	14.95
7BP14	14.95
7CP1	14.95
9GP7	11.75
9LP7	4.50
10FP4	22.50
10T1	.88
10Y	.39
12DP7	14.50
12GP7	18.50
12HP7	14.75
13-4	.80
13T4	.85
15E	1.95
15R	.65
FG-17/5557	4.95
RK-19	1.85
21-2	.65
RK-21	1.65
REL-21	1.95
23D4	1.15
24G	1.85
RK-25	3.82
FG-27A	8.25
FG32/5558	6.75
FG33	22.54
RK34	.49
35T	4.95
35T ION gauge	5.95
35TG	4.95
REL 36	.45
T-40	3.75
FG-41	122.50
RK-47	4.92
CE-48	1.90
EF-50	.79
VT-52	.45
53A	5.60
RK59	2.44
QK-60	65.00
SK-60	6.62
QK-61	65.00
QK-62	65.00
VT-62 Br	1.15
RK-63	22.50
FG-67	14.80
VT-67	.48
RK-69	2.25
72	1.32
73	1.32
RK-75	4.25
75T	5.80
VR-75	1.15
VR-78	.64
FG-81A	3.95
VR-90	1.19
91	14.80
FG-95/5560	25.00
VT-98/Br	19.50
C100A	2.30
C100E	2.30
100R	2.90
100TH	9.95
WE-101F	3.62
WE-102F	2.85
FG-104/5561	24.60

Type No.	Price
FG-105	19.50
VR-105	1.10
VU-111S	1.60
WE-113A	1.32
HY-114B	.75
WE-117A	.95
F-123A	7.75
WE-124A	3.80
F-127A	22.50
VT-127A	3.60
AB-150	12.50
VR-150	.95
FG-166	48.50
FG-172	29.50
FG-178	14.50
FG-190	12.15
HF200	16.50
L-200B	65.00
203A	7.40
203B	6.33
204A	47.50
CE-206	3.15
211	.95
WE-211D	12.50
WE-211E	12.50
212E	42.50
WE-215A	.24
217C	8.95
WE-220B	155.00
221A	1.95
227A/5C27	4.60
WE-231D	2.25
232CH	240.00
RX-233A	4.95
FG-235A/5552	94.50
WE-245A	2.35
WE-249B	4.50
WE-249C	4.50
250R	17.50
250TH	22.50
250TL	22.50
WE-254A	5.90
WE-257A	3.77
FG-271/5551	62.50
WE-274A	5.50
274B	2.85
WE-275A	6.95
WE-283A	4.25
WE-285A	5.57
WE-294A	5.75
304TH	8.75
304TL	8.75
307A	4.25
WE-310A	6.25
312A	3.95
WE-313C	4.15
316A	.89
TR-317	18.50
327A	4.25
WE-331A	9.75
WE-343A	185.00
WE-346A	2.75
WE-350A	6.95
350B	4.95
WE-356B	5.45
368A	6.95
371A	.95
371B	.95
388A	2.95
393A	8.60
394A	4.50
WE-399A	4.70
410R	185.00
414	118.60
GL-415/5550	39.50
417A	16.95
434A	24.50
446	1.75
446A	1.95
446B	2.95
450TH	42.50
450TL	42.50

Type No.	Price
451	5.75
471A	2.65
473	140.25
481A	4.31
502A	1.67
503AX	1.25
506AX	1.25
507AX	1.47
527	17.50
530	22.00
531	7.50
532A	3.75
WL-533	19.50
559	2.20
561	3.50
575A	20.58
579B	14.70
KU610	21.56
HY615	.49
616	213.75
KU-623	39.50
624	47.00
KU-627	19.80
KU-628	22.50
KU-629	11.70
631P1	5.00
WL-632B	26.10
KX642	11.34
WL-652/5551	62.50
WL-654/659	82.00
WL-670A	8.70
WL-672	22.00
672A	34.30
KU-676	52.25
677	52.25
678	46.06
WL-681/5550	49.00
700A	24.50
700B	24.50
700C	24.50
700D	24.50
701A	6.95
703A	5.95
704A	.95
705A	2.25
706AY	45.00
706BY	45.00
706CY	45.00
706FY	45.00
706GY	45.00
707A	7.95
707B	14.90
708A	4.75
709A	3.85
710A	1.70
713A	1.45
714AY	10.75
715A	6.25
715B	8.95
715C	19.50
717A	1.47
718AY	45.00
718BY	45.00
720DY	95.00
721A	3.95
722A	2.25
723A	9.95
723A/B	18.50
724A	3.22
724B	3.22
725A	8.95
726A	14.50
726B	45.00
726C	65.00
730A	25.00
788Y	1.40
800	1.75
801A	.45
802	3.30
803	4.95
805	4.50
806	33.50
807	1.65
808	2.65
809	3.60
810	10.95
811	3.60
811A	4.28

Type No.	Price
812A	3.50
813	10.50
814	3.95
815	5.25
816	1.45
826	1.25
828	9.60
829	9.95
829A	11.95
829B	12.95
830B	2.95
832	7.95
832A	9.95
833A	39.50
836	4.10
837	1.45
838	3.75
841	.49
843	.59
845W	6.75
849	29.50
851	67.00
852	19.50
857B	204.78
858	498.00
860	4.95
861	22.50
864	.35
865	1.28
866A	1.48
866A Jr./2B26	1.2
868	1.74
869B	125.40
872A	3.95
874	1.35
876	1.60
878	1.85
880	460.00
884	1.75
885	1.75
886	2.60
889A	179.00
889RA	289.10
891	218.54
892	218.54
892R	355.76
893A	617.40
893AR	1127.00
895	931.00
895R	1274.00
902P1	9.95
905	3.50
913	11.25
917	3.43
919	1.95
920	3.74
923	1.35
924	2.97
925	2.16
926	2.61
927	1.85
928	2.57
931A	5.00
954	.39
955	.55
956	.49
957	.49
958A	.69
959	2.25
991	.45
1003	.63
CK-1005	.69
CK-1006	3.30
CK-1013/5517	2.25
1201	.79
1203	.45
1291	.57
1294	.69
1299	.57
1602	2.25
1613	.89
1614	2.00
1616	1.07
1619	.39
1620	6.25
1622	2.25
1623	3.99
1624	1.90
1625	.39

Type No.	Price
1626	.30
1629	.30
1630	.95
1631	1.38
1632	.75
1633	1.00
1636	3.10
1642	.65
1644	.95
1655	1.90
1656	6.50
1665	1.80
1904	14.80
1960	.70
2002	4.85
2050	1.70
2051	1.10
5516	7.70
5517/CK-1013	2.25
5518	514.59
5528/C6L	12.50
5549	362.00
5550	49.00
5551	62.50
5552	94.50
5553	251.70
5554	180.55
5555	314.00
5557	4.90
5558	6.75
5559	19.15
5560	25.01
5561	24.60
5581	2.00
5582	2.63
5583	2.90
5584	3.89
5588	117.68
5592	1204.40
5593	85.72
5604	529.20
5610	2.10
5611	115.09
5619	382.20
5621	13.20
5622	12.23
5623	13.25
5624	13.23
5626	22.03
5627	26.45
5628	25.46
5629	20.48
5651	2.78
5654	2.95
5663	1.86
5664	9.24
5665	55.64
5670	4.10
5671	1225.00
5674	85.75
5675	16.95
5683	9.24
5685	31.27
5686	3.68
5687	4.80
5691	8.55
5692	8.55
5693	6.95
5696	1.87
5713	173.48
5718	9.33
5719	8.33
5720	22.54
5725	4.16
5726	1.72
5727	3.43
5734	17.63
5736	156.80
5740	73.50
5741	83.30
5742	14.21
5743	13.72
5749	1.96
5750	2.45
5751	3.43
5763	1.72
5770	975.10
5771	532.14
5779	78.40
5786	76.44

Type No.	Price
5794	16.43
5796	13.47
5814	3.43
5822	140.14
5826	1274.00
5830	196.00
5840	10.54
5846	126.40
5855	75.46
5876	18.38
5879	1.72
5890	25.48
5893	19.20
5896	7.10
5899	10.53
5902	10.78
5915	1.18
5934	14.70
5936	1078.00
5939WA	47.04
5974	215.60
6005	3.68
6012	4.41
6026	2.89
6072	5.39
6082	5.19
6095	1.48
6096	1.65
6099	3.95
6101	2.95
6135	2.69
6136	3.19
6137	2.45
6159	4.80
6201	5.39
UX6653	.65
7193	.45
8000	10.15
8003	13.72
8011	.87
8012	2.60
8013	2.75
8013A	4.90
8014A	55.00
8016	1.05
8020	1.28
8025	6.95
8025A	4.75
9001	1.50
9002	.95
9003	1.50
9004	.45
9005	1.95
9006	.35
189048	3.79
189049	3.79
199698	2.69

Crystal Diodes

Type No.	Price
1N21	$1.19
1N21A	1.69
1N21B	3.00
1N22	1.25
1N23	1.95
1N23A	2.75
1N23B	3.45
1N27	1.79
1N31	7.90
1N34	.66
1N34A	.90
1N38	1.50
1N38A	2.58
1N39	6.10
1N41	9.88
1N42	18.00
1N43	1.65
1N45	.94
1N52	1.05
1N55	3.05
1N60	.58

GENERATORS AND INVERTERS

Pioneer 716-3A GENERATOR (NAVY NEA-3A)—Out—AC 115V 10.4A 800 to 1400 cy. 1 ph.—DC 30V 60 A. Brand New $38.50

Pioneer 1235-3A GENERATOR—Out—30VDC 15A. Brand New—original packing $15.50

Pioneer 12133-1A INVERTER—28VDC to 115 VAC 400 cy. 3 ph. 250VA 0.8 PF—Volt & Freq. Regulated $225.00

Pioneer 12137-1A INVERTER—24VDC to 115VAC 400 cy. 3 ph. 250VA Volt & Freq. Regulated $225.00

PE-109D INVERTER—13.5VDC to 115 VAC 400 cy. 175VA 1 ph. Brand New $67.50

PE-218 INVERTER—28VDC to 115VAC 400 cy. 1500VA. New $49.50

Pioneer 800-1B INVERTER—28VDC to 120VAG 800 cy. 7A. Used $22.65

G.E. INVERTER—28VDC to 120VAC 800 cy. 750VA 1 ph. $39.50

ATR INVERTER—6VDC to 110VAC 60 cy. 75 W $22.95

Pioneer 12121-1A INVERTER—24VDC 18A. input—AC output 115V 400 cy. 3 ph. 250 VA 0.7A. Volt & Freq. Regulated—New $225.00

Pioneer 12116 INVERTER—28VDC to 115VAC 400 cy. 1 ph. 50VA $79.50

Pioneer 12117 INVERTER—28VDC to 26VAC 400 cy. 1 ph. 6VA $33.50

Leland 10563 INVERTER—28VDC to 115VAC 400 cy. 3 ph. 115VA $75.00

REVERSIBLE GEAR HEAD MOTORS

G.E. 5BA10AJ65—27.5 VDC .66A 2.35 RPM 8 oz-ft Torque $27.50

G.E. 5BA10FJ18—24 VDC .51A 9.5 RPM 10 oz-in Torque $22.50

G.E. 5BA10FJ19—24 VDC .51A 56 RPM 12 oz-in Torque $22.50

G.E. 5BA10AJ41—PM 24 VDC .55A 140 RPM 10 oz-in Torque $22.50

G.E. 5BA10AJ52—27 VDC .7A 145 RPM 14 oz-in Torque $19.50

Delco 5069230—PM 27VDC 145 RPM $19.50

Delco 5068750—27 VDC 160 RPM $22.50

G.E. 5BA10AJ51—27 VDC 160 RPM .65A 8 oz-in Torque $19.50

Delco 5069600—PM 27 VDC 250 RPM $22.50

G.E. 5BA10AJ8—27 VDC 250 RPM .72A 8 oz-in Torque $19.50

Delco 5067127—PM 27.5 VDC 250 RPM $22.50

Delco 5068820—PM 27 VDC 250 RPM $22.50

G.E. 5BA10AJ37B—27 VDC 250 RPM .8A 8 oz-in Torque $19.50

TACHOMETER GENERATOR

Elinco type PM-1M, DC Tachometer Generator—New **$27.50**

OIL FILLED CONDENSERS

MFD	VDC		Price	MFD	VDC		Price
2	400		$ .55	.5	3000		$2.40
5-5	400		1.65	1	3000		3.40
1	600		.55	2	3000		5.85
2	600		.69	3 x .2	4000		2.95
2-2	600	R'd	1.65	2	4000		7.95
3	600		.95	1	5000		5.75
4	600		1.65	2	5000		12.50
4	600	R'd	1.65	5	5000		29.50
5	600		1.75	.01-.03	6KV		1.65
6	600		1.85	1	6000		9.95
8	600	R'd	1.85	.1	7000	R'd	1.79
4-4-4	600		2.50	.1-.1	7000		5.95
4 x 3	600		2.50	.1	7500		2.85
10	600		3.25	.5	7500		7.95
50	600		7.95	1-1	7500		26.50
1	1000		.65	.075-.075	8 KV		6.50
2	1000		.90	1	10KV		29.50
2	1000	R'd	.95	.1	12KV		8.95
3.5-.5	1000		1.85	1	15KV		47.50
4	1000		1.95	.25	20KV		19.95
6	1000		2.50	1	20KV		54.00
8	1000		3.25	1	25KV		85.00
1	1200		.85	.001	50KV		24.50
1-1-1	1200		1.85	.005	50KV		34.50
.1	1500		.69	.025	50KV		37.50
3	1500		2.50	.2	50KV		67.50
4	1500		2.95	.25	50KV		70.00
.1-.5	2000		.95	7.5	220VAC		1.95
.25	2000		1.50	20	236VAC		3.95
.3	2000		1.30	1-3	330VAC		1.95
1	2000		1.95	12.75	330VAC		4.10
12	2000		8.95	15	330VAC		4.50
1	2500		2.75	5	440VAC		3.10
1-1	2500		3.85	2.9	660VAC		3.50
30	2500		14.75	7	660VAC		4.25
32	2500		15.80	8	660VAC		4.50

OILMITES

MFD	V.	TYPE	Price
.02	600	OM-6002	$ .45
.05	600	OM-6005	.48
.1	600	OM-610	.51
.25	600	OM-625	.55
.5	600	OM-650	.60
1.0	600	OM-601	.85

2 φ LOW INERTIA SERVO MOTORS

Diehl FPE-25-11—75V 60 cy. .11 Amp 4 Watts. Each $34.50

KOLLSMAN—45 Volt 60 cycle 4 watts 1500 RPM—new $22.50

PIONEER—10047-2-A 26 volt 400 cycle with 40:1 reduction gear $14.50

Minn. Honeywell type—115V 60 cy. 13.5W—Brown Instr. 76750-1 162 RPM; 76750-2 54 RPM; 76750-3 27 RPM. Any Type .... $19.50 ea.

COAXIAL CONNECTORS

83-1AC	$ .42	83-1RTY	$ .65	83-22J	$1.40
83-1AP	.30	83-1SP	.45	83-22R	.68
83-1F	1.10	83-1SPN	.50	83-22SP	.80
83-1H	.12	83-1T	1.30	83-22T	1.95
83-1HP	.22	83-2AP	1.95	83-168	.12
83-1J	.73	83-22AP	1.40	83-185	.12
83-1R	.40	83-22F	2.10	86-765	.24
				83-776	.65

UG-7/AP	$6.80	UG-58/U	$ .70	UG-185/U	$ .95
UG-12/U	.95	UG-58A/U	.90	UG-191/AP	.80
UG-15/U	1.25	UG-59A/U	2.15	MX-195/U	.75
UG-18/U	1.25	UG-60A/U	1.75	UG-197/U	2.80
UG-18B/U	1.05	UG-61A/U	2.10	UG-201/U	1.95
UG-19/U	1.60	UG-83/U	1.75	UG-203/U	.85
UG-20B/U	1.60	UG-85/U	1.60	UG-206/U	1.80
UG-21/U	.85	UG-86/U	2.25	UG-224/U	1.15
UG-21A/U	1.50	UG-87/U	1.40	UG-236/U	3.85
UG-21B/U	1.00	UG-88/U	.90	UG-245/U	2.25
UG-21C/U	1.05	UG-89/U	1.10	UG-246/U	2.35
UG-22/U	1.80	UG-90/U	1.15	UG-254/U	2.75
UG-22B/U	1.20	UG-98/U	1.85	UG-255/U	1.95
UG-22C/U	1.20	UG-102/U	.80	UG-260/U	.85
UG-23/U	1.20	UG-103/U	.68	UG-261/U	1.10
UG-23B/U	1.50	UG-104/U	1.40	UG-262/U	1.10
UG-23C/U	1.10	UG-106/U	.12	UG-273/U	1.45
UG-24/U	1.30	UG-107B/U	2.75	UG-274/U	2.30
UG-25/U	1.35	UG-108/U	2.60	UG-275/U	5.50
UG-27/U	1.25	UG-109/U	2.60	UG-276/U	2.75
UG-27A/U	2.25	CW-123A/U	.45	UG-290/U	.90
UG-28A/U	2.95	UG-146/U	1.95	UG-291/U	.95
UG-29/U	.95	CW-159/U	.60	UG-306/U	2.65
UG-29A/U	1.85	UG-166/U	32.50	UG-349/U	2.65
UG-29B/U	1.75	UG-167/U	3.75	MX-367/U	.85
UG-30/U	2.30	UG-171/U	2.25	UG-414/U	1.95
UG-34/U	9.75	UG-173/U	.35	UG-498/U	1.80
UG-36/U	12.50	UG-175/U	.12	UG-536/U	1.65
UG-37/U	17.50	UG-176/U	.12	UG-625/U	1.35
UG-57B/U	1.85	UG-177/U	.24		

Full line of JAN Approved coaxial connectors in stock UHF-N-BN-BNC-pulse—Prices on request.

COAXIAL CABLE

Type	Price Per M Ft.	Type	Price Per M Ft.
RG-5/U	$140.00	RG-22/U	$150.00
RG-6/U	180.00	RG-22A/U	285.00
RG-7/U	85.00	RG-24/U	675.00
RG-8/U	100.00	RG-26/U	475.00
RG-9/U	250.00	RG-29/U	50.00
RG-9A/U	330.00	RG-34/U	300.00
RG-10/U	240.00	RG-35/U	900.00
RG-11/U	100.00	RG-54A/U	97.00
RG-12/U	240.00	RG-55/U	110.00
RG-13/U	216.00	RG-57/U	325.00
RG-17/U	650.00	RG-58/U	60.00
RG-18/U	900.00	RG-58A/U	70.00
RG-19/U	1250.00	RG-59/U	60.00
RG-20/U	1450.00	RG-62/U	75.00
RG-21/U	220.00	RG-77/U	100.00

ADD 25% TO PRICES SHOWN FOR QUANTITIES UNDER 500 FT.

Terms 25% cash with order, bal. COD unless rated. All prices net F. O. B. warehouse. Phila., Penna., subject to change without notice.

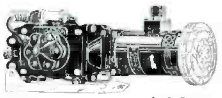
CABLE ADDRESS "LECTRONIC PHILADELPHIA"

LECTRONIC RESEARCH LABORATORIES

715-19 ARCH ST. PHILA. 6, PA.

Telephones - MARKET 7-6771-2-3

AIR COMPRESSOR, AIRCRAFT



Rated pressure 1000 PSI. measures 13½" x 9¼"; driven by 27 VDC-1/3rd HP series wound motor 11,000 RPM; 17 amp; cont. duty Mfg. General Electric Mod. #5BA40EJ28B. ....$29.95 ea.

G. E. GENERATORS

General Electric Type 5-ASB-31JJ3; 400 cycles out at 115 volts; 7.2 amps; 8,000 rpm.; size 6" long x 6" dia. $89.50 ea.

SINE-COSINE GENERATORS

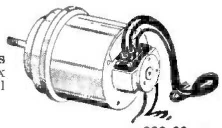
(Resolvers)

Diehl Type FJE43-9 (Single Phase Rotor). Two stator windings 90° apart, provides two output sequal to the sine and cosine of the angular rotor displacement. Input voltage 115 volts, 400 cycle............$30.00 ea.
Diehl Type FPE-43-1 same as FJE-43-9 except it supplies maximum stator voltage of 220 volts with 115 volt sapplied to rotor....................$25.00 ea.

VOLTAGE GENERATORS (RATE)

ALNICO MIDGET D.C. VOLTAGE GENERATOR Type B-35-D $17.50
ALNICO MIDGET D.C. VOLTAGE GENERATOR Type B-44-D $17.50
A.C. GENERATOR: 67 V., 20 Cyc., 2-Phase, .015 Amps. Type PM-1, 1200 R.P.M. $15.00

SYNCHRONOUS SELSYNS



110 volt, 60 cycle, brass cased, approx. 4" dia. x 6" long. Mfg. by Diehl and Bendix.
Quantities Available.
REPEATERS ....$20.00 ea.
TRANSMITTERS ....$20.00 ea.

AUTOSYN MOTOR TYPE 1

115 VAC; 60 cycle; 1-phase; DR. # 4279 Foot mounted; Mfg. Bendix Aviation Corp............$15.00 ea.

SESYN GENERATORS

General Electric MOD. 2J15M1; 115-57.5 Volts 400 Cycle ....$22.50 ea.

SYNCHROS

AUTOSYN MTR. KOLLSMAN Type #403; 32 VAC; 60 cycle; single phase..........................$22.50
AUTOSYN MTR. BENDIX Type #851; 32 VAC; 60 cycle; single phase $22.50
MICROSYN UNIT, Type 1C-006-A...........$35.00
IF Sjecial Repeater (115V-400 Cy.)........$15.00 ea.
2JIF 3 Generator (115-400 cyc.)..........$10.00 ea.
5CT Control Transformer: 90-50 Volt; 60 Cy..$45.00
5F Motor (115/90 Volt—60 cyc.)...............$45.00
5/DG Differential Generator (90-94 volts—400
TRANSMITTER, BENDIX C-78248: 115 Volt, 60 Cycle ....$25.00 ea.
cyc.) ....$30.00 ea.
Differential—C-78249; 115 V., 60 Cy...........$5.00
5N MOTOR (115 Volts!60 Cycle)..............$22.50
REPEATER, BENDIX C-78410; 115 Volt, 60 Cycle ....$37.50 ea.
REPEATER, AC synchronous 115 V., 60 cycle. C-78863 ....$15.00 ea.
REPEATER, DIEHL MFG. No. FJE 22-2: 115 Volt; 400 Cy.; Secondary 90 V.........................$27.50
5G GENERATOR (115/90) 60 cycles..........$45.00
7G Synchro Generator (115/90 volt; 60 cycle)..$75.00
6G Synchro Generator (115/90 volt; 60 cycle)..$60.00
6DG Synchro Differential Generator (90190 volt; 60 cycle) $50.00
2-JF5-J Selsyn Control Transformer: 105-55 Volts; 60 Cycle $50.00
5ID5HAI Selsyn Generator: 115-105 Volts; 60 cycle $50.00
2JIFI GENERATOR: 115—57.5 Volt; 400 cycle. $12.50 ea.
2JIHI DIFFERENTIAL GENERATOR: 57.5—57.5 Volt; 400 cycle ....$12.50 ea.
2JIGI CONTROL TRANSFORMER: 57.5—57.5 Volt; 400 cycle ....$7.50 ea.

PIONEER TORQUE UNITS

TYPE 12604-3-A: Same as 12606-1-A except it has a 30:1 ratio between output shaft and follow-up Autosyn ....$10.00 ea.
TYPE 12602-1-A: Same as 12606-1-A except it has base mountin gtype cover for motor and gea rtrain $70.00 ea.
TYPE 12606-1-A: Contain CK5 Motor coupled to output shaft through 125.1 gear reduction train. Output shaft coupled to autosyn, follow-up (AY43). Ratio of output shaft to follow-up Autosyn is 15.1. $70.00 ea.

Immediate Delivery
ALL EQUIPMENT FULLY GUARANTEED
All prices net FOB Pasadena, Calif.

INVERTERS

10563 LELAND ELECTRIC

Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 PF. **Input:** 28.5 VDC; 12 amp.......$59.50

PIONEER 12117

OUTPUT: 26 volts; 400 cycles; 6 volt amperes, 1-Phase. **INPUT:** 24 VDC; 1 amp..........$25.00 ea.

ALTERNATOR, CARTER

Mfg. Carter Motor Co.; OUTPUT: 7 VAC; 9.7 amp.; 650 cycles, and 295 VDC. 200 amps. INPUT: 26.5 VDC; 10.5 amps; 6500 rpm..............$49.50 ea.

PE 218 LELAND ELECTRIC

Output: 115 VAC; Single Phase; PF 90; 380/500 cycle; 1500 VA. **INPUT:** 25-28 VDC; 92 amps; 8000 RPM; Exc. Volts 27.5
BRAND NEW ....$39.95 ea.

PE 109 LELAND ELECTRIC

Output: 115 VAC, 400 cyc; single phase; 1.53 amp.; 8000 RPM. **Input:** 13.5 VDC; 29 amp.........$65.00

MG 153 HOLTZER-CABOT

Input: 24 V. DC, 52 amps; **Output:** 115 volts—400 cycles, 3-phase, 750 VA. and 26 Volt—400 cycle, 250 VA. Voltage and frequency regulated.....$95.00 ea.

PIONEER 12130-3-B

Output: 125.5 VAC; 1.15 amps. 400 cycle single phase, 141 VA. **Input:** 20-30 VDC, 18-12 amps. Voltage and frequency regulated $75.00

12116-2-A PIONEER

Output: 115 VAC; 400 cyc.; single phase; 45 amp. **Input:** 24 VDC 5 amp.....................$65.00

10285 LELAND ELECTRIC

Output: 115 Volts AC, 750 V.A., 3 phase, 400 cycle, .90 PF. and 26 volts, 50 amps, single phase, 400 cycle, .40 PF. **Input:** 27.5 VDC, 60 amps, cont. duty, 6000 RPM. Voltage and Frequency regulated.......$95.00

10486 LELAND ELECTRIC

Output: 115 VAC; 400 Cycle; 3-phase; 175 VA; .80 PF. **Input:** 27.5 DC; 12.5 amp; Cont .Duty. $90.00 ea.

PIONEER 10042-1-A

DC INPUT 14 Volts; **OUTPUT:** 110 Volts; 400 Cycle 1-Phase; 50 Watt..........................$75.00

94-32270-A LELAND ELECTRIC

Output: 115 Volts; 190 VA; Single Phase; 400 Cycle; .90 PF. and 26 Volts; 60 VA; 400 Cycle; .40 PF. **Input:** 27.5 Volts DC 18 amps cont. duty, voltage and freq. regulated $95.00

PIONEER 12147-1-B

OUTPUT: 115 VAC 400 cycle; Single phase. **INPUT:** 24-30 VDC; 8 amps........................$79.50

MG 149F HOLTZER-CABOT

OUTPUT: 26 VAC @ 250 VA; 115V @ 500VA; Single Phase; 400 cycle. **INPUT:** 24 VDC @ 36 amps. $75.00

EICOR CLASS "A" NO. 1-3012/08-7

OUTPUT: 125 VAC; 400 cycle; single phase; 100 VA. **INPUT:** 24-30 VDC; 11 amps; Duty int. Voltage and Frequency Regulator $99.50

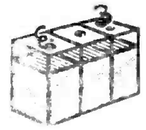
POWER REHOSTATS

Standard Brands: 5 Ohms; 100 Watt: 4.48 amps 100 Ohms; 100 Watt; 1.0 amp.
Boxed. Brand New with Knob $2.50 each—or—$25.00 per Doz.

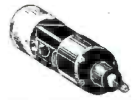
PIONEER AUTOSYNS

AY-1...........26 Volt—400 Cycle............$6.95
AY-5...........26 Volt—400 Cycle............$7.95
AY27D $12.50
AY6—26 Volt—400 cyc.........................$4.95 ea.
AY30D—26 Volt—400 cyc.................$25.00 ea.
AY14D $10.00
AY34 ....$20.00
AY20—26 Volt—400 cyc.................$12.50 ea.

MIDGET TYPE
NT-6 WILLARD 6V. STORAGE BATTERIES
Dry Charged



3 Amp-Hour rating. Transparent plastic case. SIZE: 3⅜" x 1-13/16" x 2⅝". Weight approx. 1¼ lbs. Uses standard electrolyte. Regularly lists at $12.00 each. **NOW**........New, unused......**$2.49 ea.; Four for $8.50; Quantities: 36 or more $1.85 each.**



ALNICO FIELD MOTORS

(Approx. size overall . . . 3¾" x 1¼" diameter)
DELCO TYPE #5069600: 27.5 volts DC; 250 RPM........$19.95
PM Motors Delco Type #5069371: 27.5 volts; DC Alnico Field; 10,000 R.P.M.; dimensions 1" x 1" x 2" long; shaft extension ½" diameter 0.125".....$15.00

PIONEER GYRO FLUX GATE AMPLIFIER

Type 12076-1-A, complete with tubes..........$22.50

AC CONTROL MOTOR

A. C. SYNCHRONOUS MOTOR Type RBC 2505; Volts 115; Cycles 60; RPM 2; Mfg. HOLTZER CABOT ELECT. Approx. size: 2⅝" x 2⅝" x 2⅝"..$15.00 ea.

400 CYCLE MOTORS

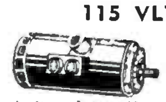
PIONEER: TYPE CK5 2 Phase; 400 cycles.$25.00 ea.
EASTERN AIR DEVICES TYPE J49A: 115 V; 0.1A; 7000 r.p.m. Single phase 400 cycle..........$17.50 ea.
AIRESEARCH: 115V; 400 CPS; Single phase 6500 RPM; 1.4 amp; Torque 4.6 in. oz.; HP .03. $10.00 ea.
EASTERN AIR DEVICES TYPE JM6B: 200 VAC; 1 amp; 3 phase; 400 cycles, 6000 RPM....$12.50 ea.
EASTERN AIR DEVICES, TYPE J31B: 115 V. 400-1200 Cycle. Single Phase......................$12.50 ea.
AIRESEARCH: AC induction, 200 V; 3 Phase, 400 Cycle, 2 H.P.; 11,000 RPM; 8 amps.......$79.50 ea.
AIRESEARCH: AC Induction, 200 V; 3 Phase, 400 Cycle, 12 H.P. 6500 RPM; 1.5 amps..........$25.00
Electric Motor: PNT—1400—A1—1A Serial No. 207, 208 V., 400 Cycles, 3 Phase Kearfott Co., Inc. $17.50 ea.

SERVO MOTOR 10047-2-A; 2 Phase; 400 Cycle, with 40-1 Reduction Gear $17.50

SMALL DC MOTORS

EMERSON #174: 12 Volt DC; 1/6th HP; 10 amp; 3800 RPM; Approx. size: 2½" x 5"..........$9.95 ea.
DELCO #5072000: 27.5 VDC; 11.75 rpm.......$15.00
DELCO #5068750: constant speed: 27 VDC; 160 RPM; built-in reduction gears and governor. $12.50 ea.
J. OSTER: series reversible motor: 1/50th H.P.; 10,-000 RPM; 27½ VDC; 2 amps; **SPERRY #806069:** approx. size 1⅝" x 3½".........................$7.00 ea.
General Electric Type 5AB10AJ37: 27 volts, DC; 5 amps. 8 oz. inches torque; 250 RPM. shunt wound; 4 leads; reversible ....$15.00 ea.
General Electric. Mod. 5BA10FJ33: 12 oz. inches torque, 12 DC, 50 RPM. 1.02 amp.........$15.00 ea.
General Electric Type 5BA10AJ52C: 27 volts DC; 5 amps. 8 oz. inches torque; 145 RPM; shunt wound; 4 leads; reversible ....$15.00 ea.
GENERAL ELECTRIC DC MOTOR Mod. 5BA10AJ64. 160 r.p.m.; 65 amp; 12 oz.-in. torque; 27V DC. $19.95 ea.
2¼ H.P. MOTOR—Mfg. LEECE-NEVILLE Co; Type 1454-MO; 24VDC; 4000 RPM; 100 amp........$35.00

115 VLT GENERATORS



Brand new Eclipse generators: 115 VAC; 9.4 amp; 1000 watts; single phase; 800 cycles, 2400-4200 rpm. DC output is 30 volts at 25 amp. Unit has spline drive shaft and is self-excited.....................$29.95

MICROPOSITIONER

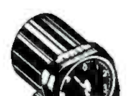
Barber Colman AYLZ 2133-1 Polarized D.C. Relay: Double Coil Differential sensitive, Alnico P.M. Polarized field, 24V contacts; .5 amps; 28 V. Used for remote positioning, synchronizing, control, etc.$12.50 ea.

BLOWER

Eastern Air Devices, Type J31B; 115 volt; 400-1200 Cycle; single phase; variable frequency; continuous duty; L. & R. #2 blower; approx. 22 cu. ft./min. $15.00

BLOWER ASSEMBLY

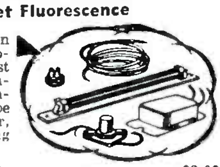
115 Volt, 400 Cycle, Westinghouse Type FL. 17CFM, complete wit hcapacitor. New............$12.50 ea.



SENSITIVE ALTIMETER

Pioneer Sensitive altimeters, 0-35,000 ft. range . . . calibrated in 100's of feet. Barometric setting adjustment. No hook-up required. $12.95 ea.

BLACK LIGHT KITS
Ultra-Violet Fluorescence

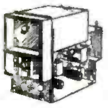


Now . . . build your own black light lamp equipment at a new low cost with these easy-to-assemble components. Kit contains: Ultra-Violet tube brackets, ballast, starter, wire, plug and wiring diagram.
4-Watt Kit—(5½" tube)...........................$3.00
8-Watt Kit—(12" tube)...........................$4.00

C and H Sales Company

BOX 356-X EAST PASADENA STATION • PASADENA 8, CALIFORNIA

COMMUNICATIONS EQUIPMENT CO.



INTERPHONE AMPLIFIER

Easily converted to an Ideal Inter-Communications set for office, home, or factory. Original. New w/conversion. Diagram **$4.75**

HI-POWER COMPONENTS

Plate Trans. Primary: 115 V, 50-60 Cy. Sec. 17-600 V/144 MA. Has "Bilt-in" Filter Choke. Oil Immersed $115

Plate Trans. Pri: 198/220/240 V, 60 Cy, 1 Ph. Sec: 3650 V/16.7 KVA, 30 KV Insulation. Oil-Immersed, Less Oil Gauge $335

Plate Trans. Amertran #31133. Pri: 110/115/120 V/60 Cy/1 Phase. Sec: 3140/1570 V, 2.36 KVA $65

Fil. Trans. Pri: 220 V/60 Cy/1 Phase. Sec: 5 VCT/10A/30 KV Test $37.50

Plate Trans. Raytheon UX6801. Pri: 115 V/60 Cy./1 Ph. Sec: 22,000 V/234 MA/5.35 KVA. Lo-Cap. "Donut" Construction $135

Reactor: Raytheon U-11533: 13.5 H @ 1.0 Amp., 13.5 KV Test

Reactor, Modulation: 50 H/3 A/80 Ohms DCR. Response: .03 Cy—10 KC. Level: plus 63db. 40 KV Test. Nominal Circuit Impedance: 3000 Oms $350

Swing Reactor: 9-60 HY/.05—400 MA, 10,000 V. Test—Kenyon $14.95

Transtat: Type TH45BG: Input 130/260 V. 50-60 Cy. 1 Ph. Output Range: 0-260 V. 45 A. Max. 11.7 KVA two-unit bank, parallel connected. Completely enclosed in cabinet with handwheel atop. Brand New $325.00

Circuit Breaker: ITE Model KJ. Will handle 600 VAC at 115 A. Break time adjustable from instant. to 10 minute. Break amperes adjustable from 115 A to 1000% overload. Brand New... $15.00

Alternator: Louis-Allis Co. Type "AL", 198-C. Output 110/220 V—1 Ph. 60 Cy. .9 P.F. 1200 RPM, completely self-regulating with built-in exciter. Brand new, original crates $795.00

SELSYNS

115 VAC 60 CYCLES 1 PHASE

1—Transmitter #C-78248
1—Differential #C-78249
Per Set **$24.50**

Transmitter Units Only .... $17.50 ea.

UPRIGHT OIL CAP

MFD	Each
220VAC/600VDC	
6.2	$1.29
15	3.49
330VAC/1000VDC	
15	3.79
1000VDC	
.5	.69
.5-.5	1.19
1	1.49
4-1.5	2.19
1.5	1.39
1500 WVDC	
1	1.59
1.5	1.59
2	1.79
2000 WVDC	
1	1.79
2500 WVDC	
.5	2.98
4000 WVDC	
.15	6.95
4800 WVDC	
.1-.1	4.79
6000 WVDC	
.1	3.69
115-.15	3.89
1.5	10.98
7000WVDC	
.1-.1	3.79
1	9.95
8000 WVDC	
.075-.075	3.79
10K VDC	
.1	8.95
15K VDC	
.0016	7.95
16K VDC	
.015	9.50
20K VDC	
.25	17.50
25K VDC	
1	85.00
.5	65.00

NON-POLAR CAPACITORS

A. C. ELECTROLYTICS

CAP.	VAC.	PRICE
13-15	220-	$1.20
20-24	110-	1.00
26-30	220-	1.35
43-65	110-	1.25
43-48	110-	1.25
50-75	110-	1.25
53-60	220-	1.50
61-69	320-	1.60
64-72	110-	1.25
72-87	110-	1.25
75-84	110-	1.25
88-106	110-	1.50
107-129	110-	1.65
130-157	110-	1.75
130-150	70-	1.50
130-180	110-	1.85
159-191	110-	1.85
161-180	110-	1.75
189-210	110-	1.95
200-220	110-	1.95
270-300	110-	2.10
324-360	110-	2.40
378-420	175-	3.00
432-480	110-	2.75
485-540	110-	2.85

932 PHOTO TUBE

Gas Phototube having SI Response, particularly sensitive to Red and Near Infrared Radiation. Can be used with Incandescent light source. Send for data. Price .... **75¢**

POWER TRANSFORMERS

Comb. Transformers—115V/50-60 cps Input

CT-129	0-0-650V @ 150 MA, 6.3V/4A, 2.5VCT/5A	5.79
CT-013	450-0-450V @ 200 MA, 10V/1.5A, 2.5V/3.5A 5V/3A	6.95
CT-341	1050 10MA,—625V @ 5MA, 26V @ 4.5A 2x2.5V/3A, 6.3V @ 3A	9.95
CR 825	360VCT .340A 6.3VCT/3.6, 6.3VCT/3A	3.95
CT-071	110V .200A 33/.200, 5V/10, 2.5/10	4.95
CT-367	580VCT .050A 5VCT/3A	2.25
CT-403	350VCT .026 A 5V/3A	2.75
CT-931	585VCT .086 A 5V/3A, 6.3V/6A	4.25
CT-456	390VCT 80 MA 6.3V/1.3A, 5V/3A	3.45
CT-931	585VCT 86 MA 5V/3A, 6. V/6A	4.95
CT-442	525VCT 75 MA 5V/2A, 1 CT/2A, 50V/200 MA	3.85
CT-43A	600-0-600V/.08A, 2.5VCT/6A, 6.3VCT/1A	6.49
CT7-501	650VCT/200MA, 6.3V/8A, 6.3V/5A	6.49
CT-444	230-0-230V/.085A, 5V/3A, 6V/2.5A	3.49

Filament Transformers—115V50-60 cps Input

Item	Rating	Each
FT-140	5VCT @ 10A 25KV Test	$22.50
FT-157	4V/16A, 2.5V/2.75A	2.95
FT-101	6V/.25A	.79
FT-924	5.25A/21A, 2x7.75V/6.5A	14.95
FT-824	2x26V/2.5A, 16V/1A, 7.2V/7A, 6.4V/10A, 6.4V/2A	8.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-38A	6.3/2.5A, 2x2.5V/7A	2.79

Plate Transformers, 115V 60Cy Input

PT 175	550-0-550VAC, (400VDC) @ 150MA	$6.30
PT 157	660-0-660 VAC, (500VDC) or 550-0-550 VAC (400VDC) at 250 MADC	8.70
PT 158	1080-0-1080V (1000VDC) at 125MA Plus 500-0-500 VAC (400VDC) at 150MADC Simult. Ratings	10.80
PT 159	900-0-900 VAC (750VDC) or 800-0-800 VAC (600VDC) at 225 MADC	10.35
PT 167	1400-0-1400 VAC (300MADC) or 1175-0-1175 VAC (1000VDC) at 300MADC	25.80
PT 168	2100-0-2100 VAC (1750VDC) or 1800-0 1800 VAC (1500VDC) at 300MADC	33.00
PT 062	2900-0-2900 VAC (2500VDC) or 2385-0-2385 VAC (2000VDC) at 300MA	48.00

10 KW TRANSMITTER KIT

1) Plate XFMR: Amertran 33134. Pri: 198/220/240V, 60 cy., 1 ph. Sec: 3650V, 16.7 KVA, 30 KV insulation. Oil Immersed.

1) Reactor, Modulation. Amertran 33153. 50 H @ 3.0 amps. DCR=80 ohms. Freq.—.03 cy. to 10 KC. Level: 63 DB. 40 KV Test. Impedance: 3000 ohms. A great value. Both units (Trans & Choke) for **$630.00**

400 CYCLE TRANSFORMERS

(All Primaries 115V. 400 Cycles)

Stock	Ratings	Price
352-7102	6.3V/2.5A	1.45
M-7472426	1450V/1.0MA, 2.5V/.75A, 6.4V/3.9A, 5V/2A, 6.5V/.3A, P/O 1D-39/APG-13	4.95
352-7039	640VCT @ 380MA, 6.3V/.9A, 6.3V6A 5V/6A	5.49
702724	9800/8600 @ 32MA	8.95
K59584	5000V/290MA, 5V/10A	22.50
KS9607	734VCT/.177A, 1710VCT/.177A	6.79
352-7273	700VCT/350MA, 6.3VO.9A, 6.3V 25.A 6.3V/.08A, 5V/CA	6.95
352-7070	2x2.5V/2.5A (2KV TEST) 6.3V/2.25A, 1200/100/750V. @ .005A	7.45
352-7196	1140/1.25MA, 2.5V/1.75A, 2.5V/1.75A —5KV Test	3.95
352-7176	320VCT/50MA, 4.5V/3A, 6.3VCT/20A, 2x6.3VCT/6A	4.75
RA6400-1	2.5/1.75A, 6.3V/2A—5KV Test	2.39
901692	13V 9A	2.49
901699-501	2.77V @ 4.25A	3.45
901698-501	900V75MA, 100V/.04A	4.29
Ux8855C	900VCT/.067A, 5V/3A	3.79
RA6405-1	800VCT/65MA, 5VCT/3A	3.69
T-48852	700VCT/806MA5V/3A, 6V/1.75A	4.25
352-7098	2500V/MA, 300, VCT, 135MA	5.95
KS 9336	1100V/50MA TAPPED 625V 2.5V/5A	3.95
M-7474319	6.3V/2.7A, 63.V/.66A, 6.3VCT/21A	4.25
KS8984	27V/4.3A, 6.3/2.9A, 1.25V/.02A	2.95
52C080	650VCT/50MA, 6.3VCT/2A, 5VCT/2A	3.75
32332	400VCT/35MA, 6.4V/2.5A, 6.4V/.15A	3.85
68G631	1150-0-1150V	2.75
80G198	6VCT/.00006 KVA	1.75
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 ALL CT	4.79
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	2.5V1.75A, 5V/3A, 6.5V/6A, 6.5V/1.2A, P/O BC800	
352-7099	360VCT/20MA, 1500V/1MA, 2.5V/1.75A, 6.3V/2.5A, 6.3V,6A, P/O BC-929	6.45
D163253	5200V.002A, 2.5V/5A	5.35
M-7471957	2.5V/20A, 12KV Test	4.85
352-7179	250V/100MA, 6.5V/12ACT 5V/2A	3.45

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	PRICE
DM 416	14	6.2	330	.170	$6.75
DM 33A	28	7	540	.250	3.95
BD AR 93	28	3.25	375	.150	7.50
23350	27	1.75	285	.075	3.95
B-19 Pack	12	9.4	275	.110	8.95
			500	.050	
DA-3A*	28	10	300	.260	6.95
			150	.010	
			14.5	5.	
PE 73 CM	28	18	1000	.350	22.50
BD 69‡	14	2.8	220	.08	12.95
D-402†	13.5	12.2	300	8.8VAC	12.50
SP 175	18	3.2	450	.06	4.49
DM 25†	12	2.3	250	.05	6.95

PE-94C Power Supply, Brand New $6.95

‡ Less Filter * Replacement for PE 94.
† Used, Excellent

INVERTERS

PE-218-H: Input: 25/28 vdc, 92 amp. Output: 115v. 350/500 cy 1500 volt-amperes. NEW $37.50

PE-206: Input: 28 vdc, 36 amps. Output: 80 v 800 cy. 500 volt-amps. Dim: 13"x5½"x10½". New $22.50

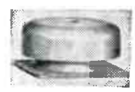
NAVY COR-211095: Input 22-30 VDC/75-60A. OUTPUT: 115V/400 CY. 1 KVA/8.7A. RPM: 4800 With coupling provision for motor. Brand New. Original packing $150.00

SELENIUM RECTIFIERS*

Current (Continuous)	18/14 Volts	36/28 Volts	54/42 Volts	130/100 Volts
1 Amp.	$1.35	$2.15	$3.70	$8.50
2 Amps.	2.20	3.60	5.40	10.50
2½ Amps.	......	......	6.00	13.00
4 Amps.	4.25	7.95	12.95	25.25
6 Amps.	4.75	9.00	13.50	33.00
10 Amps.	6.75	12.75	20.00	44.95
12 Amps.	8.50	16.25	20.50	49.00
20 Amps.	13.25	25.50	38.00	79.50
24 Amps.	16.25	32.50	45.00	90.00
30 Amps.	20.00	38.50	......	......
36 Amps.	25.00	48.50		

* F. W. Bridge

BARRYMOUNTS



C-2045
C-2060
C-2070
C-2090

45¢ each
$35/100

APN-3 SPARE PARTS

K-901684-501: SCS #229632.306, Trans $2.49
K-901689-501: SCS #229631.238, Trans 2.25
K-901692-503: SCS #229617-70, Xfmr, Fil. 2.49
K-901699-501: SCS #229617-68, Fil. Xfmr. 3.45
K-901698-501: SCS #229618-38, Plate Xfmr. 4.29
K-901695-501: SCS #229627-19, Pulse Xfmr. 3.50

BAND PASS FILTERS

INPUT IMPEDANCE: 2000 OHMS. OUTPUT: TO GRID. AVAILABLE IN FOLLOWING RANGES:

CHANNEL	Fr.	F1*	F2*
5	1155	830	1620
7	2270	1620	3180
8	3180	2270	4450
9	4450	3180	6230
10	6230	4450	720

* Fr.: Center Freq. In CPS; F1 and F2 are lower and upper limits (CPS) respectively, at —20 db points.

Price, $4.95 Each

JAN/UG CONNECTORS

UG 9/U	$0.85	UG 58/U	$0.70
UG 10U	.95	UG 89/U	1.05
UG 21/U	.80	UG 102/U	.75
UG 22B/U	1.25	UG 188/U	1.15
UG 22/U	1.20	UG 254/U	2.50
UG 27/U	1.20	UG 261/U	1.10
UG 27A/U	2.25	D-166366	.75

SPARES FOR APN-9

Power Trans., Pt. No. 352-7295-2 .... $4.95 each
Counter Trans., T111, T112, T117, Pt. No. 352-7251-2 .... $2.50 each
Counter Trans., T113, T114, T115, T116, T118, T119, T120, Pt. No. 352-7250-2 ...... $2.50 each
I. F. Trans: T107 thru T110 Pt. #352-1554S $1.00 each
Resistor: R150, R157, R162 84,000 OHMS .... .50 each
Resistor: R130, 220,000 ohms .... .50 each
Resistor: R159 120,000 ohms .... .50 each
Resistor: T152, R164, 17,000 ohms .... .35 each
Resistor: R142, 4300 ohms .... .35 each

CIRCUIT BREAKERS

HEINEMANN: .01A. 2340 V—Insulated for 5000 V. Separate Tmls. for coil and contact $1.9
#1510 M-7: 7A, 24 VDC SCS #3H900-7-3 .... $1.6
#AM 1614-100: 100 Amps, 24 VDC $1.6
#AM 1614-80: 80 Amps. 24 VDC $1.4
#AM 1610-.5: 500 MA. 1000 VDC. Curve 3. SCS #3H900A-50 .... $2.25
SCS #3H900-10-3: 40 VDC. 10 Amps $1.65

MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. SEND M.O. OR CHECK. ONLY SHIPPING SENT C.O.D. RATED CONCERNS SEND P. O. ALL MDSE SUBJECT TO PRIOR SALE AND PRICES SUBJECT TO CHANGE WITHOUT NOTICE. PARCELS IN EXCESS OF 20 POUNDS WILL BE SHIPPED VIA CHEAPEST TRUCK OR RAILEX.

131 Liberty St., New York 7, N. Y. Dept E-1 Chas. Rosen Phone: Digby 9-4124

COMMUNICATIONS EQUIPMENT CO.

PULSE NETWORKS

15A—1.400-50: 15 KV, "A" CKT, 1 microsec. 400 PPS, 50 ohms imp. $37.50
G.E. #3E (3-84-810) (8-2.24-405) 50P4T; 3KV "E" CKT Dual Unit; Unit 1, 3 sections, 0.84 Microsec. 810 PPS, 50 ohms imp.; Unit 2, 8 Sections, 2.24 microsec. 405 PPS 50 ohms imp. $6.50
7-5E3-1-200-67P. 7.5 KV "E" Circuit, 1 microsec. 200 PPS 67 ohms impedance 3 sections $7.50
7-5E4-16-60, 67P, 7.5 KV "E" Circuit, 4 sections 16 microsec. 60 PPS. 67 ohms impedance $15.00
7-5E3-3-200-67P. 7.5 KV. "E" Circuit. 3 microsec. 200 PPS. ohms imp. 3 sections $12.50
KS8865 CHARGING CHOKE: 115-150 H @ .02A. 32-40H @ .08A. 30,700V Corona Test, 21KV Test $37.50
G.E. 25E5-1-350-50 P2T, "E" CKT. 1 Microsec. Pulse @ 350 PPS. 50 OHMS Impedance $69.50
KS9623 CHARGING CHOKE: 16H @ 75 MA, 380 Ohms DCR, 9000 Vac Test $14.95
G.E. 6E3-5-2000 50 P2T: 6 KV., "E" Circuit 0.5 usec/2000 PPS/50 ohms/2 sections $7.50

PULSE EQUIPMENT

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp). Duty Ratio: .001 max. Pulse duration: 5, 1.0, 2.0 microsec. Input voltage: 115 v. 400 to 2400 cps. Uses: 1-71B, 4-89-B, 3-'72's, 1-'73. New ....Less Cover—$135
APQ-13 PULSE MODULATOR. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk pwr. out 35 KW Energy 0.018 Joules $49.00
TPS-3 PULSE MODULATOR. Pk. power 50 amp. 24 KW (1200 KW pk): pulse rate 200 PPS. 1.5 microsec. pulse line impedance 50 ohms. Circuit series charging version of DC Resonance type. Uses two 705-A's as rectifiers, 115 v. 400 cycle input. New with all tubes $49.50
SPRAGUE H-615 "E" Circuit 10KV, 0.85 microsec pulse at 750 PPS—50 ohms $27.50
SPRAGUE H-616, "E" Circuit, 10KV 2.2 microsec pulse at 3.755 PPS—50 ohms $27.50

PULSE TRANSFORMERS

GE #K-2449A
Primary: 9.33 KV, 50 ohms Imp.
Secondary: 28 KV, 450 ohms.
Pulse length: 1.0/5 usec @ 635/120 PPS. Pk. Power Out: 1,740 KW
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 $39.50
K-2745. Primary: 3.1/2.8 KV, 50 ohms Z. Secondary: 14/12.6 KV 1025 ohms Z. Pulse Length: 0.25/1.0 usec @ 600/600 PPS. Pk. Power 200/150 KW. Bifilar: 1.3 Amp. Has "built-in" magnetron well $42.50
K-2461-A. Primary: 3.1/2.6 KV—50 ohms (line). Secondary 14/11.5 KV—1000 ohms Z. Pulse Length: 1 usec @ 600 PPS. Pk. Power Out: 200/130 KW. Bifilar: 1.3 Amp. Fitted with magnetron well $39.75
UTAH X-151T-1: Dual Transformer, 2 Wdgs. per section 1:1 Ratio per sec 13 MH inductance 30 ohms DCR $7.50
UTAH X-150T-1: Two sections, 3 Wdgs. per section. 1:1:1 Ratio, 3 MH, 6 ohms DCR per Wdg $7.50
68G711: Ratio: 4:1 Pri: 200V, Sec. 53V, 1.0 usec Pulse @ 2000 PPS. 0.016 KVA $4.50
TR1049 Ratio: 2:1 Pri. 220 MH, 50 Ohms, sec. 0.75 H. DCR 100 Ohms $6.75
K-901695-501: Ratio 1:1, Pri. Imp. 40 Ohm, Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.05 usec rise $8.95
Ray UX 7896—Pulse Output Pri. 5v. sec. 41v $7.50
Ray UX 8442—Pulse inversion—40v + 40v $7.50
PHILCO 352-7250, 352-7251, 352-7287
RAYTHEON: UX8693, UX5986 ....$5 ea.
W.E.: D-166310, D-166638, KS9800, KS9948.
UTAH #9262, with Cracked Beads, but will operate at full rated capacity $5.00
UX 8693 (SCS #2Z9627-54); 3 Wdgs. 32 turns #18 wire. DCR is: 362/.372/.4 ohms. Total voltage 2500 vdc. $5.00
D-166173: Input: 50 ohms Z. Output: 900 ohms 3 Wdgs. Freq. range 10 kc-2mc. P/O AN/APQ*-13 ....$12.50

10 CM R.F. HEAD

Complete R.F. Head and Modulator delivers 50 KW Peak R.F. at 3000 MC. Pulser delivers 12KV pulse at 12 Amp. to magnetron of .5, 1, or 2 microsec. duration at duty cycle of 001. Unit requires 115V, 400-2400 Cycles, 1 phase @ 3.5A. Also 24-28 VDC @ 2A. External sync. Pulse of 120V Reg'd. Brand New. Complete with schematic and all tubes $375.00

THERMISTORS

D-164699	Bead Type DCR: 1525-2550 Ohms @ 75 Deg. F, Coefficnent: 2% Per Deg. Fahr. Max. Current 25 MA AC/DC	$2.50
D-167332	Bead Type, DCR is 1525-2550 Ohms. Rated 25 MA at .825-1.175 VDC	1.50
D-167613	Disk Type DCR: 355 Ohms @ 75 Deg. F. P. M. 2.5%, 1 Watt	1.50
D-166228	Disk Type 7120 Ohms @ 60°F. 4220 Ohms @ 80°F. 2590 Ohms @ 100°F, 1640 Ohms @ 120°F	1.50

MAGNETRONS

Type	Freq. Range(MC)	Peak Power Out (KW)	Duty Ratio	Price
2J21A	9345-9405	50		$8.75
2J22 ‡	3267-3333	265		7.50
2J27 ¶	2965-2992	275	.002	19.95
2J31	2820-2860	285	.002	24.50
2J32	2780-2820	285	.002	28.50
2J38*	3249-3263	5		16.50
2J39*	3267-3333	8		24.50
2J48	9310-9320	50	.001	24.50
2J49	9000-9160	50	.001	59.50
2J56*	9215-9275	50	.001	132.50
2J61†	3000-3100	35	.002	34.50
2J62†	2914-3010	35	.002	34.50
700B	690-700	40	.002	22.50
700D	710-720	40	.002	39.75
706EY	3038-3069	200	.001	32.50
706CY	2976-3007	200	.001	32.50
725-A	9345-9405	50	.001	Write
730-A	9345-9405	50	.001	24.50
4J38	3550-3600	750	.001	169.45

*—Packaged with magnet.
†—Tunable over indicated range.

QK 60, 61, 62—$85 ea.

KLYSTRONS

723A ....$12.50 | 2K25/723A/B $27.50
723A/B ....19.50 | 417-A (Sperry) 17.50

JUST ARRIVED!!
MAGNETRONS

5J23 ...$49 | QK-253 ..$249
4J34 ...$125 | 3J31 ...$85

TEST SETS

TS 12/AP, UNITS 1 & 2 ....$450
TS 47/APR, 50-500MC $250

BC 1203 MODULATOR

Provides 200-4,000 PPS, Sweeptime: 100 to 2,500 microsec. in 4 steps fixed mod. pulse, suppression pulse, sliding modulating pulse, blanking voltage, marker pulse, sweep voltages, calibration voltages, fil. voltages. Operates 115 vac. 50-60 cy. Provides various type of voltage pulse outputs for the modulation of a signal generator such as General Radio #804B or #804C used in depot bench testing of SCR 695, SCR 595, and SCR 535. New. Complete with tubes $150

RADAR SETS

SO-1

10 cnt. with a range of 4, 20, and 80 miles. PPI presentation on a 5 inch screen, 360 deg rotation of antenna with a pattern 8 deg in horiz. and 18 deg. in vert. plane. Operates from 115 vdc. Set consists of following: antenna, m/g—modulator, xmtr—rcvr, PPI unit, accessory control, and rectifier power unit.

MK10

GUN RADAR. Extremely accurate, rugged and compact. Designed for ship board use to direct naval gun turrets. Antenna utilizes conical scanning for accurate pointing. Max. range is 20,000 yards with an error of pm 15 yds pm .1% of range. Pointing accuracy is pm .25 deg. Pulse dur. 0.5 usec. at prr of 3600 cps. Pk. power output is 25 Kw. Primary power consumption is 1300 watts. Operates from 115V, 60 CPS Source. BRAND NEW, COMPLETE WITH SPARES AND INSTRUCTION MANUAL ....POR*

SQ

Portable radar with type PPI, "A", or "B" Scope. Frequency is Approx. 3000 Mcs. 3 ranges: 3, 15, and 45 miles. Operates from 115v, 60 cycles $850

SE

10 cm radar for use on small surface craft for Sea-Search use. Max. range 80,000 yards, with an accuracy of 100 yards ± 1% of range. Bearing accuracy 2 degrees. Operates from 115 VDC. Complete Equipment, Brand new, in original matched sets @ $850.00

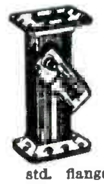
SN

Portable, lightweight, 10 cm set with ranges of 4 and 20 Mi. Presentation is on 5" "A" Scope. Operates from 115V, 50-60 Cy. Ideal for labs, Classrooms, and small boats $850.00

IFF SETS RC 148 RC 184 RC 145 RC 188 Navy BM
PRICE ON REQUEST

MICROWAVE COMPONENTS

"S Band," RG48/U Waveguide



POWER SPLITTER for use with type 726 or any 10 CM Shepherd Klystron. Energy is fed from Klystron antenna through dual pick-up system to 2 type "N" connectors ..$22.50 EACH
DIRECTIONAL COUPLER. Broadband type "N" Coupling, 20 db. with std. flanges, Navy #CABV47AAN-2 (as shown) $37.50
LHTR, LIGHTHOUSE ASSEMBLY. Part of RT39 APG 5 & APG 15. Receiver and Trans. Cavities w/assoc Tr. Cavity and Type N CPLG, To Recvr. Uses 2C40, 2C43, 1B27, Tunable APX 2400-2700 MCS. Silver Plated $32.50
BEACON LIGHTHOUSE cavity p/o UPN-2 Beacon 10 cm. Mfg. Bernard Rice, each $47.50
MAGNETRON TO WAVEGUIDE Coupler with 721-A Duplexer Cavity, gold plated $45.00
RT-30 APG-5 10 cm. lighthouse RF head c/o Xmtr.-Recvr-TR, cavity compl. recvr. & 30 MC IF strip using 60K5 (2C40, 2C43, 1B27 lineup) w/Tubes.
721A TR BOX complete with tube and tuning plungers $12.50
McNALLY KLYSTRON CAVITIES for 707B or 2K28 ....$4.00
WAVEGUIDE TO ⅞" RIGID COAX "DOORKNOR" ADAPTER CHOKE FLANGE, SILVER PLATED BROAD BAND $32.50
AS14A AP-10 CM Pick up Dipole with "N" Cables $4.50
OAJ ECHO BOX, 10 CM TUNABLE $22.50
HOLMDELL-TO-TYPE "N" Male Adapters, W.E. #D167284 ....$2.75
I.F. AMP. STRIP: 30 MC, 30 d.b. gain, 4 MC Bandwidth, uses 6AC7's—with video detector, A.F.C. less tubes $24.50
POLYROD ANTENNA, AS31/APN-7 in Lucite Ball. Type "N" feed $22.50
ANTENNA, AT49A/APR: Broadband Conical, 300-3300 MC Type "N" Feed $12.50
"E" PLANE BENDS, 90 deg. less flanges $7.50

X Band— RG 52/U WAVEGUIDE

VSWR Measuring Section. Consisting of 6" straight section, with 2 pick-up, Type "N" Output Jacks. Mounted ½ Wave apart $8.50
1" x ½" waveguide in 5' lengths, UG 39 flanges to UG40 cover ....per length $7.50
Rotating-joints supplied either with or without deck mounting. With UG40 flanges ....each, $17.50
Bulkhead Feed-thru Assembly $15.00
Pressure Gauge Section 15 lb. gauge and press nipple $10.00
Pressure Gauge, 15 lbs. $2.50
Directional Coupler, UG-40/U Take off 20db. ..$17.50
TR-ATR Duplexer section for above $8.50
Waveguide Section 12" long choke to cover 45 deg. twist & 2½" radius, 90 deg. bend $4.50
Waveguide Section 2½ ft. long silver plated with choke flange $5.75
Rotary joint choke to choke with deck mounting $17.50
90 degree elbows, "E" or "H" plane 2½" radius $12.50
Microwave Receiver, 3 CM. Sensitivity: 10-13μ Watts. Complete with L.O. and AFC Mixer and Waveguide Input Circuits, 6 I.F. Stages give approximately 120 DV gain at a bandwidth of 1.7 MC. Video Bandwidth: 2 MC. Uses latest type AFC circuit. Complete with all tubes, including 723A/B Local Oscillator $175.00
ADAPTER, waveguide to type "N", UG 81/U, p/o TS 12, TS-13, Etc. $27.50
ADAPTER, UG-163/U round cover to special btl. Flange for TS-45, etc. ....$2.50 ea.

1¼" x ⅝" WAVEGUIDE

CG 98B/APQ 13 12" Flex. Sect. 1¼" x ⅝" OD. $10.00
X Band Wave GD 1¼" x ⅝" O.D. 1/16" wall aluminum ....per ft. 75¢
Slug Tuner Attenuator W.E. guide, gold plated .$6.50
Bi-Directional Coupler. Type "N" Takeoff 25 db. coupling $27.95
Bi-Directional Coupler. UG-52. Takeoff 25 db. coupling $24.95
Waveguide-to-Type "N" Adapter. Broadband ..$22.50

WAVEGUIDE FLANGES

UG 39/U ....$1.10 | UG 51/U $1.65
UG 40/U ....$1.25 | UG 52/U $3.40
UG 40A/U ....$1.65 | UG 52A/U $3.40

MICROWAVE MIXER

CV-12/APR-6: Waveguide/mixer unit, 4000-6000 mc. Designed for use with microwave receiver. Has pick up loop for coupling to lighthouse cavity local oscillator. RF input is to 1" x 2" waveguide (contact flange). Output (thru 1n21 xtl.) is from standard 50-ohm coax connector. Brand new, complete with crystal. As shown $35.00

MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. SEND M.O. OR CHECK. ONLY SHIPPING SENT C.O.D. RATED CONCERNS SEND P. O. ALL MDSE. SUBJECT TO PRIOR SALE AND PRICES SUBJECT TO CHANGE WITHOUT NOTICE. PARCELS IN EXCESS OF 20 POUNDS WILL BE SHIPPED VIA CHEAPEST TRUCK OR RAILEX.

131 Liberty St., New York 7, N. Y. Dept E-1 Chas. Rosen Phone: Digby 9-4124

RELAYS RELAYS RELAYS

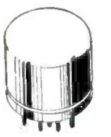
JOBBERS—EXPERIMENTERS—LABORATORIES

WRITE OR PHONE WALKER 5-9642 FOR YOUR RELAY REQUIREMENTS
Ask for Mr. Greenberg or Mr. Herzog

We have a large variety of standard types of relays and solenoids for a multiplicity of uses which for various reasons are not listed in our advertising. When inquiring concerning your needs give as much information as possible. Catalog numbers are not sufficient. Give coil voltage; specify AC or DC; give current or resistance; contact current and arrangement.

ALL MERCHANDISE IS GUARANTEED AND MAY BE RETURNED FOR FULL CREDIT

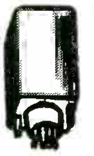
HERMETICALLY SEALED RELAYS



CLARE SERIES 5000: Clare SK Relay enclosed in hermetically sealed cylindrical can 1½" di. x 2½" h. All relays in this series are provided with a standard RMA octal plug base.

Stock No.	Type	Volts D.C.	MA	Contacts	Ohms	Price each
R438	5018	24	80	3A	300	5.95
R928	5023A	24	80	2C	300	6.95
R440	5036	36	15	2A, 1C	2450	6.95
R441	5094	36	12	2A 1C	2850	6.95
R929	5123	24	80	2C	300	7.25
R442	5167	75	30	1C(5amp)	2500	6.95

CLARE 15001; 115VAC, 60-400 cyc; DPST (2A); #R453 .... 6.95
CLARE 15006; 115VAC, 60-400 cyc; SPDT (1C); #R454 .... 6.95
ALLIED & PRICE 5709-27HPX; 24VDC; DPDT; 625 ohm; Octal Plug Base; #R449 .... 6.95
ALLIED PRHX; 24VDC; 2A, 1B, (10 amp); 300 ohm; #R450 .... 6.95
ADVANCE A8774-1Y; 6VDC; SPST (1A); 36 ohm; Solder Lug Terminals; #R443 .... 4.95



SIGMA 949; 115VAC; SPST, n.c. (1B); #R445 .... 4.95
SIGMA 71257; 6VDC; SPDT; 47 ohm; #R448 .... 5.95
STRUTHERS DUNN 181CXC100; 12VDC; 3As; 3Bs; 150 ohm; #R679 6.95
STRUTHERS DUNN 181BBX100; 6VDC; 2As; 2Cs; 36 ohm; #R447 .. 6.95
4PDT SEALED AN TYPE; 24VDC; 425 ohm; (4Cs); Standard Makes; #R446 .... 5.95
STEVENS ARNOLD Millisec Relay Type 328; 24VDC; 1B, 1C; 1600 ohm; Solder Head Terminals; #R930 9.95
SIGMA 4AH; 4 ma pull-in, 2.5 ma hold; SPDT; 5-prong Plug Base; #R444 2000 ohm; RTMA ... 4.25
SIGMA 4RJ-47G; 3VDC; SPDT; 47 ohm; Solder Head Terminals; #R448 .... 5.95
SIGMA 5RJ100S; 1.5VDC; SPDT; 100 ohm; Solder Head Terminals; #R1001 .... 6.95
SIGMA 5RJ2000G; 2.3 ma; SPDT; 2000 ohm, #R1005 .... 7.50
SIGMA 5RJ5000G; 1.4 ma pull in, 0.4 ma hold; SPDT; 5000 ohm; #R281 .... 6.95

AND MANY OTHERS

WESTERN ELECTRIC MERCURY CONTACT RELAYS

D 171584; SPDT; 24V Heater; 1 coil of 4500 ohms; operating current 6.6 ma; release current 5.2 ma. Overall length—3¼"; overall diameter—1-316". #R1021....$6.95 each

10 for $65 100 for $625

Motor Driven

TIME DELAY RELAYS

HAYDON 5901-2; Adjustable Reset timing relay from 0.2 to 1.0 min. in 0.1 min. steps; SPDT (10 amp) #R931 100V 60 cyc...$7.95
#R466 220V 60 cyc $7.95

PRICE 4063-7; Adjustable Reset Timer 9 to 54 seconds in 6 sec. steps; DPDT (10 amp) Instantaneous solenoid release; 110V 60 cyc. #R932 .... $12.95

LORD SHOCKMOUNTS

Stock No.	Series	Center Hole	LB	Other Data	Each
SM11	100	1/8"	1	Monel	.12
S12	100	1/8"	2	Steel	.10
SB12	100	Stud	2	Steel Base	.12
S14	100	1/8"	4	Steel	.12
S18	100	3/16"	8	Steel	.15
ST54	150	1/4"	4	Stainless	.20
SM54	150	1/4"	4	Monel	.25
S60	150	1/4"	10	Steel	.20
S83	150	1/4"	33	Steel	.30
S110	200	3/8"	10	Steel	.28
SM120	200	3/8"	20	Monel	.35
SM145	200	3/8"	45	Monel	.45
S279	279	3/8"	250	Steel	1.00
PD53	100PH	1/8"	3	Dural	.20
P54	150PH	1/8"	4	Steel	.25
P56	150PH	1/4"	6	Steel	.20
PS106	200PH	1/4"	6	Steel	.20
PL106*	200PH	1/4"	6	Steel	.25
PT106	200PH	1/4"	6	Stainless	.35
PT120	250PH	3/8"	20	Stainless	.40

*with ground lug

OTHER MOUNTS

ST75 150 Goodyear 1/4" 25 Stainless .25
P100 200PH U.S. Rubber with tapered rubber nozzle 1/2" long Steel .25
S2030 C2030 Barry 1/4" 30 Steel Fr. 1.00
S2335 C2335 Barry 3/8" 35 Steel Fr. 1.00
S912 Lord 2 hole Mtg Centers 1 1/2" 1/4" 12 Steel .15
S908 Lord Slotted 4 hole Mtg Centers 1 1/2" x 2 1/4" 1/4" 8 Stainless .25
S904 Lord 2 Hole Mtg Centers 1 1/2" 1/8" 4 Steel .10
S800 Cylindrical Rubber 1" Dia x 3/4" high two 1/4—20 x 1/2" steel screws vulcanized in center, U. S. Rubber........ 15¢
S801 Cylindrical Rubber 1 1/2" x 1 1/2" high with two 5/16—18 x 1/2" steel screws vulcanized in center, U. S. Rubber........ 19¢
S803 3/4" Dia. without Mtg Shell Lord 1/8" 2 Steel .10
P101 200PH U.S. Rubber 1/4" #5150C Steel .25

General Description of Series Numbers
100—1" Mounting Centers
150—1 1/2" Mounting Centers
200—2" Mounting Centers
250—2 1/2" Mounting Centers
PH—Cup type shock mount

FERRULE AND OTHER
WIRE WOUND RESISTORS
AT A FRACTION OF MANUFACTURERS' ORIGINAL COST!

IMMEDIATE DELIVERY

From Our Wide Assortment from 0.2 Ohms to 15 Megohms.

ENAMEL • GLASS
FIXED • ADJUSTABLE

New and in Perfect Condition. Nearly all made to JAN Specifications.

Send us your requirements. We have 250,000 wire wound resistors in a large variety of sizes in stock.

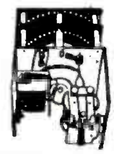
READY FOR IMMEDIATE DELIVERY!

Quantities of the following types of Relays:

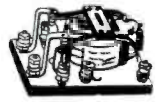
ALLIED—Most numbers

TYPE C TELEPHONE RELAYS

MINIATURE AIRCRAFT



GUARDIAN Series 110, 120, 125, 155, 165, 405, 415 and Series R Steppers



LEACH

AIRCRAFT SOLENOID CONTACTORS

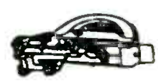
All types B2; B2A; B4; B4A; B5; B5A; B5B; B6A; B6B; B7A; B7B; B8; B9; B11; 1204-1; 1204-3, etc. available from stock in quantities in popular makes at low prices. SEND US YOUR REQUIREMENTS.

IMPULSE DIAL

To open a normally closed circuit. Ten holes — capacity: 1-10 impulses. Has 3 shunt springs, arranged to make when dial is moved off normal. #D101 ....$4.95

STEPPING SWITCHES

AUTOMATIC ELECTRIC TYPE 13

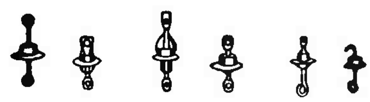


25 Position: Self Interrupter Springs; Norm. Oper Volts: 25 VDC; Max 30 VDC; 0.6 Amps; 30 Ohm. Three Levels Auto. Elect. RA92; #R900 .... $17.75

WESTERN ELECTRIC 22 Position; Make & Break Interrupter Springs; Normal Operating Voltage 6VDC; Max 8VDC 4 ohm; Five Levels #R926 .... $19.75

WESTERN ELECTRIC 44 Position; Make & Break Interrupter Springs; Normal Operating Voltage 6VDC; Max 8VDC; 4 ohm; Two Circuit Levels #R927 .... $22.50

KOVAR GLASS TO METAL SEALS HIGH-VOLTAGE FEED THRU



Many types and sizes. Send us your blueprint or sample for our quote. Our prices are a fraction of original factory cost.

SAMPLE KIT 96 Seals (8 ea. 12 types)	5.00	postpaid in USA
LAB KIT 300 Seals (20 types)	15.00	postpaid in USA

TERMS:—All prices F.O.B. Our Plant. Rated Firms Net 10 Days: All Others Remittance with Order.

Merchandise returnable within 10 days for full credit.

Orders Under $10 Remittance With Order. Plus Approximate shipping charges (overage will be returned).

324 CANAL ST., N.Y.C., 13, N.Y. WAlker 5-9642

Universal general corp.

SELENIUM RECTIFIERS

Full-Wave Bridge Types

Current (Continuous)	18/14 Volts	36/28 Volts	54/42 Volts	130/100 Volts
1 Amp.	$1.35	$2.15	$3.70	$8.50
2 Amps.	2.20	3.60	5.40	10.50
2½ Amps.	3.10	4.20	6.00	13.00
4 Amps.	4.25	7.95	12.95	25.25
6 Amps.	4.75	9.00	13.50	33.00
10 Amps.	6.75	12.75	20.00	44.95
12 Amps.	8.50	16.25	20.50	49.00
20 Amps.	13.25	25.50	38.00	87.50
24 Amps.	16.25	32.50	45.00	95.00
30 Amps.	20.00	38.50	....	.....
36 Amps.	25.00	48.50	....	.....

We can build other Rectifiers and Transformers to your Electrical and Mechanical specs . . . . Immediate Delivery!

NEW SELENIUM RECTIFIER TRANSFORMERS

Pri: 115 V., 60 cycles in.
SEC: 9, 12, 18, 24, and 36 volts
Continuous Ratings....

4 Amps......$8.75
12 Amps......16.75
24 Amps......35.75
30 Amps......45.00
50 Amps......59.75

NEW SELENIUM RECTIFIER CHOKES

2 Amps.—.06 Hy.—4 ohms.............. $3.95
4 Amps.—.07 Hy.—.6 ohm.............. $7.95
12 Amps.—.01 Hy.—.1 ohm.............. $14.95
24 Amps.—.004 Hy.—.025 ohm.......... $29.95

FILTER CAPACITORS

Capacity	W. Voltage	Ea.
500 MFD.	50 V.	.85
1000 MFD.	15 V.	.35
6000 MFD	15 V.	1.50

VICTOREEN VXR-130.

Subminiature Voltage Regulator. Brand new in cellophane bag. Used as stabilizer in battery R. F. supplies; for voltage reference & limiting circuits; for D.C. Amplifier Coupling. Nominal volts: 130... Max. DC Starting Voltage: 200 Regulation: 1 to 2.5 Ma. ± 1½%. You will find many uses for these units—Reg. $4.79
Barry Price ....only $.75 Ten for......$7.00

• New Erco 4 Channel Ship-to-Shore Marine Transmitter — Receiver — F.C.C. Approved. Brand New. Complete, less xtals @..$179.50
Write for Full Details

• **WESTERN ELECTRIC CHOKES**
NEW—HERMETICALLY SEALED
SMOOTHING 8 Henries @ 300 MA. 75 Ohms 4¾" x 5¼" x 5". W.E. # KS 9476....$4.75
SWINGING from 4 to 7 Henries. 200 to 700 MA, 42 Ohms, 5" x 5½" x 5". W.E. KS13063. $4.75

W.E. HERM. SEALED POWER TRANSFORMER Type D175847, Primary 115 AC, 60 Cy. Secondary 1000 VCT @ 500 MA. 5 V @ 5 Amps. (20 KV Insul) 5¼" x 5¼" x 6½". Brand new........$8.50

FLUXMETER

Used to calibrate field strength of magnets from 500 to 4000 gauss and indicate polarity. Probe has gap of 1¼". Beautifully built in hardwood case with hinged cover. Instructions for operation on under side of cover. Size 12¾ x 9 x 6 in. Ideal for lab and school use. New. An exceptional value at..$19.95

FULLY GUARANTEED

TUBE SPECIALS

STANDARD BRANDS ONLY

Type	Price
OA2	$ .87
OA3/VR75	1.03
OB2	.85
OB3/VR90	.90
OC3/VR105	.91
OD3/VR150	.89
OZ4	.50
1AE4	.85
1A3	.70
1A7GT	.66
1AX2	1.05
1B3GT	.85
1B22	1.20
1B23	5.75
1B24	7.15
1B26	2.20
1B27	11.50
1B32	1.45
1B35	8.00
1B42	8.25
1B46	1.85
1B63	39.50
1C6	.45
1G6GT	.60
1H4G	.60
1J6G	.55
1L4	.45
1L6	1.10
1LN5	.73
1N21-B	1.90
1N23A	1.95
1N23B	2.20
1N31	7.25
1N34A	.78
1N38	1.20
1N38A	.95
1N44/400B	1.50
1N45/400C	.90
1N48	.50
1N54	.85
1N64	.68
1N69	.65
1P23	2.50
1P28	9.00
1P40	1.55
1P42	5.00
1Q6	.75
1R4	.67
1R5	.75
1S4	.70
1S5	.70
1T4	.75
1U4	.50
1U5	.70
1V	.65
1V2	.69
1X2A	.85
1Z2	3.20
2AP1	5.70
2B22	2.25
2C21	1.05
2C22	.40
2C33	4.50
2C39	22.50
2C39A	19.50
2C40	6.00
2C43	14.95
2C44	.98
2C51	3.85
2C52	3.75
2D21	1.17
2E24	3.30
2E26	3.40
2E30	2.25
2J21/2J21A	6.50
2J22	5.00
2J26	13.00
2J27	9.70
2J31	20.00
2J32	22.00

Type	Price
2J34	18.50
2J37	12.00
2J39	6.95
2J40	32.00
2J50	18.35
2J54	62.95
2J54B	95.00
2J55	62.50
2J61	29.50
2J62	25.00
2K22	19.50
2K23	11.40
2K25	20.20
2K28	25.00
2K29	23.00
2K30/410R	320.00
2K33	175.00
2K33A	195.00
2K34	139.50
2X2	.33
2X2A	1.39
3A4	.59
3A5	.85
3AP1	5.00
3B7/1291	.39
3B22	2.45
3B24	3.95
3B25	3.50
3B26	2.75
3B28	4.95
3B29	10.50
3BP1	3.65
3BP11	7.75
3C23	6.75
3C24/24G	.90
3C27	3.50
3C31/C1B	2.50
3C33	8.75
3C45	11.75
3CP1	2.00
3D6	.40
3DP1	2.75
3DP1A	6.50
3DP1-S2	3.75
3E29	11.50
3FP7	1.75
3GP1	2.70
3HP14	6.60
3J30	95.00
3J31	75.00
3L4	.90
3Q4	.60
3Q5GT	.84
3RP1	7.50
3S4	.65
3V4	.68
3X2500A3	135.00
4A1	1.15
4B22	7.50
4B25/EL6CF	7.95
4B28/CE225	3.95
4C27	12.75
4C35	19.25
WL4D21/4-125A	30.25
4D22	18.50
4E27	14.00
4J32	220.00
4J36	140.00
4J37	195.00
4J63	195.00
4X150A	29.95
C5B	3.50
5AW4	1.50
5A6	2.75

Type	Price
5BP1	3.35
5BP4	3.35
5C22	37.50
5D21	11.98
WL5D22/4-250A	41.25
5FP7	1.25
5GP1	3.35
5J29	11.50
5J30	29.50
5JP2	19.75
5JP7	22.75
5LP5	17.00
5R4GY	1.20
5R4WGY	1.60
5TP4(RCA)	35.00
5T4	1.40
5U4G	.56
5V4G	.92
5W4	.80
5X4G	.75
5Y3GT	.44
5Y4G	.56
5Z3	.60
5Z4	1.05
6A3	1.12
EL6CF	7.95
C6J	10.75
6C21	24.95
6-4/6-4B	.39
6AB4	.65
6AB7	.90
6AC7	1.04
6AF4	1.20
6AG5	.71
6AG7	1.10
6AH4GT	.80
6AH6	1.88
6AJ5	1.30
6AJ6	1.95
6AK5	.79
6AK5W	1.50
6AK6	.90
6AL5	.55
6AN4	1.50
6AQ5	.55
6AQ6	.65
6AR5	.75
6AR6	2.70
6AS5	.70
6AS6	2.15
6AS7G	3.45
6AT6	.48
6AU5GT	1.00
6AU6	.59
6AV6	.48
6AX4GT	.72
6AX5	.72
6B4G	1.15
6B8	.75
6BA6	.60
6BC5	.69
6BE6	.63
6BG6G	1.79
6BG7	1.65
6BH6	.80
6BJ6	.70
6BK7	1.10
6BL7GT	1.00
6BN6	1.20
6BQ6GT	1.17
6BQ7A	1.23
6BX7GT	1.50
6BY5G	1.98
6BZ7	1.28
6C4	.50
6C5	.59
6C6	.65
6CB6	.65

Type	Price
6CD6G	1.80
6CL6	1.10
6CS6/5915	1.10
6F4	3.50
6F5	.68
6F6M	.65
6F8G	.90
6G12	.90
6H6	.52
6J4	4.95
6J5M	.50
6J5GT	.52
6J6	.75
6J7M	.70
6K4/6K4A	2.25
6K6GT	.59
6K7	.60
6L5G	.90
6L6G	1.05
6L6GA	1.05
6L6M	1.39

WRITE FOR QUOTATIONS ON UNLISTED TYPES.

Type	Price
6L7M	.85
6N7	.75
6P7G	.85
6S4	.58
6S7M	.95
6SD7GT	.80
6SA7GT	.64
6SA7M	.64
6SC7	.79
6SG7	.60
6SH7	.65
6SJ7	.58
6SK7M	.61
6SK7GT	.61
6SL7GT	.64
6SN7GT	.73
6SQ7	.58
6SR7	.59
6SS7	.83
6T8	.89
6U5/6G5	.75
6U8	.90
6V3	1.15
6V6-GT	.61
6V6M	1.35
6W4GT	.59
6W6GT	.75
6X4	.50
6X5GT	.50
7A4	.70
7A7	.74
7A8	.67
7B7	.76
7BP7	4.25
7B8	.75
7C4	.29
7C5	.69
7C6	.69
7C23	65.00
7C30	85.00
7E5	.39
7E6	.55
7F7	.80
7H7	.70
9LP7	3.50
10 (Special)	.95
10T1	.75
12A/112	.75
12A5	1.25

Type	Price
12A6	.75
12AL5	.70
12AT6	.50
12AT7	.89
12AU7	.79
12AV6	.50
12AV7	.90
12AW6	.88
12AX4GT	.90
12AX7	.70
12AY7	1.75
12AZ7	.90
12BA6	.65
12BE6	.64
12BH7	.85
12BY7	1.05
12BZ7	1.10
12GP7	15.25
12SA7	.64
12SC7	.85
12SG7	.78
12SH7	.63
12SJ7	.56
12SK7	.61
12SN7GT	.75
12SQ7	.55
15E	.80
15-R	.50
19AP4A	43.00
19BG6G	2.05
19T8	.90
20-4	1.20
22	.99
23D4	.85
24-A	.55
25AV5	1.20
25A6	1.15
25BQ6GT	1.25
25L6GT	.62
25Z6GT	.59
26	.55
27	.55
28D7	1.55
35A5	.62
35B5	.60
35C5	.62
35L6GT	.65
35W4	.45
35Y4	.55
35Z5GT	.48
41	.75
42	.70
45 (Special)	.40
47	.80
50A5	.75
50B5	.65
50C5	.65
50L6GT	.65
50Y6	.73
50T	3.95
53A	4.95
RK59	1.20
WL-SK60	5.15
QK-60	60.00
QK-61	60.00
VR-65	1.50
70L7GT	1.00
QK-72	250.00
RKR-72	.90
RKK-73	.90
75	.65
76	.50
77	.70
78	.75

Type	Price
80	.64
81	.95
82	.85
83	1.11
83-V	1.00
84/6Z4	.61
98R	5.50
C-100E	2.50
100-TH	5.95
101-F (WE)	2.25
101L (WE)	2.10
102-F (WE)	2.25
104-D (WE)	3.10
FG-105	17.50
VU-111	.88
HY-114B	.50
117L7GT	1.65
117Z3	.75
117Z4GT	1.55
C-120	9.90
121-A	8.00
VXR130	.75
WL-172	51.00
CV-172	25.00
183 (TS)	2.50
211/VT4C	.85
RX215	7.75
215-A	.24
227/227A	3.75
231-D	2.00
RX232	3.20
RX233A	3.35
245A	2.25
QK249	120.00
250-TH	25.75
HK-257B	14.00
271-A	6.30
FG-271/5551	55.00
275-A (WE)	5.95
HF-300	17.50
304-TH	7.75
304-TL	8.75
305A	4.50
306-A	3.95
TR317	14.75
310-A (WE)	3.75
311-A (WE)	5.95
316-A	.85
328-A	4.05
332-A	25.50
350-A	4.90
359-A (WE)	4.00
371-B	.68
373-A (WE)	3.75
374-A (WE)	3.30
387-A (WE)	2.75
388-A	1.25
393-A (WE)	7.75
394-A	2.50
403-B (WE)	5.00
404-A (WE)	12.95
407-A (WE)	4.95
408-A (WE)	3.00
416-A	12.95
417-A (Kly.)	12.95
417-A (WE)	7.50
418-A	12.00
421-A	5.95
422-A	5.95
GL-434-A	14.75
GL-446A	1.10
WL-450-TH	73.00
GL-451	3.00
464-A	9.50
GL-471-A	2.20
WL-481A	4.30
CK-501LX	1.25
WL-502A	1.65
WL-530	13.00
WL-531	5.00

Type	Price
WL-532	3.50
GL-559	1.15
GL-562	75.00
575-A	13.95
WL-579B	14.70
WL-KU610	21.50
WL-KU627	19.80
WL-529	11.70
WL-632B	26.00
635	11.00
651	65.00
ZP-653	195.00
WL-672-A	34.25
WL-KU676	52.25
WL-677	52.25
WL-678	46.00
701A	6.50
700-A	19.95
700-B	19.95
700-D	19.95
703-A	4.50
704-A	.85
705-A	.98
706B/or C	18.50
706EY	27.50
707-A	5.00
707-B	9.25
708-A	3.50
709-A	2.00
CK-710	.95
713A	.90
714-AY	9.95
715A	3.00
715B	4.00
717-A	.80
719-A	16.00
721-A	1.95
722A	1.50
723A/B	13.40
724-A	1.70
724-B	1.90
725-A	4.75
726-A	8.75
726-C	59.50
728 AY, BY, CY, DY, EY or FY	99.50
730-A	19.50
801-A	.35
803	3.25
805	3.20
807	1.55
808	1.50
WL-810	15.95
810	10.75
811	2.95
811-A	2.90
812	2.65
812-A	3.50
WL-813	17.75
813	10.25
814	3.50
815	5.00
816	1.40
822	19.50
826	.95
827-R	53.00
828	9.50
829	6.75
829-A	6.75
829-B	8.95
832	6.50
832-A	7.50

Type	Price
WL-833-A	49.00
834	8.00
836	3.00
837	.95
838	2.90
841	.40
WL-845	13.50
849	29.00
860	2.25
861	15.00
865	.95
866-A (JAN)	1.25
866-A (CBS)	1.75
872-A	2.75
874	.95
884	1.50
885	1.65
WL-889-RA	289.10
WL-891	218.54
892-R	195.00
902	5.00
902P1	9.00
918	2.20
921	1.85
922	1.60
924	2.60
927	1.65
954	.35
955	.45
956	.45
957	.45
959	1.75
968	1.50
991/NE-16	.50
FM1000	.40
CK1005	.65
CK1006	1.50
CK1027	2.75
1201/1201A	.65
1203A	.45
1299A	.55
1608	4.95
1612	2.00
1613	.80
1616	.85
1619	.35
1622 (6L6M)	1.95
1624	1.50
1625	.30
1626	.20
1629	.25
1630	.90
1632	.45
1636	2.75
1638A	.50
1655	1.75
1655	1.75
1960	.60
2050	1.40
2051	1.00
5516	7.65
WL-5550/681	49.00
WL-5552/651	120.00
WL-5553/665	251.50
WL-5554/679	180.55
WL-5557/17	8.40
WL-5558/32	14.40

Type	Price
WL-5559/57	21.90
5636	5.75
5637	3.00
5643	8.00
5545	7.75
5646	7.75
5654	1.75
5670	3.25
5676	1.15
WL-5583	9.24
WL-5685	31.27
5687	2.75
5693	6.20
5694	2.50
5702	2.85
5702-WA	4.50
5703	1.20
5703-WA	3.50
5718	6.00
5719	5.50
5725	4.10
5726	1.50
5732	3.95
WL-5736	156.80
5744	2.25
5749	1.90
5751	2.95
5763	1.30
5780(WE)	350.00
5787	4.25
5795(WE)	350.50
5814	1.85
5829	2.75
5838	3.00
5840/SN1039A	7.75
5844	2.00
WL-5846	126.40
5881	2.50
5886	3.00
5948/1764	395.00
5964	1.45
5991	3.95
5910	.75
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5995	6.00
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6096	Write
6097	Write
6099	Write
6101	Write
6201	5.00
7193	.35
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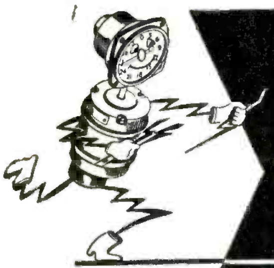

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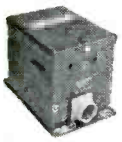
SA-342 . . . . $24.50

I-82-F RADIO COMPASS INDICATOR

Fairchild Instrument. 5 inch 0 to 360 degree dial. 26 volts-400 cycles single phase. May be operated on 10 to 15 volts 60 cycles. Kollsman design.

SA-284 . . . . $9.50

400 CYCLE TRANSTAT



Input 115 volts, 400 cycles single phase. Output 75 to 120 volts at 6.0 amp. Completely enclosed with AN connector for input and output. Locking device for permanent setting.

SA-368 . . . . $4.75

MOTORIZED MODULATING TEMPERATURE CONTROL

White-Rodgers Type 6203X. 24 volts d-c at .4 amp. Adjustable temperature range of 340 to 550 degrees F with a differential of 30 degrees. 30 seconds for 90 degree rotation. ¼" output shaft extends ½". 10-¾" x 2-¾" x 3-½".

SA-393 . . . . $24.50

ELINCO PM-2

Permanent magnet type. Voltage guaranteed lineal with speed within 1%. Generates approximately 1.75 volts per 100 rpm. (DC output voltage). Use for rate generator in servo-system or as tachometer generator. Use to 2000 rpm.

SA-53 . . . . $29.50

⅓ HP ADJUSTABLE SPEED DRIVE

Stepless speed range of 50 to 1750 rpm with the turn of a knob. Complete system consists of rectifier cabinet, remote control station and motor. Operates from 220 volts single phase line. A fortunate purchase of 150 motors allows us to sell this drive at a fraction of the cost of comparable drives.

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C-1 AUTOPILOT SERVO

28 volt d-c shunt motor runs continually at 2250 rpm. Two electric clutches connect the motor shaft through a reduction gear and differential gear to the output drum, which rotates clockwise or counter-clockwise. The output shaft speed is 15 rpm at 300 in./lb. torque maximum. Two electrically operated brakes hold the unit in a locked position so that there is no free-wheeling, and provides fast stopping.

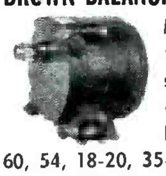
SA-180 . . . . $49.50

TYPE AYLZ 3055S MICROPOSITIONER

Barber-Colman. Polorized d-c relay. Double coil differential current sensitive. Alnico (P.M.) Field. Use for remote control, positioning etc.

SA-437 . . . . $6.75

BROWN BALANCING MOTOR



Minneapolis Honeywell reversible two phase gearhead servo motor. 115 volts 60 cycles. Models with the following speeds available: 27, 60, 54, 18-20, 35-40, 162, 30, 110-130, 180, 17, and 25. Total input 13.5 watts. 4 watts on amplifier phase.

SA-436 . . . . $19.50

PRESSURE WARNING SWITCH

Exhibit Supply Co.—Range 80-160 psi. Pressure activates normally open Micro Switch. 2-¼" x 1-¼" x 4-¾".

SA-373 . . . . $1.75

DRAFTING MACHINES

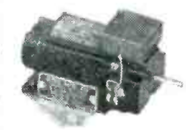
VECTOR PLOTTING MACHINE—Manufactured for the Navy for Aircraft Navigation. 18" arms with approximately 18" scale.

SA-375B $14.50

MODIFIED MACHINE—The same machine as listed above except modified to handle standard scales as sold by Bruning and supplied with the machine. One 18" and one 12" scale.

SA-375A $34.35

DIEHL PM MOTOR



Type FD6-21 -27.5 volts d-c single shaft with speed of 10,000 rpm WE No. KS-15098L01. Ideal for models, blowers, etc.

SA-433 . . . . $8.75

RADIO CONTROLLED SERVO UNIT

Used in Glide Bomb, complete from receiver to actuators which move control surfaces. Contains the following major components: 1. Receiving set #AN/CRW-3 (BC-455) with DM-32A Dynamotor. Frequency range 6.0 to 9.1 mc. 2. Multi-channel servo amplifier (Amplifier Selector AM-41/CRW-3). 3. Barber Colman 14 volt d-c rotary actuator. 4. White Rogers rotary actuator. 5.24-volt d-c Gyro. 6. Heating unit.

SA-387A $69.50

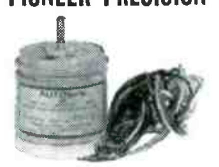
SA-387B As above but with BC-454 receiver. Frequency range 3 to 6 mc.

THREE PHASE INVERTER

Leland Type 10563—115 va inverter input 28 volts d-c at 28 amps. Output 115 volts 400 cycles at .75 power factor. Both voltages and frequency adjustable. Weighs only 8.7 lbs.

SA-159 . . . . $59.50

PIONEER PRECISION AUTOSYNS



Pioneer Type AY101D Transmitter or Control Transformer for controlled servo circuits. 26 volts 400 cycles single phase. Weighs 5 oz.

SA-24 . . . . $19.50

We also have in stock Type AY201-3B, AY231-3-B, AY-131D and AY223.

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SCR 284
SCR 543

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SCR 269 Instruction Book.........1.50
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PL 55 ....New .40
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PL 151 A 50
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AN/ARN-7 COMPLETE	ARC-3
SCR-269 COMPLETE	APN-9
AN/ARC-1 VHF EQUIPMENT	APN-1

BC-611 & BC-721 HANDIE TALKIES, Plus SPARE PARTS. Quantity available.

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MT-283 MOUNT	0-16 LFO
MT-284 MOUNT	ATC DYNAM'T'R
SA-22 ANT. LOAD	C-87 CONTROL BOX

AN/APG-13A RADAR
Absolutely complete, brand new

AN/APN-2	MG-153
SCR-729 New	APS-2, 3, & 15 Components
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RTA-1B	AN/ARC-5 VHF
BC-1016	SCR-274 & ARC-5,
APA-6 INDICATOR	Command Equipm't
APA-11 INDICATOR	R-4/ARR-2 Receivers
APA-17 RADAR	BC-640 VHF XMTR
HS-33 HEAD SETS, NEW	SCR-510
	SCR-522
MG-149F & H	MG-153

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SO-7	AN/ART-13
AN/ARN-7	AN/ARC-1
SCR-269	BC-611

SCR-718 A, AM, B & C
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TEST EQUIPMENT

Spectrum Analyzer, Model TSX-4SE-8500-9600 MC., calibrated linear below cut-off attenuator, calibrated frequency meter, tuned mixer, 4 I.F. stages, 3 video stages, overall gain 125 db., regulated power supply.

Spectrum Analyzer, same as above but modified for 100 to 1000 MC frequency range.

X Band VSWR Test Set, TS-12, complete with linear amplifier, direct reading VSWR meter, slotted waveguide with gear driven traveling probe, matched termination and various adapters, with carrying case.

R. F. Power Meter—1 to 600 MC 0-15 and 0-60 Watt scales. May be used as dummy load for 0 to 1000 MC.—100 W maximum,

VSRW less than 1.1 from 0 600 MC., less than 1.3 from 600 to 1000 MC.

X Band Pick up Horn, AT48/UP with coax fitting.

TS-45/APM-3 Signal Generator 8700-9500 MC, 110V 60-800 cps.

TS-35A/AP X Band Signal Generator, pulsed, calibrated power meter, frequency meter, calibrated attenuator, 110V 60-800 cps.

30 MC I.F. Strip, Video and Audio Amplifier and 115 volt 60-2600 cps Power Supply, Bandwidth 10 MC, new, part of SPR-2 receiver.

High Pass Filter, F-29/SPR-2, Cuts off at 1000 MC. and below; used for receivers above 1000 MC.

TS-125 Calibrated S Band Power Meter with attenuator.

TS-110 S Band Echo Box 2400 to 2700 MC., Portable.

S Band Signal Generator Cavity with cut-off attenuator. 2300 to 2950 MC., 2C40 Tube, with modulator chassis.

VD-20K Voltage Divider for measuring high video pulses, ratio's 1:10 and 1:100, transmission flat within 2db 150 cps to 5 MC.

Waveguide Below Cut-off Attenuator L101-A, UHF connectors at each end, calibration 30-100 db.

TAA-16 Tuned Linear Audio Amplifier, 300 to 8000 cps. output meter reads direct in VSWR or Power DB. Regulated power supply, 110V 60 cps.

FPM 3 X Band Power and Frequency Meter, frequency meter 8500 to 9600 MC., accuracy ± 4 MC absolute, ± 0.5 MC on frequency difference up to 660 MC. Calibrated attenuator 0-30 db, power measuring range .1 to 1000 MW, pulsed or CW without external attenuator, video detector, self-contained battery powered, portable, with coaxial and waveguide adaptors.

T85/APT 5, 300 to 1600 MC, 40 watt noise modulated transmitter.

110-330 MC Oscillator Butterfly.

80-300 MC. Mixer Butterfly with socket for 955 (used as diode).

400-800 MC. Oscillator Butterfly with 703 tube mounted on it.

Field Intensity Meter, RCA 308A, 120 to 18000 KC.

S Band Signal Generator—2K28 Klystron, self-pulsed or ext. triggered.

Mark 5, "S" Band Signal General—2.4 to 3.4 KMC 2C40 Oscillator, Motor tuned.

X Band Receiver, tuneable, waveguide input 9200-9600 MC.

QX Checker, Boonton, Type 110.-A.

Synschroscope—Sylvania Model 5.

Synchroscope—Model P4.

D.C. Amplifier—TS 580/U-GR Model 715 AM.

Sweep Speed Calibrator, 200 KC, 1 MC, 5 MC.

Tuning Units P/O APR-4 TN16 30-80 MC, TN17 80-300 MC., TN18 300-1000 MC. TN19 1000-2200 MC., TN54 2200-4000 MC.

AN/APR 1 Receiver, used with above tuning units. 110V 60 cycle.

Measurements 75 Standard Signal Generator, Calibrated output, 124 to 510 MC.

Rotary Joints, Coaxial, S Band.

Antenna, Coaxial, pressurized S Band. Can be used with parabolic reflector.

Microfilter—Ferris Model 10B + 10C.

F.M. Test Set—X Band, with wavemeter and wattmeter, 110V 60 cycle AC.

Recording Ammeter—Esterline Angus 0.-5MA.

Recording Ammeter—Esterline Angus 0-1MA.

TS-36—8.5 to 9.6 KMC Power Meter .1-000 MW.

TS 33 8.7 to 9.5 KMC Frequency Meter and Video Detector.

K Band—slotted line, gear driven traveling probe.

K Band—Attenuator 27 to 34 KMC.

K Band—Misc. Waveguide + Waveguide components.

Dummy Loads.

TS-13/AP Consists of Signal Generator "Xa" Band, Wavemeter + wattmeter.

TS-14—Test Set for "SA" Band radar— uses 2C40 oscillator, self-contained, power monitor, self-pulsed 115V 60-800 cycles.

Impedance Bridge—Type TBX-1BR 8.5 to 9.6 KMC—CRT Indicator.

Video Amplifier, 25 watts.

Vacuum tube Bridge, General Radio 561D

S Band crystal mixer, tunable.

Klystron Power supplies with or without modulation.

Calibrator Model 3 (MIT).

TS-226 peak power meter.

TS-305 peak power meter.

TS-231 Hi Power Dummy Load.

TS-184 Signal Generator.

TS-278 Signal Generator.

HIGH POWERED DUMMY LOADS

X Band, 1¼" x ⅝" guide, choke or plain flange, dissipates 350 watts average power continuously in still air. VSWR less than 1.15 between 7 and 10 KMC, weight 5¼ pounds.

X Band, ½" x 1" guide, choke flange, dissipates 250 watts average power continuously in still air, VSWR less than 1.15 between 8.2x12.4 KMC, weight 3¼ pounds.

X Band 1¼" x ⅝" guide, plain flange, dissipates 200 watts average power continuously in sttill air, VSWR less than 1.15 between 7-10 KMC, weight 3¼ pounds.

X Band, 1¼" x ⅝" guide, plain flange, dissipates 250 watts average power continuously in still air, weight 2 pounds 4 ounces.

S Band, 1½" x 3" guide dissipates 1,500 average power in still air, VSWR less than 1.15 between 2. 5 to 3.7 KMC, choke flange, weight 13 pounds.

K Band, VSWR less than 1.15 dissipates 50 watts average power.

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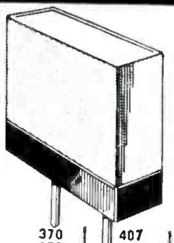

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377	413	450	483	515
379	414	451	484	516
380	415	452	485	518
381	416	453	466	519
383	418	454	487	520
384	419	455	488	522
385	420	456	490	523
386	422	457	491	525
387	423	458	492	526
388	424	459	493	527
390	425	461	494	529
391	426	462	495	530
392	427	463	496	531
393	429	464	497	533
394	430	465	498	534
395	431	466	501	536
396	433	468	502	537
397	434	469	503	538
398	435	470	504	540
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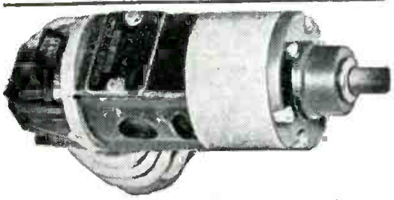

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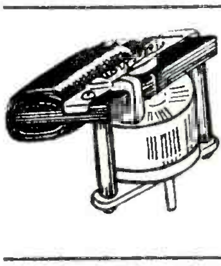

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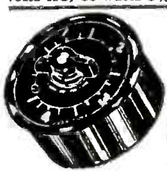

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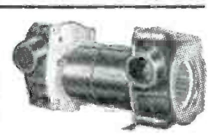

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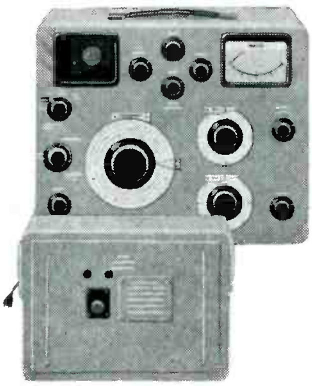

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NORTH HOLLYWOOD, CALIF.

WESTON METERS

Model 301, RECTIFIER TYPE
0-150 Volts AC, 1000 ohms per volt AC, Round bakelite case .... $9.97 Ea.
NEW! BOXED .... 10 for $89.97

OTHER WESTON MODEL 301

0-200 Microamps DC	$9.97
0-10 Volts DC (1000 ohms/v)	7.97
0-1Ma (KV Scale)	7.97
0-50 Ma DC	7.97
0-1.5 Mills DC	7.97

MODEL 731

0-200 Microamps (Spec. Scale)	9.97
0-1 Ma (0-100 Scale)	8.97

MODEL 506

0-200 V	5.97
0-200 Microamps	7.97
0-1 KV with Mult	7.97

WESTERN ELECTRIC METERS
3½ inch round

0-50 MA	5.97
100-0-100 Microamps DC	8.97
0-1.5 Ma DC	5.97

WESTINGHOUSE METERS—Model NX35

0-500 Microamps (0-100 Scale)	6.97

GENERAL ELECTRIC

0-150 Volt AC—Model AO 22	7.97
0-3 Amp RF w/thermo—Model DO44	7.97
0-5 Amp RF w/thermo—Model DO44	7.97
Running Time, 99,999 hours 115v, 60 cy	10.97

UTC COMMERCIAL GRADE TRANSFORMERS

Type CG, Fully cased, Hermetically sealed, Primary 115 V 60 CY. Tapped from 105 Volts in 6 steps, Secondary 750-0-750V., 325 Ma Continuous duty rating. BRAND NEW .... $9.97 Ea.

Type CG Choke to match, 12 Henry, 325 MA. BRAND NEW .... $4.97 Ea.

G. E. RELAY CONTROL

(Ideal for Model Controls, Etc.)

Contains a sigma midget 8,000 ohm, relay (trips at less than 2 MA), high impedance choke, bimetal strip, neon pilot and many useful parts. The sensitive relay alone is worth much more than the total low price of ..... $1.27 Each 10 for $9.97

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NEW GOV'T SURPLUS
STANDARD BRANDS
2" METERS

DB meter—10 to +20	$3.47

3" METERS

0-200 Microamps	$6.97
0-400 Microamps	5.97
0-500 Microamps	5.97
0-200 Milliamp	4.57
0-1000 Milliamp	4.57
0-1.5 Volts AC	4.97
0-8 Volts AC	4.97

4" METERS

0-200 Microamps	$8.97

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4 MFD—600 VDC	$0.97
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Ohmite, 250 Ohm, 100 Watt. **57c**

Special, 5 for $2.57

ACME PLATE TRANSFORMER

Pri. 220V 50/60 Cy, 3 Phase, Delta Connected. Secondary 3 phase, Y connected, 2622 Volts @ 7.5 KVA .... Ea. $99.57

RAYTHEON PLATE TRANSFORMER

Pri. 220V single phase, tapped, 60 cycle. Secondary. 6000 Volts to 8000 Volts @ 1 Amp. in 400 Volt steps .... Ea. $99.57

SOLA CONSTANT VOLT TRANSFORMERS

Input 95-125 V 60 Cy Output Regulated 115V

250 VA	$33.67
500 VA	48.67
1 KVA	79.97

TYPE G H.V. MICAS

G4	.00062	30KV	$39.57	G3	.0013	15KV.	29.97
G4	.0012	25KV.	44.57	G2	.0043	8KV.	14.97

CARTER SUPER DYNAMOTOR

12V Input, 400V Output @ 200 MA $24.97

CONTINENTAL DYNAMOTOR

11V Input, 475V @ 210 MA Output $19.97

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Stock too long to list. We can supply most sizes, so order what you need.

10 Watts. From 1 Ohm to 70K Ohms ...... Ea.	$ .15
20 Watts. From 4 Ohms to 50K Ohms ...... Ea.	.20
25 Watts. From 1 Ohm to 100K Ohms ...... Ea.	.30
50 Watts. From 5 Ohms to 100K Ohms ...... Ea.	.40
100 Watts. From 50 Ohms to 100K Ohms ...... Ea.	.50

ADJUSTABLE SLIDER, WIRE WOUND

10 Watts from 1 Ohm to 10K	$ .25
25 Watts from 20 Ohms to 2.5K	.35

EIMAC VACUUM CONDENSERS

6 MMF 32 KVDC (VC 6-32)	$9.97
12 MMF 32 KVDC (VC 12-32)	10.97
50 MMF 32 KVDC (VC 50-32)	12.97
100 MMF 5 KVDC G. E.	4.97

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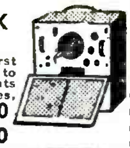

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HS-23 high impedance	$2.95	$4.75
HS-33 low impedance	2.45	5.75
HS-30 low imp (featherwt)	1.49	2.45
H-16/U high imp (2 units)		4.95
CD-307A cords, with PL55 plug and JK26 jack, 8' long		1.19

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T-17 Shure Handmike 200-ohm carbon single button. Press-to-talk switch, 5' cord & plug. BRAND NEW $7.95
Used, Excellent $5.50

CARBON HANDMIKE, Sig Corps, 200 ohm single button. Press to talk switch, 4' cable, plug. BRAND NEW 5.95

	USED	NEW
T-45 Lip Mike, navy type		$1.85
T-30 Throat Mike	.49	.85

DYNAMOTORS

Type	Input		Output		Excellent Used	Brand New
DM-32A	28V	1.1A.	250V	.05A.	$4.90	$7.50
DM-33A	28V 28V	5 A. 7 A.	575V 540V	.16A. .25A.	2.25	3.95
DM-34D	12V	2.8A.	220V	.080A.	14.50	....
DM-37	25.5V	9.2A.	625V	.225A.	14.75	....
DM-40	14V	3.4A.	172V	.138A.	....	7.95
DM-28	28V		224V	.07A.	3.95	6.95
DM-21	14V		235V	.09A.	6.85	16.50
PE-73	28V	20 A.	1000V	.350A.	9.50	12.50
PE-86	28V	1.25A.	250V	.060A.	2.95	5.50
PE-94A	28V	10 A.	300V 150V	.200A. .101A.	7.50	11.50
PE-94B	28V	10 A.	300V 150V	.200A. .101A.	8.50	11.75
PE-94C	28V	10 A.	300V 150V	.200A. .101A.	10.00	12.75
PE-98	14V	21 A.	300V 150V	.200A. .101A.	22.50	37.50
PE-101	13V 26V	12.6A. 6.3A.	400V 9V AC.	.135A. 1.12A.	3.75	4.85
PE-103	6V 12V		500V 500V	.160A. .160A.	27.50	44.50
PE-104 (Vibrator)	6V 12V	1 A. 5 A.	84V 51V	.09A. .03A.	12.50	14.50
DM-414 (with filter)	14V	2.8A.	1.4V 220V	.400A. .080A.	....	12.50
PS-225 (with filter)	28V	3.2A.	375V	.150A.	....	10.50
EICOR Dynamotor D-401	27V	6.05A.	300V 18V AC	.200A. 2.2A.	....	9.95
PE-135AX (with filter)	24V	12 A.	500V	.200A.	....	34.50
GENERATOR						
GN-39-F (16" L, 8" dia. 50 lbs.)	14.6V	25 A.	1000V	.350A.	....	39.50

INVERTERS

PE-206 Inverter—Leland
In: 28V DC—38A.
Out: 500V 800 cyc. 80VA. 1 Ph. 9.75 12.50

PE-218 Inverter—Leland-Wincharger—GE.
In: 28V DC—92A.
Out: 115V 380/500 Cyc. 1500VA. 1 Ph. . 16.50 24.50

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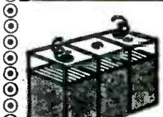

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20 AMP. HR. BRAND NEW $2.69
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2AP1	5.75	3GP1	2.75	F-128A	75.00	354A	15.00	724B	1.75	838	3.00
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2C44	1.00	4J34	75.00	C-202	12.50	394A	2.50	726C	45.00	860	2.00
2D21	1.00	4J35	125.00	204A	25.00	417A	7.50	728CY	35.00	861	13.50
2E22	1.75	5BP1	3.00	F-207	100.00	GL-434A	12.00	728DY	35.00	866A	1.00
2J21A	6.50	5BP4	3.00	WL-218	25.00	446A	1.00	728EY	35.00	869B	55.00
2J26	12.50	5CP1	3.75	250R	5.00	446B	3.00	728GY	35.00	872A	2.50
2J27	9.25	5D21	11.00	250TH	15.00	450TL	37.50	802	3.00	878	1.25
2J31	19.00	5FP7	1.00	250TL	13.00	WL-460	12.00	803	3.00	884	1.25
2J32	20.00	5FP14	15.00	251A	150.00	464A	7.00	805	3.00	885	1.50
2J33	20.00	5JP1	13.00	253A	6.00	527	15.00	807	1.25	892R	250.00
2J34	18.00	5JP4	13.00	267B	7.00	631-P1	4.75	808	1.50	902-P1	7.50
2J36	75.00	5JP11	35.00	271A	5.75	700A	13.50	809	2.50	913	10.00
2J38	12.50	5J30	23.50	274B	2.00	700D	13.50	810	9.75	923	1.00
2J56	75.00	5J32	60.00	276A	7.50	701A	5.25	811	2.50	931A	4.25
2J61	28.50	5R4GY	1.00	282A	7.50	702A	2.50	812	2.50	959	1.50
2K25	19.75	C6A	7.50	283A	3.75	705A	1.00	813	10.00	CK-1006	1.50
2K41	90.00	C6L	5.50	286A	6.50	706AY	25.00	814	2.50	1614	1.50
3AP1	5.00	6BL6	50.00	304TH	6.75	706FY	35.00	815	4.50	1624	1.25
3BP1	3.00	6BM6	60.00	304TL	6.75	706GY	35.00	816	1.25	2050	1.25
3B22	2.25	6C21	15.00	307A	3.00	707A	6.00	822	17.50	ZB-3200	125.00
3B24	3.75	6J4	4.75	310A	3.00	707B	8.75	826	1.00	8002R	85.00
3B24W	7.50	7BP7	3.00	311A	3.25	708A	2.50	828	9.00	8005	4.25
3B25	3.50	9LP7	3.00	313C	3.00	709A	2.50	829A	6.00	8012	1.75
3B26	2.75	12DP7	12.50	323B	9.75	715A	3.00	829B	8.00	8013	2.00
3B28	4.00	12GP7	13.50	328A	4.00	715B	4.00	830B	2.00	8020	1.00
3C23	6.75	RX-21	7.50	329A	7.50	715C	16.50	832	6.50	8025	4.00
3C24/24G	1.00	RK-23	2.00	348A	7.50	719A	15.00	832A	7.50	PD8365	50.00

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Magnolia Park Station

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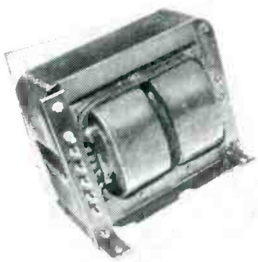
3 OUTSTANDING TRANSFORMER VALUES!



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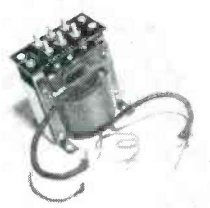
3100 Volts Each Side of Center at 500 M.A. Primary tapped for 98, 104, 110, 116, 123 Volts, 60 cycle A.C. Conservatively rated. 15 KV. impregnated mica insulation. Balanced secondary windings. Special high silicon low loss core. Size: 9" L. x 8" H. x 7½" W. Shipping wt: 60 lbs. Priced extremely low at **$34.50.**



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10 Volts (C.T.) at 10 amps. 5 KV. insulation. Primary tapped as above. Absolutely top quality. A highly useful type for many applications. Be sure to order spares at this low price: **$3.25 each.**

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728EY	99.50
728FY	99.50
800	1.50
805	3.20
829B	12.50
830B	2.75
832A	7.50
837	.95
838	3.25
865	.95
872A	3.50
921	1.85
922	1.60
954	.35
955	.45
956	.45
959	1.75
966	1.50
1612	2.00
1614	1.95
1616	.85
1619	.35
1620	6.20
1625	.30
1636	2.50
1641	2.00
5545	35.00
5550	39.50
5551	60.00
5557	8.50
5588	14.00
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5634	4.50
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5638	3.00
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5642	1.20
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5644	12.00
5645	7.50
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5651	3.00
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5670	3.25
5676	1.15
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5837	110.00
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5881	2.50
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6095	write
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6097	write
6098	write
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6101	write
6111	11.50
6112	11.50
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REctor 2-1297-8

2½" ROUND PANEL METERS

0-1 MA DC G.M. Lab Spec black scale 0-150	$3.50
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0-50 Volts DC Gruen GW 508	4.95
0-300 Volts DC Sun 2 AP 380	4.95
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30-0-30 AMP DC G.E. DW 51 Metal Case Int. Sh.	3.00
0-50 Amp DC G.E. 50 MV less shunt	3.50

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0-50 Micro Amp DC Electrotech	$ 8.50
0-30 V. DC Weston 301 62 ohms/volt metal case	7.50
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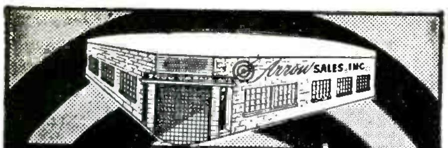

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.5	50	2.34	40	225	6.41	500	300	6.93
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1.1	50	2.34	50	50	2.10	700	225	6.41
1	50	2.34	60	25	1.86	750	25	1.86
2	25	1.86	75	25	1.86	750	150	4.90
2	100	3.86	75	50	2.10	780	100	3.60
2	300	6.93	75	75	3.25	800	25	1.86
3	100	3.86	75	300	6.93	1000	25	2.10
3	225	6.41	80	50	2.10	1000	50	2.22
5	25	1.86	100	25	1.86	1200	225	6.41
5	50	2.10	100	50	2.10	1200	300	6.93
5	100	3.86	100	100	3.60	1250	50	2.22
6	25	1.86	100	150	4.63	1250	150	4.90
6	50	2.10	125	25	1.86	1500	25	2.10
6	75	3.25	150	50	2.10	1500	50	2.22
7	25	1.86	175	25	1.86	1600	50	2.22
7.5	75	3.25	175	500	9.88	1800	50	2.22
7.5	225	6.41	185	25	1.86	1800	150	5.15
8	50	2.10	200	25	1.85	2000	25	2.10
8	500	9.88	200	50	2.10	2000	50	2.22
10	25	1.86	200	100	3.60	2250	150	5.15
10	50	2.10	200	150	4.63	2500	25	2.10
10	100	3.60	250	25	1.86	2500	50	2.22
12	25	1.86	250	50	2.10	2500	100	3.71
12	50	2.10	300	50	2.10	2500	150	5.15
12.5	500	9.88	300	75	3.25	3000	25	2.22
13	100	3.60	300	100	3.60	3000	100	3.71
15	25	1.86	350	25	1.86	5000	25	2.22
15	75	3.25	350	150	4.63	5000	50	2.34
15	100	3.60	370	25	1.85	5000	100	4.11
16	50	2.10	375	150	4.63	7500	50	2.34
20	25	1.86	400	25	1.86	7500	100	4.40
20	50	2.10	400	75	3.25	10000	50	2.50
25	25	1.86	500	25	1.86	10000	100	4.75
25	300	6.93	500	50	2.10	15000	52	2.75
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.004	10 KV	2.25	2.	660 AC	2.45
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.02	7500	5.30	2.	2000	2.75
.05	10 KV	7.49	2.	2500	5.49
.1	2 KV	1.65	2.	3000	6.25
.1	3 KV	3.49	2.	4000	10.95
.1	3500	3.90	3.	240AC	1.95
.1	6000	7.95	3.	600	2.09
.1	7500	11.25	3.9	330AC	2.50
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.25	1500	1.40	4.	400	1.75
.25	2000	1.80	4.	600	1.95
.25	2500	2.75	4.	700	2.25
.25	3000	3.49	4.	800AC	3.75
.25	3500	3.95	4.	1000	2.50
.25	4000	6.50	4.	1500	3.49
.25	5000	7.49	4.	2500	7.49
.3	600	.98	5.	50	1.25
.3	2000	1.85	5.	600	2.35
.5	600	1.19	5.	10KV	P.U.R.
.5	1500	1.59	6.	400	2.49
.5	2000	1.85	6.	600	2.85
.5	2500	2.90	6.	1500	4.25
.5	3000	4.25	8.	440AC	3.90
.5	7500	8.95	8.	600	3.38
.75	1000	1.25	8.	1000	3.95
1.	250 AC	.70	8.	1500	5.10
1.	330 AC	.79	10.	600	3.75
1.	500	.65	10.	1000	4.25
1.	600	.68	10.	2500	14.95
1.	1000	1.59	12.	1000	4.59
1.	1500	1.85	15.	600	Spec.
1.	2000	2.35	15.	1000	7.49
1.	2500	3.49	15.	5000	P.U.R.
1.	3000	4.95	30.	90AC	4.75
1.	5000	9.95	50.	330AC	P.U.R.
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1.25	330AC	.80			
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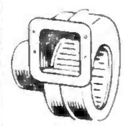

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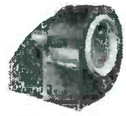

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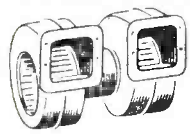

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JANUARY, 1954

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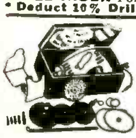
* Deduct 10% Drill & Index Combination

55 PCS DRILL KIT



Model 200JK. Includes ¼" Jacobs Geared Chuck & Key Drill, Asst'd Drill Bits & Accessories for Grinding, Sanding, Polishing, Buffing, Paint Stirrer & Many Other Uses. 55 Pieces in All Prepaid Your Door..$19.98

KITS AND COMPONENTS

Oil Condensers Assorted	5 for	$1.25
Electrolytics Assorted	5 for	1.25
Silver & Mica Cndsrs	15 for	1.25
Controls, Popular Values	5 for	1.25
Resistors, ½ & 1W	100 for	1.25
Vitreous W W Resistors	8 for	1.25
Sockets, Asstd. 8, 7, 5, 4P	12 for	1.25
Iron Core Slug & Screw	50 for	1.25
Knobs, Asstd. w/Insert	10 for	1.25

"TAB" Special — YOU PICK 'EM $1.00 Lots of 5

METER BUYS

0-30 VDC "AN" $1.98; 2 for $3.25
0-60 ADC "AN" Type Mtg Less Shunt.....2.95; 2 for 5.00
0-15 VAC GE 2½ Rnd 800cy 1.29
1-150 VAC/Wstghs/2½ Rnd 3.49
0-150 VAC/25–125cy/3½" Square RA35/Wstgh............ 5.98
0-1MACD Wstghs 3½" Sq RA35 $6.49 @,. 2/$11
0-500 MADC/2½"; Rnd Triplett 221 T.... 4.98
0-120 MA RF 3½" Rnd Weston 301.......12.98
0-800 MADC/3½" Rnd.......$4.95 @, 2 for $9
1MA Miniture 1½" Round..............$4.49

EXECUTIVE DRILL KIT

A must for the Engineer or Serviceman. Includes 200H ¼" Hvy Duty drill with Jacobs geared chuck & key (chrome finish). UL approved. Asst chrome vanadium speed drill bits, attachments for polishing, sanding, buffing, and heavy vinyl plastic Holster, that fits on your belt. "TAB" Special.
Prepaid your door USA................$24.00

866A KIT AND XFORMER

2 Tubes, Sckts, xfmr Input 115 Volt 60 cyc output 2.5vct, 10A/Hv insul. SPECIAL..$4.98

"TAB" THAT'S A BUY

ADJUST-A-VOLT "STACO" VARIABLE VOLTAGE TRANSFORMER

Type20/0–135V/3A/N...$11.98
Type116U/135V/7.5A/N. 16.98
Type 116 Specs 116U & Csd/N.............. 21.98
Type 1126/0–135V/15Amp/Csd/N........ 43.98
Type 1226/0–270V/9Amp/Csd/N........ 43.98
STACO/3000B/0–135V/30Amp/Csd/N.... 55.00
GR 50A/VARIAC/0–135V/45Amp/LN....112.00
GR 50B/VARIAC/0–270V/31Amp/LN....112.00
STACO/LRL-5/METERED/140V/5A/N 41.50
STACO/PAL-7/METERED/135V/7.5A/N 40.50

Industrials: Order 6 Deduct 5%: 12 or more 10% delivery from stock.

RHEOSTAT SPECIALS

15 ohm 25W w/knob..........$1.49; 2 for $2.49
20 ohm 50W Model J......... 1.98; 2 for 3.50
60 ohm 50W w/knob.......... 2.25; 2 for 3.98
100 ohm 50W Model K........ 1.98; 2 for 3.50
200 ohm 25 Model D......... 1.49; 2 for 2.49
250 ohm 25W................ 1.19; 3 for 2.98
300 ohm 225W Model P....... 2.98; 2 for 5.00
350, 500, 5000 ohm Slotted shaft, 25 watt..............79c; 3 for 2.00
Write for Others and Quantity Prices.

INFRARED SNOOPERSCOPE

SEE IN DARK TUBE

Image-Converter Tube HiSensitivity simplified design 2" dia Willemite screen—Resolution up to 350 lin/in. Complete data & tube......ea. $7.98; 2 for $13.98
Snooperscope Pwr Supply
1800VDC/35MA, Using Doubler Crkt. Transformer, Rectifiers Sockets, Resistors, Capacitors and Diagram 115V/60cy Oper.......................$6.98

DC POWER-SUPPLY

0 to 12VDC/2 AMP variable DC supply—inpt 115v/60 cy. Usable LAB supply, filament D.C. plating, battery charging, model railroad includes voltage or speed control and center off reversing sw. Ideal for two "HO" loco's. "TAB" Special to Your Door. Prepaid USA.........$10.95; 2 for $20

FILAMENT TRANS.

6.3V/2A.......................$1.08; 2 for $1.98
2.5V/2A @ 79c, 2 for $1.49; 10 for........ 6.49
2.5VCT/10A 5KVINS......................... 3.59
2.5VCT/10A 12.5 KVINS..........$6.98; 3 for $18
7.5VCT/12A CSD KENYON 15 KVINS...10.95
24V/1.25A CSD @ $1.98 Two for.......... 3.49
2X12V/2A or 24V/2A @ $3.89 Two for..... 6.98

FILTER CHOKES

12Hy/80ma/3KVins......... 2.25
10Hy/75ma................ 1.25
10Hy/125ma/UTC/Csd/H'sld/1 KVins......... 1.98
50Hy/125ma/Csd/H'Sld..... 2.89
20Hy/300ma or 15Hy/400ma/12KVins Kenyon........ 8.95
13.5Hy/1Amp/17KVins/Raytheon..........39.95
Dual 2 Hy/300ma USN..........95c; 2 for 1.49
6 Hy 175ma 250 Ohm..........$1.49; 2 for 2.49
10 Hy 100ma Freed......................1.39

TRANSFORMERS

All 115 V 60 Cyc Input TV & CR Pwr Xmfr up to 20" tubes. Hi VOLTS to 20 KV (w/quadrupler ckt.) ALL tubes. PL & Fil wndgs 300 VDC/275Ma Full-Wave.; 6.4V/10.3A, 5.4V/8A, 2.5V/3A Hypersil Core. Oil Impreg..........$5.98 @, 2 for $10, 6 for $24
1000VCT/45MA, 795VCT/80MA, 360VCT/55MA 3X5V/3A, 6.3VCT/1A, 6.3VCT/.3A CSD HVINS CAN BE USED 2X RATING RAYTHEON, SPECIAL..........$4.50 @, 2 for $8, 6 for $22
950VCT/100MA, 5V/2.5A, 5V/5A, 45V/1A, 10V/1.5A WESTERN ELECT..........$5.49
900V/35MA, 2X2.5V/2A, XCLENT 1800V DBLER TWO 2X2 FIL WNDGS........$2.25
850VCT/148MA, 5V/3A, 6.3V/5A, 6.3V/3A $5.49; 2 for $9
800VCT/150MA STANCOR..$4.98; 3 for $12.00
780VCT/250MA, 5V/6A, 12.6V/5.5A......$7.95
778VCT/200MA, 5V/3A, 6.3VCT/5A THORDASON...$5.98 @, 2 for $10, 6 for $24
770VCT/200MA, 5V/6A, 12.6V/5.5A......$6.95
770V/2.5MA, 2.5V/3A, HVINS HMSLD includes FILTER PARTS 4/scope.................$3.69
720/85MA, 5V/3.5A, 6.3V/3.5A...........52.98
700VCT/120MA, 2X6.3V/3A, 6.3V/1A Price............$3.98; Two for..........$7.25
680VCT/200MA, 5V/3.5A, 6.3V/4A, 78V/1A $4.39; 3 for $12.
600VCT/50MA, 6V/3A, 6V/1.5A, 5V/1A..$2.49
420VCT/90MA, 6.3V/1.9A, W/INPUTS 6, 12, 24, 115VDC & 115 & 230 VAC @.........$1.49

MERCURY THERMO REGULATOR

DUAL CKT, 105° F & 32° F. Extremely sensitive & accurate for most exacting requirements—Research, Fire Prev., Freeze, Pt Control, or Max-Min Temp Control. Brand New, w/data & ckt. Ea. 98c; 12 for $10.00

EICO TEST EQUIPMENT

Stock #	Type	Kit Price	Built Price
145K	Sig Tracer	$19.95	$28.95
221K	VTVM	25.95	49.95
315K	Sig Gen	39.95	59.95
322K	Sig Gen	23.95	34.95
360K	Sweep Gen	34.95	49.95
377K	Aud & Sq Gen	31.95	49.95
470K	Scope 7"	79.65	129.50
425K	Scope 5"	44.95	79.95
625K	Tube Tester	34.95	49.95
566K	VOM	14.90	18.95
1171	Resistance Decade		24.95

Industrials & Schools Write Qty Price
We Buy, Sell & Trade Insts

"AN" CONNECTORS REDUCED UP TO 90% OFF LIST

Send Us Your Query

FEDERAL "ITT" SELENIUM BATTERY CHARGER RECTIFIER

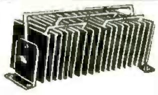
10–0–10 Volts (CT) 100 Amp (Fan-Cooled) Replace Your Old inefficient Sulphide Rect. with the New Selenium Types. SPECIAL..$11.98

SELENIUM RECTIFIERS

1/2 WAVE FOR RADIO & TV

CURRENT (Cont.)	LIST PRICE	"TAB" PRICE	QTY 12 FOR
65MA @ 130V	$1.50	$0.59	$6.48
75MA @ 130V	1.85	.69	7.58
100MA @ 130V	2.05	.79	8.68
150MA @ 130V	2.25	.99	10.78
200MA @ 130V	3.15	1.39	14.98
300MA @ 130V	3.30	1.49	15.98
400MA @ 130V	4.25	1.89	20.38
500MA @ 130V	4.40	1.98	21.28
230MA @ 18V	1.40	.59	5.98
230MA @ 36V	2.25	.89	8.38
250MA @ 300V	6.95	1.39	14.98

SELENIUM RECTIFIERS



We specialise in Rectifiers and Power supplies to your specifications. Immediate delivery.

Current Cont.	18/14 Volts	36/28 Volts	54/40 Volts	130/100 Volts
1 Amp	$1.35	$2.15	$3.70	$8.50
2 Amp	2.20	3.60	5.40	10.50
4 Amp	4.25	7.95	12.95	25.25
6 Amp	4.75	9.00	13.50	33.00
10 Amp	6.75	12.75	20.00	44.95
12 Amp	8.50	16.25	25.50	49.00
20 Amp	13.25	25.50	39.00	87.50
24 Amp	16.25	32.50	45.00	95.00

Rectifier & Transformer Combination
115 Volt 60 cyc Input
up to 14VDC at 12 amps..............$19.98
up to 28VDC at 4 amps............... 14.98
up to 28VDC at 12 amps.............. 29.98
up to 28VDC at 24 amps.............. 59.95
up to 28VDC at 50 amps..............127.00
C "TAB" fast delivery SPECIALS

RECTIFIER XFMRS

PRIMARY 115V 60 cyc
SECONDARY 0-9-12-18-24-36V
CONT. CURRENT 4 amp.....$8.75
12 amp......16.75
24 amp......35.75
30-32-34-36V/40A..........59.75
18 Volt 2 amp............. 1.98

RECTIFIER CHOKES

4 Amp	.07 Hy	.6 Ohm	$7.95
12 Amp	.01 Hy	.1 Ohm	14.95
24 Amp	.004 Hy	.025 Ohm	29.95

MICA CONDENSERS

Fig.	MFD	WVDC	PRICE
A	.033	600	69c; 5 for $2.50
A	.03	600	69c; 5 for 2.39
A	.02	600	69c; 5 for 2.25
A	.015	2500	1.75; 2 for 3.00
B	.01	600	56c; 3 for 1.20
B	.01	1000	49c; 3 for 1.25
B	.01	1200	69c; 3 for 1.49
A	.005	2500	1.19; 3 for 2.95
B	.004	600	49c; 3 for 1.10
B	.002	1200	58c; 3 for 1.25
A	.002	2500	98c; 3 for 2.25
A	.001	1200	55c; 3 for 1.20
C	.0007	3000	89c; 3 for 2.39
A	.0004	2500	39c; 6 for 1.95
A	.0001	600	25c; 5 for 1.00
C	.0001	8000	89c; 3 for 2.00
C	.0001	5000	1.49; 4 for 5.00
C	.00005	3000	39c; 4 for 1.00

Write for Condenser Listing

CONDENSER SPECIALS

2 MFD 1000 VDC 330 VAC "CD" MFGR 25¢ LOTS OF 10
Smaller Quantities Each........49c; 3 for $1.25

OIL CONDENSERS WAREHOUSE CLEARANCE SALE RECTANGULAR CASE

.5MFD 1500VDC............95c; 2 for $1.50
5MFD 600VDC.............1.50; 3 for 4.00
3MFD 330VAC 1000VDC....49c; 3 for 1.20
2x2MFD 600VDC Vlt. Q....$1.25 @, 2 for $2
BATHTUB SIDE TERMINALS
1MFD 600VDC.............39c; 3 for 1.00
4MFD 50VDC..............50c; 5 for 2.00
.1MFD 2000VDC...........1.05; 5 for 4.50
2x.1MFD 400VDC..........49c; 5 for 2.00

OIL CONDENSER SPECIAL

10 MFD 600 VDC $1.75 ea.
LOTS OF 3
Case Dimensions, Not Including Insulators, 4⅛H—3⅜W—1¼"D
Quantities Less Than 3, Ea...........$1.98

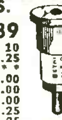
OIL CONDENSER SPECIAL

2 MFD 600 VDC
Aerovox Type PO9. Steatite insulators, Adjustable Mounting Clamp, Case 2" Dia x 2¾" High. Brand New. Special....69c; 3 for $1.50

STORAGE BATTERIES

36 Volt WILLARD Mini-BRAND NEW 5 oz Designed Portable Equip. Models...98c; 4 for $3
Four 36V BATTERIES w/acid*........... 3.35
2V 20AH Willard PLUS 2V. Vibrator..... 2.98
2V 20AH Batt. W/Vib. & Acid*.......... 3.59
4V/16AH Gould......................... 2.89
6V/6AH Willard NT6/BB214U............. 2.98
6V/6AH Batt. W/Acid*.................. 3.25
6V/40AH Willard....................... 6.98
6V/40AH Batt. W/Acid*................. 9.25
* Acid is shipped in Bottles, R'Exp only.

CRYSTAL DIODE HDQTRS.



1N23B Sylvania $1.89
New, Boxed & Jacketed Lots of 10
Smaller Quantity, Unit Price $2.25

1N21	85c;	6 for $ 4.00
1N21A	$1.55;	5 for $ 7.00
1N21B	$2.89;	4 for $10.00
1N34	64c;	10 for $ 6.25
1N47	$4.00;	5 for $16.25

TAB PHOTOFLASH LAMPS

"Tab" No.	Replaces	W-Sec. Max.	Each
U5W	SPRG/FA104	150	$5.98
U10	GE FT114	100	7.25
No. 1	AMGLO 5804X	100	10.98
23ST	GE FT 210	200	9.98
VA	SYLV. 4330	200	9.98
22ST	FT 110	200	9.98
V4X4	X400	200	10.98
DX	SPRGFA100	150	9.00

100 WATT SEC PHOTOFLASH KIT

Includes DX Flash Lamp Rated 150 Watt Sec Flash Lamp Holder & 8" Reflector & Cable, Power Transf and Condensers. Ten 100MFD/450V/100W.S. Condensers, Resistors, Capacitors Rectifiers & Sockets.......................$29.98
Or With 2 "CD"* 525 MFD (1050 MFD/100 WS) Condensers......................$36.98
100 Watt Sec Condenser Bank .72MFD/1800V Per Unit, 85 Units Total 61.2MFD 100 Watt Secds. "TAB" SPECIAL..................$7.98
*525MFD 450V "CD" Condenser.$8.00; 2 for 15.
16MFD/600VAC/1800VDC/2800VIntermit't $6.

SOCKET ASSEMBLIES

⅝" Jewel Bayonet Socket Light Dimmer (Shutter) 33¢ EA.
Regular 97c
Less Than (3) Ea....39c Lots of 5
Dialco 31101 Pilot Light 1" Jewel 115V, High Polish Finish, Reg. $1.03 "TAB" Price.........85c @ 10 for $7
Neon Panel Lite Dialco 95408 Clear With Lamp. Reg. $1.09; SPECIAL.79c
Pilot Lamps #40-41-44-46-47.........10 for .65

PRECISION OILER OR CARBON TET DISPENSER

Indispensible for the Laboratory or Service Shop. Designed for Pin Point Oiling or When Using Carbon Tet, For Quieting & Cleaning Controls. A Precision Made Needle Point Permits Use on the Most Delicate Lubrication Job Special..........89c; 6 for $5.00

CIRCUIT BREAKERS

Heinmann Magn Bkrs. Amps; 3, 7, 9, 12, 15, 20, 30, 35, 40, 80, 180 Ea. $1.69; 10 for $15.0
Sq. D & CH Toggle Sw Brkrs, Amps; 5, 10, 15, 20, 25 98c..................10 for $8.98
Klixon Therma Push Button Brkrs Amps; 5, 10, 15, 20, 25, 30 89c..........10 for $7.98

YOU PICK THEM 59c WHILE THEY LAST ELECTROLYTIC CONDENSERS

AEROVOX - "CD" - MALLORY - SPRAGUE

2X 20MFD/450VDC......69c; 3 for $1.95
2X 15MFD/450VDC......98c; 3 for 2.50
3X 20MFD/400VDC......79c; 2 for 1.29
80MFD/450VDC.........79c; 2 for 1.29
25MFD/450VDC.........69c; 3 for 1.98
45MFD/450VDC.........79c; 2 for 1.29
20MF/450V&20MF/25V..........3 for 1.95
50 mf/350vdc FP...............5 for 1.00
30–15–10 mf/250vdc............5 for 1.00
40–20mf/250–25vdc.............6 for 1.00
30–2x20mf/450–25vdc...........3 for 1.00

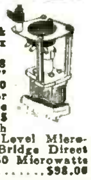
MICROWAVE FLANGES and WAVE GUIDE

UG39 to UG40 "X" Band Adapter, Flange to Choke. Sperry Dsgn..........$1.45; 6 for $7.
UG40/AV Choke Broad Band....$1 45; 6 for $7.
UG51/U Choke..............$1.45; 6 for $7.00
UG52A/U Choke Plain Flange $3.00; 6 for $15.
UG52A/U Round 2¾" OD With Indexing Slot $3.00; 6 for $15.

FLEXIBLE WAVE GUIDE
CG166/U (42") (E165003) Terminates UG52/U Stock #WGF-3.............$20.00; 3or $54.00
CG166/U (12") (E137858) Terminates fUG52/U Stock #WGF-1..............$5.00; 3 for $12.00
CG166/U (24") Terminates UG52/U Stock # WGF-2............$11.00; 3 for $30.00
Technicraft (2½") Rigid to Flex X-Band. E-Plane Wave Guide. UG40 to Rigid W.G. Ending in UG40. Round Threaded Keyed Choke Pt # D154124 W.E. & Z1305 Philco. Stock # WGF/R-1......................$5.00; 3 for $12.
Technicraft (3") W.G. (X-Band) to UG39 Plain Flanges. Stock # WGF-4......$2.50; 3 for $6.00
Technicraft (4") W.G. (X-Band) to UG39 Plain Flange. Stock # WGF-5.......$3.00; 3 for $8.00
Rigid Wave Guide (X-Band) 90° Bend E-Plane 9½ x 6¼". UG40 Choke Flanges Each End Pt # BO-78225. Stock # WGR-R1.......$10.00
Horn Antenna & W.G./UG135/U Flange 90° Twist "X" W.G. to 180° Elbow & Matching Enclosure, Pt # BO-715403. Stock # WGR-H1 $29.98
Cord & UG/Plug TS33/AP Freq Mtr(Coxis)8 S.C 16FK4W11-1.46 .406 Special.........$1.#

AT49A/APR4 Broad Band Conical Antenna 300 to 3300 Mc's. Type N Feed..............$10.98
H.V. Transformer, Filament 6.3V/40A 60Kvins $49.98
G.E. K2465/#352-7150-3 Fitted With Magnetron Well Filament & HV. Pulse Plate TR.....$39.00

MICROWAVE



Klystron Mts Assy (723AB) & Coupling to 2 Type "N" Co-Ax Fittings. As Shown.
"TAB" SPECIAL..........$12.98
1 Microsecond Delay Line "Millen" $2.95; 4 for $10.00
Variable Attenuator 3CM Vernier ADJ, RND Choke to Straight Flange 1" x ½"...................$39.98
Watt Meter Low Power, Used with Bolometer, Bridge Measures Low Level Microwave Power. Balanced Barreter Bridge Direct Reading. Self Calibrating Range, 50 Microwatts to 10 Milliwatts. SPECIAL.............$98.00

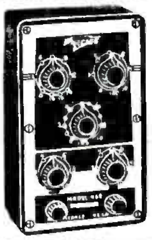
BARRETERS-THERMISTORS-VARISTORS
Barreter Sperry Type 811/125 Ohm $1.50; 12 for $15.
Barreter Sperry Type 821/200 Ohm $1.50; 12 for $15.
Thermistor (Tube) W.E. D167332........$1.45
Thermistor W.E. D168391...............$2.98
Thermistor (Button) W.E. D170396......$1.45
Varistor W.E. 17A/CUO.................$1.98
Varistor W.E. 38C/CUO.................$2.49
Varistor W.E. 40A/CUO/SPL.............$1.50
Varistor W.E. 41A/CUO/SPL.............$1.50
Varistor W.E. D97966..................$2.49
Varistor W.E. D163906.................$ .98
Varistor W.E. D178220.................$1.79

THAT'S A BUY "TAB" THAT'S A BUY
Dept. 1E 111 Liberty Street, New York 6, N. Y., U. S. A.
PH. RECTOR 2-6245 CABLE: "TABPARTS"

Money Back Guarantee (Cost of Mdse. Only) $5 Min. Order FOB N Y C. Add Shpg. Charges or 25% Dep. Prepaid Mdse. USA only. Prices Subject to Change Without Notice.

"TAB" THATS A BUY

RESISTANCE DECADE BOX



PRECISE AGAIN LEADS THE FIELD with its New Low-Priced Resistance Decade Box. Ideal for specialized service work. Compact in size for Bench Drawers and Tool Boxes. Engineered with the customary Precise Accuracy and Dependability.
5 Separate Switches, 11 Positions on Each; plus or minus better than 1% for Extreme Accuracy; Readings from 10 OHM to 1,111,110 OHM in 5 Decades. Deeply etched Aluminum Panel; Rugged Construction; Complete with famous Precise Simplified Construction Manual. 3¾" x 6¾" x 2".

#468K (KIT) $18.95
#468W....factory wired.........$24.95
#478K—Capacity Decade..kit...$18.95
#478W—Capacity Decade..wired $24.95

PRECISE ACCESSORIES

Model 999 Hi-Voltage Probe, for use with VTVM #909 or 907. Essential for every TV serviceman, engineer and ham. Rugged construction features include: 3 individual media protection against voltage breakdown, changeable tips & resistors, swivel mount, mechanical shockproof construction.

"TAB" SPECIAL #999............$6.98

Model 912ARF Probe, input capacity less than 3mmf frequency range up to 250mc, input resistance; 200K ohm 1mc, 150K ohm 10mc, 25K ohm 100mc. Calibrated at 75mc for accuracy, impedance & shunt capacity. The finest low price RF probe made.

#912A25 Probe VTVM 909 & 907 **$4.25**
#912T MM Probe Oscilloscope.....**$4.25**

Model 960. 10 to 1 capacity attenuator probe, permits scope measurements with 1/10 capacity loading effect. Frequency range through 100mc. Less than 7mmf input capacity #960..... $5.95

MODEL 635 UNIVERSAL AF SINE—SQUARE & PULSE GENERATOR

Efficiently & effectively tests all AUDIO & VIDEO CIRCUITS ✓ ✓ ✓ These Features

Sine Waves
Square Waves
Wien Bridge Oscillator
Pulses
Variable impedance output
Veritably constant output
Voltage Regulated
Cathode follower output
Band 1—20-40 cycles
Band 2—40-200 cycles
Band 3—200-2000 cycles
Band 4—2000-20,000 cycles
Band 5—20,000-200,000 cycles

"Tab" Special #635K (Kit)...........$33.50
#635W (Factory Wired)..............$52.50

MODEL 630 RF-AF & TV MARKER GENERATOR

Check these features: • Advanced circuitry • Variable modulation, cathode follower output • Crystal marker • Wein bridge AF Osc • Coalpitts RF Osc • Constant output impedance • Vernier tuning • Complete shielding • Fundamentals through 110 Mc • Rugged design, quality components • 7 RF bands 300 Kc to 330 Mc. • 4 audio bands, 20 cy to 20 Kc.

"TAB" SPECIAL #630K (KIT).........$33.95
#630KA (KIT) Pre-Assembled RF Head **$38.95**
#630 W FACTORY WIRED.............$53.95

SUPER VALUE INTRODUCTORY OFFER

SOLDERING IRON
LONG NOSE PLIERS
DIAGONAL CUTTING PLIERS
SCREW & NUT DRIVER SET
ROLL OF SOLDER
REGULARLY SOLD FOR..$4.98

With Precise or Eico Test Equipment "TAB" SPECIAL **$1.98**

EICO TEST INSTRUMENTS

Model 625 tube tester. Features include 4½" easy to read meter; speedroll chart; lever switches for testing individual elements; checks all the latest Radio—TV—and VR tubes; protective overload indicator; etched panel rugged heavy gauge steel.
"TAB" SPECIAL #625K (KIT)........................$34.95
#625 (FACTORY WIRED)................................49.95

Model 1040 battery eliminator and charger kit. 5 to 8 volts 10 amp continuous; 20 amp intermittent; heavy duty rectifier; full wave bridge; voltage and current output meter; fused primary; automatic reset secondary; rugged steel cabinet; a serviceman's "must" for auto radio repair.
"TAB" SPECIAL #1040K (KIT)........................$25.95
#1040 (FACTORY WIRED)................................34.95

Model 950A Resistance-Capacitance bridge and R-C-L comparator. Designed to meet the needs of the laboratory or serviceman. Measures and tests; resistors 0.5 to 500 MEGOHM; condensers 10MMF to 5000MFD; voltage source 0—500DV for electrolytic leakage test; power factor; separate leakage test for mica and paper condensers. Rugged steel case.
"TAB" SPECIAL #950A-K (KIT)......................$19.95
#950A (FACTORY WIRED)................................29.95

Model 511 VOM accurate, compact and rugged; DC 5 Rngs to 2500V; AC (4) Rngs to 1000V; output (4) Rngs to 1000V; DC (3) Rngs to 100MA; DC (2) Rngs to 10AMP; ohms (3) Rngs to 1 MEG; DB-8 to +55; etched panel, rugged case.
"TAB" SPECIAL #511K (KIT)........................$14.95
#511K (FACTORY WIRED)................................17.95

Model 145 Signal tracer; audibly traces RF, IF, Video and audio CRKTS from antenna to speaker. Quickly localizes faulty stage and pinpoints defective parts and intermittents. High sensitivity and gain. Freq. response over 200MC; VTVM jack for stage gain comparison; usable as intercom or PA system.
"TAB" SPECIAL #145K (KIT)........................$19.95
#145 (FACTORY WIRED)................................28.95

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CP½ AND CP1 1% ACCURACY MANUFACTURED TO "JAN" SPECIFICATIONS

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Type CP½ ½ Watt...12 for $1.25; 100 at $9; 1000 at $72
Type CP1 1 Watt...12 for $1.68; 100 at $12; 1000 at $96

Test equipment for college, school, Laboratory, Government & industrials; Supplied in easy to build Kit or factory Wired form. Designed for continuous use on Factory production line.

TUBE SPECIALISTS

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OB2	1.37
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OC3/VR105	.92
OD3/VR150	.92
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1B22	1.82
1B23	8.87
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1B26	2.24
1B27	11.98
1B32/532A	2.48
1B35	9.15
1B37	14.87
1B38	29.45
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1B42	17.48
1B46	1.98
1B63	45.00
1L4	.48
1L6	1.35
1LD5	.98
1LN5	.78
1P6	.78
1R5	.59
1U4	.52
1U5	.54
1V2	.70
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2C36	27.00
2C39A	26.98
2C40	7.20
2C43	17.48
2C44	1.15
2C51	3.88
2D21	1.18
2E43	1.49
2J31	27.00
2J32	29.48
2J33	27.00
2J34	24.98
2J37	12.70
2J38	69.98
2J39	6.98
2J42	148.98
2J48	24.25
2J49	84.00
2J50	99.98
2J55	84.98
2J56	149.00
2J62	49.45
2K22	23.48
2K23	11.48
2K25	28.49
2K25/723AB	23.88
2K28	27.48
2K33	219.48
2K39	134.99
2K41	126.00
2K42	145.00
2K45	129.48
2K48	99.48
2P23	298.00
2X2	.42
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3B23/RK22	4.95
3B24	4.70
3B25	4.39
3B26	3.70
3B28	7.90
3C22	85.00
3C23	8.67
3C31/C1B	3.45
3C33	9.51
3C45	9.98
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3D21A	8.15
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4C35	21.49
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6A8GT	.90
6AC7	.80
6AG5	.71
6AG7	1.14
6AH6	1.22
6AJ5	1.40
6AK5	.77
6AK5W	2.79
6AK6	.92
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6AN5	2.90
6AQ5	.52
6AQ5W	2.78
6AQ6	.81
6AQ7GT	1.29
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6AS5	.79
6AS6	2.22
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6AU5GT	1.10
6AU6	.56
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6AV6	.49
6B4G	1.18
6B8G	.60
6BA6	.54
6BA7	1.09
6BC5	.63
6BC7	1.23
6BD6	.83
6BE6	.54
6BF5	.98
6BG6G	1.58
6BH6	.63
6BJ6	.69
6BK7	1.58
6BL7GT	1.19
6BN7	2.69

6BO6GT	1.20
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6C4	.52
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6D6	.84
6F4	6.20
6F6	.79
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6J5	.54
6J6	.58
6K4A	3.68
6K6GT	.54
6K7	.58
6K8	1.08
6L6	1.48
6L6G	1.08
6L6GA	1.08
6L6GAY	1.98
6SA7GT	.66
6SC7	.90
6SF5	.78
6SF7	.73
6SG7	.64
6SH7	.61
6SJ7	.58
6SK7GT	.56
6SL7GT	.64
6SN7GT	.68
6SO7GT	.62
6SR7	.62
6SS7	.88
6T8	.96
6U4	.74
6U8	.99
6V6	1.39
6V6GT	.59
6W4GT	.52
6X4	.49
6X5GT	.54
6Y6G	.88
7A8	.68
7C7	.76
7F7	.82
7F8	1.24
7H7	.72
7N7	.92
7V7	1.06
7Y4	.68
8D21	298.00
12AL5	.54
12AT6	.54
12AT7	.89
12AU6	.72
12AU7	.69
12AV6	.52
12AV7	.98
12AW6	1.18
12AX7	.98
12AY7	1.69
12BA6	.59
12BA7	.94
12BD6	.59
12BE6	.59
12BF6	.85
12BH7	1.29
12SA7GT	.68
12SC7	1.08
12SF5GT	.54
12SF7GT	.84
12SG7	.80
12SH7	.63
12SJ7GT	.54
12SK7	.66
12SL7GT	.62
12SN7GT	.68
12SO7GT	.54
12SR7	.66
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25Z5	.78
25Z6GT	.58
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35T	4.88
35L6	.58
35Y4	.68
45Z3	.88
48	1.98
50A5	.76
50C5	.54
50L6GT	.62
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78	.78
80	.58
81	1.38
83	1.12
83V	1.22
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FG105	19.48
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417A/5842	18.50
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446B	3.48
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CK505AX	1.79
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531	5.72
CK532DX	1.89
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CK537AX	2.60
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CK539DX	2.19
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CK544DX	.99
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707A	7.90
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725A	9.98
726A	14.48
726B	44.88
726C	64.88
801A	.42
803	3.48
805	3.22
807	1.54
808	2.62
809	3.58
810	10.88
811	3.00
812	2.70
813	11.48
814	4.98
815	5.98
829	7.94
829B	12.48
832	7.72
832A	9.92
833A	39.45
836	5.95
837	1.42
849	29.45
860	4.48
865	1.26
866A	1.50
872A	3.29
917	2.59
925	2.14
927/CE25	1.70
CK1005	.68
1613	.82
1614	1.95
1625	.32
1632	.68
1633	.98
1634	1.18
1635	1.69
1636	3.08
1642	.62
1644	.92
2050	1.48
2050W	2.48
5618	3.50
5635	11.57
5637	6.53
5640	11.57
5641	7.52
5643	11.57
5644	11.57
5646	11.57
5651	2.24
5654	1.72
5656	12.08
RK5657	298.48
5663	1.06
5670	3.44
CK5672	1.20
CK5678	1.29
5687	3.74
5691	7.54
5692	8.52
5693	6.24
5694	3.65
CK5702	2.90
CK5703	1.29
WL5736	156.48
5713	120.00
5749	1.72
5751	2.88
5769	298.00
5812	2.99
5814	2.08
5820	148.00
5840	7.98
5844	2.98
5881	2.70
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1N21A	$1.55
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1N23	1.35
1N23A	1.98
1N23B	2.22
1N25	4.98
1N26	8.75
1N27	1.55
1N34	.64
1N34A	.90
1N35	1.65
1N38A	1.29
1N41	8.95
1N42	16.95
1N43	1.73
1N45	1.45
1N46	.69
1N47	4.00
1N48	.55
1N51	.45
1N54	.78
1N54A	1.00
1N58A	1.15
1N60	.60
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PRECISE MODEL 610 AM—FM AND TV

The first low-priced RF Signal Generator to reach 110 MC on fundamentals, 330 MC on harmonics, with the accuracy and stability of high-priced equipment PRECISE achieves this by slug and capacity tuning of the coils, along with complete isolation of the Colpitts Oscillator by a Cathode Follower Buffer Output. The first kit to offer: a complete factory pre-assembled and pre-tuned RF Head; Cathode-Follower Output; External Modulation; Speech Amplifier; Bridge Type AF Oscillator; Colpitts RF Oscillator Drum Dial; Coaxial Fittings; Individually Tuned Coils; Vernier Tuning; Separate RF Section; Complete Shielding, 400 Cycle and 60 Cycle Internal Modulation. 8" x 11" x 5"; leather handle; wrinkle steel cabinet; deeply etched aluminum panel; amphenol type connectors; wt.: 10 lbs. TUBE COMPLEMENT: 6C4, 12AX7, 6X5.

RF FREQUENCIES:
Band 1 —300KC to 1MC FUNDAMENTALS
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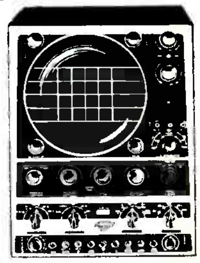
Band 3 — 3MC to 10MC FUNDAMENTALS
Band 4 — 10MC to 30MC FUNDAMENTALS
Band 5 — 30MC to 110MC FUNDAMENTALS
Band 5A—60MC to 220MC 2nd Harmonic
Band 5B— 90MC to 330MC 3rd Harmonic

"TAB" SPECIAL #610K (KIT)..........$23.95
#610KA (PRE-ASSEMBLED RF HEAD)...$28.95
#610W (FACTORY WIRED)...........$39.95

8½ INCH SCOPE LABORATORY DESIGN

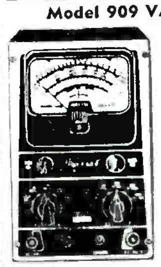


*8½ INCH TUBE 8CP1
*WIDE RANGE
*PUSH-PULL INPUT THRU OUTPUT
*VOLTAGE REGULATED
*HI-LOW-NORMAL SYNCH
*INTENSIFIER ANODE
*EXTRA FAST RETRACE
*TV PICTURE CLARITY (8½ x 7 ft.)
*LAB TESTED ACCURACY
*LOW IN PRICE
*MODEL 308K (Kitform) **$129.50**
*MODEL 308W LAB WIRED, TESTED, AND CALIBRATED **$229.50**
*SPECIFICATIONS: PRECISE 8½" & 7" SCOPES

• VERTICAL FREQ RESPONSE: FLAT (3db) DC to 5 mc's constant R. • VERTICAL SENS: GREATER THAN 10 mv PUSH-PULL (3.94mv/cm). • VERTICAL & HORIZ FREQ Compensated Step Attenuators. • P.P. DC Amplifiers from Input thru Outpt. • P.P. or single ended. (immediate switching) at inputs 1 & 2. • POSITIONING: NON-VARYING BRIDGE type on VERT & HORIZ. • BLANKING; Internal (return trace blanked), external (return trace not blanked), 60 or 120 cycle BLANKING thru Blanking amplifier circuit. • SYNC: External, INTERNAL-Positive, Negative, 60 or 120 cycle Sync. • SWEEP RATE: Driven or non-driven linear sweeps from 1 cycle to 80KC in five ranges (1–10 cycles uses external C circuit); Trigger potentiometer. •• MAGNIFIER: Electronic magnifier and positioner permits part of a signal to be magnified up to ten times horiz deflection.) • CALIBRATION: Internal square wave calibrator and potentiometer for using oscilloscope as a VTVM on Peak to Peak measurements. • CALIBRATION SCREEN: Edge-illuminated scale and graticule may be turned on or off; filtered screen. • OUTPUTS ON FRONT PANEL: Plus Gate output; Sawtooth output; 60 cycle phasing output; 60 cycle unphased output; Calibration output. • FOCUSING: Astigmatism-focus and intensity control. • DIRECT: Deflection plates available from rear of cabinet. • INTENSITY MODULATION: Z modulation through modulation amplifier. • SINUSOIDAL FREQ. Response (For any setting of controls). With minimum trace deviation for direct, Capacitive or AC/DC coupling. • SCOPE TUBE—NEW 8CP1 in #308 & 7VP1 in #300 (Green trace) Other scope tubes available. WRITE • FUNCTIONAL DESIGN: Easy to OPERATE & CONNECT 5 way Binding Posts. • MATERIAL: Low loss components thruout; plus SAFETY MARGIN fused POWER SUPPLY, OVERDESIGNED for CONTINUOUS use. DEEP ETCHED Aluminum Panel. FINEST COMPONENTS Available (No Surplus). Heavy duty Steel cabinet & New reinforced GIRDER "U" circuit chassis for extreme stability. In KIT form easy to BUILD complete with "EXPLODED VIEW." Instruction Tech Manual & All Components. GUARANTEED TO SATISFY THE ENGINEER or LAYMEN.

MODEL 300K/7" OSCILLOSCOPE KIT...$94.95
MODEL 300W/7" FACTORY WIRED...$199.50

Model 909 VACUUM TUBE VOLTMETER



CERAMIC precision resistors—1% or better.
Deeply ETCHED panel—raised numerals. Rugged steel cabinet. Amphenol hi-voltage DC Connector. Special, separate 5v. AC scale for accuracy on low voltages. 250V. scale enables you to read line voltages accurately.

RANGES:
+DC: 0-5-25-250-500-1000 Volts
—DC: 0-5-25-250-500-1000 Volts
AC: 0-5-25-250-500-1000 Volts
Ohms: Rx1-Rx10-Rx1000-Rx 10,000-Rx-1,000,000 ohms; from .2 Ohms to 1 Billion Ohms.
DB: From —20 to +55 DB

• Special true zero alignment scale for FM & TV discriminators.
• Burn-out proof circuit.
• 25 Megohm input impedance on DC.
• Complete with test leads and internal battery.
• Rugged oversize 4½" meter.
• Specially prepared 3 color SPEED instruction books with exploded views that explain each step and define the purpose.

Frequency: Up to 250 Mc with #912 RF probe (additional)...$4.25
Voltage: Up to 30,000V with #999 probe (additional)........$6.9

"TAB" SPECIAL #909K (KIT)..........$25.98
#909W (FACTORY WIRED) SPECIAL....$37.50

DELUXE V.T.V.M. MODEL 907 METER 7"

* Vertical or horizontal construction.
• Meter is mounted above instrument (similar to #909, or beside instrument. Please specify.
Gigantic 7½" meter, for greater accuracy. All the unusual special features & specifications as Model 909, in a really deluxe version

"TAB" SPECIAL #907K (KIT).........$38.98
#907W (FACTORY WIRED)...........$57.98

THAT'S A BUY **"TAB"** THAT'S A BUY
Dept. 1E 111 Liberty Street, New York 6, N. Y., U.S.A. Ph. Rector 2-6245 Cable: "TABPARTS"

Money Back Guarantee (Cost of Mdse. Only $5 Min. Order FOB NYC. Add Shpg Charges or 25% Dep. Tubes Gtd. via R-Exp. only. Prices Subject to Change Without Notice.

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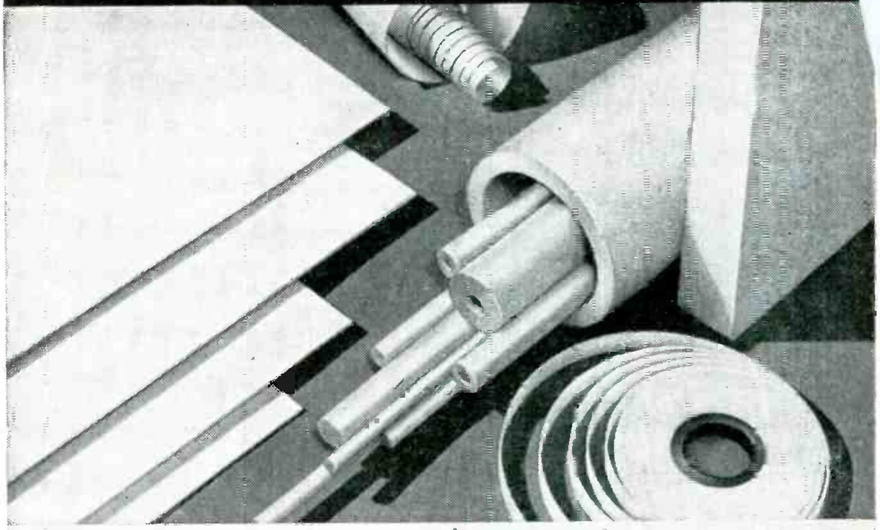

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H. E. Hilty, Mgr.

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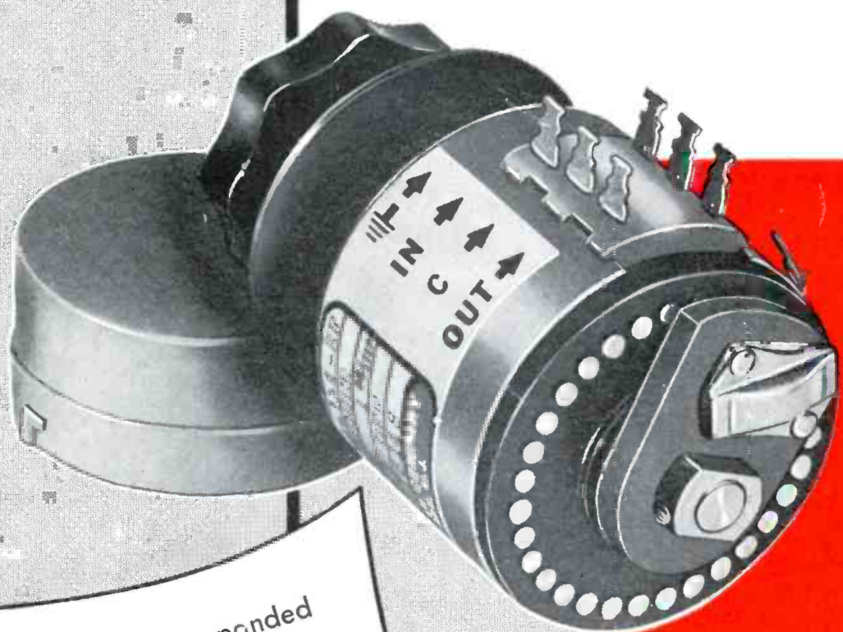
THESE ARE THE

REASONS

WHY DAVEN IS THE LEADER IN THE AUDIO ATTENUATOR FIELD



LA-130 Series,
Ladder Network
30 Steps, 1 3/4 Diameter

Greatly expanded production facilities enable Daven to make delivery from stock on a large number of standard attenuator types.

1. "KNEE-ACTION" ROTOR . . . gives positive contact and low contact resistance under all conditions.
2. BRASS CASE OF 2-PIECE CONSTRUCTION . . . gives excellent shielding and allows more compact equipment design.
3. "LOCK-TITE" DUST COVER . . . designed to withstand severe vibration and at the same time allow easy accessibility.
4. ENCLOSED ROLLER-TYPE DETENT MECHANISM . . . gives positive indexing, but does not increase depth of unit.
5. LOW-LOSS MOLDED TERMINAL BOARD . . . has high resistance to leakage.

Write for complete catalog data.

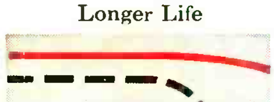
THE DAVEN CO.

WORLD'S LARGEST MANUFACTURER OF ATTENUATORS

191 Central Ave., Newark 4, N. J.

Why you can expect peak performance from regular RCA receiving tubes

Longer Life



Superior Performance

At no extra cost

● It's a matter of bonus values! At no greater cost to you, RCA receiving tubes give you the superior performance and reliability usually claimed for specialty-designed types of other manufacturers. That's because RCA receiving tubes are being improved constantly to keep pace with your present and future design requirements.

For Instance

The RCA-5U4-G features a new electrolytic coating on its channel filament which produces a uniform, hard emitter —leading to greatly increased life over the older version.

The RCA-6W4-GT incorporates a new RCA-developed carbonized plate-coating material having improved heat-dissipating properties. Result! The RCA-6W4-GT offers longer life and increased reliability.

The RCA-6AL5 utilizes double helical heaters to insure low hum. Cathodes are pinched to minimize cathode shift within the mount. Both features make possible greatly reduced microphonics. Carefully controlled contact potential assures high and uniform sensitivity.

RCA's continuing program of quality improvement means superior receiver performance, less factory-line rejects, and fewer "in-warranty" failures. And remember, this *peak performance* from regular RCA receiving tubes costs you no more . . . actually costs you less in the long run.

For additional technical information write RCA, Commercial Engineering, Section A19Q, Harrison, N. J. For application assistance, simply call your nearest RCA Field Office:

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(MIDWEST) Whitehall 4-2900
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(WEST) Madison 9-3671
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ELECTRON TUBES **HARRISON, N. J.**