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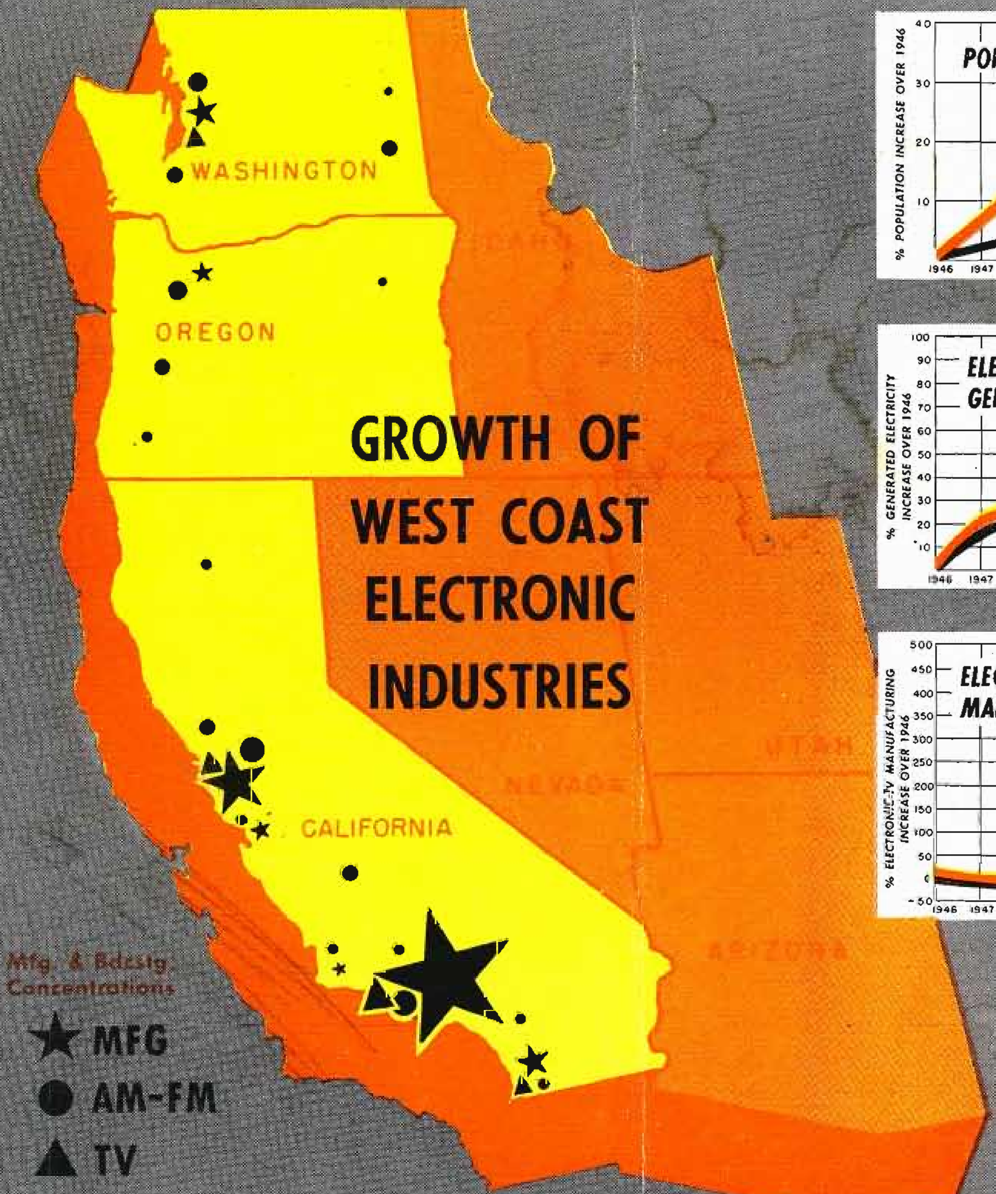
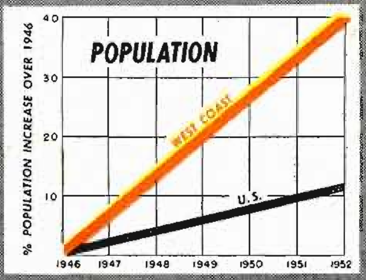
TELE-TECH

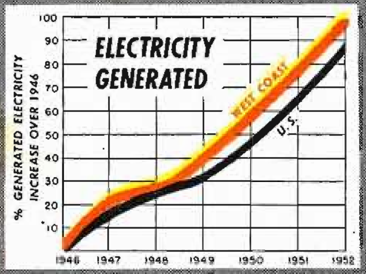
RADIO-TELEVISION-ELECTRONIC INDUSTRIES

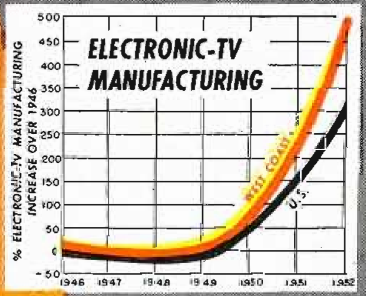
GROWTH OF WEST COAST ELECTRONIC INDUSTRIES



GROWTH COMPARISON
U.S. & WEST COAST
1946-1952







In this issue:

Computing With Servo-Driven Potentiometers
Microwave Pulse Power Measurements
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Television Sweeps • Combination UHF-VHF Tuner • Effect of Filament Voltage on Tube Characteristics

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TELE-TECH

RADIO-TELEVISION-ELECTRONIC INDUSTRIES

Edited for the 19,000 top influential engineers in the Tele-communications and Electronic Industries, TELE-TECH each month brings clearly written, compact, and authoritative articles and summaries of the latest technological developments to the busy executive. Aside from its engineering articles dealing with manufacture and operation of new communications equipment, TELE-TECH is widely recognized for comprehensive analyses and statistical surveys of trends in the industry. Its timely reports and interpretations of governmental activity with regard to regulation, purchasing, research, and developments are sought by the leaders in the many engineering fields listed below.

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SEPTEMBER, 1952

FRONT COVER: MAP OF THE BOOMING WEST COAST *shows the concentrations of broadcasting and electronic-TV manufacturing installations in California, Washington and Oregon. Densest manufacturing area, indicated by the size of the symbol, is the Los Angeles region which accounts for almost 70% of the more than 400 companies engaged in production and development. AM and FM broadcasting shows a more even geographical spread of some 300 stations. TV broadcasting is still an up-and-comer, with California having 11 of the 12 stations on the air. Apace with the meteoric growth of West Coast electronic industries, the curves show how the impressive rise of population and generated electricity—key indications of a region's activity—have surpassed the average for the U.S.*

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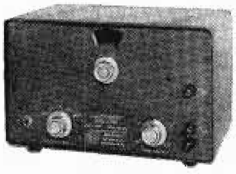
moderately priced

★ Oscillators — .009 cps to 520 kc



Models 400-A, 420-A, 430-A
12" wide, 7" high

The Models 400-A, 420-A, and 430-A are compact RC Oscillators with outstanding performance, moderately priced. The Models 400-A and 420-A provide both sine and square wave output.

Models 410-A, 400-C, 420-C
19" wide, 8¾" high

The Models 410-A, 400-C, and 420-C are designed with sturdy steel cabinets for rack panel mounting. These units feature sine and square wave output. The Model 400-C provides either balanced or single ended output.

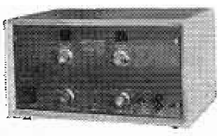
Model	Featuring	Frequency Range	Distortion	Output	Power Consumption	Price
400-A	Sine and Square Wave True RC Oscillator Compact Design	.009 cps to 1.1 kc	1%	25 mw/10 v	45 watts	$350.00
410-A	Sine and Square Wave Amplitude ±.25 db Low Distortion	.02 cps to 20 kc	1/4%	10 mw/5 v	150 watts	$950.00
420-A	Sine and Square Wave Audio and Sub-Audio Compact Design	.35 cps to 52 kc	1%	25 mw/10 v	45 watts	$290.00
430-A	Wide Range Compact Design Outstanding Value	5 cps to 520 kc	1%	50 mw/10 v	45 watts	$145.00
400-C	Sine and Square Wave Rack Panel Balanced Output	.009 cps to 1.1 kc	1%	100 mw/10 v	65 watts	$375.00
420-C	Sine and Square Wave Rack Panel Audio and Sub-Audio	.35 cps to 52 kc	1%	100 mw/10 v	65 watts	$325.00
440-A	Push-Button Controlled Excellent Resetability Low Distortion	.01 cps to 100 kc	1/10%	100 mw/10 v	120 watts	$450.00

★ Filters — .01 cps to 200 kc

Models 310-A and 360-A
12" wide, 7" high

The Models 310-A and 330-A are variable band-pass filters with unity pass band gain and 24 db/octave outside the pass band. Both high and low cut-off frequencies are independently adjustable over the entire frequency range.

The Models 350-A and 360-A are variable rejection filters which provide either a rejection band in which the gain falls at a rate of 24 db/octave or a sharp single frequency null. Both high and low frequencies are independently adjustable.



Models 330-A and 350-A
18" wide, 10" high

Model	Type	Featuring	Frequency Range	Noise & Hum	Power Consumption	Price
310-A	Band-Pass	Variable Band-Width Zero db Insertion Loss 24 db/octave Slope	20 cps to 200 kc	3 mv	40 watts	$275.00
330-A	Band-Pass	Low Internal Noise Zero db Insertion Loss 24 db/octave Slope	.02 cps to 2 kc	0.1 mv	50 watts	$450.00
	Band-Pass	Audio and Sub-Audio Range 24 db/octave Slope Variable Band-Width	0.2 cps to 20 kc	0.1 mv	50 watts	$450.00
340-A	Servo	Proportional-Plus-Derivative Proportional-Plus-Integral Servo-Design Filter	.01 cps to 100 cps	10 mv	40 watts	$350.00
350-A	Rejection	Low Internal Noise Rejection Band or Null 24 db/octave Slope	.02 cps to 2 kc	0.1 mv	50 watts	$450.00
360-A	Rejection	Variable Rejection Band Variable Null 24 db/octave Slope	20 cps to 200 kc	5 mv	40 watts	$275.00

ABOUT THESE INSTRUMENTS

The Oscillators and Filters described here are being effectively used in a growing number of interesting applications for engineering, research, and production.

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All instruments are fully guaranteed for one year against defective materials and workmanship.

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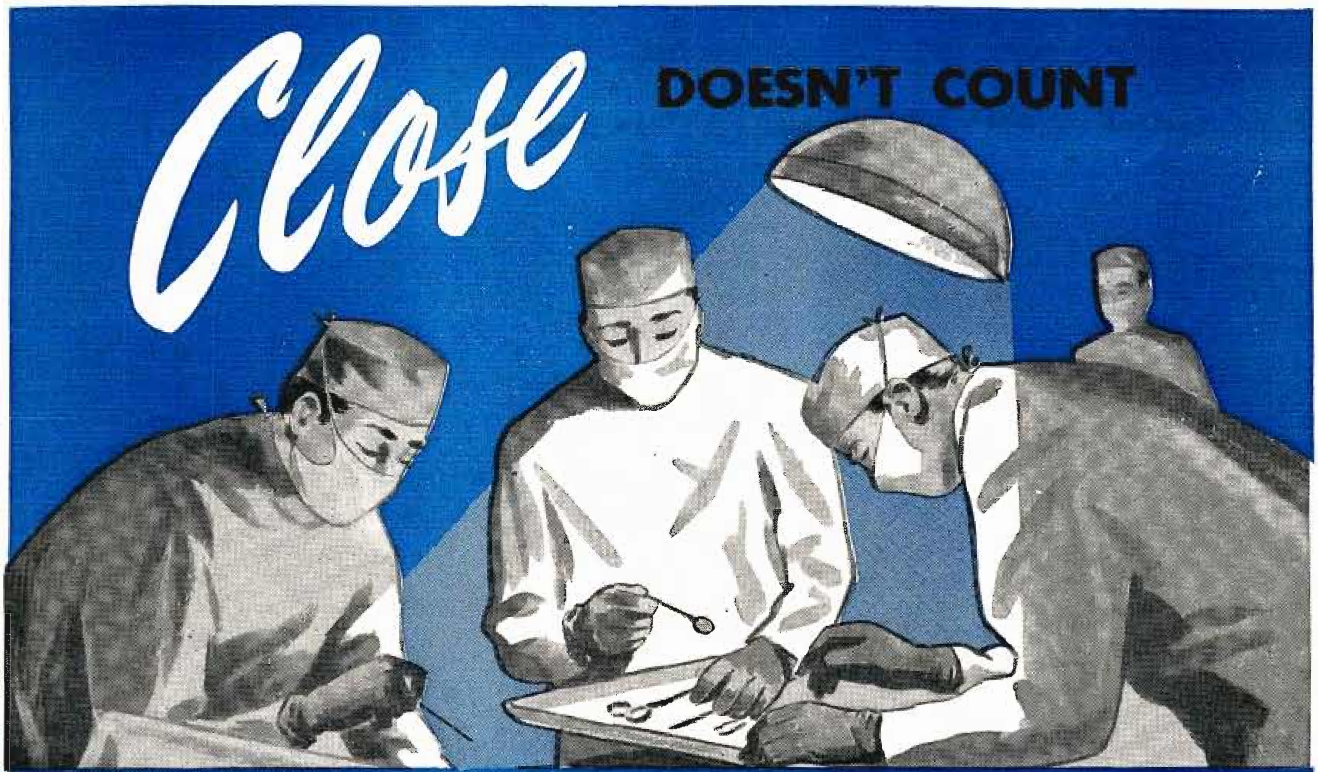

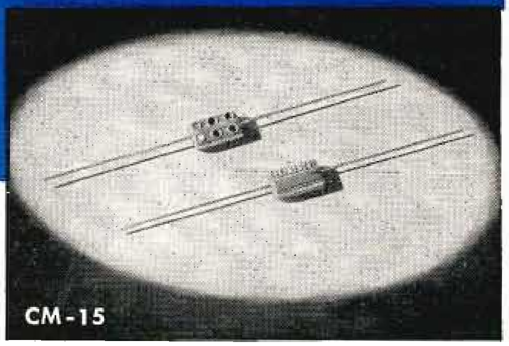
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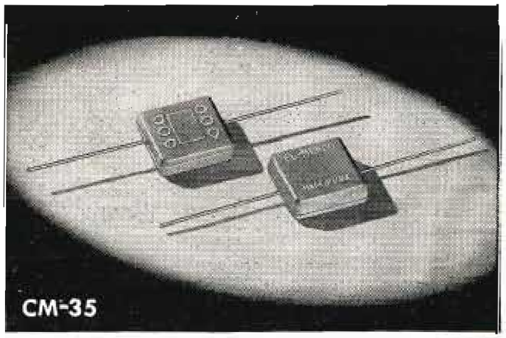
This is why El-Menco Capacitors are designed for the ultimate in reliability and are built with razor-edge accuracy.

Lessons have been learned from surgery . . . today a doctor always allows a large margin of safety in standard operations. For long life and freedom from failure in your electronic applications every El-Menco Silvered-Mica Capacitor is factory-tested at more than **double** its working voltage.

For peak performance in compact form . . . for higher capacity values, which require extreme temperature and time stabilization . . . there are no substitutes for El-Menco Capacitors. Available for every specified military capacity and voltage.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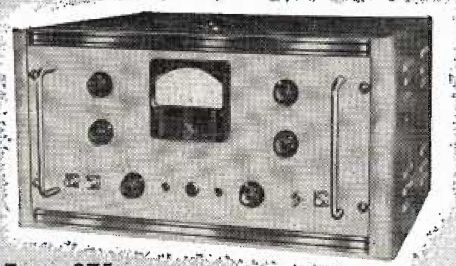
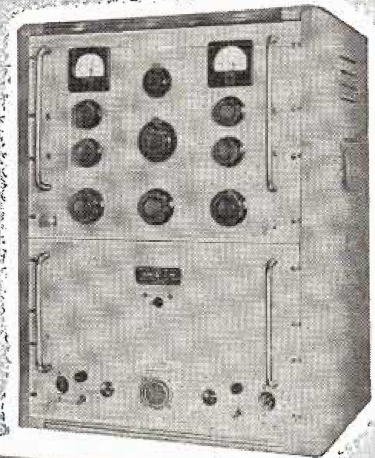


Type 275 VOLTAGE STANDING WAVE RATIO AMPLIFIER
300—3000 cps.



Type 801-A UNIVERSAL KLYSTRON POWER SUPPLY
300-1500 V at 65 ma; 1.5—3.6 KV at 25 ma

THE STANDARD OF COMPARISON IN

Augmented by many new components, the PRD line of RF Test Equipment is presently the most complete line available covering the entire frequency range from .01 to 40 kilomegacycles per second. The units listed indicate the wide diversity and applicability of PRD equipment. In addition to the standard line, PRD specializes in the design and manufacture of special equipment to meet special requirements. A skilled staff of engineers is available to analyze your requirements and to assist in the application of standard or special components to your test problem. PRD equipment is engineered and manufactured to the highest attainable standards. No effort has been spared to make this equipment the finest available anywhere with the result that PRD equipment is now used in leading laboratories all over the world.

FREQUENCY MEASURING DEVICES

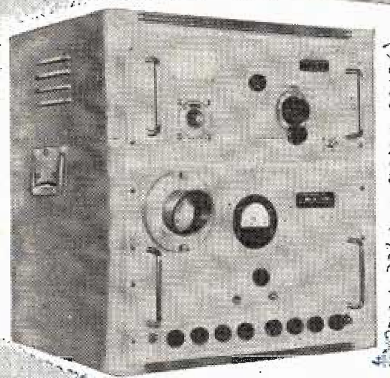
Frequency Meters	Frequency Range (kmc/sec)	Type No.	Transmission Line Size (Nominal O.D.—inches)	R—Reaction T—Transmission
General	0.47—0.95	584	3/8	T
Purpose	3.95—5.85	574	2 x 1	R
	4.00—10.0	562-A	3/8	Detector included
	5.85—8.20	575	1 1/2 x 3/4	R
	7.05—10.0	576	1 1/4 x 5/8	R
	8.2—10.0	585-A	1 x 1/2	R
	8.2—10.0	585-B	1 x 1/2	T
	8.2—10.0	586-A	1 1/4 x 5/8	R
	8.2—10.0	586-B	1 1/4 x 5/8	T

In addition to the General Purpose Frequency Meters listed above, PRD manufactures a complete line of Precision Frequency Meters covering the entire frequency range from 0.55 to 39.0 kmc/s. Transmission line sizes include 3/8" coaxial line and all standard wave guide sizes from 0.280" x 0.140" I.D. to 2" x 1" O.D. All types are available in Reaction and Transmission styles.

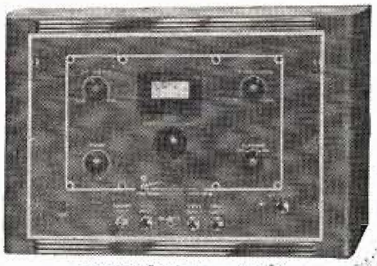
The Type 500 Frequency Standard Multiplier is available to generate standard frequency signals in the UHF and microwave regions when used with the Type 612-A Tunable Crystal Mount.

SIGNAL SOURCES AND RECEIVERS

ITEM	DESCRIPTION
TUBE MOUNTS	
Type 701	For type 2K28 klystrons, 2.400—3.445 kmc/sec
Type 702	For type 2K25 klystrons, 8.50—9.60 kmc/sec, 1 1/4 x 5/8 waveguide
Type 703	For type 2K25 klystrons, 8.50—9.60 kmc/sec, 1 x 1/2 waveguide
OSCILLATORS	
Type 705	Covering the frequency range from 7.0 to 11.0 kmc/sec
Type 706	Covering the frequency range from 3.6 to 7.3 km/sec
POWER SUPPLIES Type 801-A	Providing all required electrode voltages to operate a wide variety of klystrons, plus internal modulators
SPECTRUM ANALYZERS	
Type 853	Covering the frequency range from 2.40 to 3.40 kmc/sec
Type 854	Covering the frequency range from 8.50 to 9.60 kmc/sec
Type 855	Combining both of the above ranges in one instrument
GENERATORS	
Type 902	Covering the frequency range from 3.65 to 7.30 kmc/sec
Type 903	Covering the frequency range from 7.00 to 10.5 kmc/sec
Type 907	Covering the frequency range from 35 to 900 mc/sec
NOISE GENERATORS Type 904	For the direct measurement of noise factors in the range of 10 to 1000 mc/sec

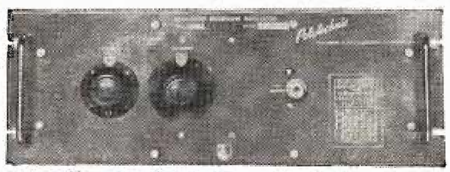


Type 854 UNIVERSAL SPECTRUM ANALYZER
8.5—9.6 kmc/s



Type 907 BROADBAND SWEEP FREQUENCY GENERATOR
35—900 mc/s

Type 904 VHF-UHF NOISE GENERATOR
.01—1.0 kmc/s



Type 706 BROADBAND MICROWAVE OSCILLATOR
3.6—7.3 kmc/s

Polytechnic RESEARCH & DEVELOPMENT COMPANY • INC

TELE-TIPS

COMMUNITY TV SYSTEMS, because of "wired-in" audiences, offer some new marketing potentialities. Municipalities employing these wire services have an excellent means for disseminating information on local events and conditions. TV camera(s) can feed video into the distribution system which then can be made available in subscribers homes on an unused VHF channel frequency. Thus local news, sports events, civic meetings and a host of other activities can be telecast about the town. Such installations could also be used to familiarize would-be future radio-TV-electronic engineers with practical equipment and operational techniques.

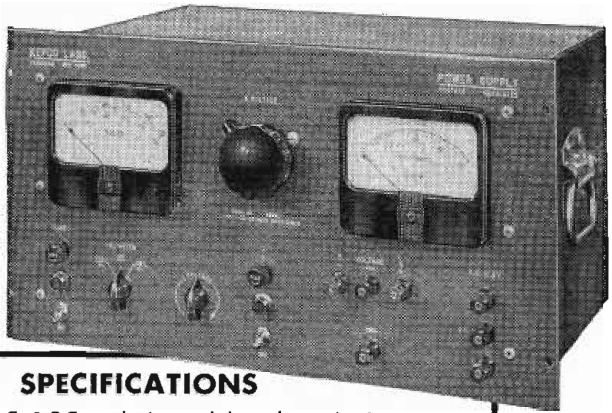
STATIC—Tests at the Bureau of Standards have shown that frictional-electricity potentials as high as 5000 volts can be developed by such common-everyday-occurences as getting up from a plastic-covered chair! Oscillographic records, however, indicate that if the resistance between the person and the chair is less than 20 megohms, the voltages will not exceed 300 volts. This is less than the minimum sparking voltage in air and is thus not hazardous. Conductive shoes, conductive soles, and conductive linoleum are now being required in hospitals and other places involving explosive gases, to provide high-resistance conductive paths for the safe dissipation of the static charges likely to be generated by ordinary movement.

ELECTRONIC POLLS—Dr. W. R. G. Baker, GE vice-president, points out that it is now possible for legislators to take electronic opinion polls of their constituents. "Our electronic age, which broadcast radio ushered in, now has created a means by which the American public may be an interested and informed participant in self-government. I believe most legislators keep a rather sensitive finger on the public pulse. Should they desire a means of instantaneously recording the reactions of an adequate number of citizens to obtain a true sample of opinion, our engineers can build the electronic equipment to provide this service."

(Continued on page 16)

VOLTAGE REGULATED POWER SUPPLIES

For Industrial and Research Use



MODEL 815

DC POWER SUPPLY SPECIFICATIONS

REGULATION: ½% for both line (105-125 volts) and load variations.
REGULATION BIAS SUPPLIES: 10 millivolts for line 105-125 volts.
½% for load at 150 volts.
RIPPLE: 5 millivolts RMS

VOLTS	CURRENT	MODEL
100-325 0-150 Bias 6.3 AC.CT.*	0-150 Ma. 0-5 Ma. 10 Amp	**131**
100-400 6.3 AC.CT.	0-150 Ma. 10 Amp.	**141**
200-500 6.3 AC.CT.	0-200 Ma. 6 Amp.	**245**
0-300 0-150 Bias 6.3 AC.CT.	0-150 Ma. 0-5 Ma. 5 Amp.	**315**
0-500 6.3 AC.CT.	0-300 Ma. 10 Amp.	**500R**
#1 200-500 #2 200-500 #3 6.3 AC.CT. #4 6.3 AC.CT.	0-200 Ma. 0-200 Ma. 6 Amp. 6 Amp.	**510**
0-500 0-150 Bias 6.3 AC.CT.	0-300 Ma. 0-5 Ma. 10 Amp.	**615**
0-350	0-750 Ma.	**700**
0-350	0-1.50 Amp.	**710**
0-350	0-2.25 Amp.	**720**
0-350	0-3.00 Amp.	**730**
0-600	0-750 Ma.	**750**
0-600	0-1.50 Amp.	**760**

VOLTS	CURRENT	MODEL
0-600	0-2.25 Amp.	**770**
0-600	0-3.00 Amp.	**780**
#1 0-600 #2 0-600 #3 6.3 AC.CT. #4 6.3 AC.CT.	0-200 Ma. 0-200 Ma. 10 Amp. 10 Amp.	**800**
0-600 0-150 Bias 6.3 AC.CT.	0-200 Ma. 0-5 Ma. 10 Amp.	**815**
0-1000 Ripple 10 mv. 6.3 AC.CT.	0-50 Ma. 10 Amp.	**1020**
0-1200 Ripple 10 mv. 6.3 AC.CT.	0-20 Ma. 10 Amp.	**1220**
200-1000 Ripple 20 mv.	0-500 Ma.	**1250**
0-1000 Ripple 20 mv.	0-500 Ma.	**1350**
100-400 Regulation 0.01% Ripple 1 Mv. 6.3 AC.CT.	0-150 Ma. 10 Amp.	**2000**
0-30 Ripple 0.1%	0-30 Amp.	**3030**
0-3 Regulation 5 Mv. Ripple 1 Mv.	0-100 Ma.	**3100**

*All AC Voltages are unregulated. All units are metered except Models 131, 315 and 3100
All units designed for relay rack mounting or bench use.

The Kepco Voltage Regulated Power Supplies are conservatively rated. The regulation specified for each unit is available under all line and load conditions, within the range of the instrument. Write for specifications.

MANUFACTURERS OF ELECTRONIC EQUIPMENT • RESEARCH • DEVELOPMENT

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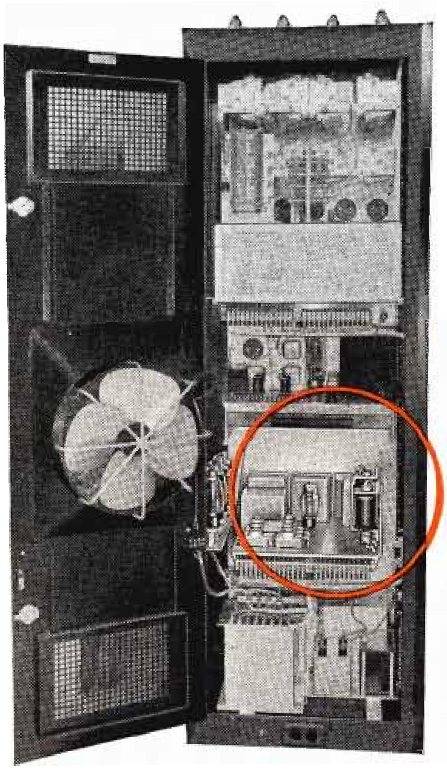


TELE-TIPS

(*Continued from page* 10)

NOT ALL TVI laid at their doors is the responsibility of amateurs, but during the last three years "hams" have almost been driven off the air because of rash actions of many TV servicers in blaming ham rigs for all interference which can't be cured. Because hams can play a very important part in civil defense (as they did in World War II) it is essential that they be allowed to continue their activities, provided they do so properly and within regulations laid down for them by FCC. As a result, joint action of the RTMA Service Committee and the RTMA Amateur Committee will be fostered, with the objective of making servicemen more cognizant of the problems of amateurs, and how to recognize and cope with genuine ham interference when it exists.

ANY MUSICAL POTPOURRI can be produced with a new electronic music box which is keyed by a perforated roll of paper. Claimed to be a composer's and arranger's paradise, the music box can give the operator at the flick of a switch a note higher than the highest one produced on any known instrument, an out-of-this-world vibrato, or a simulated flute section sounding in front of the reeds with the strings off to the right as in a symphony orchestra. With this versatile device, the composer or arranger can translate any musical idea directly into music without the restrictions and limitations of conventional instruments. Speed, variety in tone quality and color, in attack and release, in volume and effects such as "tones moving in space," are obtained merely by turning the proper knobs and controls.

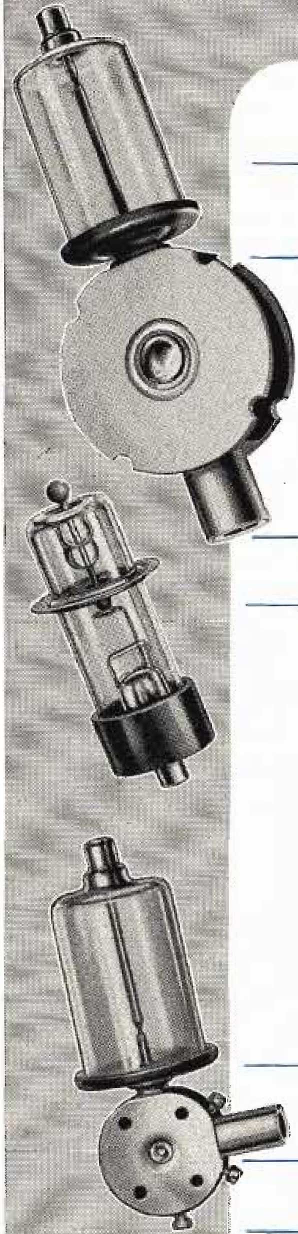
FREE-FLOATING buoy-type weather stations have been developed by the National Bureau of Standards for the Navy Bureau of Ships, which report weather data by radio, automatically and unattended. Designed by P. D. Lowell and W. Hakkarinen, the NBS buoy automatic weather station incorporates various weather-responsive devices to switch a radio transmitter on and off at rates that can be translated by a receiving station into temperature, pressure, and wind data. Information is transmitted in predetermined sequence at intervals of three hours. Self-contained batteries provide sufficient power for reliable operation at over-water distances up to 400 miles.

UNDERWATER TV holds considerable promise, reports the *Journal of the British IRE*. This was dramatically indicated by the discovery of the submarine Affray in 280 ft. of water with a modified TV camera. Remote controls for focusing and adjustment of lens aperture, a lighting assembly and moisture indicator were included with the submerged TV unit. An inclinometer was employed to show camera angle. Future developments envisage operation at depths greater than 100 ft. It has been found that under certain conditions artificial lighting is unnecessary down to 80 ft., and experiments to date show that tungsten lighting is superior to sodium or mercury vapor.

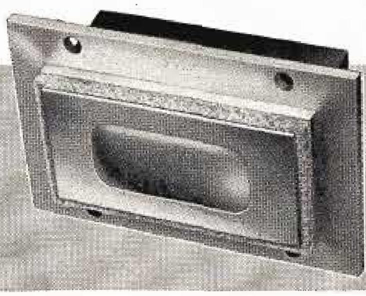
TRY IT OUT!—"Long experience has taught me not always to believe in the limitations indicated by purely theoretical considerations or even by calculations. These—as we all know—are often based on insufficient knowledge of all the relevant factors. I believe, in spite of adverse forecasts, in trying new lines of research, however unpromising they may seem at first sight."
—Marconi.

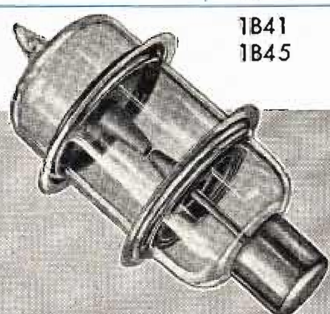
Bomac FOR GAS SWITCHING TUBES

TR, ATR, PRE-TR, HYDROGEN THYRATRONS CRYSTALS AND MICROWAVE COMPONENTS



BAND	FREQ.	DESCRIPTION	TYPE
K BAND	23630-24580	TR, Integral Cavity, Tunable	1B26
	23500-24500	ATR, Fixed-Tuned, Low Q	1B36
	23350-24950	TR, Band Pass	BL-11
X BAND	9300-9450	Cross Guide Duplexer	BL-3
	9050-9600	ATR, Fixed-Tuned, Low Q	1B35
	9050-9600	ATR, Fixed-Tuned, Low Q Fast Recovery Time	6038
	8750-9300	ATR, Fixed-Tuned, Low Q	ATR388
	8600-9650	TR, Glass Envelope, Fixed-Tuned	724B
	8600-9050	ATR, Fixed-Tuned, Low Q	1B37
	8490-9600	TR, Integral Cavity, Tunable	1B24A
	8490-9600	TR, Integral Cavity, Tunable	1B60
	8490-9578	TR, Band Pass	1B63A
	8490-9600	TR, Integral Cavity, Tunable Reservoirless	BL-22
Xb BAND	6200-6700	ATR, Fixed-Tuned, Low Q	1B51
	6000-7100	TR, Integral Cavity, Tunable	1B50
S BAND	3550-3700	ATR, Fixed-Tuned, Low Q	1B52
	3400-3550	ATR, Fixed-Tuned, Low Q	1B53
	3300-3700	Pre-TR	1B54
	3250-3400	ATR, Fixed-Tuned, Low Q	1B57
	3100-3650	TR, Band Pass	1B55
	3000-3100	ATR, Fixed-Tuned, Low Q	5793
	2900-3000	ATR, Fixed-Tuned, Low Q	5792
	2870-3230	TR, Band Pass	5853
	2800-2900	ATR, Fixed-Tuned, Low Q	1B56
	2750-2850	ATR, Fixed-Tuned, Low Q	ATR387
	2700-3400	TR, Glass Envelope, Tunable	1B27
	2700-3300	TR, Glass Envelope, Fixed-Tuned	1B62
	2700-3300	TR, Glass Envelope, Fixed-Tuned	721B
	2700-2800	ATR, Fixed-Tuned, Low Q	1B44
	2650-2950	Pre-TR	1B38
	2600-3000	TR, Band Pass	1B58
	2600-3000	TR, Band Pass Pressurized System	6117
L BAND	1215-1355	TR, Glass Envelope, Tunable	BL-25
	900-1200	TR, Glass Envelope, Fixed-Tuned	1B23
	1075-1095	TR, Fixed-Tuned, Electrodeless Discharge	1B40
Ku BAND	16,200-16,800	ATR, Fixed-Tuned, Low Q	BL-15
	16,200-16,800	TR, Integral Cavity, Tunable	BL-16
SPARK GAP MODULATORS			1B41
			1B45





SUBSCRIPTION — TV

Readers Comment on "Pay-as-You-See" Television as Discussed in July Tele-Tech, pages 33, 66 and 67

Improved Tastes, Wider Enlightenment

Your editorial on subscription television in TELE-TECH is well-conceived and well-expressed. Serious practical problems lie in the path of the ultimate development of subscription television as a public service and your editorial makes a realistic appraisal of them.

Certainly much good to the public and to the television industry can come from a successful establishment of subscription television, because it will provide entertainment to a segment of the public which is not getting as much of certain kinds of entertainment and instruction as it would like. And also because, in time, subscription television would make contributions toward improved tastes and wider enlightenment on the part of the public at large.

Vigorous effort should be applied to working out a solution of the many problems involved in subscription television so that it may be launched on a sound and permanent basis. Your editorial, since it stimulates the active interest of engineers in the possibilities of subscription television and the problems which must be solved before it can be a reality, makes a worthwhile contribution toward a desirable goal.

Yours sincerely,
GLEN McDANIEL
President
Radio Television Mfrs. Assn.
777 14th St., Washington, D.C.

Eventual Authorization

My guess is that the F.C.C. will have to authorize Subscription-TV ultimately, but only after much delay. Educational stations especially will need it. By that time it will be obvious that uhf stations will have to be used. Its competitive effect on commercial programming has yet to be appraised!

THEODORE C. STREIBERT
WOR, General Teleradio, Inc.
President's Office:
1440 Broadway, New York

Keep Open Mind for New Ideas

"Subscription-TV" is, in my opinion, an involved problem and it would be most difficult for one to express himself very clearly on the subject. As a matter of fact, the entire problem of TV programming in the future is anything but clear.

I am in favor of "Subscription-TV" or any other formula which would insure quality programming for the future. I am, of course, not qualified to pass on the technicalities involved in connection with "Subscription-TV." I believe there are many, but I also believe there is enough ingenuity to enable the industry to solve such problems.

Since programming must play such a vital part in the development of this industry, it is important that all of us keep an open mind on any new suggestions which may be advanced, including "Subscription-TV," in the hope that a clear-cut formula may eventually be found.

BENJAMIN ABRAMS
President
Emerson Radio & Phonograph Co.
111 Eighth Ave., New York 11 N.Y.

TV Sponsor Will Continue Carrying Load

Our company's view on subscription television is quite objective. We have no strong feeling one way or another for or against subscription television. We do take with a grain of salt many of the reasons that are put forth to justify its existence. We feel that broadcasters will, over free television, provide the American public with the quality of program that it wants (which, incidentally, at this time we think is pretty close to what the American public will continue to want). To be sure, television costs are increasing and at the present time seem awkward to many sponsors. We do not despair, however, of American ingenuity coming into play, and means will be found to justify these costs—whether it be on a dual sponsorship or local purchase basis, or some other yet to be conceived scheme. Expenditures on television will be justified, and the sponsor will continue to carry a big part of the load.

Subscription television may very well offer an excellent opportunity to supplement the service of free television. I think that as supplementary service it will provide only a small margin of service to the American public but nevertheless one that may be entirely sound, economically, and very desirable from the entertainment standpoint.

ROBERT W. GALVIN
Executive Vice President
Motorola, Inc.
4545 Augusta Blvd., Chicago

"A Most Revolutionary Development"

During the months ahead, the potentialities of Subscription-TV will inevitably invoke the attention of those who are grappling with the mounting cost of TV productions.

We, at Paramount, and our associates in International Telemeter Corporation, believe that Telemeter represents the most simple, convenient and practical device to enable the public to pay for programs they would like to see. Telemeter, as the only presently proposed "pay-as-you-see" system, may well turn out to be one of the most revolutionary developments in the history of the entertainment business. It seems that everybody likes to use the term "pay-as-you-see" for his system but the term aptly fits only Telemeter.

Our recent demonstration of Telemeter in New York, which inspired highly favorable comments, established its technical practicability. We shall endeavor to learn more about the economic aspects of Telemeter in the test planned for Palm Springs this fall.

PAUL RAIBORN
Vice President
Paramount Pictures Corp.
Times Square, New York

RCA Also Has Subscription-TV System

"In response to a question about subscription television, Chairman Sarnoff explained that subscription television is a system by which a person who receives a television program on his home receiver pays for the program. General Sarnoff said that a system of subscription television is technically feasible and that the Corporation has done work on development of such a system. He added that his own reaction to subscription television is that, while there may be a place for it in the future, the matter involves not merely the technical ability to provide subscription television service but also involves the changing of the American way of broadcasting without charge to the listener or to the looker. The greatest thing about radio broadcasting and about television, the Chairman said, is its universality, its ability to reach everyone, everywhere all the time, without direct payment by the owner of the receiver."—From official report of RCA stockholders' meeting of May 6, 1952.

Other Cures for TV's Ills

Since my responsibilities involve close association with General Electric's television activities as a station operator and a sponsor, I should be happy to afford you a few of my thoughts on the subject if you will let me speak as an informal observer rather than as an expert. Frankly, I have formed no opinion for or against subscription television of itself. I do think that two of the arguments in favor of it presented in your summary invite comment.

First, it does not seem to me that subscription television is the only answer to the problem of high costs. I believe that competent station management would agree and expects that increasing competition and the development of television broadcasting in the traditional pattern of a new industry will produce improved methods and economies which cannot now be foreseen and will result in lower unit time costs as well as lower costs-per-thousand. It would also seem that great opportunities for economy exist in the production costs of television as it stands today; the continued growth of the medium and expanding competition in this area may very well diminish or remove

(*Continued on page* 180)

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

"National's quality control program starts with engineering research on the raw materials used and the development of material specifications. The next step is the preparation of process specifications for the various manufacturing operations. The final step is the testing of all products against specifications. We develop such specifications for all of our new products. For standard grades, we actively co-operate with A.S.T.M., N.E.M.A., and Government agencies in establishing standard values for essential properties. Rigid adherence to this program of quality control makes National products dependable—uniform."

Gerald H. Mains
Director of Research, Phenolite Div.
National Vulcanized Fibre Co.

George Holton, in charge of electrical testing laboratory, measuring dissipation or power factor at 1000 cycles of silicone Fiberglas sheet, Grade G-7-834, in a study of electrical characteristics of this new grade. The silicone Fiberglas material has heat resistance up to 250°C. and the lowest dissipation factor of any thermosetting laminate yet available.

National Laminated Plastics nationally known—nationally accepted

NATIONAL VULCANIZED FIBRE

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

PHENOLITE Laminated PLASTIC

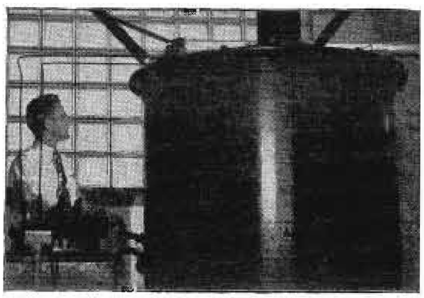
Phenolite possesses an unusual combination of properties—a good electrical insulator, great mechanical strength, high resistance to moisture; ready machinability, lightweight. Sheets, Rods, Tubes, Special Shapes.

National Vulcanized Fibre Company

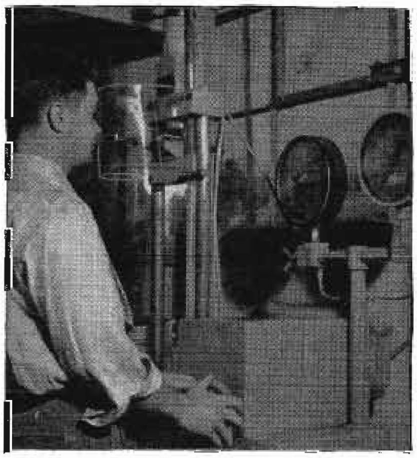
Wilmington Delaware

Offices in *Principal Cities*

Since 1873



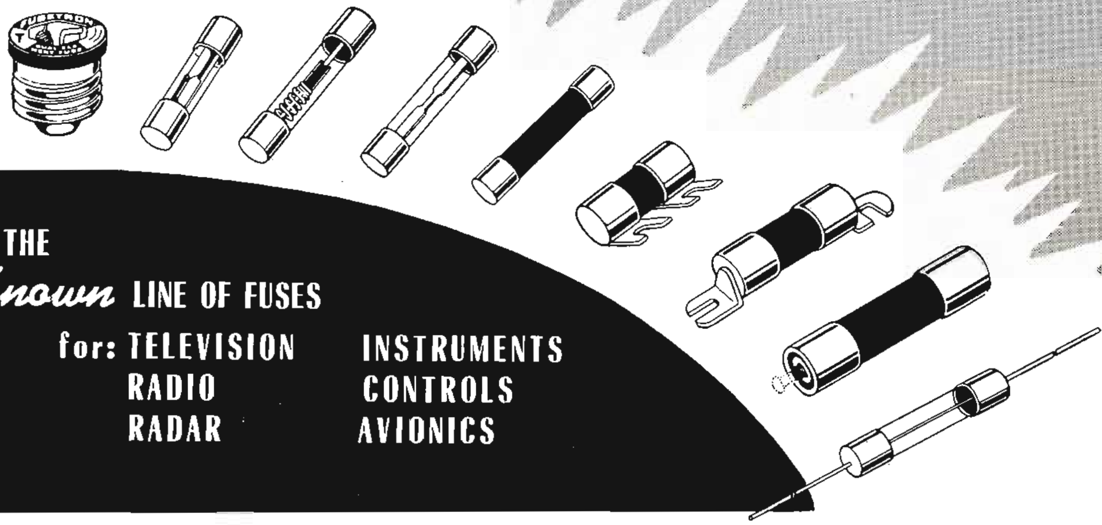
C. A. Mellinger, electrical engineer, testing dielectric breakdown of phenolic laminated sheet to meet requirements of N.E.M.A. standards for high dielectric strength. Test is made after sheet has been soaked in hot water (50°C) for 48 hours. This transformer makes possible tests up to 100 kilovolts.



Francis Corcoran tests the flexural strength of a piece of ⅛th inch thick Phenolite, Grade XXX-401, against the requirements of MIL-P Specification 3115B, type PBE. He uses a testing machine which employs hydraulic pressure to determine the number of pounds per square inch required to break the specimen supported as a beam.

BUSS FUSES

Help Protect Your Product . . . Your Profit . . . Your Reputation



THE
Known LINE OF FUSES
for: TELEVISION, RADIO, RADAR, INSTRUMENTS, CONTROLS, AVIONICS

38 year's service to American homes, farms and industry is behind every fuse that bears the BUSS trademark. Your customers have confidence in BUSS . . . they know the BUSS name represents fuses of unquestioned high quality.

To maintain this high standard each and every BUSS fuse is tested in a highly sensitive electronic device that rejects any fuse that is not correctly calibrated — properly constructed and right in physical dimensions.

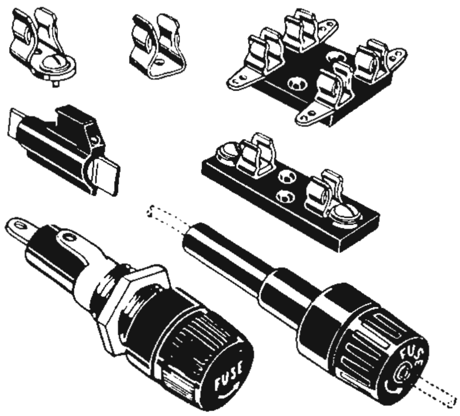
It's easy to select a BUSS fuse that's *right* for your fuse application. The complete BUSS line includes: Dual Element (Fusetron slow blowing type fuses), Renewable and One-Time types — available in all standard sizes, and many special sizes and designs.

IF YOU HAVE A PROTECTION PROBLEM — We welcome requests for help in selecting the fuse or fuse mounting best suited to your conditions. Submit sketch or description showing type of fuse contemplated, number of circuits, type of terminals, and the like. Our staff of fuse engineers is at your service.

For More Information
CLIP THIS HANDY COUPON NOW . . .

BUSSMANN MFG. CO., Division McGraw Electric Company
University at Jefferson St. Louis 7, Mo.

. . . *Plus*
A COMPLETE LINE OF FUSE CLIPS, BLOCKS AND HOLDERS



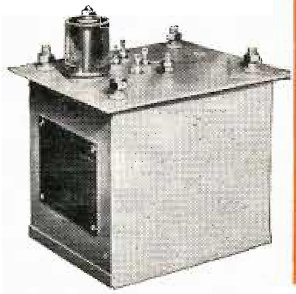
BUSSMANN Mfg. Co. (Division of McGraw Electric Co.)
University at Jefferson, St. Louis 7, Mo.
Please send me bulletin SFB containing complete facts on BUSS small dimension fuses and fuse holders.

Name..
Title..
Company..
Address...
City & Zone.......................State....................... TT-952

a complete line of hermetically sealed oil-filled HIGH-VOLTAGE COMPONENTS

Rectifiers

Small, lightweight a-c to d-c power supply units for use with cathode-ray tubes, television camera tubes and radar indicator scopes, electron microscopes, and similar jobs. Typical outputs are 7, 9 and 13 kv. Low regulation—the 7-kv unit illustrated does not exceed 3.5% regulation per 0.1 milliampere load, holds ripple on output voltage to less than 1%. Size, only 6" x 6" x 7"; weight 8 lb.



Pulse Transformers

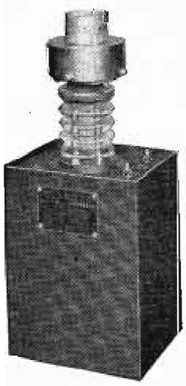
Pulse transformers for use with either hard-tube or line-type modulators. Available in voltage ratings of 10 kv or above. These units are ideal for radar applications, stepping up or down, impedance matching, phase reversing and plate-current measurements. Also suitable for nuclear physics research work, television and numerous special applications in and out of the communications fields.

Resonant Reactors

Resonant-charging reactors, accurately designed and constructed for radar service. Usually required in ratings of 40 kv and below, 1 ampere and below and 300 henries and below. Higher ratings are being built, and can be considered. When required, small- and medium-size designs can be provided with 3 to 1 range of inductance adjustment.

Filament Transformers

Filament transformers available with or without tube socket mounted integral with the high-voltage terminal. Low capacitance. Ratings to match any tubes; insulated to practically any required level.

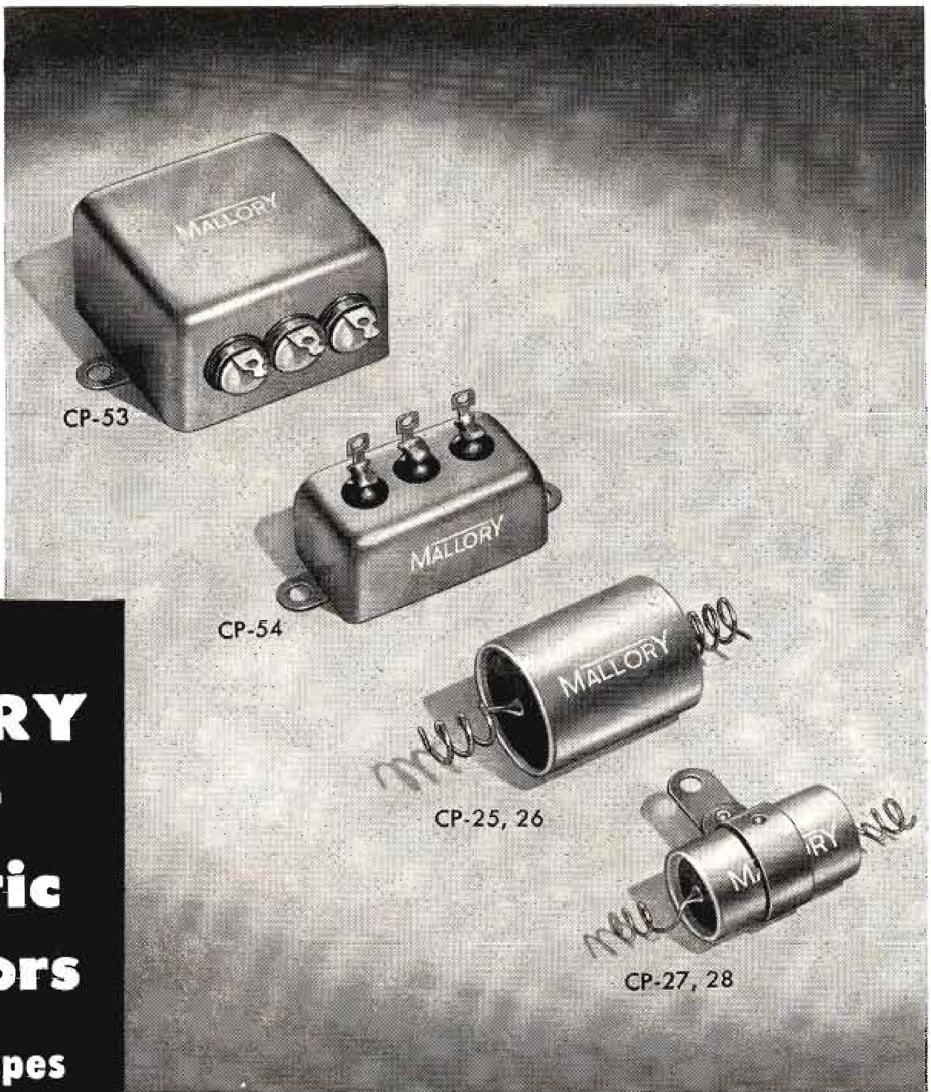


Illustrated here are typical high-voltage components manufactured by General Electric. They are built to meet Armed Services requirements. All are oil-filled and hermetically sealed—with excellent ability to withstand mechanical shocks and to operate continuously for long periods in widely varying temperatures.

Your inquiries will receive prompt attention. Since these components are usually tailored to individual jobs, please include with your inquiry, functional requirements and any physical limitations. Address the nearest G-E Apparatus Sales Office or write Section 401-63, General Electric Co., Schenectady 5, N.Y.

GENERAL ELECTRIC

401-63



MALLORY paper dielectric capacitors

JAN-C-25 types

For use in military electronic equipment, Mallory manufactures a line of paper dielectric capacitors which will conform to Characteristic E of Specification JAN-C-25. Included in the Mallory line are the following types:

CP-25, CP-26, CP-27, CP-28
CP-29, CP-53, CP-54, CP-55

Into these military-type capacitors go the same engineering know-how and production craftsmanship which have made Mallory capacitors the standard of quality in the industrial and electronic fields. They are now in quantity production and your inquiry will receive prompt attention.

Look to Mallory for all your capacitor needs . . . whether for military or civilian applications.

New Folder Describes JAN-C-62 Capacitor Types

In addition to paper dielectric capacitors Mallory produces a full line of electrolytic capacitors conforming to JAN-C-62. Write for your copy of the new Technical Information Bulletin. It is an ideal reference for everyone who uses or specifies electrolytic capacitors.

P. R. MALLORY & CO. Inc.
MALLORY

SERVING INDUSTRY WITH THESE PRODUCTS:

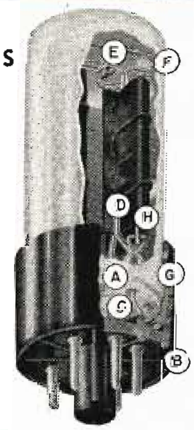
Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Dry Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO., INC., INDIANAPOLIS 6, INDIANA

CONSTRUCTIONAL HIGHLIGHTS 5Y3WGTA

For high altitudes: A. Cavity stem (patent pending). B. Barrier base. C. Optimized lead spacing. All three offer maximum isolation and insulation of high-voltage leads for stratosphere operation.

For ruggedization: D. Four-point mount support. E. "Mouse-trap" filament tensioner springs. F. Resilient superstructure cross springs. G. Low-pass mechanical filter between base and mount structure to absorb high-frequency components of shock. H. Cataphoretic-coated filament.



Is your aircraft equipment climbing up . . . up . . . up? Need an all-purpose rectifier — preferably ruggedized — to meet the challenge? High-altitude 5Y3WGTA . . . also the original ruggedized filamentary-type tube . . . is your answer.

At 50,000 feet* CBS-Hytron 5Y3WGTA offers you: Same maximum current and voltage ratings (with safe bulb temperatures) as the standard 5Y3GT at sea level. Plus JAN-1A ruggedization to withstand destructive shock, vibration, acceleration, and impact. And single-ended construction . . . convenient for both new and older equipment. (The 5Y3WGTA is interchangeable with the 5Y3GT or 5Y3WGT.) Check the 5Y3WGTA's ratings . . . its rock-solid construction.

90,000 FEET UP! New CBS-HYTRON 6004

Climbing higher still? Plate connections to top caps of 6004 push ceiling far into stratosphere. CBS-Hytron 6004 operates at 90,000 feet — higher at adjusted ratings — free from arc-over and at safe bulb temperatures. See comparative data for ratings.

COMPARATIVE DATA

Max. Ratings	5Y3WGTA	6004
Operating altitude	50,000 ft.*	90,000 ft.*
Peak inverse plate voltage	1,400 v†	1,000 v††
Peak plate current per plate	400 ma.	400 ma.
Bulb temperature	185° C	185° C
JAN-1A ruggedized	Yes	No
Basing	Single-ended	Double-ended

*Adjusted rating chart available for higher altitudes.† At 50,000 feet.†† At 90,000 feet

CBS HYTRON RADIO TUBES

MAIL TODAY FOR COMPLETE DATA

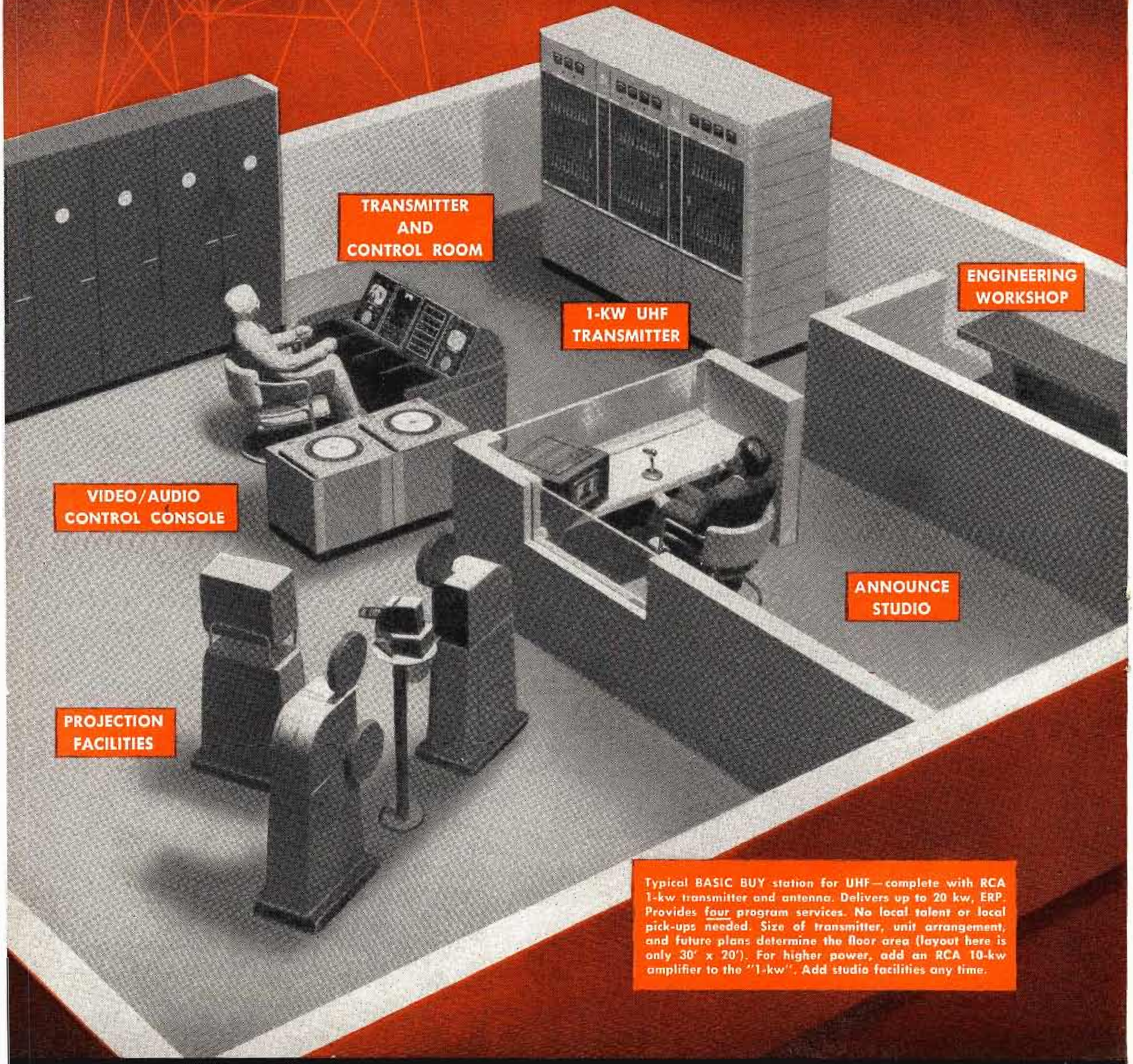
MANUFACTURERS OF RECEIVING TUBES SINCE 1921
HYTRON RADIO AND ELECTRONICS CO.
A DIVISION OF COLUMBIA BROADCASTING SYSTEM, INC.
SALEM, MASSACHUSETTS

HYTRON RADIO & ELECTRONICS CO.
Salem, Massachusetts

Please send me full data (including adjusted rating chart for higher altitudes) on CBS-Hytron high-altitude rectifiers: 5Y3WGTA and 6004.

YOUR NAME..
(please print)
COMPANY..
STREET ADDRESS..
CITY AND STATE..T

RCA's TV "Basic



Typical BASIC BUY station for UHF—complete with RCA 1-kw transmitter and antenna. Delivers up to 20 kw, ERP. Provides four program services. No local talent or local pick-ups needed. Size of transmitter, unit arrangement, and future plans determine the floor area (layout here is only 30' x 20'). For higher power, add an RCA 10-kw amplifier to the "1-kw". Add studio facilities any time.

Buy" does the most

–VHF or UHF!

4 PROGRAM SERVICES

– no local studios needed!

- Network programs
- Local films (16mm)
- "Stills" from local slide projector
- Test pattern from monoscope (including individualized station pattern in custom-built tube)

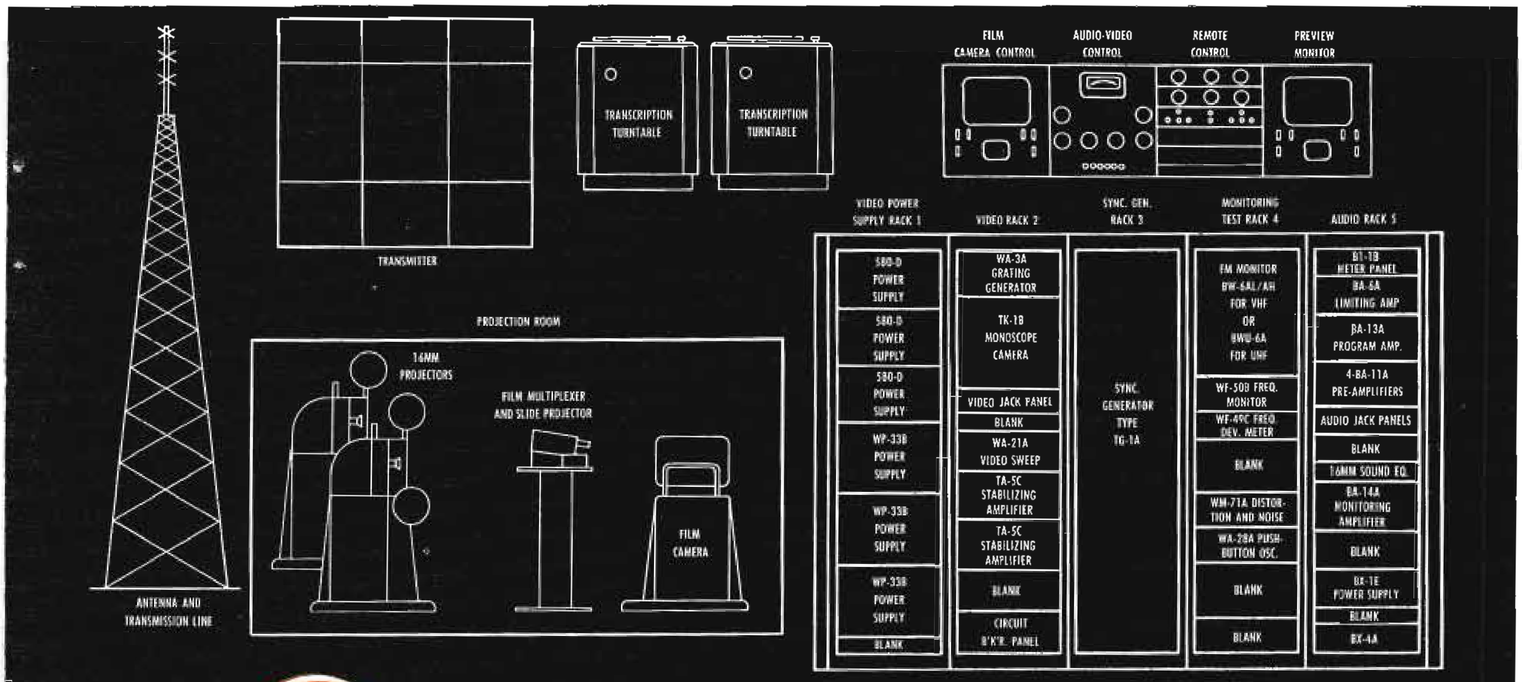
THIS PICTURE ILLUSTRATES what we think is the minimum equipment a TV station should have to start with—*and earn an income.* The arrangement can handle any TV show received from the network and provides station identification and locally inserted commercials as required. In addition, it offers an independent source of revenue—by including film and slide facilities for handling local film shows and spots, or network shows on kine recordings.

The BASIC BUY includes: A transmitter and an antenna (necessary for any TV station); monitoring equipment (required by FCC); film and slide equipment (for local programs—and extra income); monoscope camera for reproducing a test pattern of known quality (important for good station operation and as an aid to receiver adjustment); and a control console that saves operator time and effort (it enables one technical man to run the station during nearly all "on-air" periods).

RCA's BASIC BUY can be used in combination with any RCA TV transmitter and antenna, of any power—VHF or UHF. Matched design and appearance make it easy to add facilities any time (you need never discard one unit of a basic package). And note this: *RCA BASIC UNITS ARE IDENTICAL TO THE RCA UNITS USED IN THE BIGGEST TV STATIONS!*

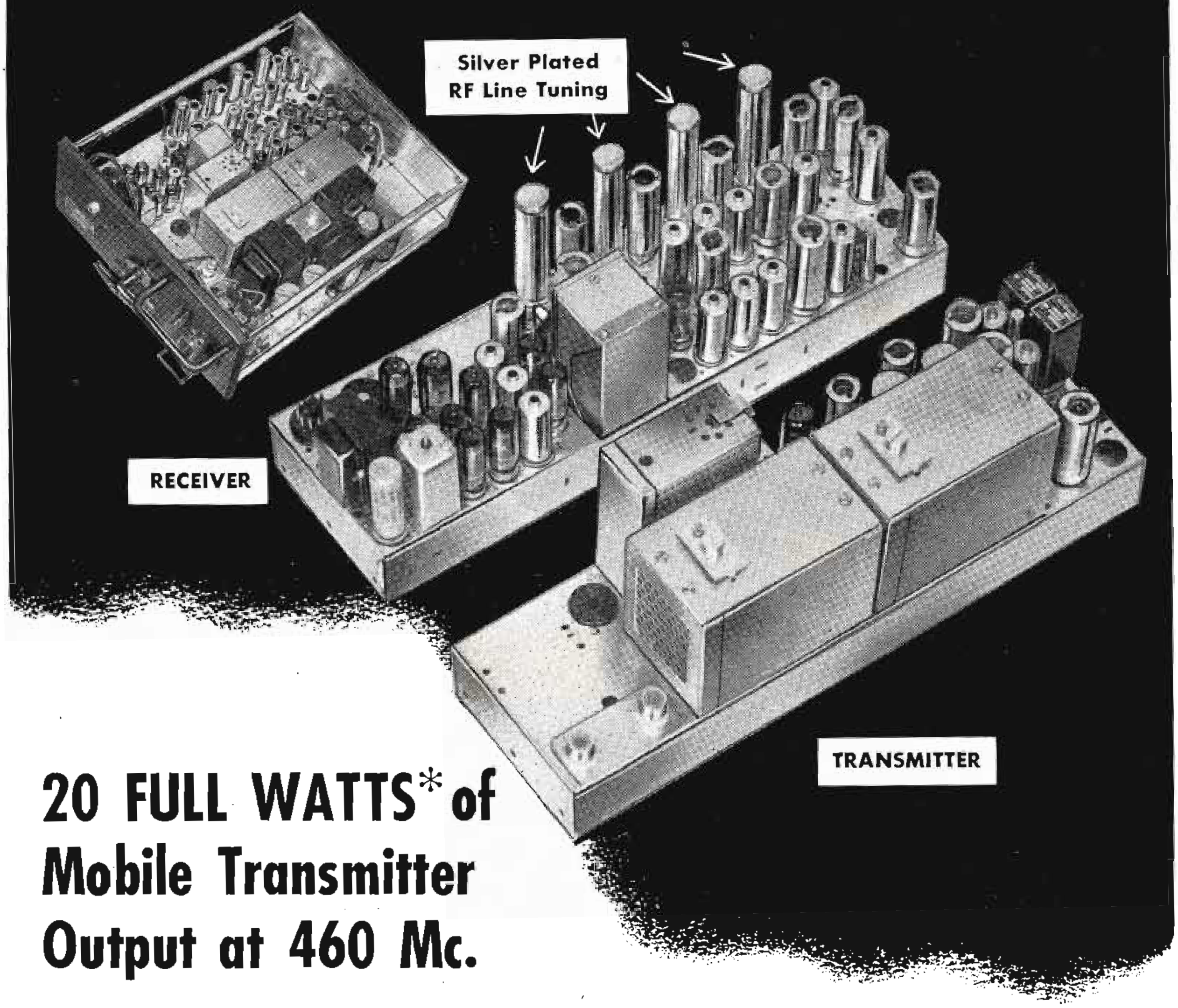
RCA's BASIC BUY is already being adopted by many TV station planners. Let your RCA Sales Representative work out a flexible package like this for you—show you how to do the most with the least equipment!

This is what the BASIC BUY includes!



RADIO CORPORATION of AMERICA
ENGINEERING PRODUCTS DEPARTMENT CAMDEN, N.J.

NEW MOTOROLA 460 MC. with A.F.C.



20 FULL WATTS* of Mobile Transmitter Output at 460 Mc.

AUTOMATIC FREQUENCY CONTROL

Motorola's new crystal controlled A.F.C. system provides positive barriers so that the receiver cannot jump to a strong adjacent channel signal.

This new Motorola A.F.C. technique is fortified with extraordinary system stability. The A.F.C. crystal controlled oscillator provides a full 10 to 1 correction ratio and keeps the receiver tuned on the nose to the distant transmitted carrier.

The new U. H. F. tuned circuits and research design cavities for ground grid amplifier operation provide phenomenal circuit stability, spurious rejection and extraordinary efficiency.

TRANSMITTER

The Motorola 460 Mc. system with 9 tuned circuits provides 18* to 20* Watts with *Efficiencies of more than 65%!*

SILVER PLATED SEALED TUNED CAVITIES

By use of silver plated line sections, high standards of selectivity protect the receiver from high power U.H.F., TV intermodulation.

Motorola

Communications & Electronics Division
4545 Augusta Blvd., Chicago 51, Illinois
Rogers Majestic Electronics Ltd., Toronto, Canada

Helipot

come to **Helipot**
for the largest selection of
single turn
precision potentiometers

The same engineering know-how and precision manufacturing facilities that have made HELIPOT the world's largest manufacturer of multi-turn potentiometers, have also established its leadership in the design and production of high precision *single*-turn potentiometers. These single-turn units are built with the same infinite care . . . on the same types of specially-designed equipment . . . by the same highly trained personnel that have made Helipot multi-turn potentiometers the world's standard. *Result*—a wide selection of single-turn potentiometers, available in volume, built to the highest-possible standards—*at mass-production economies!*

Most of the units shown at right are readily adaptable to special requirements—servo mountings, ball or sleeve bearings, ganged assemblies, single or double shaft extensions, taps spot-welded to a *single* turn of winding at virtually any desired point, and many other optional features to meet the needs of *your* applications.

So, no matter what your requirement in precision potentiometers, bring it to Helipot!

ADVANCED ENGINEERING! VOLUME PRODUCTION!

MODEL L SERIES (3" DIA.):
A high-precision single-turn unit with continuous mechanical rotation and minimum electrical dead space. Model L has bushing mounting, sleeve bearings . . . LS, servo mounting, sleeve bearings . . . LSP servo mounting, ball bearings. All are gangable to 8 sections, sections phaseable after assembly to within ±1°. Many other features.*

MODEL J (2" DIA.):
The first production designed potentiometer with ball bearings as a standard feature—also versatile three-way servo mounting. Individual sections can be easily ganged and independently phased by the user after installation without external brackets or clamps. Many other unique features.*

MODEL G (1 5/16" DIA.):
A compact, single-turn precision potentiometer—low in price, extra rugged. Developed initially for remote positioning and indicating in aircraft applicatons—now also used for general instrumentation and servo mechanisms. Continuous 360° rotation. In certain resistance values is excellent for high temperature applications—at ambient temperatures as high as 165°C. under certain conditions.*

miniature

MODEL T "TINYTORQUE" (7/8" DIA.):
A miniature ultra-low-torque unit for guided missiles and aviation electronics. Features shielded ball bearings, highest possible precision and quality, long life, rugged dependability. Length only 25/32"—weight only 0.56 oz.—starting torque only 0.005 oz. in., when specified—negligible running torque. Sliders phaseable to within 3°. On vibration tests units have successfully withstood frequencies 0 to 2000 c.p.s. in 3 planes, accelerations up to 20 G's for periods to 1 hr.*

See your nearest Helipot Representative for complete details. Or write direct!

Duodials *for every application*

Duodial turn-indicating knob-dials are ideal for Helipots and other multi-turn applications. Available in a wide range of sizes and turns ratios . . .

MODEL RA:
The beautiful new 10 turn *Precision Duodial* with a "feel" and appearance that add distinction to the finest instrument panels. Features excellent readability, positive locking lever, easy assembly. Available in 10:1 ratio only.

MODEL R:
Standard 2" Duodial in 10:1, 15:1, 25:1, 40:1 turns ratios for various Helipot ranges. Locking device, if desired.

MODEL W:
Large 4¾" Duodial for primary control applications. Easy to adjust and read. Finger hole for rapid rotation. Available in turns ratios of 10:1, 15:1, 25:1, 40:1.

THE LABORATORY HELIPOT (MODEL T-10):

A 10 turn Helipot, "R" Duodial and 3-way binding posts combined in a handsome walnut-cased unit ideal for laboratory and instruction purposes. Simplifies making and changing experimental circuits. More compact and 5 times faster to set than decade boxes. Linearity 0.1%, Power Rating 5 watts, Standard Resistance Ranges 100 to 100,000 ohms—others on order.

THE Helipot CORPORATION
SOUTH PASADENA, CALIFORNIA

Field Offices: Boston (CO. 7-1941), New York (Rockville Center 6-1014), Philadelphia (COllingswood 5-3515), Rochester (CU. 7640), Schenectady (DE. 2319), Cleveland (PR. 1552), Detroit (TO. 8-3130), Chicago (PA. 5-1170), St. Louis (SW. 5584), Los Angeles (RY. 1-8345), Seattle (FR. 7515), Dallas (ST. 3335), Ft. Myers, Fla. (FO. 1269-M). Canada: Cossor, Ltd. Toronto (PR. 1226) and Halifax (4-6488). Export Agents: Frathom Co., New York City 18, (BR. 9-1296).

Accurate – Portable – **AVAILABLE**

Gold Plating of the oscillator cavity and tuning plunger assures smooth action and reliable performance over long periods. Generous use of silicone-treated ceramic insulation, including resistor and capacitor terminal boards, and the use of sealed capacitors, transformers, and chokes, insures operation under conditions of high humidity for long periods.

The Type H-12

UHF SIGNAL GENERATOR

900-2100 Megacycles

This compact, self-contained unit, weighing only 43 lbs., provides an accurate source of CW or pulse amplitude-modulated RF. A well-established design, the Type 12 has been in production since 1948. The power level is 0 to −120 dbm, continuously adjustable by a directly calibrated control accurate to ±2 dbm. The frequency range is controlled by a single dial directly calibrated to ±1%. Pulse modulation is provided by a self-contained pulse generator with controls for width, delay, and rate; or by synchronization with an external sine wave or pulse generator; or by direct amplification of externally supplied pulses.

Built to Navy specifications for research and production testing, the Type H-12 Signal Generator is equal to military TS-419/U. It is in production and available for delivery.

Price: $1,950 net, f.o.b. Boonton, N. J.

Type H-14 Signal Generator

(108 to 132 megacycles) for testing OMNI receivers on bench or ramp. Checks on: 24 OMNI courses, left-center-right on 90/150 cps localizer, left-center-right on phase localizer, Omni course sensitivity, operation of TO-FROM meter, operation of flag alarms.

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Aircraft Radio

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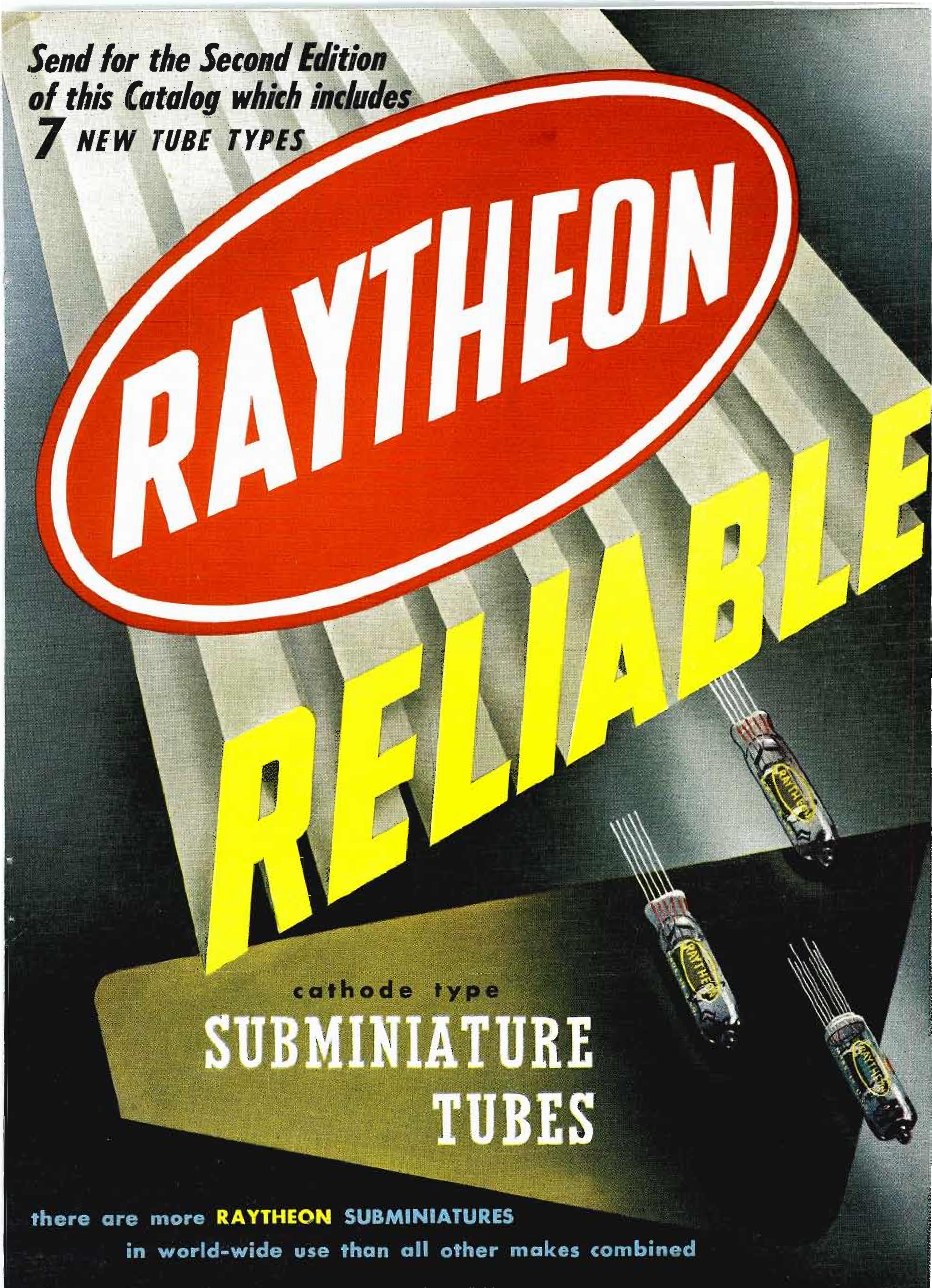
WRITE TODAY for descriptive literature on A.R.C. Signal Generators or airborne LF and VHF communication and navigation equipments, CAA Type Certificated for transport or private use.

Dept. 3

Dependable Electronic Equipment Since 1928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Usable in the UHF region

Type	Description	Heater Volts	Heater Ma	Plate Volts	Plate Ma	Grid Volts	Screen Volts	Screen Ma	Amp. Factor	Mut. Cond.
CK5702WA	RF Amplifier Pentode	6.3	200	120	7.5	$R_k = 200$ ohms	120	2.5	—	5000
CK5703WA	High Frequency Triode	6.3	200	120	9.0	$R_k = 200$ ohms	—	—	25	5000
CK5744WA	High Mu Triode	6.3	200	250	4.0	$R_k = 500$ ohms	—	—	70	4000
NEW CK5783WA	Voltage Reference		Operating voltage approximately 86 volts between 1.5 and 3.5 ma.							
CK5784WA	RF Mixer Pentode	6.3	200	120	5.2	−2	120	3.5	—	3200
NEW CK5787WA	Voltage Regulator		Operating voltage approximately 100 volts between 5 and 25 ma.							
NEW CK5829WA	Dual Diode	6.3	150		Max. Peak Inverse 360 volts. $I_o = 5.5$ ma. per plate					
NEW CK6021	Medium Mu Dual Triode	6.3	300	100	6.5	$R_k = 150$ ohms	—	—	35	5400
NEW CK6110	Dual Diode	6.3	150		Max. Peak Inverse 460 volts. $I_o = 4.4$ ma. per plate					
NEW CK6111	Medium Mu Dual Triode	6.3	300	100	8.5	$R_k = 220$ ohms	—	—	20	5000
NEW CK6112	High Mu Dual Triode	6.3	300	100	0.8	$R_k = 1500$ ohms	—	—	70	1800
CK6152	Low Mu Triode	6.3	200	200	12.5	$R_k = 680$ ohms	—	—	15.8	4000

Note: All dual section tube ratings (except heater) are for each section.

Write for Raytheon RELIABLE Subminiature Tubes Catalog T containing complete mechanical and electrical data on these tubes.

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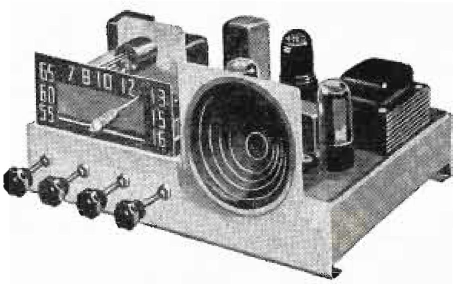
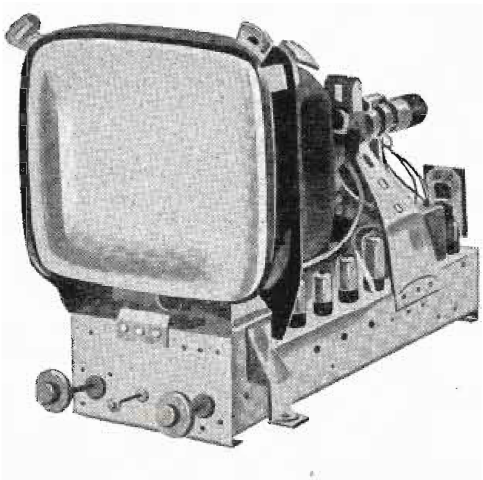
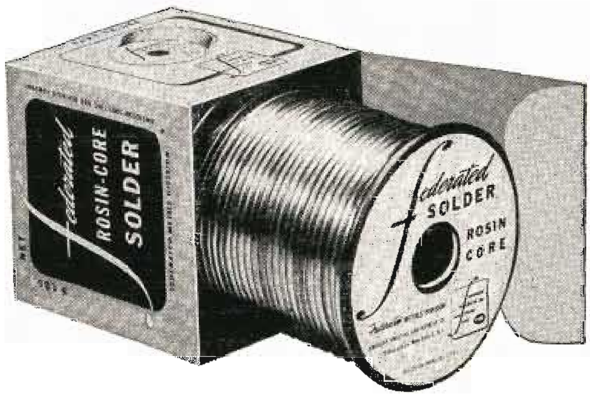
RELIABLE SUBMINIATURE AND MINIATURE TUBES • GERMANIUM DIODES AND TRANSISTORS • NUCLEONIC TUBES • MICROWAVE TUBES • RECEIVING AND PICTURE TUBES

FOR RADIO  AND

TV  SOLDERING THAT LASTS...

USE... 

For any soldering job that demands freedom from corrosion and conductive flux residue . . . for ease of working and unequalled consistency . . . there is nothing better than Federated Rosin Core Solder.

Each Rosin Core Solder composition, of which there is a variety for different purposes, is a tin and lead alloy with a rosin flux that is effective but not corrosive. Because the rosin residue is chemically inactive, current leakage at radio and television frequencies is prevented.

Federated Rosin Core Solder is a quality product that is unsurpassed for the permanence of the bond it produces . . . for the consistently easier soldering job it does! Look for it in 1, 5, 20, 25, and 50-pound sizes on the familiar orange and black metal spool. Listed by Underwriters' Laboratories Inc.

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—built man-size for man-sized TV jobs!

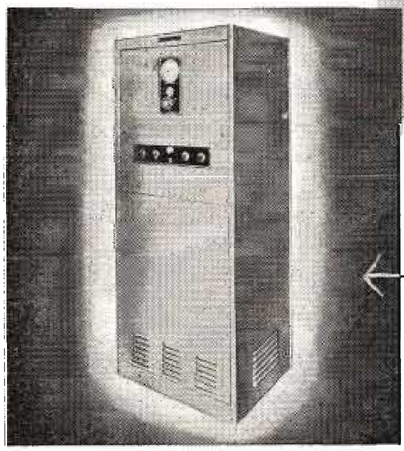
AUTO-DRYAIRE* DEHYDRATORS

MODEL 105-507

AUTO-DRYAIRE* DEHYDRATOR

SPECIFICATIONS:

- Fully automatic—dry air available without interruption. Capacity 3 CFM
- Dewpoints below — −40° F.
- Floor model—26″ W x 22″ D x 66⅞″ H
- Operating pressure adjustable up to 50 PSI
- Serves up to:
  40,000 ft. 1⅝″ Transmission Line.
  10,000 ft. 3⅛″ Transmission Line.
  3,500 ft. 6⅛″ Transmission Line.



MODEL 105-507 is fully automatic—this particular unit delivers 3 CFM. There are many others in the complete family of Auto-Dryaire* Dehydrators having characteristics to meet all requirements—standard models with deliveries from .15 CFM to 3.0 CFM; larger capacities to specifications.

For performance plus, specify the following products of our manufacture: SEAL-O-FLANGE* TRANSMISSION LINE, AM, FM and TV TOWER HARDWARE, LO-LOSS SWITCHES, and COAXIAL DIPOLE ANTENNAS. Inquiries invited.

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makes good capacitors better
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E-therm impregnated capacitors are now available in production quantities. E-therm is a unique new impregnating material developed and compounded by Sangamo. E-therm impregnated capacitors far exceed the requirements of JAN Specifications. E-therm possesses exceptionally high thermal stability and superior electrical characteristics. E-therm impregnated capacitors mean—higher operating temperatures—lower power factor—higher resistance—longer life.
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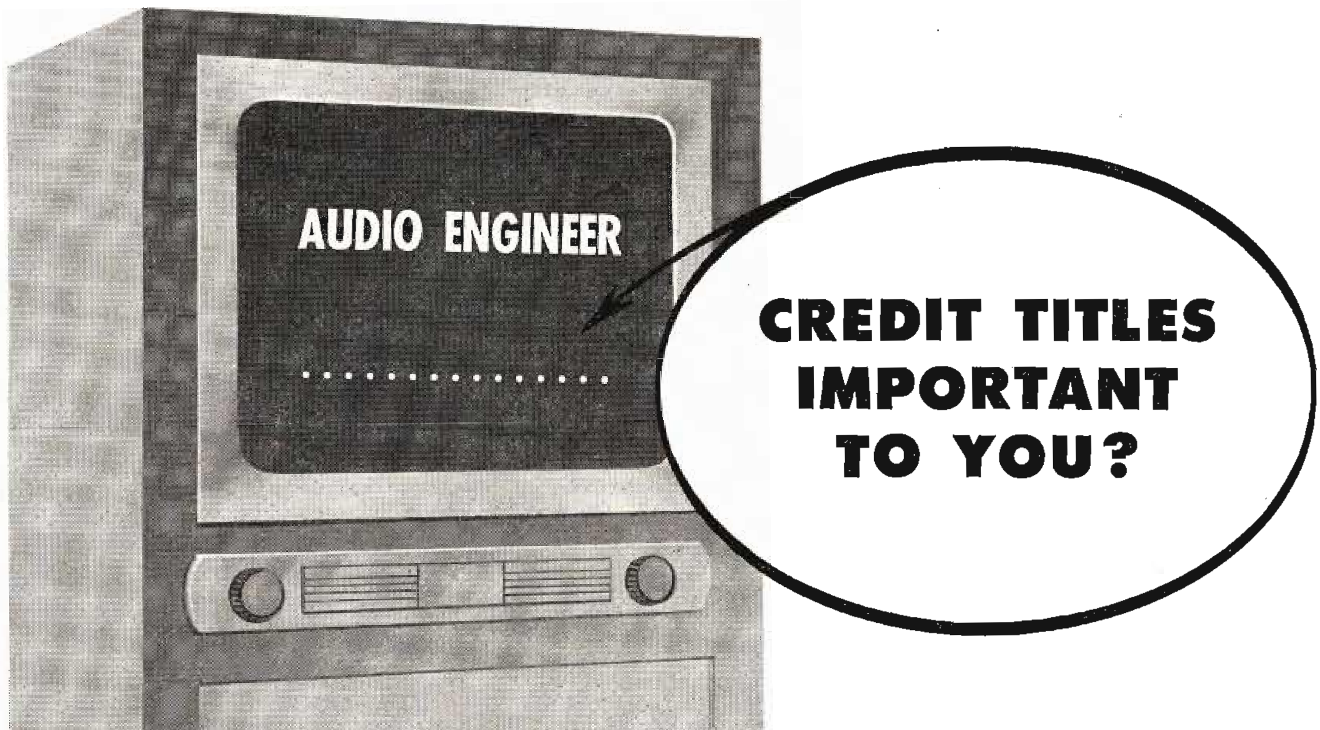

Is your audio system doing justice to your experience? Maybe the Boss can't see buying a completely new system . . . Why not bring your system up to par with the kind of audio that sells the program and the sponsors' products?

Transmitting intelligible sound is an admirable accomplishment . . . sound that entertains, emphasizes, and sells . . . is easily within your reach —

YOUR AUDIO IS ENTITLED TO THE BEST

THE CINEMA 4031-B
PROGRAM EQUALIZER

Used in all types of speech input equipment. The 4031-B corrective equalization saves on recording retakes; improves tonal quality; provides emphasis when needed during the program. Widely used in Motion Pictures, T-V, Recording and Miltary Communications.

THE CINEMA 6517-D
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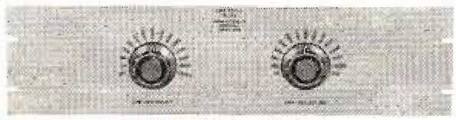

Cut off characteristics ideal for shortening frequency range; providing sound effects, such as telephone, whispering, spooks, etc. Clickless control allows insertion upon cue. Used in Motion Pictures, T-V, and Scientific Laboratories.

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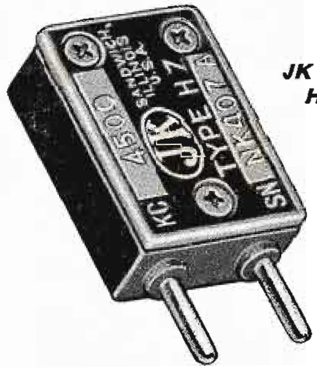


JK STABILIZED H-7 CRYSTAL

CRYSTALS FOR THE CRITICAL

The H-7 crystal is in common use with two-way police radio systems. Frequency range: 3 to 20 mc. Water and dust-proof, it is pressure mounted, has stainless steel electrodes. Just one of many JK crystals made to serve EVERY crystal need!

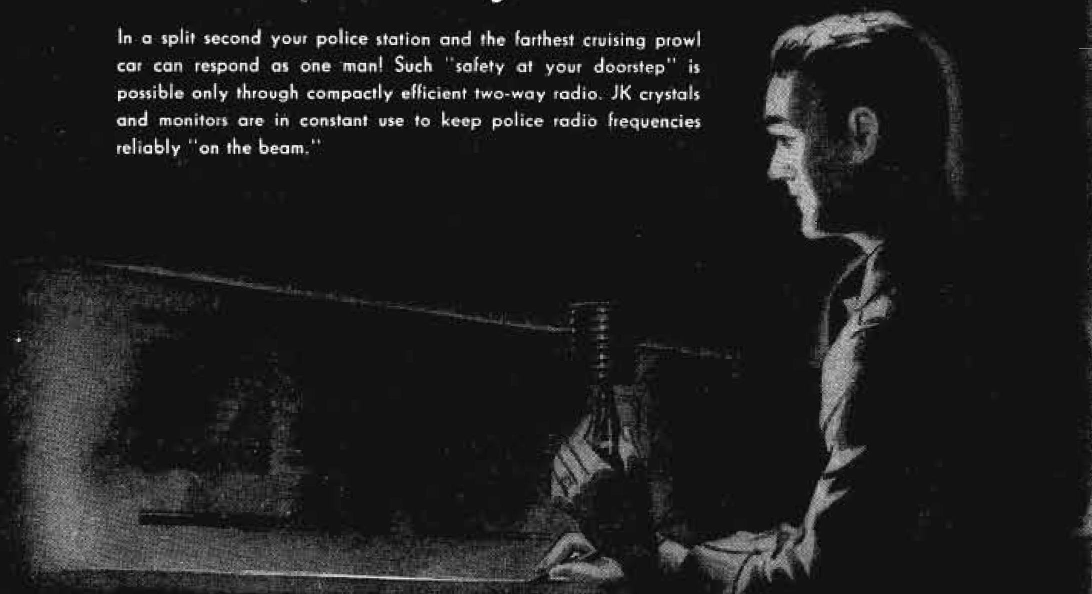
FREQUENCY & MODULATION MONITOR

the JK FD-12

Monitors any four frequencies anywhere between 25 mc and 175 mc, checking both frequency deviation and amount of modulation. Keeps the "beam" on allocation; guarantees more solid coverage, too!

Time-Saver to Prowl Cars, Life-Savers to Thousands!

In a split second your police station and the farthest cruising prowl car can respond as one man! Such "safety at your doorstep" is possible only through compactly efficient two-way radio. JK crystals and monitors are in constant use to keep police radio frequencies reliably "on the beam."



THE JAMES KNIGHTS COMPANY
SANDWICH 2, ILLINOIS


AUGUST 10, 1952

The Los An

GUARANTEED QUALITY SPEAKERS

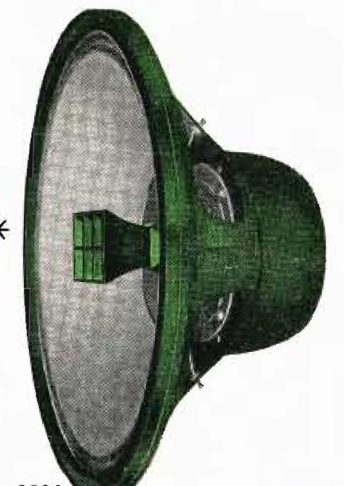
BEVERLY HILLS, Aug. 10—For the first time in the history of the audio industry a manufacturer is guaranteeing the quality of his loudspeakers. The new Altec Lansing "Duplex" loudspeakers, just introduced this week, have an unconditional factory guaranteed frequency range of 30 to 22,000 cycles. Principals at Altec state that no other speakers on the market have this great a frequency range.

These two new loudspeakers, twelve inch 601A and the fifteen 602A are improved versions of famous Altec 604 "Duplex"

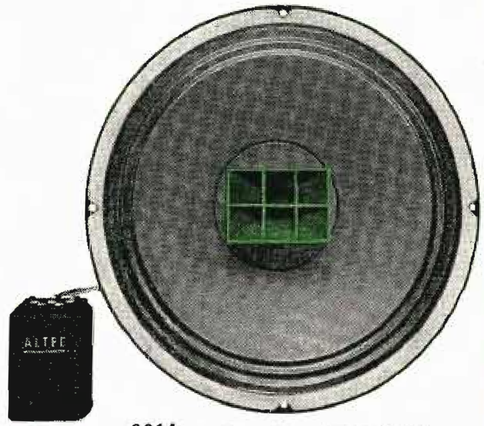
Trading throughout tures develop The key motors and steady almo but towa weakened A few tween 1 gave the Most lo tions to a

The new Altec DUPLEX*

LOUDSPEAKERS



602A Net Price with network, $114.00



601A Net Price with network, $89.00

TECHNICAL DATA	601A	602A
Diameter:	12"	15"
Power Capacity:	20 watts	20 watts
Impedance:	8 ohms	8 ohms
Weight:	15 lbs.	25 lbs.

FOR YEARS the Altec 604 "Duplex" has represented the highest quality attainable in a loudspeaker. Now two new speakers join the 604 to provide you with an even higher standard for quality sound reproduction. These two new "Duplex" speakers, the twelve-inch 601A and the fifteen-inch 602A, are the finest in the world. Hear and compare these guaranteed quality speakers at your Altec dealer today.

GUARANTEED QUALITY: When you buy an Altec 601A or 602A Loudspeaker, the quality of your purchase is protected with this guarantee. "The Altec Lansing Corporation unconditionally guarantees that, when mounted in an adequate cabinet, this loudspeaker will reproduce all of the tones from 30 cycles to 22,000 cycles."

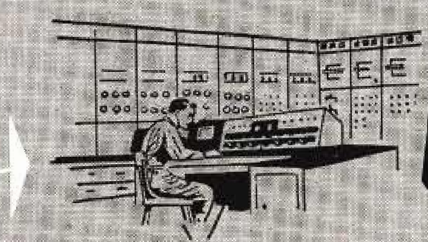
ALTEC®
LANSING CORPORATION

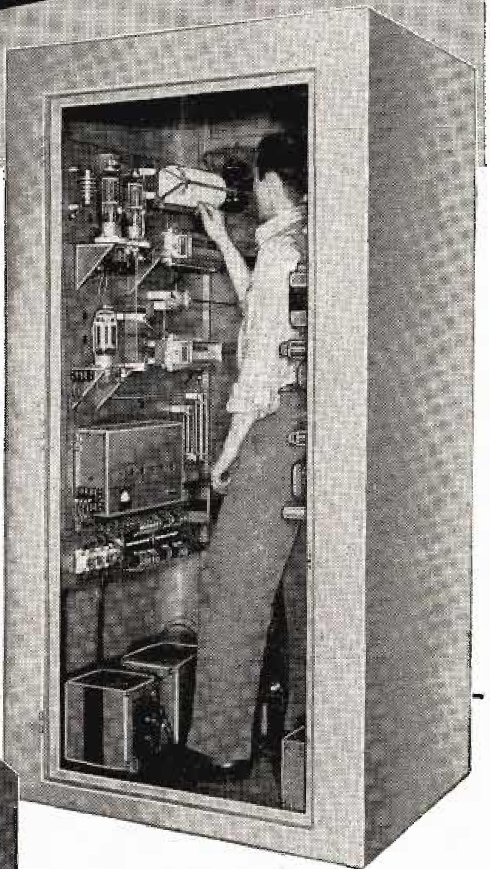
the Symbol of Quality

*DUPLEX: *Mechanically and electrically independent high and low frequency loudspeakers mounted within the physical size of a single frame.*

ALTEC LANSING CORPORATION • 9356 SANTA MONICA BLVD., BEVERLY HILLS, CALIF. • 161 SIXTH AVE., NEW YORK 13, NEW YORK

DESIGNED FOR THE *Engineer*

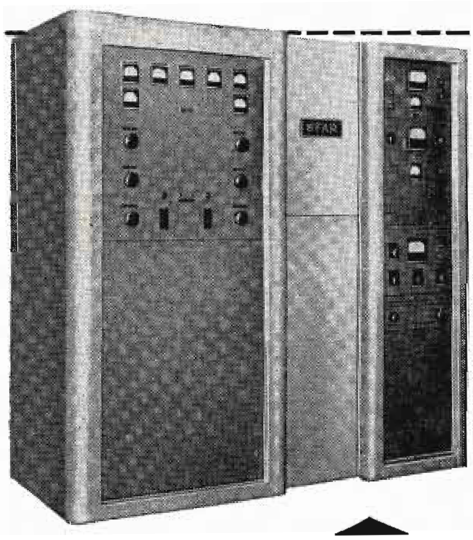




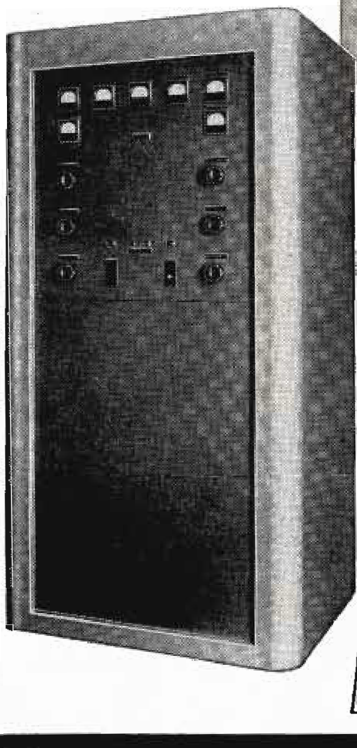
GATES BC-250GY is a big, roomy 250 watt broadcast transmitter that satisfies every engineer's requirements for component accessibility—easy servicing. In this "walk-in" transmitter any part can be reached in seconds!

This freedom from cramping means extra dependability, too, because bigger parts — rated conservatively — are used. Air circulation is free, with no pockets or areas of stagnant air.

The popularity of GATES' roomy, easy-to-service construction is apparent in the fact that, since World War II, more United States broadcasters have bought GATES Transmitters than any other make.



GATES GY-48 Broadcasting's only complete 250 watt radio transmitting plant, ready to connect to antenna and studios. Consists of transmitter, all monitors, limiting amplifier, switching panel, monitor speaker, joiner strip with call letter plate and all interconnecting cables. — Ready to operate 120 minutes after unpacking.



BC-250GY TRANSMITTER
Stands 78" high, 40" wide and 33" deep. Beautifully finished in hand-rubbed satin gray. Employs time proven 810 tubes in final power amplifier and Class B modulator. Eleven tubes and six tube types in entire transmitter. Operates from 230 volts single phase 1.6KW power consumption at 100% modulation. All transformers fully cased. Single or dual sets of tubes and crystals optional. Availability prompt.

CONELRAD
Broadcasters of all powers, participating in Conelrad, will be interested in the modest cost of the BC-250GY Transmitter — in many instances less costly than alterations of existing equipment to meet Conelrad requirements.

GATES

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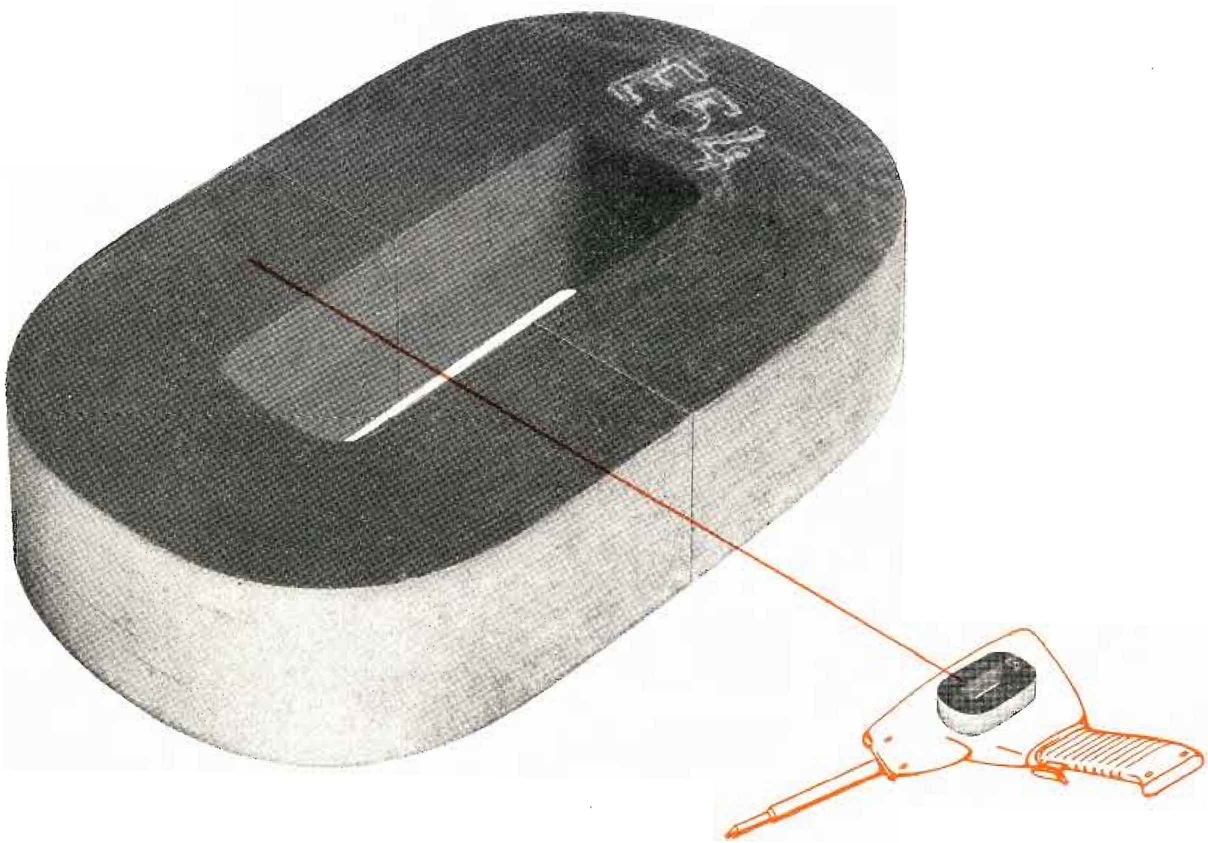

HIPERSIL® CORES

help revolutionize this soldering gun!

In designing their new Versa-Tool soldering gun, Phillips Manufacturing Company wanted a power unit that would provide instantaneous heat for off-on operation, yet operate on household voltage. A transformer was needed to build adequate amperage. But it had to be small, to fit into the handle . . . lightweight, for balance . . . reasonable in cost, to insure competitive pricing of the assembled unit.

Westinghouse Type RC Hipersil Cores provided the complete answer.

Because Hipersil Cores have greater flux-carrying capacity, Phillips engineers were able to cut size and weight of the transformer, effecting considerable savings in coil as well as core costs. But, better still, because the two-piece cores simplified assembly, manufacturing costs were slashed.

Hipersil Cores can cut cost, size and weight in all types of electrical and electronic transformers. Available in a wide range of sizes and shapes for low or high-frequency applications. Greater flux-carrying capacity, compact construction, plus the savings they effect in your manufacturing costs make them the best transformer cores on the market today. For more technical information on applying Hipersil Cores to your product, write to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-70628

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

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TELE-TECH
RADIO-TELEVISION-ELECTRONIC INDUSTRIES

O. H. CALDWELL, Editorial Director ★ M. CLEMENTS, Publisher ★ 480 Lexington Ave., New York (17) N. Y.

Electronic "Promised Land"

Every man in the radio-electronic industry probably harbors a hope of someday visiting California and the West Coast—or eventually moving West to live!

And there is good reason for these dreams of the West Coast as the electronic Promised Land—even aside from its happy and advantageous climate.

For no section of the USA has such complete and diversified development of the radio-electronic-TV industries as does the far West—and California in particular.

★ ★ ★

Here is Hollywood with its extensive sound-picture, radio and TV studios, employing electronic equipment on an unparalleled scale.

Here are great airplane factories absorbing millions of dollars worth of electronic apparatus, as military needs soar and aircraft become 50% to 60% electronic.

Here are independent radio and TV receiver manufacturers initiating new ideas in set design and efficiently serving the whole West with native brands.

Here are dozens of electronic equipment and component makers, continually producing new ingenuities and new features, some bound to influence all U.S. production.

Here are great research laboratories, bringing forth new fundamental electronic conceptions. And here electronic invention flourishes, developing new tubes, new circuits, new methods.

Here are famous universities, known worldwide for electronic teaching and research. And here, too, reside many electronic notables—electronic scientists and inventors.

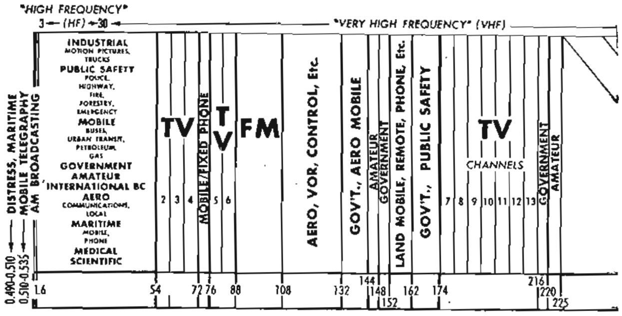
★ ★ ★

So a great area of electronic activity has developed along the blue waters of the Pacific, as shown by our front cover. The charts there depict the growth of population over the last six years, the growth in the use of electricity, and the swelling output of the West Coast electronic industries, measured against rate of national growth. Like the rest of the nation's recent electronic expansion, the West Coast growth at present depends disproportionably on military production. But this unbalance can be remedied with the eventual emergence of peacetime priorities.

In the following pages of this special issue we salute the West Coast as a premier radio-electronic-TV area—a region of electronic leadership and vision capable of "showing the way" to the rest of the industry in both electronic expansion and a philosophy for comfortable individual living.

RADARSCOPE

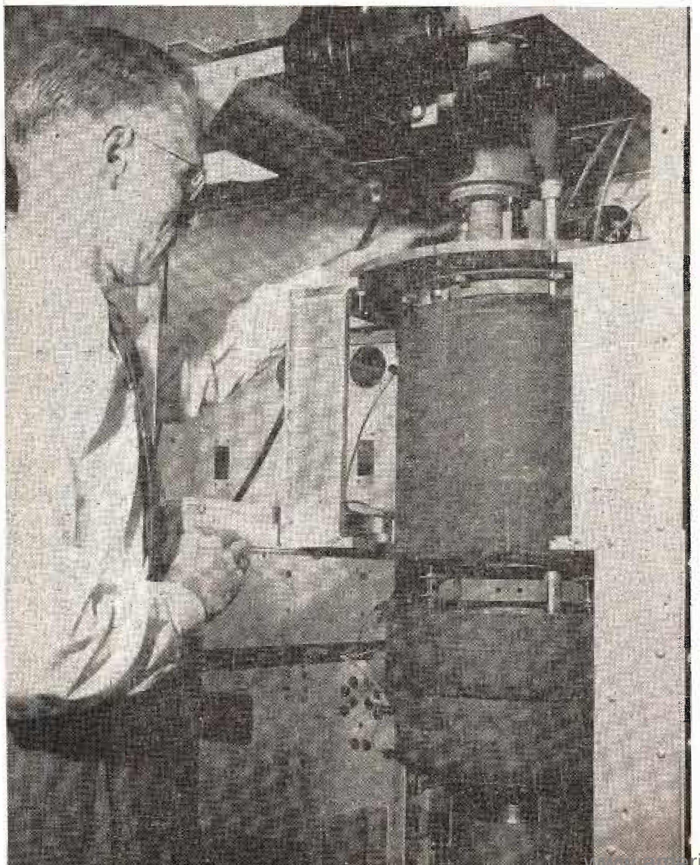
Revealing Important Advances Throughout the Spectrum of Radio, TV and Tele Communications



PROPAGATION

BEYOND HORIZON—A new theory for the propagation of VHF radio waves beyond the horizon has been announced by the National Bureau of Standards. The theory, developed by Dr. J. Feinstein of the NBS staff, not only accounts for VHF and microwave signals that have been observed at distances beyond the horizon but explains the natural and inevitable—as against "unusual" or "accidental"—occurrence of such transmission. The theory suggests a new role for the gradual change in the refractive index of the atmosphere with height. This change, or gradient, leads to reflection as well as refraction of VHF waves as they travel out into space from the transmitter. The amount of reflection is small, but it is enough to lead to appreciable propagation of signals beyond the horizon. This gradient-reflection theory appears to be corroborated in regard to frequency, angle dependence, range, etc., by NBS experiments and by other research in the field. Further experimental verification will be sought using new NBS transmitters located at 9000 feet altitude on Cheyenne Mountain in Colorado and extra-sensitive receiving equipment placed on the gradually sloping plains eastward from the site.

H. M. Crosby, GE engineer, adjusts new 15 KW klystron in experimental transmitter at Syracuse plant. Tube, developed by Varian Associates of San Carlos, Calif., for GGE is said to be most powerful yet for UHF telecasting applications. In this test, tube provided sync output of 12 KW operating at 750 MC. Driving power less than 100 watts. The tube is now being marketed by GE.



AVIATION

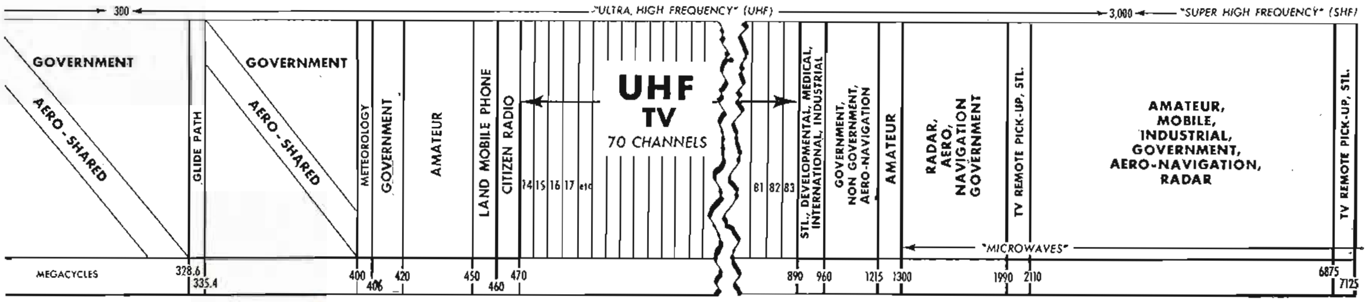
DME FOR THE MASSES of private pilots will soon be available. Weighing only 25 pounds the new model is scheduled for delivery to the CAA in the near future. This increasing use of radio equipment, and therefore increased battery drain, on private aircraft may eventually pose the same problem for aircraft lighting and low-voltage circuit engineers that the increased radio load on the automobile battery and lighting circuit posed for automotive engineers. In the case of the auto it became necessary to add an ac alternator and metal rectifier to maintain the auto battery at its proper condition of charge. A similar, light-weight power plant may be needed for light aircraft if this trend toward electrification and radiofication continues.

BROADCASTING

IN ENGLAND, radio and television are about to be put on the same footing as radio and television in Canada; that is, there will be a government sponsored system—the BBC,—while privately-owned and operated stations will be allowed to broadcast limited commercial announcements. Thus the Lion lies down with the Huckster! The charter of the BBC was extended recently by the House for a period of ten years with the proviso that private commercial broadcasting will be allowed as soon as equipment and materials are available. (England has 500,000 TV sets, France 40,000 and Russia 30,000)

COMMUNICATIONS

AIRCRAFT COMMUNICATIONS INTELLIGIBILITY was a key topic of discussion at the International Air Transport Association Technical Conference recently held in Copenhagen. It was agreed that substantial improvement could be achieved through careful selection of radio-telephone vocabulary, and better voice placement and diction. Notice was taken of the fact that while the range 200 to 6,200 CPS will cover almost all speech sounds, the top limit of this range can be reduced to between 2,500 and 3,200 CPS without significant loss of understanding, as long as the vocabulary is familiar. Speech clipping, which emphasizes the more important sounds, was heavily stressed as a means of increasing effective vocal transmission. Cockpit noise, either entering into transmission through the microphone or obscuring reception through receivers, was held to be a major



factor in limiting intelligibility. It was suggested that manufacturers pay more attention to cockpit soundproofing. Because of the deterioration of quality occasioned with carbon microphones, plus the fact that these units have reached the limit of their capabilities, it was felt future microphone improvements would be among magnetic and dynamic types. Elimination of ear-battering radio noise between messages, which causes pilot listening fatigue, could be achieved by selective signaling or squelch circuits. Experimental evidence was introduced to show that single sideband transmission enhanced intelligibility in the face of interference, eliminated distortion due to selective fading, and improved signal strength by 9 db.

MOBILE

RADIO COMMUNICATIONS SYSTEMS will find an increasing number of uses in serving retail stores. One of the first of such two-way mobile-radio installations, station KGC209, was recently put into operation at Hess Brothers Department Store, Allentown, Pa. The 35.94 MC transmitter can contact more than 30 delivery and service vehicles in a 60-mile radius to expedite deliveries and appliance servicing to widely scattered customers. As radio manufacturers make retailers more aware of the advantages of mobile communications, additional stores will install their own systems.

MANUFACTURING

$90,000,000,000—For the edification of the de Forest 45-year celebration committee, we recently estimated the total value of the radio, TV, LD telephony, motion-picture and electronic equipment since the audion's invention in 1907, putting this total at $60 billions. But this $60 billions figure covers only the total physical equipment to date, based on Dr. de Forest's invention since issue of his patent. If we add the annual income from radio-TV broadcasting, communications tolls, and sound-picture admissions (all services depending on the tube), the total would be considerably greater—perhaps $85 to $90 billions.

Annual dollar turnover based on the de Forest invention will probably total $8 billions:

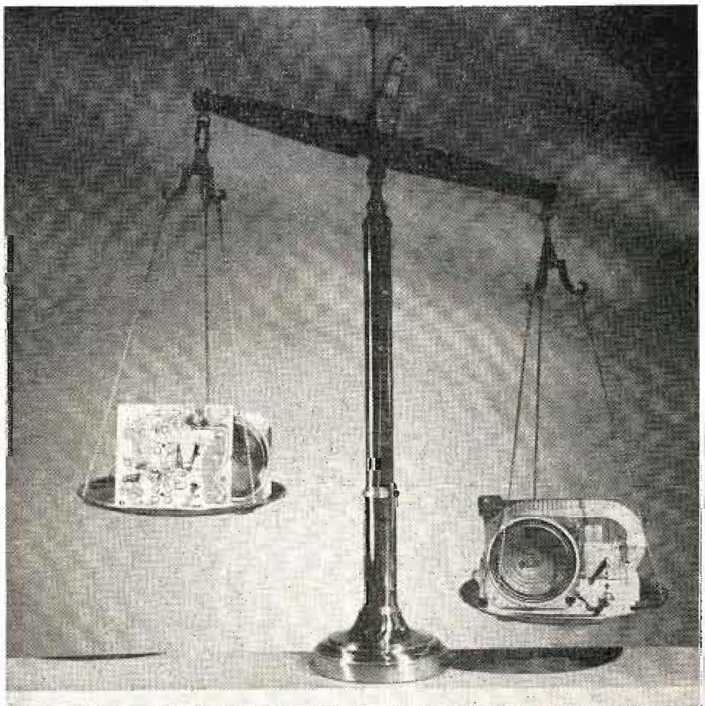
Equipment		
Military electronic apparatus	$3	billions
5,000,000 TV sets	1¼	billions
12,000,000 radio sets	½	billion
Miscellaneous communication and industrial equipment	½	billion
Services		
Broadcasters' income (radio and TV)	1	billion
Movie admissions	1	billion
Communications tolls	½	billion
Miscellaneous services	¼	billion
Total	$8	billions

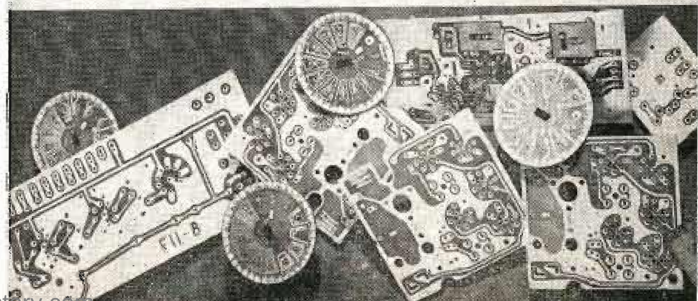
INTERNATIONAL

CARRIER-CURRENT transmission on a large scale! In an effort to increase and improve radio coverage in Italy the Italian broadcasting organization is using the overhead power transmission lines in small cities of up to 8,000 inhabitants to radiate low intensity signals on approximately 1500 kc. About 20 watts rf is fed into a 260 volt transmission line. The street lighting wires are used to carry rf over the whole of the town. Field intensity about two miles from the town is negligible. But almost all parts of the town receive adequate signal strength which results in a signal-to-noise ratio of about 40 db or better.

MACHINE PRODUCTION

At Motorola, conventional home radios are now machine mass-produced using the "placir" plated-circuit process. In this a pattern of extremely thin copper, duplicating the wiring layout of the set, is applied to a die-stamped plastic base. Tube sockets are made by boring holes into the plastic base when circuit is applied. Photo above compares size and weight for new and old type, electrically identical, chasses. Below, wide variety of circuit designs and layouts possible with "placir" plated circuits.





Microwave Pulse

"Notch" methods developed to measure
unsatisfactory. Two equipment designs

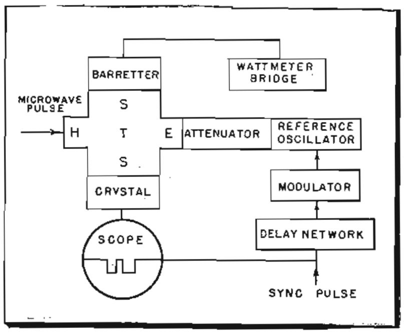


Fig. 1: Microwave pulse wattmeter provides a direct power reading. Note scope presentation

By W. H. DOBBERTIN
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San Diego 12, Calif.

Power is one of the few fundamental quantities which can be measured at microwave frequencies; at lower frequencies the voltage, current, and impedance are the quantities usually dealt with. At microwave frequencies voltage and current are ambiguous quantities and cannot be uniquely defined. On the other hand, power is independent of the characteristic impedance of the transmission line.

Power measurements are usually made by converting the microwave energy directly into heat, although there are a few instances where the desired conversion is into light. The microwave energy is converted to heat in a resistance material and the heat thus generated is conducted to a fluid of some kind, allowing the power to be computed by calorimetric methods. In some cases the energy conversion is directly to the fluid, while in others it is absorbed directly in the thermocouple.

Practically all of the methods mentioned above are useful for measuring large or medium powers, i.e., powers down to approximately one watt. Below this figure, variations in temperatures and rates of fluid flow combine to introduce significant errors in the measurements. The equipment necessary to make power measurements by the above methods is rather cumbersome and does not lend itself well to field use; the results are usually not direct reading.

Fig. 2: Spreading of wavefront into side arms from E plane junction; side arms out of phase

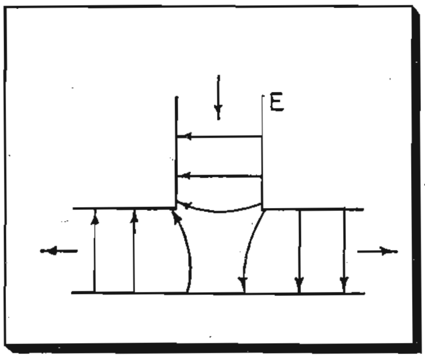


Fig. 3: Cancellation of waves at the magnetic plane junction for reflected waves out of phase

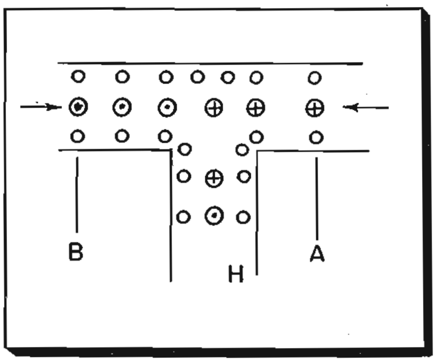


Fig. 4: Spreading of wavefront into side arms from magnetic plane junction; side arms in phase

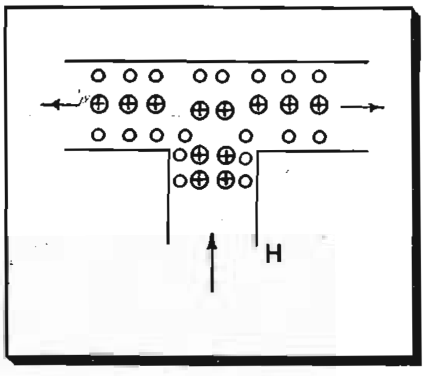
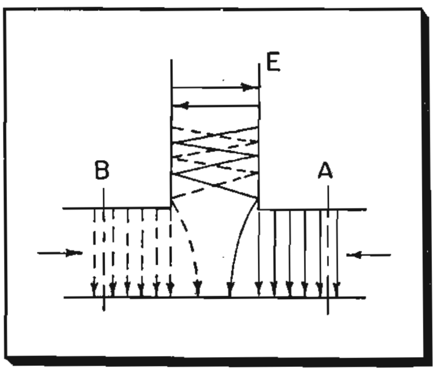


Fig. 5: Cancellation of waves at the electric plane junction for reflected waves in phase



For the measurement of low powers, a different technique has been used. The waveguide or coaxial line is terminated in either a thermistor, a resistive material having a negative temperature coefficient, or a barretter, a device which has a positive temperature coefficient. The microwave energy absorbed by these materials changes their resistances. It is this resistance change which enables one to measure the power. Knowing the resistance change as a function of applied power, the unit may be calibrated. The calibration of these bolometers is dependent upon their characteristics remaining constant from dc to the microwave frequencies; this is very nearly the case. The element is usually connected as one arm of a bridge circuit. To avoid changes in line termination, the bolometer is maintained at some constant resistance. The bridge is balanced with zero r-f signal and at some desired value of current. With r-f power impressed on the bolometer, the bridge is rebalanced by changing the bridge voltage. The change in power to the bolometer element represents the microwave power. Direct reading bridges of this type are useful down to about 1 mw. At lower levels these bridges become unstable because of temperature effects and bridge voltage variations.

Bridge Types

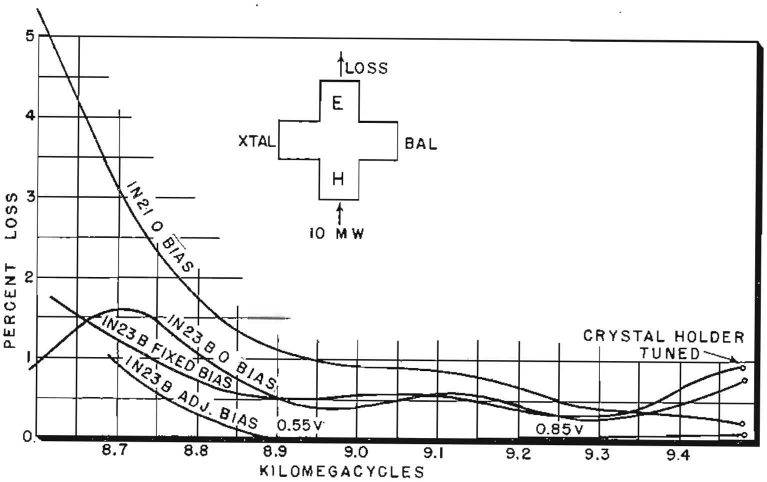
Several bridge types are available which utilize a combination of ac and dc to maintain bridge balance automatically. The change in the ac component required to maintain balance is used as a measure of r-f power. These instruments are direct reading and have a useful lower limit of 0.02 mw. One such bridge circuit, designed and built in the laboratories at Convair in 1946 had a lower useful limit of 2 μw.

The power meters described above are basically designed for use with CW signals. The thermal inertia of the calorimeter, thermocouples, and bolometers is quite large, which makes it possible to use these elements for the measurement of pulse power since they tend to integrate

Power Measurement Techniques

levels down to the microwatt range where CW techniques prove

discussed, one for production use and one for field or laboratory



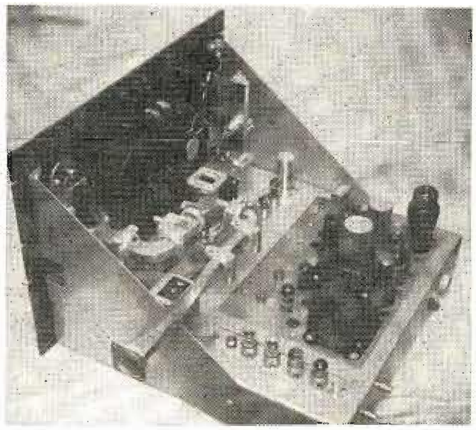


Fig. 6: (l) Unbalance vs. frequency for wattmeter T. Fig. 7 (r) Rack mounted microwave power measuring system has frequency meter and bridge

the pulses. This technique is useful where the average value does not fall below the useful limit of the meter. For the calorimeter meters, the heat losses represent the lower limit of sensitivity. The ability to read a temperature difference is also a limiting factor. The accuracies usually become worse as the lower limit is approached. The ac-dc bridge does not have such a definite limit as the calorimeter types. The lower limit here is in general one of stability of the meter.

In any discussion of microwave power it becomes necessary to differentiate between *average power* and *pulse power*. Both are time averaged values but differ with respect to the time interval involved. If the power is averaged over a long period of time with respect to both the duration of a single pulse and the time interval between pulses, the average is known as average power. Pulse power is always greater than average power except in the limiting case of CW power.

Comparison Methods

For measuring pulse powers below 0.02 mw average power level, techniques other than those using only wattmeter bridges are necessary. One such method utilizes a microwave receiver to convert the energy to a lower frequency, then amplifying the pulse to a suitable level for detection and scope or meter presentation. A signal from a calibrated i-f signal generator is then fed through the i-f amplifier with sufficient amplitude to produce a signal equal in amplitude to the unknown pulse. Having previously measured the system conversion loss, the unknown pulse level can then be computed or read off a calibrated dial. An alternative method would be to use a constant-level oscillator and a variable-gain i-f amplifier; in either case, a scope presentation is the most desirable since the readings obtained are more independent of pulse shape. This method, while capable of measuring powers down into the microwatt range, requires an initial calibration and frequent checks to verify the system conversion loss.

One way of increasing the utility of the average power meter having a 0.02 mw useful lower limit is to incorporate it as a part of a comparison *system* wherein a square wave modulated signal is used to calibrate a crystal detector as an r-f envelope viewer.

The crystal detector, as a coaxial line or waveguide termination, generates a current which is proportional to the microwave power absorbed. Because the time constant of the crystal is very small, the output follows very closely the modulation envelope of the microwave energy. In using this comparison method, the microwave pulse is first fed to the crystal detector, the output of which is connected to an oscilloscope. Having established an amplitude reference on the face of the scope, the detector is then connected to a square wave modulated microwave source. The level of this signal is made equal to that of the pulse. The square wave generator output is then measured with the wattmeter bridge. Since the duty cycle of the square wave source is one-half, a reading of 0.02 mw corresponds to an 0.04 mw power level. It is important here to make sure the reference generator is actually generating an equal wave.

It should be noted here that a new term, *peak-pulse-power,* must be used since the peak amplitudes of the modulation envelopes were compared. To compute average pulse power, the shape of the pulse must be known. In many cases the desired value is peak pulse power.

Notch Method

If the duty cycle of the comparison generator is increased until the off period is very small, say 1 μ sec, the average power, in a 1000-cycle repetition rate system is practically CW power since the error is only 0.1%, which in most cases is negligible. The detected wave-form envelope becomes a notched CW signal. We have then a 1000-cycle repetition rate, a pulse (notch) level equivalent to the CW reference level, and no corrections are necessary for duty cycle. The peak pulse power level is read directly on the

(*Continued on page* 162)

Dielectric

Analysis of the fibration of ferromag-
clutches. Semiconductive fibers when

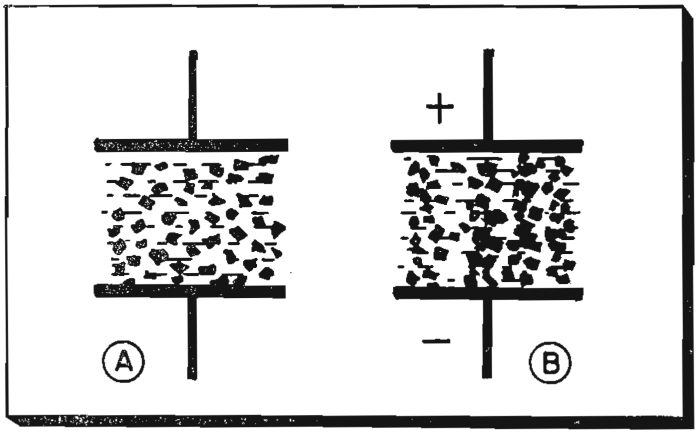


Fig. 1: (A) Electric fluid before energizing. (B) Electric field causes fibration

By HANS E. HOLLMANN
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Ferromagnetism is caused by the magnetic dipoles which, when subjected to an external magnetizing field, align their moments in a parallel orientation. In soft iron, the dipoles follow the magnetizing force with a certain relaxation time, the cause of hysteresis. In hard ferromagnetics, such as steel, the dipoles keep their orientation when the external field is cut off so that a permanent magnet results. Another implication of the hysteresis loop is that the permeability is nonlinear. Accordingly, the inductance of an associated iron choke is also nonlinear, the principle of magnetic modulators and amplifiers. Furthermore, the magnetic attraction of the dipoles causes the iron to contract, an effect known as magnetostriction.

Similar phenomena occur in crystalline dielectrics such as mica, rochelle salt, barium titanate, mixtures of barium and strontium titanate, etc., the dielectric constant of which builds up to values as high as 10,000. In the case of ferroelectricity, the electric dipoles align their moments in a parallel array either by mutual attraction or by the influence of an external polarization. At the same time, the arrangement and the resulting dielectric constant is a function of the applied field strength. Consequently, the dielectric constant of ferroelectrics is also nonlinear and shows hysteresis loops. The analogy between ferromagnetism and ferroelectricity becomes even more striking if the temperature effects are taken into consideration.

Since the orientation of the magnetic as well as electric dipoles is counteracted by thermal agitation, the arrays break down at certain temperatures: the Curie points.

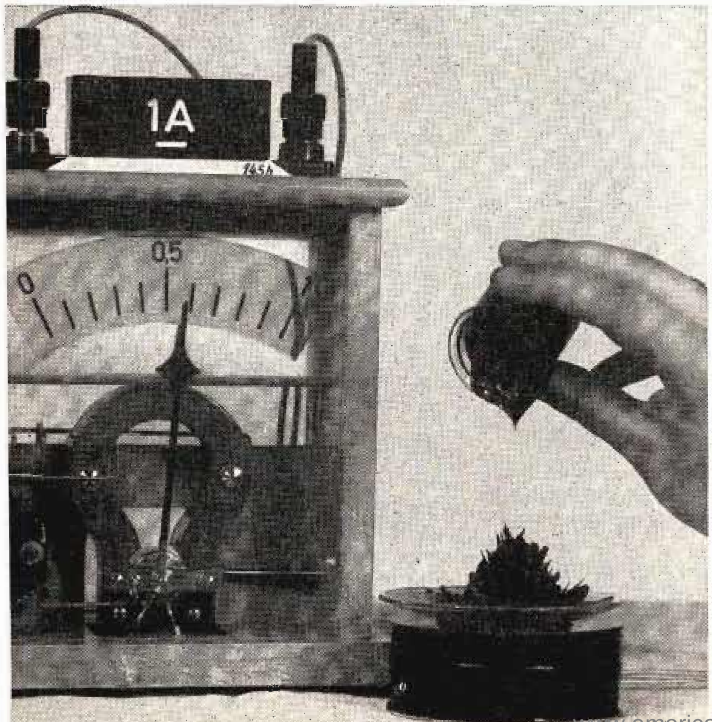
In addition, ferroelectrics also contract or expand under the influence of an applied voltage. The resulting electrostriction permits significant use for electromechanical transducers, in particular emitters for supersonics.

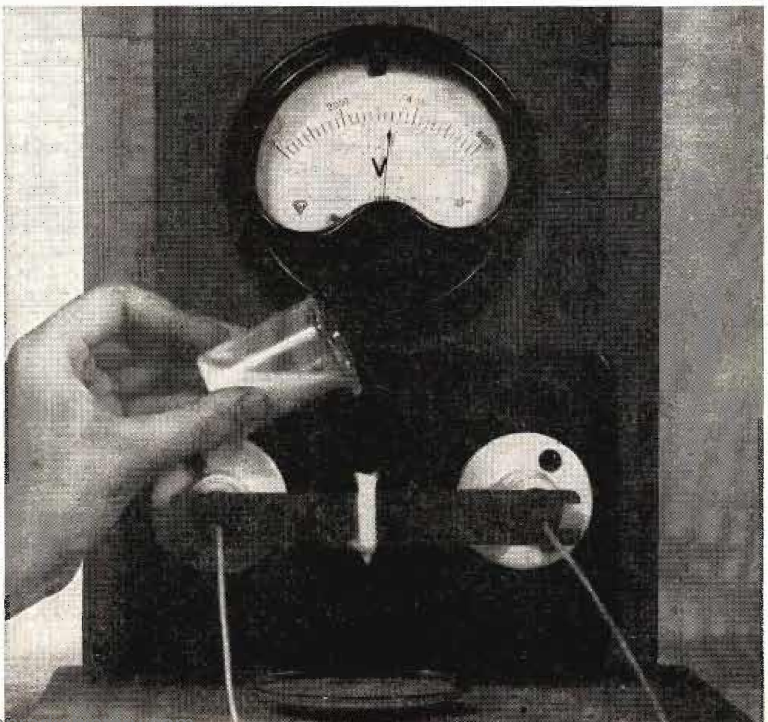
It may be mentioned that the multicrystalline ceramics show the reciprocal effect in that they produce electrical charges when subjected to a mechanical strain or stress, similar to the piezoelectric effect commonly associated with single crystals of a polar type of symmetry.

Colloidal Suspension

As far as ferromagnetism and ferroelectricity is concerned, we deal with dipoles and dipole moments of atoms and molecules in particular patterns. On the basis of this knowledge, let us now turn to another field, namely to the magnetic and electrical performance of colloidal suspension and solid colloids composed of fine ferromagnetic, dielectric, insulating or semiconductive particles suspended or dispersed in a suitable

Fig. 2: (l) Magnetic fluid from cup solidifies as it drops into magnetic field. Fig. 3: (r) Electric fluid forms viscous bridge between electrodes





and Semiconductive Suspensions

netic and dielectric colloids guides design of magnetic and electric "frozen" permit formation of "Polaristors," a nonlinear resistor.

medium. In the field of such colloids, the multimolecular particles take the place of the former atoms and molecules.

Fibration of Dielectric

The implications of this significant step becomes clear when we refresh our memory by considering the peculiar properties of the so-called magnetic fluids and electric fluids. Both are suspensions of fine particles; in the one case iron dust, in the other case dielectric powders such as starch, flour, magnesium oxide, etc., intermixed with oil. When energized, i.e., when the magnetic fluid is acted upon by a magnetic field or the electric fluid by an electric field, the particles become magnetically or electrically polarized, attract each other, and form chains or fibers preponderantly along the lines of force (Fig. 1).

This fibration manifests itself in various ways. First, the fibers increase the viscosity and shear resistance transverse to the lines of force, in the magnetic case to such a degree that the fluid solidifies when subjected to a strong magnetic field. This may be demonstrated by the experiments illustrated in Fig. 2. The glass container is filled with magnetic fluid. When energized by the field of the nearby coil, the fluid instantaneously becomes so viscous that it resists flow. As soon as the cup is lifted, the fluid is de-energized and flows out, but again solidifies as it drops into the field of the coil, thus forming the strange looking agglomeration with needle-sharp peaks shown in the photograph. When the coil is de-energized, the agglomeration collapses and the solid suspension again assumes its original liquid state.

Similar Experiment

A similar experiment may be carried out in the electrical field (Fig. 3). Electric fluid is poured through an air-gap capacitor. Under a high dc or ac voltage, the fluid thickens and forms a viscous bridge between the electrodes. It drops, of course, as soon as the voltage is cut off.

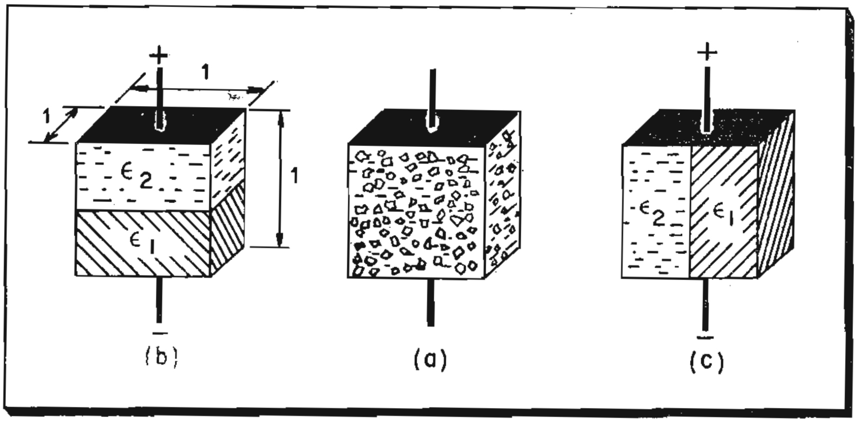


Fig. 4: Particles in liquid capacitor (a) are distributed between theoretical extremes of (b) and (c)

This viscosity effect has been put into ingenious use in magnetic and electric fluid clutches, where the innumerable fibers between the coupling elements transmit torques from the driving to the driven element proportional to magnetic or electrical control fields. Magnetic fluid clutches are constructed for forces up to thousands of horsepower, while electric fluid clutches are less powerful but require a negligibly small energizing power and exhibit a low relaxation time.

Distribution of Particles

Any change of the distribution of the suspended particles must be accompanied by electrical effects. Consequently, the fibration increases the dielectric constant of magnetic as well as electric fluids. In order to explain the phenomenon in a qualitative manner, let us consider the liquid-filled capacitor illustrated in Fig. 4. Its dielectric is a mixture of equal volumes of high-dielectric particles having the dielectric constant ε_1 and of oil with the dielectric constant ε_2. Normally, the particles are in unknown random distribution. It can, however, easily be seen that the capacity under any distribution must lie between the two theoretical extremes (b) and (c) according to which the particles are packed in a single layer parallel to the electrodes (b) or parallel to the electric field (c). In case (b) there obviously are two capacities $C_1 = 2\varepsilon_1/4\pi$ and $C_2 = 2\varepsilon_2/4\pi$ in series so that the total capacity is

$$C_b = \frac{2}{4\pi} \cdot \frac{\varepsilon_1 \, \varepsilon_2}{\varepsilon_1 + \varepsilon_2}$$

In case (c), two capacities $C_1 = (\varepsilon_1/2)(4\pi)$ and $C_2 = (\varepsilon_2/2)(4\pi)$ are in parallel so that the total capacity becomes

$$C_{(c)} = \frac{1}{4\pi} \frac{\varepsilon_1 + \varepsilon_2}{2} = \frac{(\varepsilon_1 + \varepsilon_2)^2}{4\varepsilon_1 \cdot \varepsilon_2} C_{(b)}.$$

Any fibration in the direction of the electric field constitutes a change from case (a) toward case (c). Since $C_{(c)}$ is always greater than $C_{(b)}$, such a change yields a greater capacity or a greater dielectric constant of an equivalent homogeneous medium provided the mix ratio is not too low.

In fact, such a capacity effect has been verified by experiments with the aid of a magnetic fluid capacitor energized by a magnetic field, and with the aid of an electric fluid capacitor under the influences of dc or ac voltages impressed upon its electrodes. The effect, however, exhibits a long relaxation time because the particle migration through the viscous medium is very sluggish. Although the capacity of such a colloidal capacitor varies with the applied control voltage, this nonlinearity does not conform with the common conception because the particles are unable to follow even moderate frequencies.

The dielectric control effect is

(Continued on page 135)

Combination

Compact and figures of 14

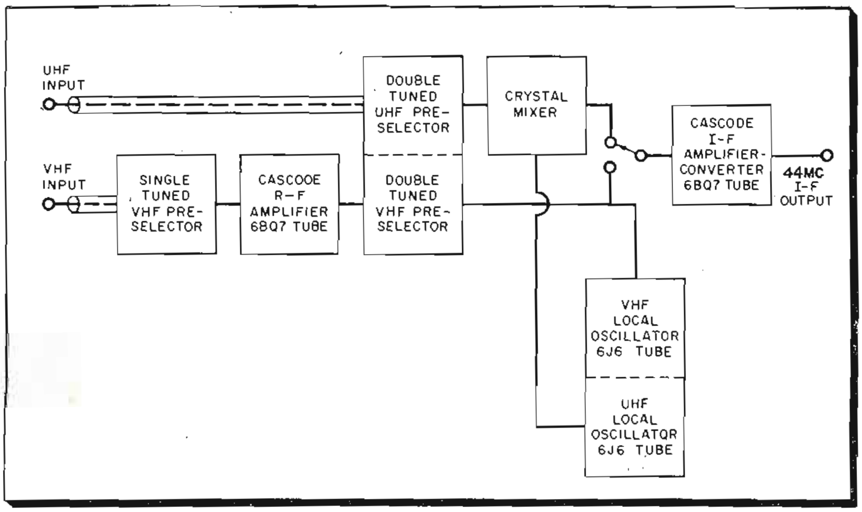


Fig. 1: Combination TV tuner covers VHF channels 2 to 13 and UHF channels 14 to 83

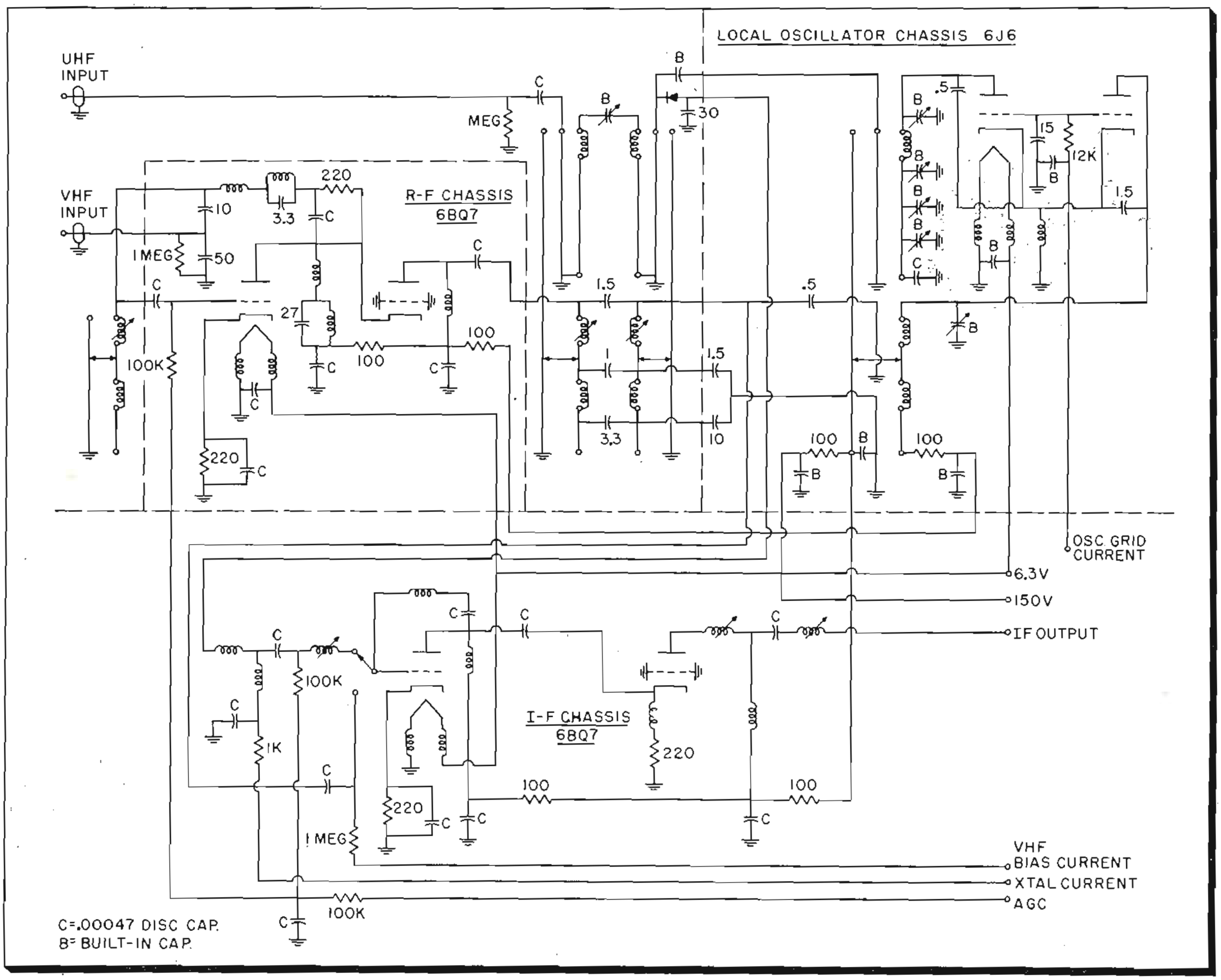
By H. A. FINKE & S. DEUTSCH
Polytechnic Research & Development Co., Inc.
202 Tillary St., Brooklyn 1, N. Y.

WITH the recent opening of UHF channels for TV broadcasting, the tuner assumes a foremost position in the array of problems confronting the set designer. Numerous interim solutions are being offered, most of which are either expensive or fail to meet optimum performance possibilities.

Most tuner designers appear to be in agreement that an optimized combination VHF-UHF tuner represents the most desirable long range solution to the problem. There will undoubtedly be many forms of combination tuners. The optimum design should be one that:

a) Makes maximum use of the same parts for the VHF and UHF channels.
b) Obtains optimum performance in all respects consistent with the state of the art.
c) Makes use throughout of sim-

Fig. 2: Tuner circuit uses 72 ohm coaxial cables to feed input signal to separate UHF and VHF preselectors. Output to receiver i-f is 44 MC



UHF-VHF Television Tuner

economical design uses printed circuit sub-assemblies. Noise and 5 db measured for UHF and VHF sections, respectively

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This paper was presented at

"WESCON–1952"

Western Electronic Show & Convention
August 27-29
Municipal Auditorium, Long Beach, Cal.

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ple, compact, economical design and fabrication techniques.

The Polytechnic Research and Development Co. has developed a combination VHF-UHF TV tuner that occupies approximately the same physical space as a conventional VHF tuner alone. The performance and cost is competitive with the best that the present state of the art can produce

It will be recalled that the VHF range covers 54 to 88 and 174 to 216 MC (channels 2 to 13) while the UHF range covers 470 to 890 MC (channels 14 to 83). A block diagram of the unit is shown in Fig. 1. We may examine the UHF and VHF sections of the block diagram separately:

UHF Section: The UHF signal is brought in through a 72 ohm coaxial cable and is inductively coupled to a double-tuned preselector network. The preselector consists of ¼ wavelength printed-circuit resonant lines whose electrical length is controlled by means of a short-circuiting slider. Energy is inductively coupled out of the preselector and fed to a crystal mixer.

Local Oscillator Signal

The local oscillator signal is created by one half-section of a 6J6 tube operation at half the desired frequency. A relatively large amount of oscillator injection is used in combination with a biasing resistor in series wth the crystal, in order to obtain efficient second-harmonic mixer action. The local oscillator is tuned by a ¼ wavelength printed-circuit resonant line similar to that of the preselector.

The i-f output of the crystal is passed through a 44 MC cascode am-amplifier using a 6BQ7 tube. The output of this tube then goes to the receiver i-f strip.

VHF Section: For VHF operation, the r-f signal is carried through a 72 ohm coaxial cable to a single tuned preselector circuit. The signal is then amplified by a 6BQ7 cascode r-f amplifier. The B plus supply of this tube is automatically switched off, when in UHF operation, by the local oscillator short-circuiting slider.

From the r-f amplifier, the signal goes through an over-coupled double-tuned preselector network to the input grid of the previously described UHF cascode i-f amplifier. An r-f switch at the input grid of this tube transforms the UHF cascode i-f amplifier into a VHF cascode mixer.

The local oscillator short-circuiting slider removes B plus from the first half-section of the 6J6 tube and applies it to the second half-section for VHF operation The local oscillator, on VHF, becomes a conventional fundamental-frequency device.

The VHF preselector and local oscillator tuned circuits are in the same assemblies as the UHF tuned circuits, and also consist of ¼ wavelength printed-circuit resonant lines. The same short-circuiting sliders serve for UHF and VHF operation.

A schematic of the tuner is shown in Fig. 2. The dotted lines are used

(*Continued on page* 176)

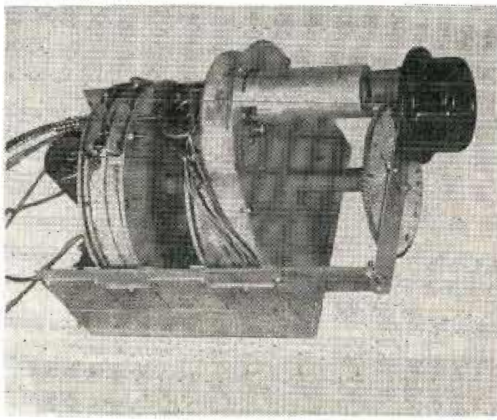


Fig. 3: Top of TV tuner with shield in place

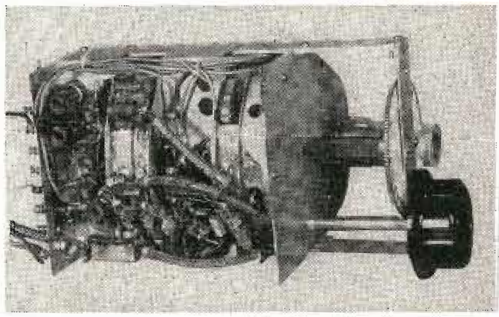
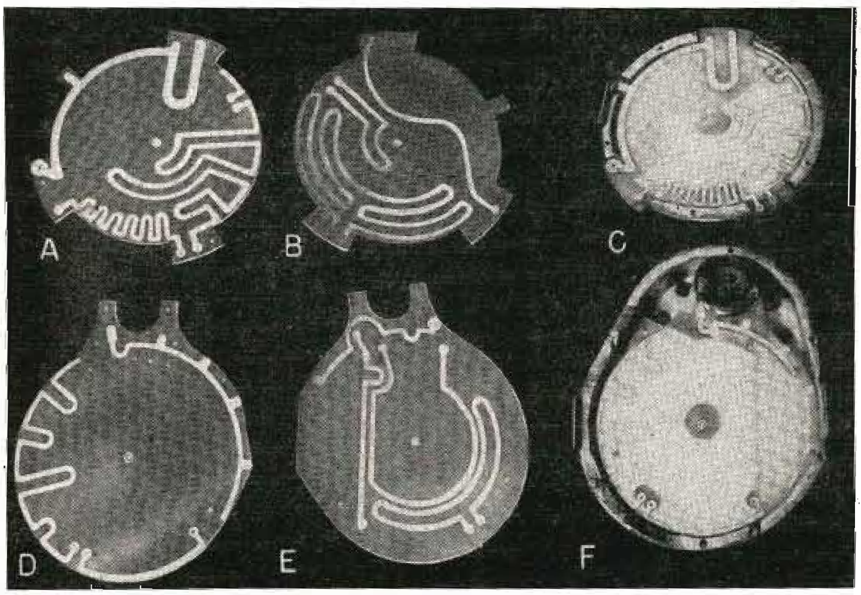


Fig. 4: Bottom of tuner chassis shows wiring

Fig. 5: Printed circuit configurations used in sub-assemblies are responsible for compactness



Speech Input Systems for Broadcasting

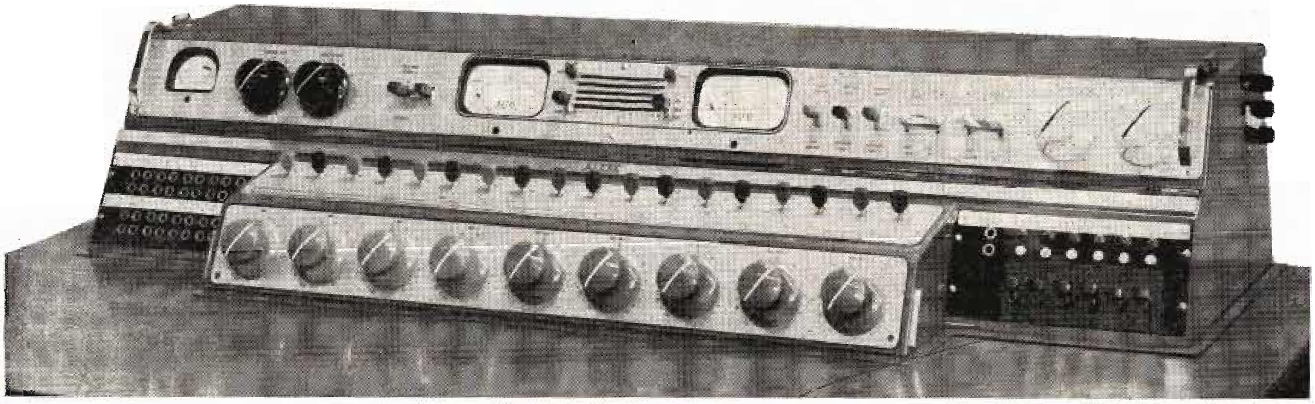


Fig. 1: Model 250A Speech Input Equipment has two main program channels and one independent monitoring channel for loudspeaker listening

New console design includes size reduction in amplifiers and components to permit large number of inputs required for TV. High gain and low distortion permit more distant audio pick-up

By JOHN K. HILLIARD, Chief Engineer
Altec Lansing Corp., 9356 Santa Monica Blvd., Beverly Hills, Cal.

THE demand for a greater number of microphones and other inputs, especially in TV operation, has necessitated a reduction in size of amplifiers and other components. The reduction in size mainly centers around the use of smaller transformers, tubes and associated components. The reduction in size requires no compromise in efficiency or standards of quality.

Increased balance between transformer windings permits the attenuation of longitudinal currents up to 40 KC, by as much as 75 db. This is important in input transformers in order to reduce induction noise in long telephone circuits. The use of a large amount of feedback to insure gain stability and low distortion, requires that resistors and capacitors be accurate and stable with wide variation in temperature.

Miniature tubes are required because of space consideration. High step-up ratios on input transformers are desirable to maintain good signal-to-noise ratios. Tube engineers, however, offer no immediate reduction in the input capacity of low noise tubes. This fact requires that the transformer design level off at a secondary impedance on input transformers at a value not to exceed 80,000 ohms where a frequency range of at least 20 to 20,000 CPS is required.

The purpose of a preamplifier is to amplify the output of microphones and other low level inputs in a manner that the highest signal-to-noise ratio can be achieved. Experience indicates that not over 40 db of gain is practical and the maximum power capacity of the amplifier should exceed +20 dbm, so momentary overloads will not arise. To provide an output of +8 VU on a line, with the customary 6 db attenuation for line isolation, an output of +14 VU from the line amplifier is required.

Mixer System Loss

The loss of the mixer system which involves as many as nine controls, is approximately 18 db. A minimum of 10 db of control is needed which brings the level down to within 10 db of the microphone input and this is considered to be the most attenuation that can be used and still preserve the original signal-to-noise ratio. We then must supply about 70 db of gain to reach +14 VU. Good practice requires the use of a master volume control. For best signal-to-noise ratio considerations, this should be placed about midway in gain of the overall system. The amplifier used for this purpose is called a booster and can conveniently be of the same design as the preamplifier.

Up to this point 75 db of gain and 40 db of loss has been used, and approximately 50 db more are required to bring a signal of —65 VU up to +14 VU. In the case of this specific design, it was found expedient to keep the types of amplifiers and tubes to a minimum. A monitor amplifier of approximately 50 db gain and 8 watts capacity was considered adequate. This requirement of gain was the same as the line amplifier, and if the signal-to-noise ratio was sufficient, the one amplifier could be used for both the line and monitor amplifier.

Only two basic types of amplifiers are used in the Altec Lansing Model 250A Console: A-428A voltage amplifier, and A-429A power amplifier. Each of the amplifiers has two functions. The voltage amplifier is used as a preamplifier before the mixer system, and as a booster amplifier after the mixer. The power amplifier is used as a line amplifier following the booster, and as a monitor amplifier. When used as a monitor amplifier, its output is increased to 8 watts by applying additional plate voltage.

Network programs from a single studio require as many as 20 to 40 of both types of amplifiers. The use of this number of amplifiers justifies plug-in connection so that the maintenance can be reduced to the insertion of a spare at the time of suspected trouble. This plug-in feature applies also to power supplies.

The Altec Lansing Model 250A Speech Input Equipment is a complete ac operated console type, program production unit for the ampli-

and Recording Use

fication, control, and monitoring of programs originated by microphones, transcriptions, tapes, remote inputs or equivalent sources. See Fig. 1. It has two main program channels, capable of simultaneous operation on separate programs without interference. In addition, it has an independent monitoring channel for loudspeaker listening to programs being transmitted through either of the two main channels, or direct from incoming lines or cue circuits. The monitor channel may also be used to feed cue program back to the remote line circuits, or talkback to one or the other of two studio loudspeakers. All control knobs and keys are color coded for ease of recognition.

Additional Facilities

Other facilities provided are an audition or sound reinforcement output with volume control, two VU meters, headset monitoring jacks, and studio light and signaling control circuits. A patch panel is provided with normalled through jack connections for four program lines and two utility lines, jack termination for two additional utility lines, and input and output normalled through jack connections for two auxiliary preamplifiers which may be installed within the console. In addition to terminals for connecting an external talkback microphone, mounting provisions are made within the console for such a unit.

The equipment has a nine-channel, low impedance parallel mixer. Seven of these mixer volume controls are associated with seven preamplifiers provided in the equipment for operation from a maximum of 12 connected microphones (seven simultaneously), or equivalent low level sources. The other two mixers are associated with higher level inputs which may be incoming program lines. By the use of the jack panel and patch cords, two of the mixers associated with preamplifiers can be disconnected from the preamplifiers and used for high level inputs. Each of four program lines can be provided with repeat coils in the console. Any combination of the nine simultaneous inputs can be connected to either one or the other of the two main amplifier channels.

The block diagram of Fig. 4 shows in simplified form the function of the individual circuit elements. The attached level diagram illustrates levels at different points in the system with various input signals, and corresponding gain settings required to yield +8 VU at the output line terminals. A maximum net gain of 100 db is provided from the low level input terminals to the output line terminals; 40 db from remote line inputs; and 60 db from utility inputs. The monitor amplifier has a gain of 50 db with an output of 8 watts.

Plug-in Amplifiers

Terminal strips to which the permanent connections are made are located in both ends of the console. No external junction boxes or auxiliary enclosures are required. All amplifiers and power supplies are of the plug-in type. Access to these units is obtained from the front of

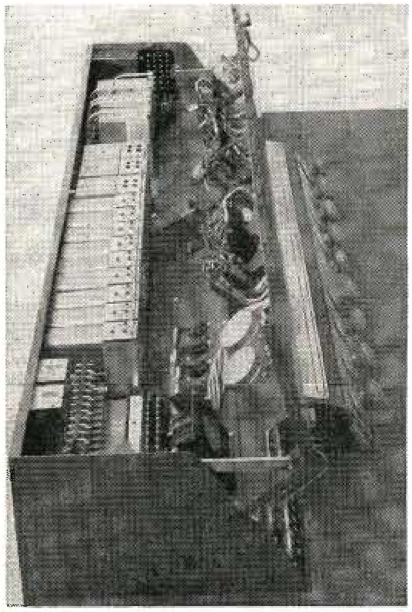


Fig. 2: Raising lid exposes plug-in amplifiers

the console, by raising the hinged top lid. See Fig. 2. This exposes as well, key switches, attenuators, and other controls mounted in the upper portion of the console. The lower deck lid, containing input transfer keys, channel selector keys, and mixer controls is hinged also.

Terminal strips to which the permanent connections are made are located in both ends of the console, thus eliminating external connection boxes and large plug-in connectors. The P-522 power supplies furnish the plate and filament voltages to the plug-in type amplifiers, while the P-523 power supply supplies 12 v. for the operation of relays and signal lamps. Three loudspeaker muting relays are a component part of this power supply. All power supplies are built on plug-in chassis.

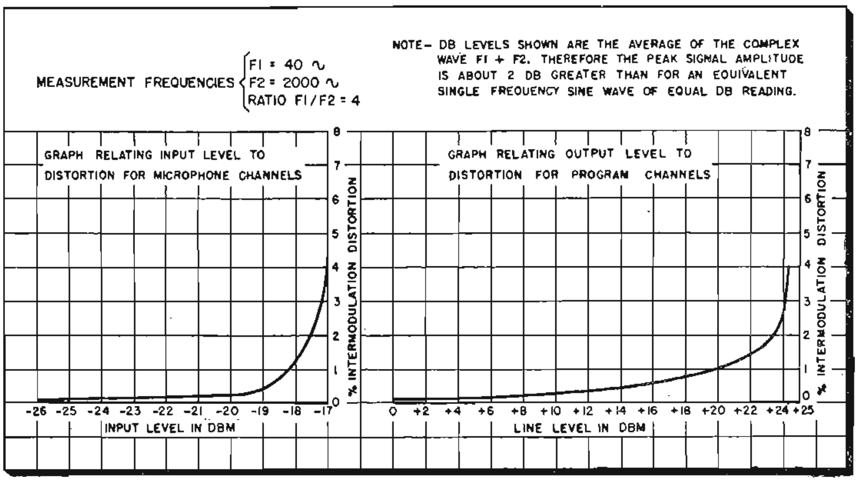
Jacks connected across the outputs of each of the two main amplifier channels are provided for headset monitoring. These are high impedance outputs (100,000 ohms).

Audio Circuits

The functional schematic diagram, Fig. 4, is a simplified version of the complete signal audio schematic.

Low Level Inputs to Mixer Circuits: Each of the five microphone keys provides a means of selecting either of two microphones, one in Studio A or the other in Studio B, and connecting this source to a preliminary amplifier, one of which is associated with each microphone key. In the mid-position of these keys, the sources and the amplifier inputs are short circuited and grounded. The output of each pre-

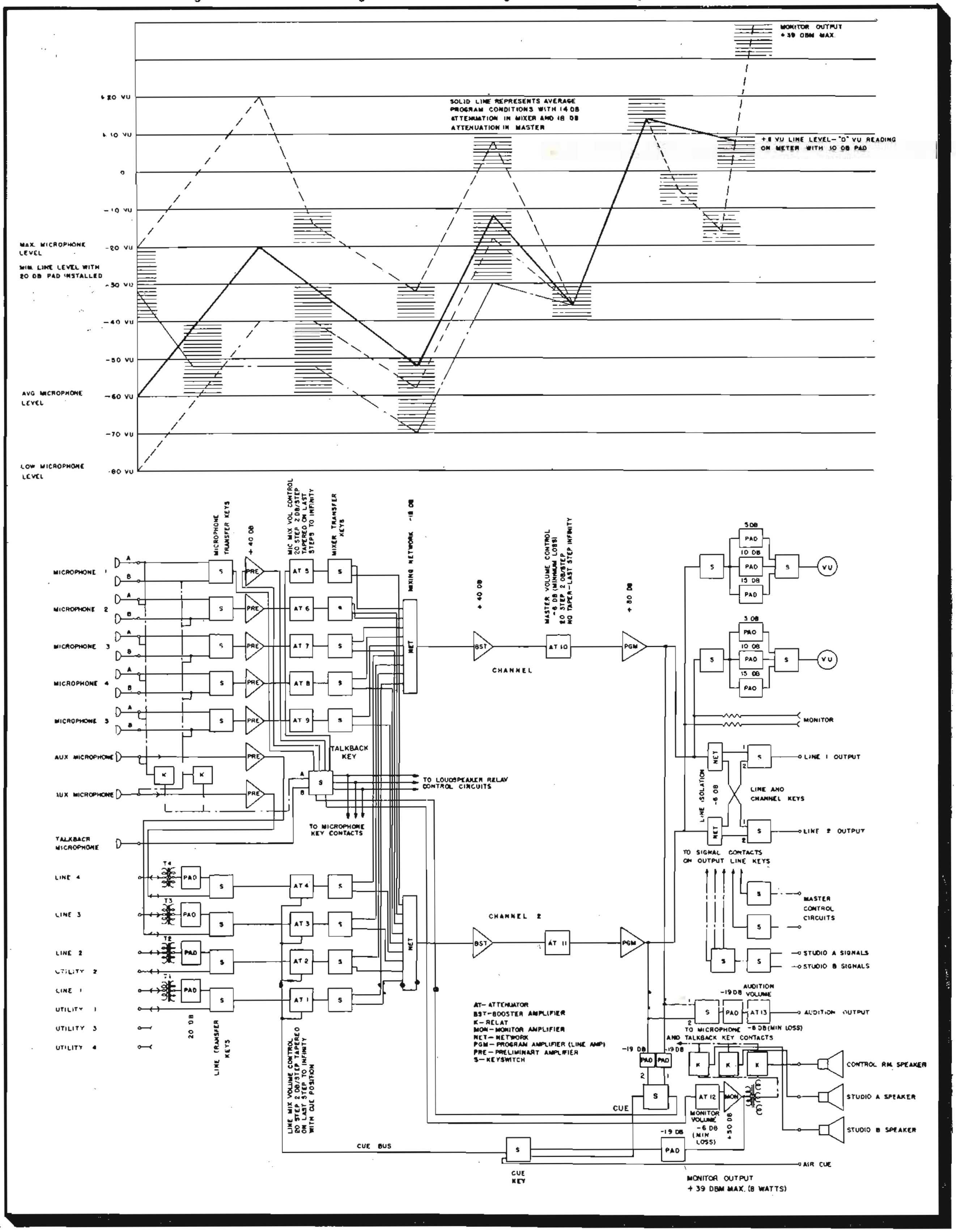
Fig. 3: Intermodulation distortion curves for Model 250A Console with A-428B and A-428B amplifiers



SPEECH INPUT (Continued)

liminary amplifier is connected to a 600:600 ohm ladder type mixer volume control. In addition to the audio circuits on these keys, contacts are provided in the loudspeaker relay control circuit so that when the keys are thrown to the "Studio" position, the loudspeaker in the studio is cut off, preventing operation of a loudspeaker with a live microphone. Operation of this circuit is described in more detail under "Talkback."

Fig. 4: Functional block diagram and chart showing levels at different points in the system.



All these circuits are identical, except that the Talkback Key is interposed between the key for microphone #1 and the input of preliminary amplifier #1.

Line Inputs and Utility Inputs to Mixer: Connections for four incoming program lines are provided. These are terminated in jacks on the console and are normalled through a set of jacks, a 600:600 repeating coil, and a 20 db loss pad to the "line-utility" keys. Four utility lines also terminate in jacks, two of these being normalled through a set of jacks to the "line-utility" keys.

Access to Terminals

Access to the input and output terminals of two of the preamplifiers is had through jacks in the console. Microphones #11 and #12 are normalled to the inputs of these amplifiers and the outputs are normalled through jacks to the #3 and #4 "line-utility" keys.

The arrangement of the "utility" input circuits contemplates levels comparable with the output of the microphone preliminary amplifiers. However, the two preamplifiers accessible in the jack panel provide for the use of low level inputs on the utility lines. Thus, the patching jacks provide means for substitution of inputs in a variety of combinations.

Nine-Channel Mixer: Each of the mixer volume controls is associated with an individual mixer transfer key which provides means for connecting the output of each mixer to either of the two line or main amplifier channels, in any desired combination.

Resistance of 1,200 ohms is substituted across the line amplifier input in place of each actual mixer volume control output when it is off, or when it is connected to the other line amplifier, so that each amplifier input is always terminated in approximately 130 ohms., i.e., the equivalent of nine mixer volume controls. The 600 ohm ladder mixer volume controls are built out to 1,100 ohms by series resistance to provide proper impedance terminations.

Line Amplifier to Output Lines: Two simultaneous programs may be handled separately by the two line amplifiers, each channel being governed in overall level by separate master gain controls between the first and second stages of each line amplifier channel.

Output line keys provide means for connecting either of the two channels to either or both of the two outgoing lines. In any combination

(*Continued on page* 192)

Passive Reflector Design Chart

By F. E. BUTTERFIELD,
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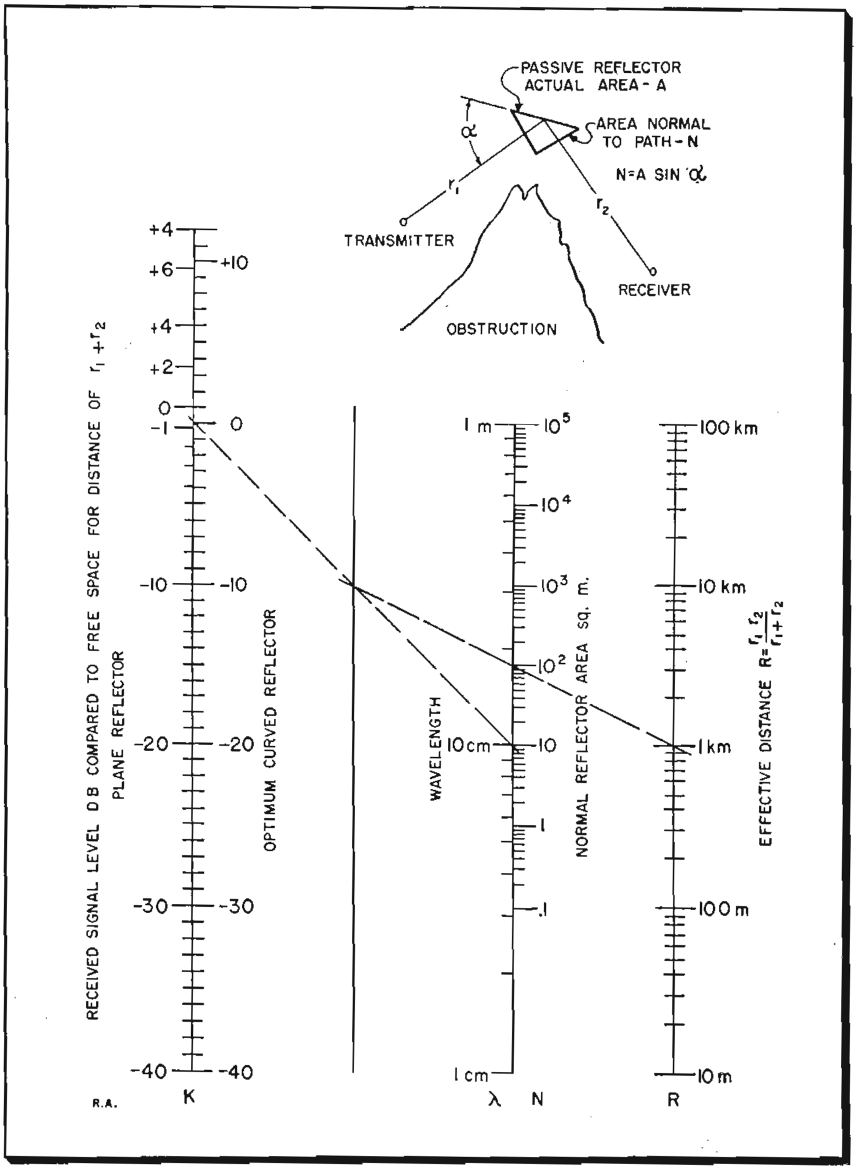
THE passive reflector is a convenient device for providing radio paths free of obstacles. It is often used to permit ground level rather than tower installation of microwave link equipment. In this case only the passive reflector sheet is tower mounted. The passive reflector is capable of small signal gains over free space transmission if the reflector size is not limited or if the reflector can be curved. The gain from flat reflectors results from restriction of the reflector to the first Fresnel zone.

The alignment chart basically expresses the relationship $N = K \lambda R$, where K is the resulting proportion of free space field strength. It also takes into consideration the phase distribution across the reflector for flat sheets. This phase distribution is not ideal for sheets larger than $N = \frac{1}{2} \lambda R$ and hence the gain of these sheets is reduced.

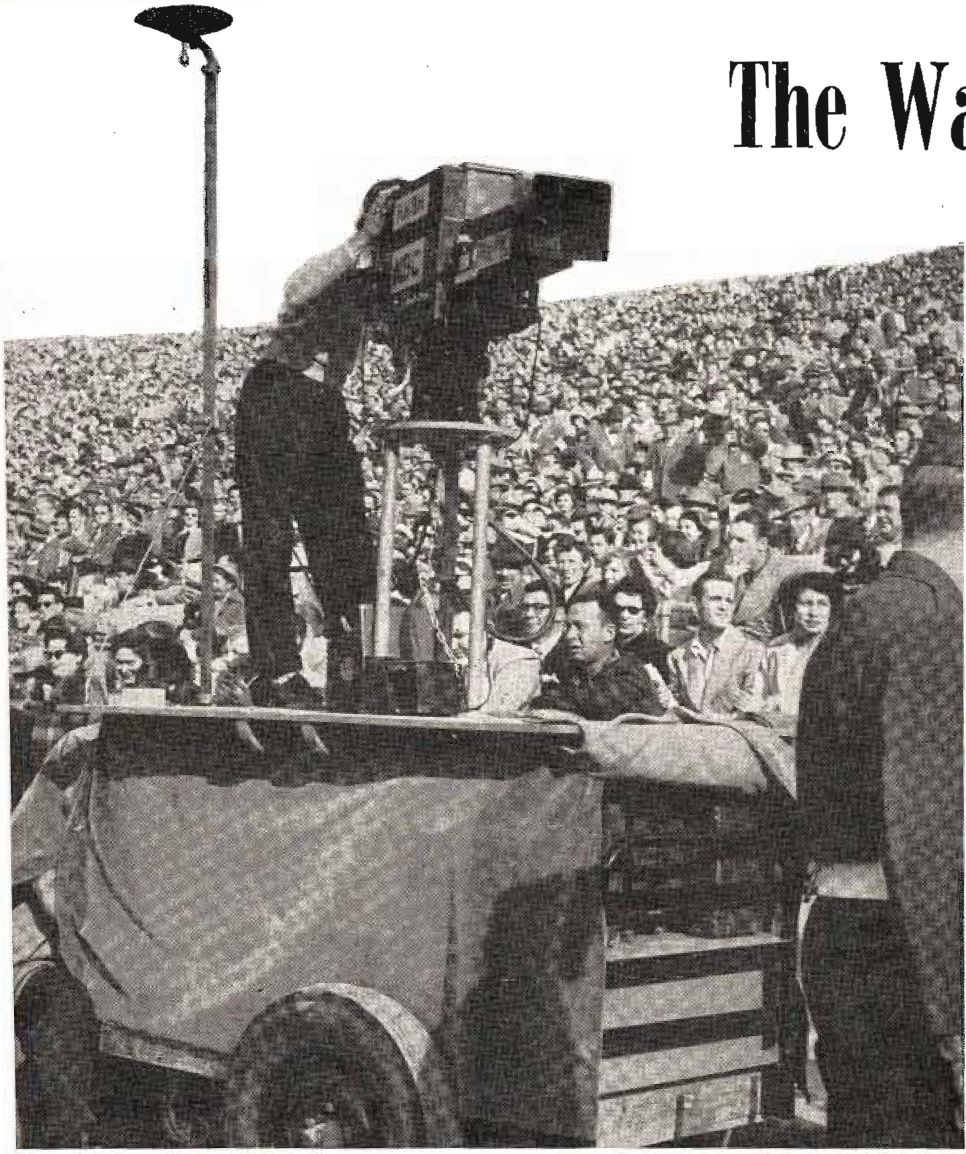
The chart is strictly accurate only for circular areas (elliptical reflectors) but is very nearly correct for square areas (rectangular reflectors) if these do not project beyond a circle of radius $\sqrt{\lambda R}$. The chart is not accurate for those cases where the reflected fields and the fields diffracted over the obstacle interfere or where the reflection efficiency is reduced by limited size (normal reflector area less than λ^2). Large reflectors focus the radio waves and therefore work best with antennas of small diameter compared to R.

This chart is number 15 in TELE-TECH's "Page from an Engineer's Notebook" series.



The Walkie-Pushie-

Trailer-borne
supplied by



NBC's walkie-pushie-lookie TV camera swings into action. Note non-directional microwave antenna

By J. E. BURRELL,
TV Technical Supervisor
National Broadcasting Co., Sunset Blvd. & Vine St., Hollywood 28, Calif.

The manifest advantages of a portable TV camera are demonstrated by the flexible and unencumbered operation which may be achieved in covering sporting events, conventions and out-of-the-way disasters. Although the portable unit employing the vidicon tube (developed by RCA Princeton Labs.) is light, compact and performs notably well, not many broadcasting installations have purchased one of these units. Consequently, it is the purpose of this article to show how a West Coast NBC group developed a portable TV camera using standard RCA components on hand, in conjunction with a battery and motor-generator power supply.

It was decided that the projected mobile camera should have the following features: It should have no wires attached; it must be quiet, give off no fumes, be safe, and ready for use in a short time. It was suggested that the quickest way to achieve these requirements would be to use already existing and available components, powered by 120 v. of automobile storage batteries driving a 120 v. dc to 115 v. ac motor-generator. The picture would be sent to a receiving location by microwave transmitter.

Equipment immediately available and ready for use on the project included one standard RCA field type sync generator, one camera chain (consisting of camera, camera control, and power supply), one RCA TT 1 A microwave transmitter and an oscilloscope to monitor the microwave transmitter signal. It was, therefore, only necessary to provide a mobile source of power, a means of transportation and to develop a non-directional antenna system for the transmitter and we would be "in business."

Twenty automobile storage batteries were obtained to furnish the 120 v. necessary to drive the motor-generator. A low slung trailer was made, using three large rubber-tired wheels to minimize friction, and the batteries were placed on the trailer floor to keep a low center of gravity. Figs. 1 and 2 show this arrangement. The power supply circuit is shown in Fig. 3.

A feature of this circuit is the ability to charge the batteries directly from the city power lines, thus saving the cost of an expensive rectifier. The city power drives the ac generator as a synchronous motor while the 120 v. dc motor now becomes the battery-charging generator. Brushes were not shifted for this transition, yet no serious sparking resulted. The system also provides the advantage of being able to run the entire unit from the city power lines during warm-up periods, thereby conserving battery power.

Meters are provided on the control panel located immediately below the camera control unit to allow the video engineer to monitor the power supply at all times. See Fig. 4.

Adjusting Antenna

Adjusting the non-directional antenna proved to be the most complex job on the entire project. It was found that in order to convert the microwave antenna in the most simple manner, from directional to non-directional, it would be necessary to change from horizontal to vertical polarization. This was accomplished with the antenna shown in Fig. 5. The radiator of this antenna is a tiny rod projecting through the top of the ground plane disc. The knurled ring to the left

Lookie Television Camera

pick-up unit made from readily available standard components. Power auto storage batteries which are recharged from city power lines

and below the antenna radiator is the loading adjustment while the adjustment immediately below is to eliminate reactance in the system. This adjustment proved to be very critical but once adjusted required no further attention for several months of operation. Standard RCA microwave waveguide was used in connecting the antenna to the transmitter.

Control Panel Meters

Meters used in the motor-generator control panel in the lower part of Fig. 4 are: One 60 cycle frequency meter; one 0 to 150 ac voltmeter; one 0 to 150 dc voltmeter; one 0 to 20 center scale dc ammeter; and one 0 to 30 ac ammeter.

The switch box on the left side of the control panel is used to switch city power into the unit. The two indicator lights to the right of this switch are used to indicate when the motor-generator output is in phase with the city power. When the indicator lights are at the extinguished point, the city power and the power from the motor-generator are in phase. The large switch to the right of the panel is the dc bat-

Fig. 1: Batteries are placed on trailer floor

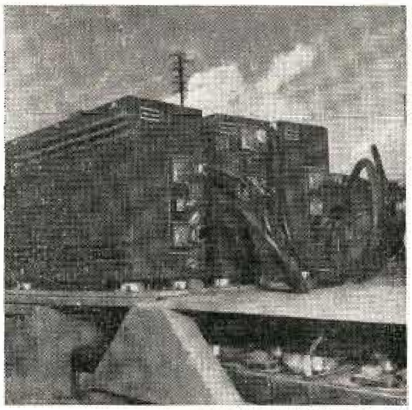


Fig. 2: Power equipment mounts above batteries

Back-Pack Camera—TV's Roving Eye

Cynosure of engineering eyes today is the portable pack-back TV camera and transmitting equipment used by NBC—the walkie-lookie. Incorporating the C73162 Vidicon pick-up tube, the unit contains all the circuitry for producing a standard 525-line, 30-frame interlaced picture, and transmitting it to a control point within a mile from the camera.

Operation of the RCA-developed unit is indicated in the accompanying block diagram. A blocking oscillator provides the basic frequency of 31,500 CPS, which is twice the line scanning frequency. A counter chain divides this figure by 525 to obtain the 60-CPS field frequency. The camera output, thus controlled by the deflection circuit, feeds a video amplifier which is monitored by a 1-inch kinescope. The video then goes to a "boot strap" modulator employing positive sync modulation; that is, the sync pulses are in the direction of increased carrier.

The sync pulse, from the audio pulse-modulator, provides the unconventional means for adding the audio information to the video carrier. Pulses at horizontal frequency are generated by a multivibrator and modulated by the audio to produce a sync pulse whose front is fixed, but whose width varies with the sound modulation.

While this composite carrier is being formed, the VHF FM receiver is picking up a combined 154.49 MC signal from the control point. This signal contains audio instructions plus a 60-CPS sine wave which is compared to the field frequency from the sync generator. The comparison is accomplished in a phase detector whose output is applied to the 31,500-CPS oscillator and counters as an AFC to maintain the correct frequency. In this manner the gen-

(*Continued on page* 175)

Fig. 1: Self-contained portable pick-up equipment transmits UHF signal to control receiver

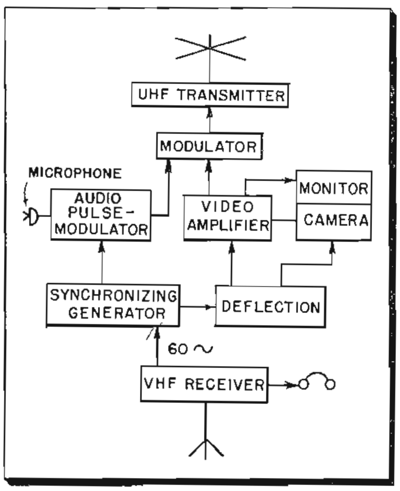
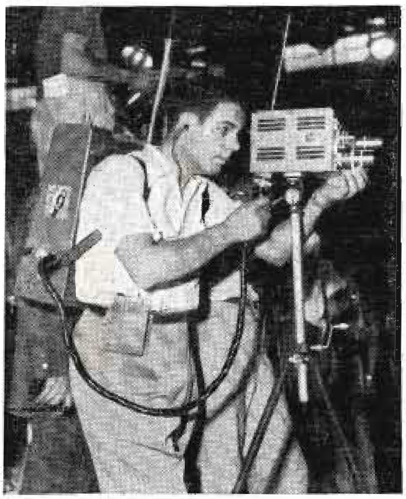


Fig. 2: Walkie-lookie gets an on-the-spot view of activities at the political conventions



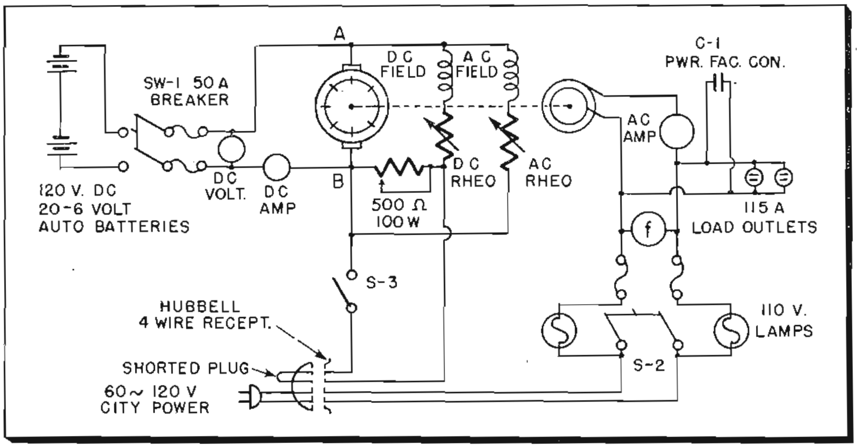


Fig. 3: Power supply circuit permits batteries to be charged from city power lines

tery switch which connects the batteries to the motor when the unit is operating as a motor-generator. Two rheostats control ac and dc field currents.

Operating Procedure

Turning on the equipment in preparation for use is done in the following manner: The battery switch is turned on, starting the motor-generator. The ac and dc field rheostats are adjusted until the indicated 60-cycle output is 115 v. As the camera equipment is turned on it will be necessary to readjust the rheostats to compensate for the added load, and it may also be necessary to make minor adjustments as the battery voltage drops. Although interrelated in these adjustments, the ac rheostat essentially controls the output voltage while the dc rheostat controls the frequency.

If the sync generator is operated on crystal the receiver synchronizing problem will be eliminated, but serious hum bars may appear in the picture, and the edge of the raster may weave in a figure "S" pattern when the local ac is not synchronized with the "crystal" frequency.

The operation of the associated equipment is the same as if it were operated at a fixed location. The only extra precautions are to make sure the frequency and voltage are maintained at the corrct points.

If available, it is desirable to operate the equipment on city power during warm-up periods. The following procedure is to be used in making the connection: After turning on the battery switch, the city power ac switch is turned off and city power plugged in. This energizes the two indicator bulbs, which will go on and off unless the generator is exactly in phase with the city power. The dc field rheostat motor speed control is turned until the phasing lights go out, thus indicating that the motor-generator is in phase with the city power. At this point, the ac switch should be thrown on and S-3 closed. The purpose of S-3 closed at this point is to allow maximum field current and hence charge batteries on city power. The dc rheostat still controls the rate of charge. (When on battery, city power is pulled and S-3 circuit automatically is opened by removal of Hubbell 4 wire plug.) When this has been accomplished the equipment is taking power from the city mains and the motor-generator is reversed in action, i.e., the ac section has become a motor and the dc section is acting as a generator which will charge the batteries.

The dc rheostat now becomes a charging rate control and the ac rheostat is a power factor control. The dc ammeter indicates the rate of charge. The ac rheostat should be adjusted for minimum ac current (unity power factor).

Operation by Battery

When it is desired to operate on battery power, the ac and dc rheostats are set at their previously determined positions. This must be determined by trial during a previous operating period. The power cable to the city mains is disconnected and the unit is ready to be operated as a self-contained mobile unit. Unless the control rheostats have been preset to deliver the correct voltage and frequency under load, the output of the generator may go as high as 150 v. and serious damage to the equipment may result.

The receiving equipment used is a standard RCA TR 1 A, with the receiver head rotated 90° for vertical polarization. This rotation was accomplished by mounting the receiver on a bracket as shown in Fig. 6. The use of a right angle antenna waveguide "hook" would enable one to leave the receiver head on the conventional mounting.

It should be noted that the parabola reflector is equipped with an aircraft optical machine gun sight. On more extreme range, a 2-power rifle scope may be used to align the antenna. Both sights are adjusted by pointing to the transmitter antenna after maximum field strength has been determined by the receiver when the signal is "panned in."

Picture Output

Picture output from the receiver is fed into an RCA TA 5 C stabilizing amplifier to allow the receiver operator to compensate for minor changes in the "walkie-pushie" output, and to match sync ratio with the regular mobile unit equipment. The output of the TA 5 C goes directly into the switching system in the program control position.

The total drain on the batteries, with all the above equipment turned on, is 18 amperes. The

(*Continued on page* 161)

Fig. 4: Control and monitoring units for video and power are easily handled by the operator

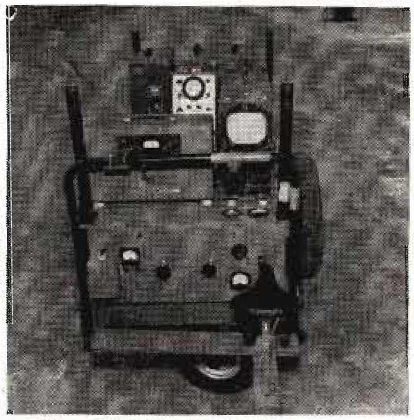
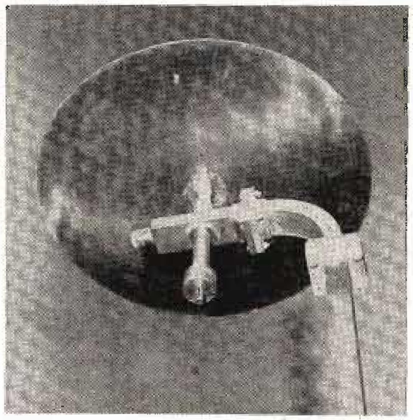


Fig. 5: Non-directional microwave antenna is vertically polarized, uses standard waveguide



VHF-UHF Rescue Transceivers

Subminiature versions of URC-4 include printed circuitry and tiny combination microphone-speaker. Water-tight unit measures 3.5 x 2.75 x 1.5 inches

By C. F. MAASS & R. R. REILLY
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THE multitude of mechanical problems involved in the design of a subminiature transmitter-receiver are often as elusive of solution as the electrical problems. Here is an account of the technical activities of one company engaged in the development of sea rescue radio equipment, and a detailed description of what was done to overcome many design obstacles.

The first subminiature program instituted at Hoffman Radio Corp. was a production type contract in 1945 for the AN/CRC-7 VHF Sea Rescue Transmitter-Receiver. This unit was operable, but unsatisfactory in several ways. Point-to-point wiring produced a low order of reproducibility, and induction heating frequently caused detuning. Further experience was gained in work under a research for the AN/CRT-6 rescue transmitter for collapsible life rafts.

The development of the AN/URC-2 and AN/URC-6 followed early in 1947. Both electrical and mechanical problems seemed almost insurmountable. It was during this period everyone associated with the project became full-fledged machinists. Before electrical breadboard design could start, mechanical features such as coil forms, variable capacitors, and overall form factor had to be determined. None of these items could be tied down until all manufacturers with contracts for developing prototype air-sea rescue units were contacted in regard to all components necessary. Since, at this date, miniaturization was in its infancy, the result of the component survey was very poor.

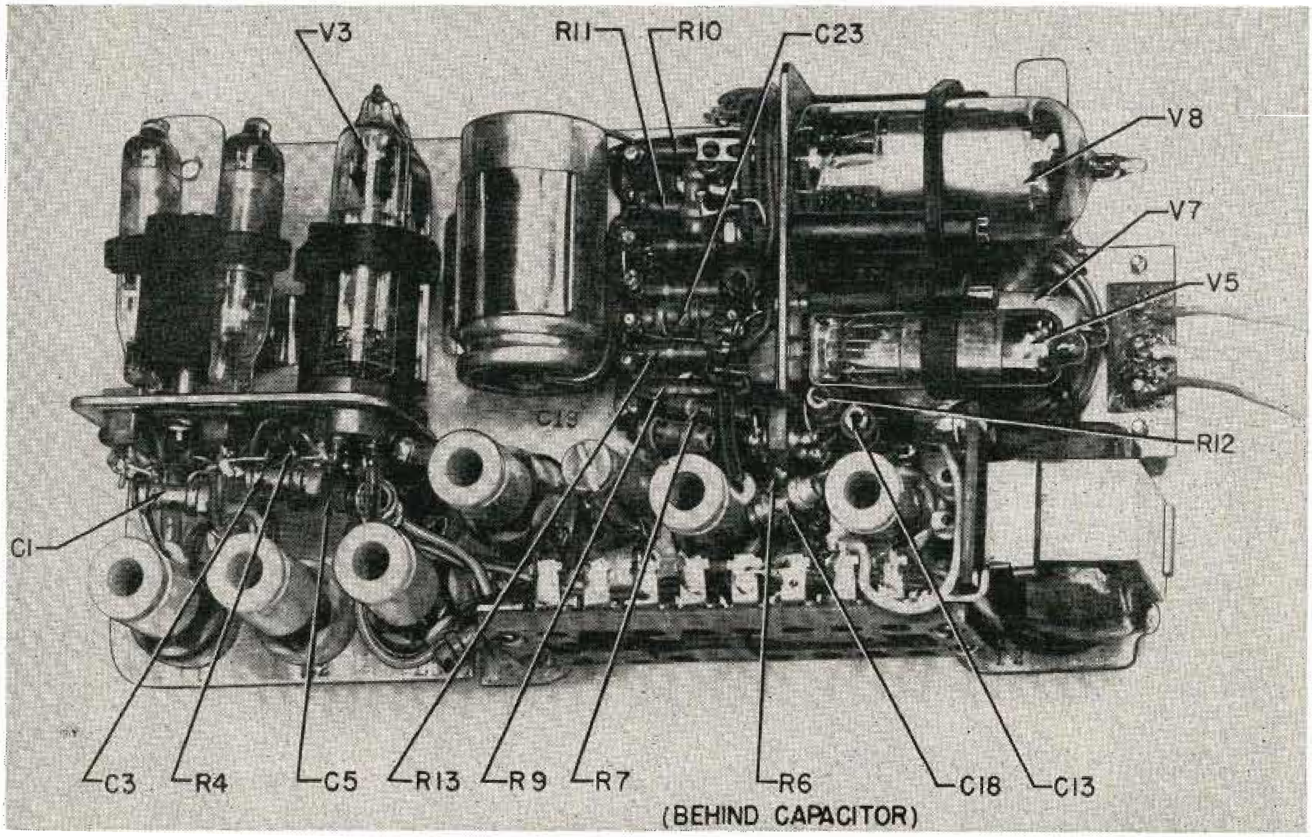
The Radio Receiver-Transmitter URC-6 comprised a super-regenerative receiver and a crystal-controlled transmitter designed for operation on any frequency in the VHF range of 119 to 127 MC. By interchanging the crystal, plate tank assemblies, and receiver coil with those supplied in the Maintenance Kit, conversion could be made from the URC-6 to URC-2 which operated on any frequency from 131.5 to 142 MC.

The receiver consisted of a self-quenching super-regenerative detector followed by a two-stage resistance-coupled amplifier.

Crystal-Controlled Oscillator

The transmitter consisted of a crystal-controlled oscillator using a conventional Miller type oscillator with a 3rd overtone crystal operating at 30.375 MC. The audio stages in the transmitter made use of the

Fig. 1: Compact URC-4 sea rescue transmitter-receiver operates at 121.5 and 243 MC. Unit succeeded single-band VHF types URC-6 and URC-2



same tubes and circuits that were used for the audio stages in the receiver.

The mercury-cell battery used to operate the equipment was rated 1.34 v. per cell. The nominal "A" voltage was 1.34 v. and the "B" voltage was 94 v.

AN/URC-4 Released

About this time, the AN/URC-4 was released. This was a two-band version of the URC-2 and 6 operating at 121.5 and 243 MC. The preliminary design and component selection for the URC-2 and 6 were to be used for this unit as far as functional circuitry permitted.

The first models of the URC-4 utilized separately quenched super-regenerative detectors for the receivers. For maximum efficiency one detector and tuned circuit were used for VHF and a different one for UHF. A separate quench oscillator and audio amplifier were common to both detectors. Figs. 1-3 show the URC-4 construction and circuitry.

The transmitter section was similar to that of the URC-2 and 6 with the exception that when UHF operation was desired an additional frequency doubler stage was added as the UHF output. Bandswitching for both the transmitter and receiver was accomplished by means of a five-pole, double-throw slide switch. The same audio tubes were used for both the transmitter and the receiver.

For VHF operation, the whip antenna was extended to its full length. When UHF operation was desired the two top sections were collapsed.

The first models of the original URC-4 had hardly been built when it was realized that the units were already outmoded. New developments in subminiature tubes and the additional knowledge that we had gained while working with these first units convinced us that only by starting all over again would we get a really satisfactory equipment.

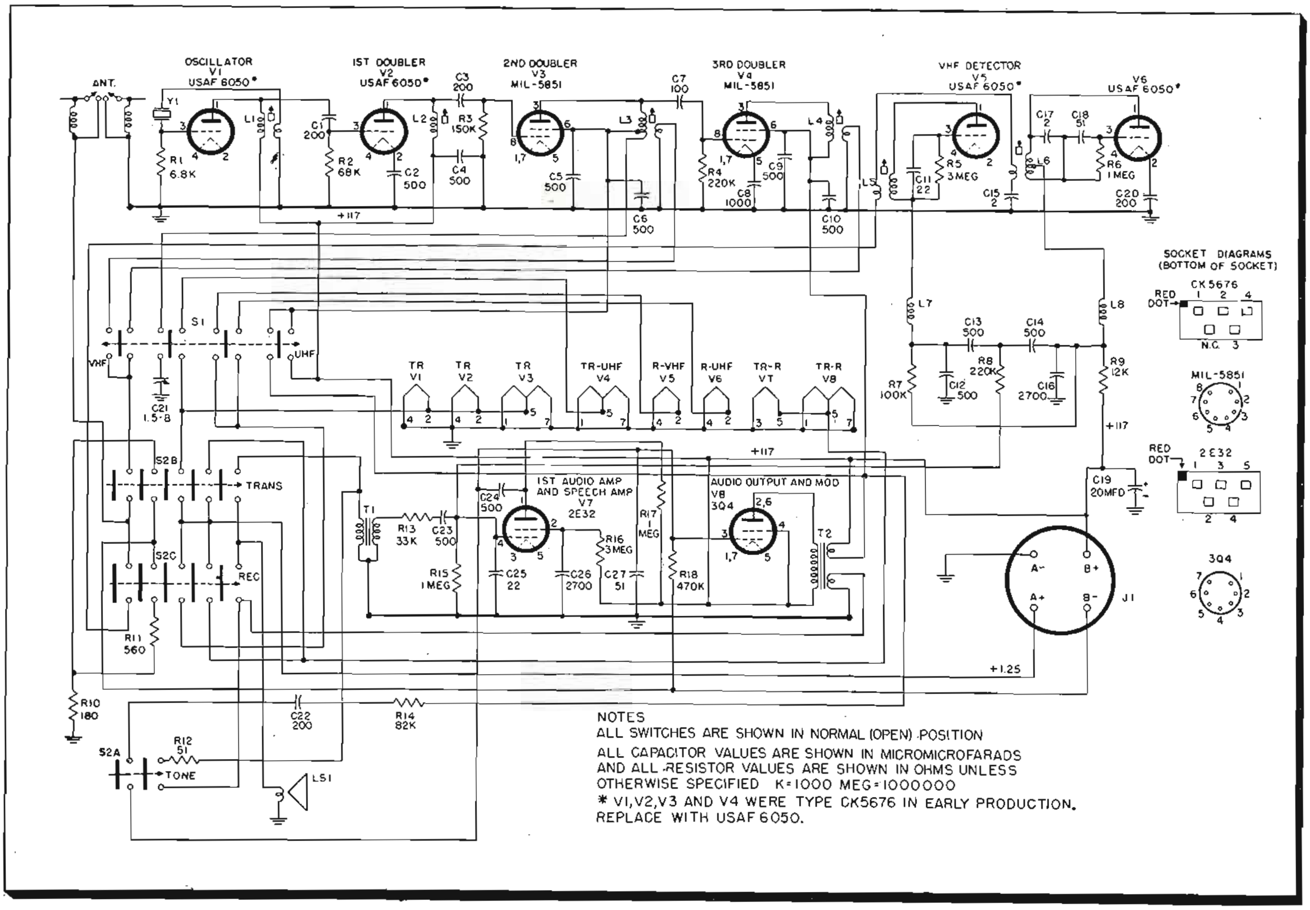
The limitations of the quarter-wave whip had been recognized several designs past. More satisfactory results were obtained from a quarter-wave counterpoise which could be carried in the operator's pocket until more range was desired, when it could be extended and attached to the case of the receiver-transmitter. The next obvious step was to make the counterpoise an integral part of the unit. Since any antenna suitable for 120 MC must work equally well in the 240 MC region, some method of accomplishing this had to be included.

Early tests with rigid samples showed that the best form for the antenna assembly was what appeared to be a horizontal dipole mounted atop two vertical feeder rods. Actually one side of the antenna only was fed. The other part was the matching counterpoise. To incorporate this antenna change into the unit meant a complete mechanical redesign.

Antenna Requisites

Primary requisites of the antenna were: (1) Completely collapsible within the case; (2) Suitable electrical connections from the chassis to antenna made without jeopardizing the water tight seal; (3) Easily adjustable in length to obtain maximum efficiency on VHF and UHF bands; (4) Loading coils which would be part of the antenna circuit when antenna was extended to the VHF position, but automatically shorted out when collapsed to UHF position; (5) Easily erected under adverse conditions, and adjustable

Fig. 2: URC-4 transmitter-receiver uses crystal-controlled oscillator and separately quenched super-regenerative detector for VHF and UHF



by operator wearing heavy gloves; (6) Antenna form factor when erected to take form of a T to meet dipole requirements.

The antenna consists of two vertical telescoping sections, two horizontal telescoping sections, a plastic cap and the related locking mechanism, loading coils, and spring contacts assembled to the plastic cap. The twelve individual telescoping sections are made of stainless steel tubing with an average wall thickness of 0.010 in. The end of each section is slotted and bowed out to obtain a spring action. The plastic cap assembly contains the subassemblies which include the loading coils and detent springs which hold the horizontal antenna arms firmly in position when extended. In the center of the plastic cap assembly is the slide lock mechanism, which locks the antenna assembly in the case when it is in storage position, and also confines the two center sections which are spring loaded. Shorting out the loading coils for UHF is accomplished by an internal spring contact in the large diameter section of both horizontal antenna arms.

The complete antenna assembly can be telescoped and housed within the case with the exception of the plastic cap. The form factor of the cap is such that, when the antenna is collapsed, it conforms to the contours of the case.

Storage Position

When the antenna is in storage position, three of the four telescoping sections are housed in tubes which are an integral part of the casing. These tubes act as retaining wells and although water can enter them, it cannot enter into the chassis compartment. The fourth antenna section is housed in the plastic tube, which, insulates this section of the antenna from the case. The plastic tube, when installed is sealed at both ends of the case, and contact is made from the chassis by means of a spring contact which engages a molded-in metal inset in the plastic tube.

The cases of the original URC-4's were fabricated from brass. The complication of the case necessitated by the new antenna assembly made the cost of this method of construction prohibitive for large scale production. The redesigned case is an intricate zinc die casting, with an average wall thickness of 0.040 in. and weighs approximately one pound.

The receiver went back to a self-

(*Continued on page* 168)

Improved Mobile Whip Antennas

EXPENSIVE repairs and considerable inconvenience often result from the frequent breakage by obstructions of 30-35 MC, ¼-wave, vertical mobile antennas mounted on high vehicles. Presented herein, is a brief survey by M. R. Friedberg, Director, Communications Dept., Ward Products Corp., Cleveland, Ohio, on methods employed to reduce the high incidence of breakage.

The first attempt to solve the problem was a retracting antenna. Since electric motors are electronically "hot" and affect radiation, the selected method to raise and lower the antenna was compressed air control. This led however, to the problem of tapping into the vehicle air brake system. Compressed air from this source was reliable, but all connections had to be perfect to prevent leakage. Then, too, there was the economical limitation that the system could be used only on vehicles which already used compressed air.

Retracting antennas are also subject to human errors. The driver, intent on traffic and other situations, could fail to notice the impending obstruction, or forget to retract the antenna. The result was obvious—breakage was only slightly reduced. Serious, too, was the possible failure to raise the antenna after retraction.

Suffice to say, although carefully tried, retracting antennas introduced more problems than they solved. A new antenna was necessary. Greyhound, requiring dependable communications on interstate buses, contacted Ward Products, and a new antenna, Model SPPC-88, is the result.

Double Spring Used

This antenna, shown in Fig. 1, uses a double spring for maximum flexibility. First, there is friction-free steel base spring mounted to the junction box. On this is the whip, and the base of the whip is itself coiled, acting both as a spring and as an electrical coil. The entire arrangement can bend without breakage to a minimum protrusion of only four in. above the roof, and spring back on release to its full vertical height of 45 in. Simple as this may seem it introduced two additional problems—short circuiting of the spring coil in bending, and ground plane affects on the ⅛-wave whip.

Short circuiting was extremely serious for it occurred not only when the whip was fully deflected, but also during the rapid vibration as the whip returned to its vertical position. The problem was solved by coating the coil section with Plastizole plastic insulation.

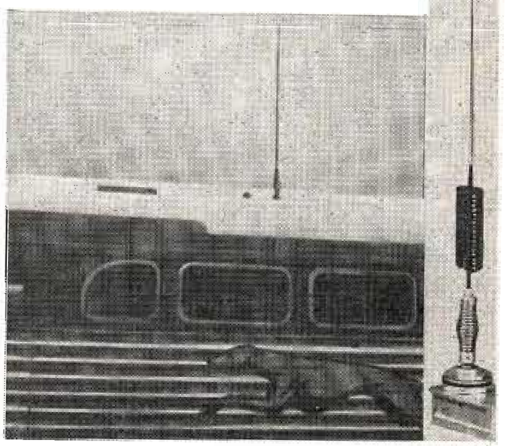
All whips are affected by ground planes introduced by the vehicle surface. This affect seriously impairs the antenna radiation pattern and, more importantly, gives the antenna a varying impedance. Usually a ¼-wave whip is pruned to the theoretical length required by the operating frequency; however, ⅛-wave was believed to be better in this case due to its shorter length.

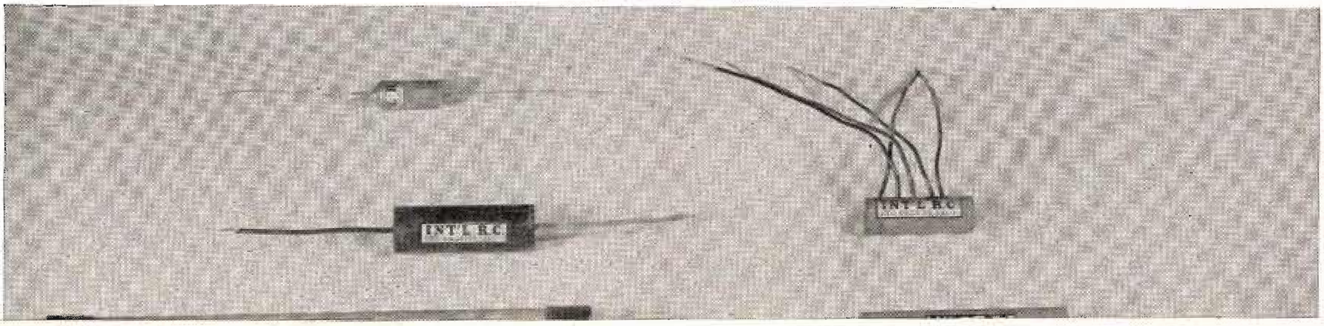
Generally, ⅛-wave base loaded whips are more sensitive to ground plane affects and, consequently, more critical. Exact tuning would require adjusting whip length to the contour of the specific vehicle on which it was to be installed, meaning higher installation costs, and a separate antenna for each frequency. The problem was solved with a series capacitor in the junction box. After a simple adjustment for ground plane variations on impedance, the antenna then presents a constant impedance of 50 ohms to the coaxial transmission line. In fact, measured vswr closely approximates 1:1.05. The radiation pattern is essentially omnidirectional.

Side Mounting

Normally, roof-top antennas are mounted on the center of the vehicle to minimize ground plane effects. In some cases, it is desirable to mount the antenna to the side of the vehicle, as did Greyhound. Side mounting is advantageous if it is desirable to have the antenna close to the mobile unit, or if vehicle height is such that even a four-in. protrusion is too great.

Fig. 1: New 45-in. antenna uses double spring for maximum flexibility. Whip may be lowered to have protrusion of 4 in. without breaking





An Improved Direct-Reading

New unit, using oscillator fundamentals and harmonics to cover 20-480 MC 0.005% long term stability in laboratory applications. Low frequency oscillator

By LEONARD S. CUTLER

Chief Engineer, Gertsch Products Inc. 11846 Mississippi Ave. Los Angeles 25, Calif.

THE rapid development of the VHF communication field in recent years has brought about the need for a wide-range, accurate, portable frequency meter. During World War II, several portable meters were developed. These meters were of the heterodyne type in which indication of frequency was obtained by aural means. They had two major deficiencies:

(1) They cannot be read directly in frequency. This is due to the fact that it is impossible to make a calibrated oscillator linear to the required accuracy. Therefore, since two dials must be used in order to obtain the reading accuracy, a set of arbitrary calibrations must be used. This calls for a calibration book in which frequency is indicated as a function of the arbitrary dial units.

(2) A second deficiency of these instruments is limited accuracy. It has been shown from experience that the best accuracy obtainable in the field is limited to about 0.005%. The reason for this limitation is due to slight mechanical changes in the variable capacitor and coil combination because of aging, temperature effects, and humidity.

With this in mind, we set out to develop a frequency meter which would fulfill the need and overcome these two deficiencies. This resulted in the development of our model FM-1 and, subsequently, our model FM-3. The Model FM-1 was designed to cover the frequency range from 20 to 480 MC. The fundamental range was 20 to 40 MC, and harmonics were used above 40 MC. This means that the instrument was to be direct reading from 20 to 40 MC. In order to make the instrument direct reading, we decided to interpolate between megacycle points. For example, to generate 22.5 MC, we would set one dial at 22 and another dial at .500. To accomplish this, we used a 1 mc crystal and its harmonics for the megacycle points, and to interpolate, we used an oscillator covering a 1 MC range. We chose the range of 1 to 2 MC for this oscillator since it is impossible to cover from 0 to 1 MC in a single oscillator. Therefore, using the above example of 22.5 MC, we could use the 21st crystal harmonic plus 1.5 MC from the low frequency oscillator to generate this frequency. We could also use the 24th crystal harmonic minus 1.5 MC. Basically, this is the system used in the models FM-1 and FM-3.

The decision was made to use the crystal harmonic minus the Low Frequency to measure or generate a frequency. The reasons for this decision are as follows:

(1) To keep the same basic frequency range using the sum frequency would require that the tuned circuit for selecting crystal harmonics would have to tune from 19 through 38 MC. Using the difference frequency, the tuned circuit has to tune from 22 through 41 MC. This slightly smaller tuning range in the latter case allows a more uniform dial calibration and better tracking.

(2) Due to the fact that in the case of the difference frequency method the selected harmonics start at 22 MC, the difference in amplitude between the first and last harmonic selected is smaller than in the case of the sum method, thus allowing a more uniform instrument response over the band.

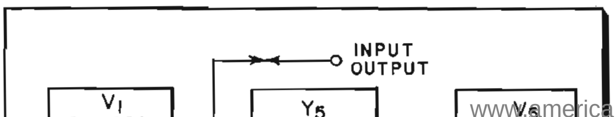
For the above two reasons, the difference frequency method was selected.

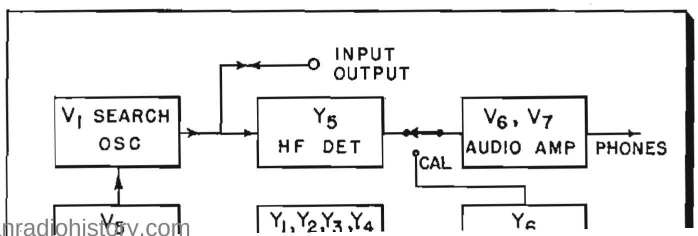
The use of crystal harmonics minus a low frequency to measure or generate a frequency has the following disadvantages:

(1) Not only is the desired frequency present in the output but also the sum frequency and sum and difference frequencies for all the other crystal harmonics are present. To eliminate these spurious or unwanted outputs, we use a tuned crystal harmonic multiplier which selects the desired crystal harmonic and attenuates all the others. Using the

Fig. 1: (Left) Block diagram of model FM-1 covering 20-480 MC

Fig. 2: (Right) Block diagram of model FM-3 developed from FM-1





VHF Frequency Meter

range, offers 0.001% accuracy, enables direct frequency readings.

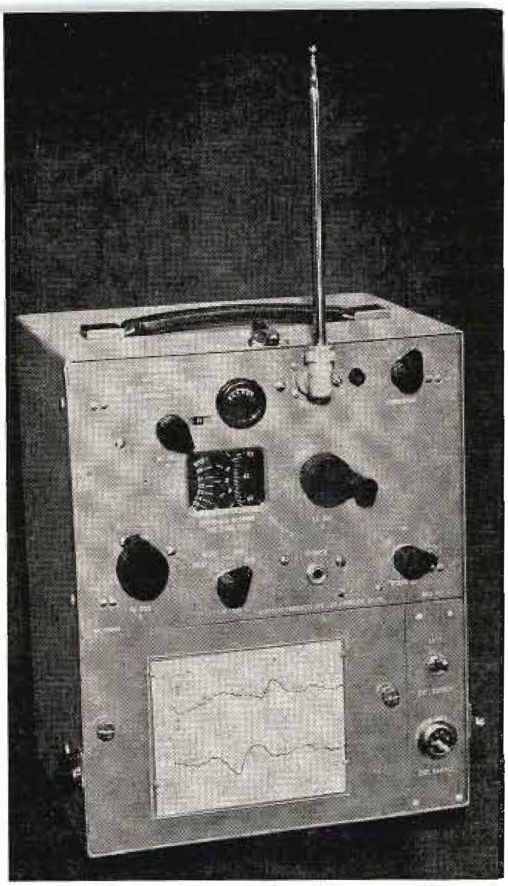


Fig. 3: Panel view of FM-3 VHF frequency meter

above example of 22.5 MC, we would select the 24th crystal harmonic and attenuate all others.

(2) Another difficulty remains. When the instrument is used as a source of frequencies, the 24th crystal harmonic, the low frequency signal, and the sum frequency are also present as well as the desired difference frequency. To overcome this difficulty, we used a transfer oscillator to transfer the unknown signal into the instrument or to transfer the known signal out of the instrument. The crystal harmonic and low frequency oscillator signal are not present when the transfer is made.

(3) Still another difficulty arises in this system. After the signal has been transferred into the instrument and the low frequency oscillator and crystal harmonics are applied, the undesirable signals are still present in the instrument. Due to the lack of perfect selection in the tuned crystal harmonic multiplier, other harmonics besides the desired harmonics exist to a small degree. These undesired harmonics cause spurious responses. Also harmonics of the low frequency oscillator cause spurious responses. To eliminate the crystal harmonics and the low frequency oscillator signal we use a balanced modulator for combining them. The sum frequency causes no concern because it is always far enough away that it is not noticed.

Oscillator Tuning

With reference to the block diagram, Fig. 1, V_1 is the high frequency transfer oscillator tuning from 20 to 40 MC, with its dial reading from 20 to 40. V_3 is the 1 MC crystal oscillator. V_2 is the tuned crystal harmonic multiplier. This is gang-tuned to the high frequency transfer oscillator and so adjusted that it tracks 1.5 MC above the transfer oscillator. This automatically selects the proper crystal harmonic when the transfer is tuned either to the unknown signal or in the vicinity of the desired signal output. V_4 is the low frequency oscillator which covers the range 1 to 2 MC. Its dial is calibrated from .000 to 1.000 as the frequency goes from 2.000 to 1.000.

The low frequency oscillator signal and the signal output from the tuned crystal harmonic multiplier are combined in the balanced modulator consisting of four specially selected germanium diodes, Y_1 through Y_4. These germanium diodes are arranged in a balanced ring modulator. The output from the balanced modulator is fed to the detector, Y_5, another germanium diode. Here the difference frequency from the balanced modulator is used to measure the frequency of the transfer oscillator after it has been matched to the unknown signal frequency or the transfer oscillator is matched to the difference frequency from the balanced modulator previous to transferring a known signal out of the instrument. The audio difference frequency from the detector is fed to a one-stage audio amplifier, V_5.

Assuming that it is desired to measure an unknown frequency, for example 22.5 MC, the operation would be as follows:

(1) With all circuits inactive except the transfer oscillator, the detector, and the audio-amplifier, the transfer oscillator is tuned to zero beat with the unknown signal which has been fed into the instrument by suitable coupling.

(2) The remaining circuits are activated and the unknown signal is effectively removed. The transfer oscillator is now tuned to 22.5 MC and this frequency appears at the detector input. Also, since the tuned crystal harmonic multiplier is gang-tuned to the high frequency transfer oscillator, it is now tuned to 24 MC, thereby selecting the 24th crystal harmonic which is fed to the balanced modulator. Since the low frequency oscillator covers from 1 to 2 MC, the difference frequency output from the balanced modulator will cover from 23 to 22 MC. Therefore, the low frequency oscillator is tuned until the difference frequency output from the balanced modulator matches the frequency of the high frequency transfer oscillator. When this has been accomplished, the 22 is read from the high frequency oscillator dial, and the .500 is read from the low frequency oscillator dial.

To generate a known frequency, for example 22.5 MC, the procedure is reversed.

The low frequency oscillator is first tuned to 1.5 MC, and its dial then reads .500. The transfer oscillator is then tuned between 22 and 23 MC until its frequency matches the difference frequency output from the balanced modulator. All circuits except the transfer oscillator and the detector and the audio amplifier are then made inactive, and the desired frequency is available at the output jack of the instrument. The 1 MC crystal is also used as a standard to correct the low frequency oscillator to its dial readings. This can be done at any frequency which is q/p times 1 MC, where q and p are integers and q is equal to or greater than p and where the response is audible. Provision is made for modulating thc transfer oscillator for identification purposes by converting the audio amplifier into an audio oscillator.

Theoretically, the Model FM-1 has a potential accuracy of ten times that of previous instruments. This is due to the fact that the instrument frequency is composed of the difference frequency between a crystal harmonic and a low frequency which is at least one-tenth of the crystal harmonic. This also enables the instrument to be direct reading, since the calibration accuracy of the low fre-

(*Continued on page* 205)

The Electronic West Coast

A survey of the opportunities for professional advancement, electronic de
Pacific Coast country. Hollywood, radio-TV centers, airplane factories and

By DR. LOUIS N. RIDENOUR
Ridenour Assoc., Consulting Engineers
2000 Stoner Ave., Los Angeles 25, Cal.

As this special West Coast issue of TELE-TECH attests, there has been enormous growth of electronic research, development, and manufacturing in California and the West. While the industry is still largely centered in the Midwest and the East, even the established Eastern firms (and to us out here, anything east of Salt Lake City is the East, without need for qualification) are tending more and more to put branch laboratories and plants out West. RCA in Los Angeles, IBM in San Jose, Motorola in Phoenix, are examples of this trend.

What are the causes of this growth? What is its future? What has the West to offer electronic industry? I speak of these matters only with the greatest diffidence. For one thing, I'm not a Native Son of California, only a Native Son-in-law. For another, I am a brand-new recruit to Western electronics, not an old-timer who can speak with the authority of extensive first-hand experience. But at the request of the Editor, I will say how it looks to me.

In the Nineteen-Thirties

Twenty years ago, as a graduate student at Cal Tech, I was building primitive counting instruments for nuclear particles: the great-grandparents of the streamlined commercial instruments that have been born of the atomic energy program. At that time, we could get standard radio parts locally from distributors and suppliers, but anything the least bit special had to come from the East. The preferred method of shipment apparently was by sailing vessel around the Horn, to judge from delivery times. In addition to radio, about the only important branch of the electronics industry located out here was that connected with the making of sound motion pictures.

Ten years ago, I made an expedition to California to recruit members for the fast-growing Radiation Laboratory at the Massachusetts Institute of Technology, whose successes in microwave radar development were leading to a bigger demand for equipment development than the original staff could satisfy. By this time, there were substantial technical groups maintained by most of the large motion-picture producers and often there were sizeable and competent electronic staffs in the aircraft companies. Sizeable, that is, by the standards of the time; in many cases you could count the electronics people in a major aircraft company without taking off your shoes. Most of the new Radiation Laboratory recruits came from the movie industry, since we couldn't move war-plant men. They regarded a period of living in Cambridge, Mass., as a major sacrifice made in the name of the war effort, and got back here as soon as they could, once things were over.

DR. RIDENOUR

In addition to his activities as consulting engineer, now also serves as vice-president and chief engineer of the Telemeter system of subscription-TV. His recent activities and distinctions include:

Chief science adviser, Joint Chiefs of Staff, Pentagon; Radar Committee, Joint Chiefs;
Special adviser Secretary of Air Force;
Consultant Secretary of War;
Radar adviser U. S. Strategic Air Forces in Europe;
Institute of Advanced Study, Princeton Univ.;
Professor University of Pennsylvania;
Professor University of Illinois;
Editor-in-chief Mass. Inst. Technology Radiation Laboratory Series of 27 technical volumes;
Editor Radar System Engineering;
Received Presidents' Medal for Merit;
Phi Beta Kappa; Sigma Xi;
B.S. University of Chicago;
Ph.D. California Institute of Technology.

Post-War Expansion

The explosive post-war growth of Western electronics is well known. In part, of course, it is simply a direct consequence of the general population increase out here. There are more people, so there is more activity in electronics, just as there are more barbers. In part, it is a result of the wartime and post-war atomic energy program, some of whose most important development and production centers are in the West. But perhaps the largest single factor in the growth of Western electronics is the aggressive development program of the major aircraft companies in the general field of automatic control.

Hughes, Boeing, North American, Convair, Lockheed, and Northrop all maintain research and engineering groups consisting of several hundreds or even a few thousands of technical men. While these groups are very largely concerned with the development and design of airborne electronic equipment needed for the flying machines the companies build, in several important instances they are engaged on projects of a more general nature. Hughes is a specific case in point; its electronic development, which is extensive, replaces rather than supports the manufacture of aircraft.

Climate $2000 per Annum

Needless to say, these large electronic groups in the Western aircraft companies could not have been built up without nation-wide recruiting. And nation-wide recruiting has been carried on, as all of us know. I was once told by the Dean of a prominent California university that, in setting staff salaries, his university

—A NEW WAY of LIFE

velopment and enjoyable living offered by the numerous smaller corporations all add lure

figured that the climate was worth $2000 per year. In the recruiting campaign carried on by Western electronic groups, the salaries offered have been competitive with those elsewhere, and the amenities stemming from the California climate have been thrown in free on top of that. We have all seen the ads about "smog-free San Diego", about the "Healthful Southwest, Land of Enchantment" (Sandia), about "a 'bonus' every day in better living—just because you live in Southern California, in an area (Burbank) where the climate is beyond compare."

"Engineers Wanted" Ads

To Easterners, this sort of thing probably seems unfair, or silly, or maybe both. Their ads stress technical challenge, job security, opportunity for professional advancement; they either austerely ignore the amenities of location or deal with it in a word: "pleasant Alexandria" (Va.), "beautiful suburban and country areas" (near Baltimore), "the educational and industrial heart of New England" (Boston). There is no rich, beautiful prose like this: "Ideal climate—cool, clean, dry. Mountains, desert, Mexico, Hollywood, Los Angeles, Pacific Ocean, beaches and bay—only hours or minutes away. It offers you a new way of Life . . . pleasant, refreshing, happy."

Corny or not, the appeal of the West seems to have been working. Immigration of electronics men from the East has ben substantial, and is still going on. While the "stretch-out" in the military development and procurement programs has somewhat slowed down the local rate of growth, you still see a good many of the climate ads in the technical press.

"Start Your Own"

In addition to the great electronics groups maintained by the aircraft companies, there is a host of smaller specialized electronic firms in the West. The present tax laws seem purposely contrived to induce an ambitious and competent young man to start a company of his own, rather than taking even quite a good job with an established outfit. At any rate, they have had that effect here, as elsewhere. You can scarcely throw a horseshoe over your shoulder anywhere in Los Angeles County without injuring the vice-president of a small electronics firm, usually one with ambitions to apply the information-processing techniques of modern electronics to the clerical and control problems of business and industry.

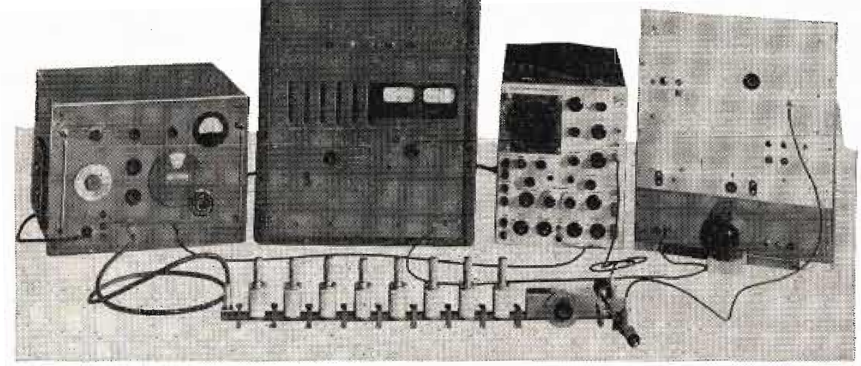
And, of course, there are the indigenous radio, radar, and television manufacturers: Gilfillan, Hoffman, Packard-Bell, and the rest. It all adds up to a pretty big picture, as this magazine will elsewhere tell you in detail.

What of the future? That, as usual, is anybody's guess. It is certainly true that the needs of the rearmament program have fallen particularly heavily on the electronics industry, and much of the West's present growth in electronics is directly due to government support which may diminish in the years to come. This might be depressing or even disastrous to the vast organizations that have been created out here. However, it need not be. The recent tremendous growth in the scope and power and applicability of modern electronic devices and techniques suggests that an immense consumer-goods industry, potentially far bigger than the radio or the television industry, awaits development. Under the stress of declining government contracts, the competent electronics groups will undoubtedly put every effort on developing new applications of electronics which, if successful, will come in to replace military contract work.

What has the West to offer electronic industry? A large and growing population, available both as producers and consumers. Plenty of room for expansion, along with other rapidly growing industries. The climate that the ads tell about. And, with modern transportation, the West isn't so very far away from civilization. Nowadays you almost never see an advertisement that says: "Prices slightly higher west of the Rockies." Like everyone else out here, I am waiting with anticipation for an ad that says: "Prices slightly higher east of Salt Lake City." We may live to see it, too; some brash Westerner will run it out of sheer bravado.

View along Wilshire Boulevard in Los Angeles, Calif. Lafayette Park is in foreground, exclusive Town House at right center. The Hollywood Hills are on extreme right with Santa Monica at extreme far end of the Boulevard. Ewing Galloway photo.

Visual Display Methods for Microwave



Visual display type microwave frequency standard for rapid production measurements. In foreground is a series of waveguide frequency meters undergoing calibration

A new technique replaces time-consuming point-by-point measurements in production tests of waveguide devices

By F. J. BURKHARD
Hewlett Packard Co.
395 Page Mill Road, Palo Alto, Calif.

TWO years ago the Hewlett-Packard Co. undertook to develop and manufacture a complete line of waveguide type test equipment. Such a program involved a substantial extension of existing production methods, because the manufacture of waveguide equipment is largely concerned with machine work and with accurate assembly of machined parts.

For electrical reasons it is often necessary to machine waveguide test equipment parts to very close mechanical tolerances. To check the performance of equipment containing these precision parts, it is often necessary to make time-consuming point-by-point electrical measurements over wide frequency ranges.

To accomplish rapid and accurate production testing, a number of visual measurement techniques were devised. These techniques are generally as accurate, or even more accurate, than the more laborious point-to-point methods. Since these techniques have proved valuable in the production of test equipment, it is thought that they may have further value in other production operations. They are described here for the benefit of those who have similar problems.

In a recent production application it was necessary to measure vswr over a 2000 MC band located in the 10,000 MC region. Because of the nature of the application, at least three such vswr measurements were required for each production equipment. The equipment to be measured was a test set having a circuit like that shown in Fig. 1. The tests required vswr measurements of the output impedance of the generator, input impedance of the power meter, and input impedance of the thermistor mount in the power meter circuit.

Thermistor Mount

The thermistor mount was measured in a pre-assembly procedure using the set-up shown in Fig. 2. Three klystrons are operated at frequencies corresponding to the two ends and the middle of the band over which the thermistor mount is to be used. The klystrons are modulated from a triple-pulse generator that pulse modulates each klystron in turn. The three klystrons are fed into a common waveguide line which is terminated with a hybrid-Tee. The H-arm *A* of the tee is terminated with a flat load so that negligible reflection occurs. The second H-arm *B* is terminated with the thermistor mount to be investigated. Reflections from this mount enter the E-arm *C* where they are detected in a crystal mount and applied to the vertical system of an oscilloscope.

This arrangement results in the oscilloscope presentation shown in Fig. 3. Each pulse of the presentation corresponds to the r-f frequency of one of the klystrons; the amplitude of the pulses is proportional to the reflection coefficient of the thermistor mount at that frequency.

The overall system is calibrated so that it is only necessary for production personnel to maintain the amplitude of the displayed pulses below a mark calibrated on the screen. The measurement set-up is thus equivalent to a "go-no go" gage. Owing to the simplicity of the presentation, relatively non-technical personnel quickly become expert at making necessary adjustments in the thermistor mount to insure conformance with specifications.

The remaining two measurements required for the test sets are vswr measurements of the output impedance of the generator and of the input impedance of the power measuring circuits. These measurements are complicated by the fact that they involve the use of an electrically long output cable which is provided with the equipment.

The measurements are made looking into the equipment from the end of the long cable. The reflections arise from discontinuities at various points in the system such as at connectors. Since these discontinuities are separated by large electrical distances, the reflections will combine in random phases and at some frequencies may all add in phase to give a relatively large reflection. The end result is that the vswr looking into the cable has a large number of peaks (see Fig. 4), all of which must be carefully investigated.

To avoid the necessity for investigating these peaks by the point-by-point method, the reflectometer set-up of Fig. 5 was devised. The test set to be measured is fed from a modulated signal source through two directional couplers. Reflections from the test set are carried by the auxiliary arm of one coupler to a crystal detector and then to the

Measurement

vertical deflecting system of an oscilloscope. The auxiliary arm of the coupler at the output of the signal source feeds a portion of the incident power to the horizontal deflecting system of the 'scope.

The oscilloscope presentation thus becomes a presentation of reflected energy vs. incident energy (Fig. 6) and is a direct measure of reflection coefficient of the equipment under test. By calibrating the set-up, only a few minutes are required to tune the signal source over the entire range and check reflection coefficient.

Oscilloscope Presentation

The oscilloscope presentation consists of two dots (Fig. 6) which result from the square-wave modulation used on the signal source. It is only necessary that the slope of a line connecting the two dots be kept less than the slope of a line previously calibrated on the 'scope. This is a check that can readily be made by non-technical personnel in a matter of a few minutes rather than some two hours previously required.

One of the most interesting new electronic measuring instruments to become available in some time is the high-speed frequency counter. This instrument automatically measures frequencies up to 10 MC and displays the measured value in columns of lighted numbers. Operation is extremely simple so that the instrument is well suited to production measurement applications.

In the production of microwave equipment there are numerous frequency measurements of many types to be made. Such measurements are greatly speeded up when a visual display method is used. A display type secondary frequency standard that is essentially direct-reading to more than 10,000 MC was devised by combining a frequency counter, which is itself a secondary frequency standard, with other equipment. The standard has a double advantage in that it is unambiguous as well as easy to use.

A diagram of the microwave frequency standard is shown in Fig. 7. The basic plan of measurement is to compare the unknown frequency with known marker pips on an oscilloscope.

Microwave Source

In Fig. 7 a FM microwave signal source such as a klystron is fed to a waveguide tee. Into one arm of the

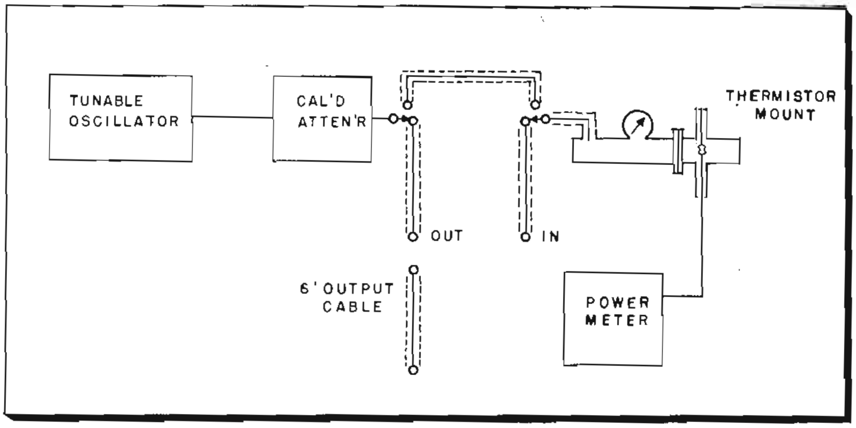


Fig. 1: Microwave vswr measurements made looking into "out" and "in" terminals of six-foot cable

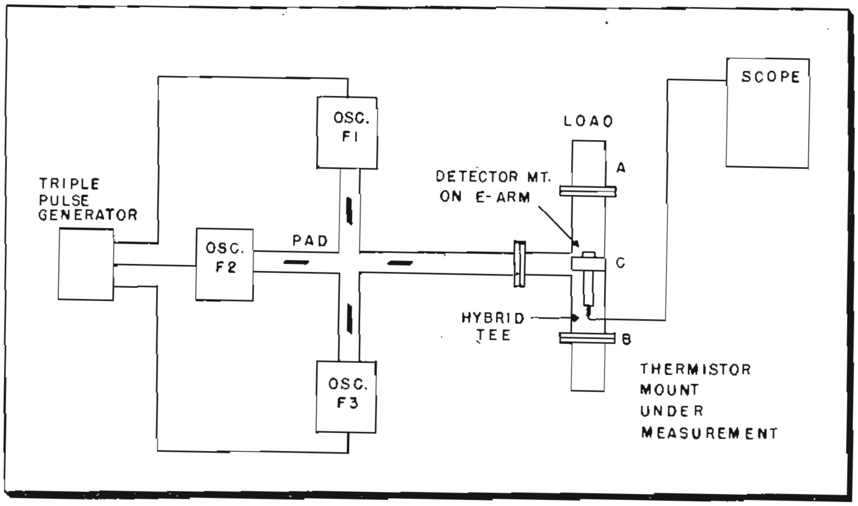


Fig. 2: Three-frequency set-up for visual presentation of reflection coefficient of thermistor mounts and waveguide-coax adapters. Three klystrons used are modulated in turn by pulse generator

Fig. 3: Scope display of three-frequency test

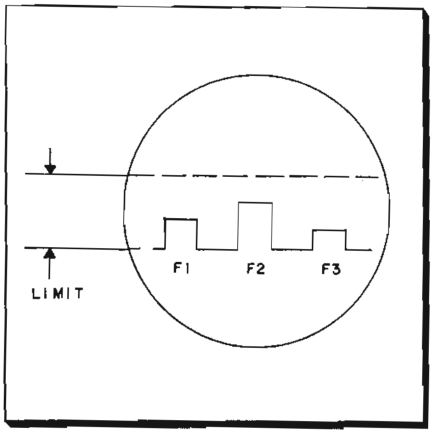
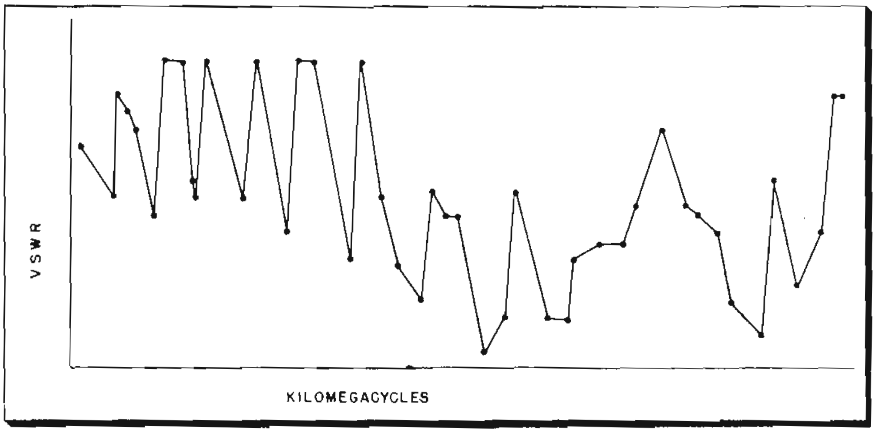
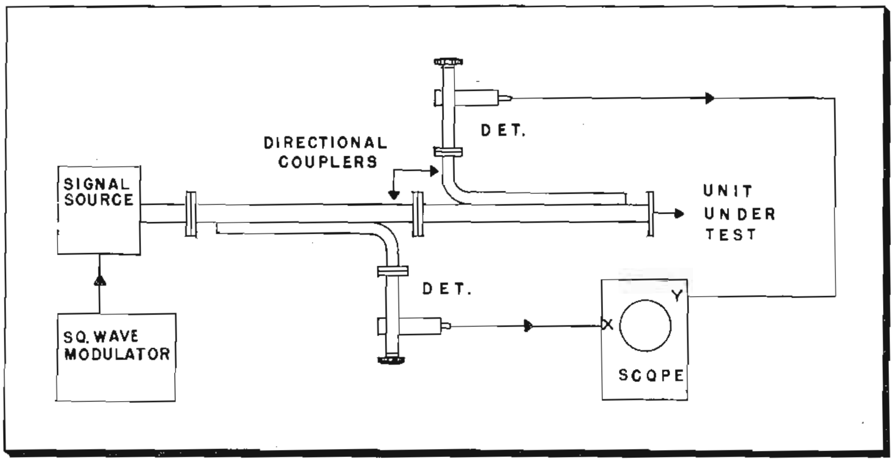


Fig. 4: Typical vswr curve of output impedance of circuit illustrated in Fig. 1





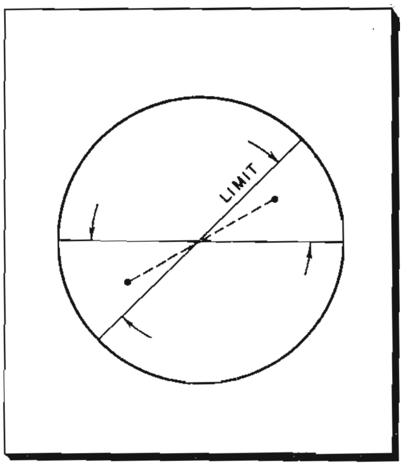


Fig. 5: (l) Reflectometer set-up for presentation of reflection coefficient eliminates point-by-point method of investigating peaks.
Fig. 6: (r) Scope presentation obtained with reflectometer. Limit line indicates maximum reflection allowed in production.

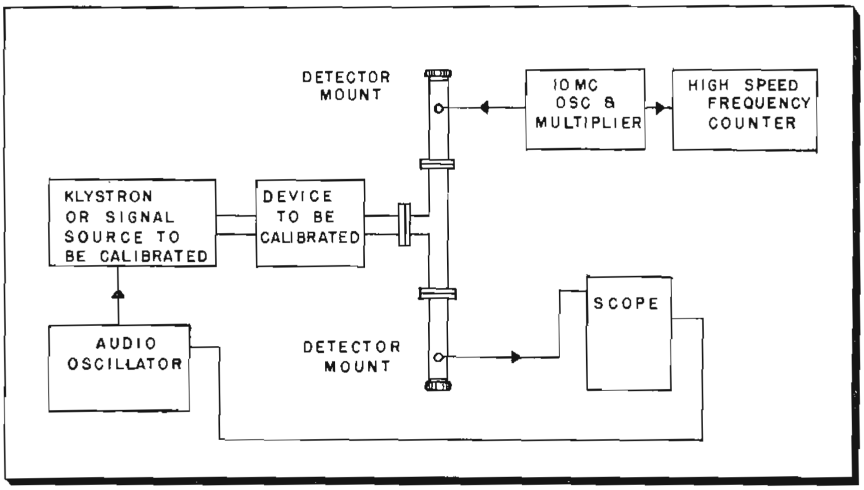
tee is fed the output of a harmonic generator which in turn is fed from an oscillator tunable from approximately 9.8 to 10.2 MC. The oscillator is provided with an expanded tuning mechanism so that precise frequency settings can be obtained, The operating frequency of the oscillator is accurately measured and displayed by the frequency counter.

System Output

The output from the system is taken from a detector mount connected to the second arm of the tee. This output is connected to the vertical system of an oscilloscope. The resulting presentation is shown in Fig. 8. The power curve of the modulated signal source appears on the oscilloscope as the familiar humped curve. The output of the harmonic generating system appears as one or more marker pips superimposed on the power curve. The two detector mounts in the system are tunable in order to discriminate against marker pips outside the frequency range of interest.

The principal use for this standard has been in calibrating microwave devices such as wavemeters and signal sources. When calibrating a wavemeter, the wavemeter is connected between the signal source and the tee. The power absorbed by the wavemeter causes a notch to appear in the power curve of the signal source. By appropriate tuning of the 10-MC oscillator, one of the marker pips can be made to coincide accurately with the notch. The frequency of the marker pip can then be determined from the reading of the frequency counter. One of the advantages of this visual display type microwave standard is that the frequency of the marker pips can be found without ambiguity. How this comes about can be described by assuming that an unknown frequency of, say, 6,000 MC is to be measured. If the 10-MC variable oscillator is tuned exactly to 10 MC, the 600th harmonic will give a marker pip at 6,000 MC. Now, when the 10-MC oscillator is tuned to the next lower frequency that gives the same 6,000-MC marker pip, the oscillator frequency will be 9.983361 MC and the harmonic will be the 601st.

Fig. 7: Visual display type microwave frequency standard uses FM signal fed to waveguide tee



Marker Pip Frequency

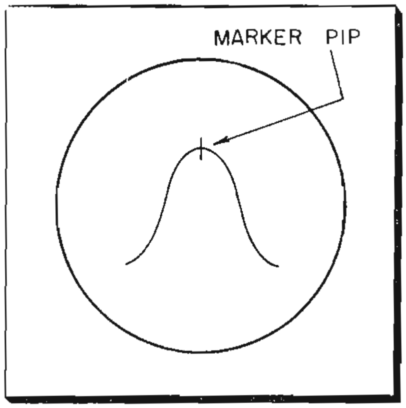
In a typical measurement the frequency of the marker pip and the harmonic causing the marker pip may not be known. It will be known only that two adjacent oscillator settings (10 and 9.983361 MC in the above example) give the same marker frequency. However, it is easy to show that the number of the harmonic is

$$N_h = \frac{f_2}{f_1 - f_2} = \frac{9.983361 \times 10^6}{(10 - 9.983361) \times 10^6} = 600$$

where N_h is the number of the harmonic at f_1 and where f_1 and f_2 are the higher and lower frequencies respectively of the 10-MC oscillator.

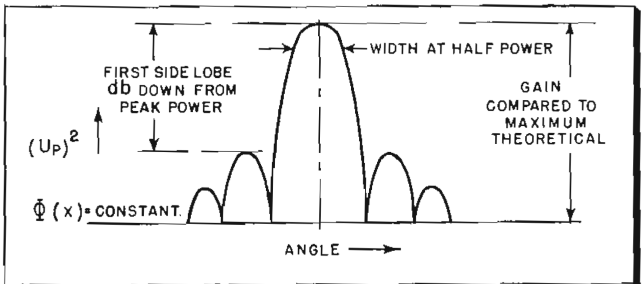
Besides calibrating, the visual display type standard is excellent for such purposes as investigating frequency drifts, detuning arising from mechanical tolerances, etc.

Fig. 8: Scope display of microwave standard



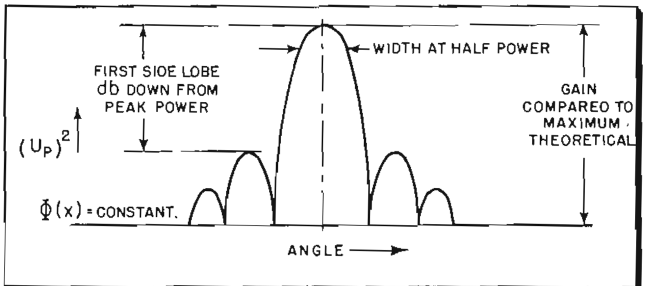
Optics of Microwave Antennas

Applied principles of geometrical and physical optics provide means for calculating shaped-beam antennas to produce a specified pattern



APERTURE DISTRIBUTION AMPLITUDE	GAIN COMPARED TO MAXIMUM THEORETICAL	WIDTH AT HALF POWER	FIRST SIDE LOBE db DOWN FROM PEAK
CONSTANT	1.0	$1.02\ \lambda/D$ (RADIANS)	17.6
TAPERED TO $1/\sqrt{10}$ AT EDGES	0.75 (APPROX)	$1.22\ \lambda/D$	20.
$\left[1-\left(\frac{r}{r_0}\right)^2\right]^2$	0.56	$1.47\ \lambda/D$	30.6

Fig. 1: Diffraction pattern for circular aperture



APERTURE DISTRIBUTION AMPLITUDE	GAIN COMPARED TO MAXIMUM THEORETICAL	WIDTH AT HALF POWER	FIRST SIDE LOBE db DOWN FROM PEAK
CONSTANT	1.0	$0.88\ \lambda/D$ (RADIANS)	13.2
TAPERED TO $1/2$ AT EDGES	0.97	$0.97\ \lambda/D$	17.1
TAPERED TO $1/\sqrt{10}$ AT EDGES	0.85 (APPROX)	$1.15\ \lambda/D$	19
$\cos^2 \frac{\pi x}{2}$	0.67	$1.45\ \lambda/D$	32

Fig. 2: Diffraction pattern for linear aperture

By ALLEN S. DUNBAR
Stanford Research Institute, Stanford, Calif.

THE microwave region of the electromagnetic spectrum lies in a transition between the ordinary radio spectrum, in which the wavelength is large compared to all the elements of the system, and the optical region, in which the wavelength is very small in comparison to the parts of the system. The employment of optical devices such as mirrors and lenses, however, gives a characteristic appearance to most microwave antennas, and it is convenient to apply the principles and techniques of geometrical and physical optics to microwave antenna design.

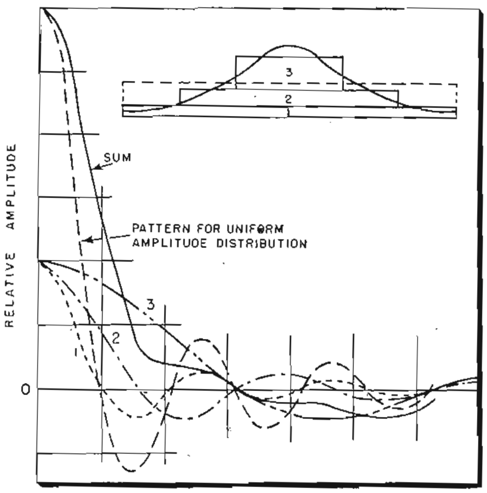
The purpose of this article is to examine the optics of microwave directive antennas. The highly directive beam of a microwave antenna is most often produced by placing a partially directive simple radiator, such as a dipole or electromagnetic horn, at the focus of a large focusing object, such as a paraboloidal reflector or a converging lens. The use of these objects is based upon the concept of geometrical optics, according to which the reflector or lens takes the rays from the elementary radiator, assumed to be essentially a point source, and converts them into a beam of parallel rays. The resulting beam is never as simple as a pencil of completely parallel rays, however, but it is in fact the diffraction pattern of a large, non-uniformly illuminated aperture.

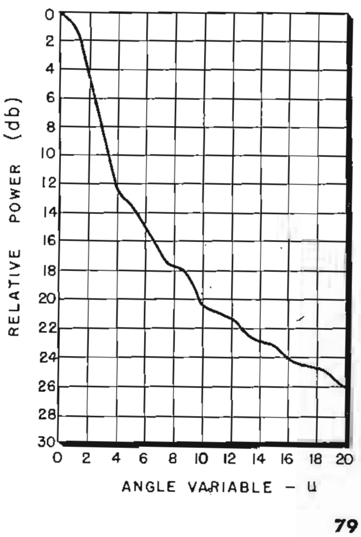
In the analysis of a microwave antenna, a satisfactory degree of correspondence with experiment is obtained by applying geometrical optics within the optical system as far as the aperture and then applying physical optics to find the diffraction pattern radiated by the aperture.

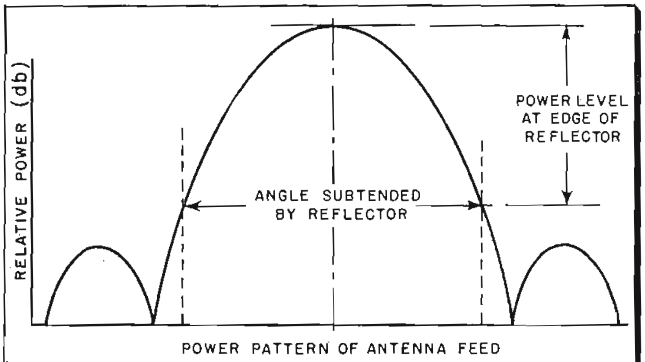
Because geometrical optics is an ideal theory in the sense that it represents the limiting case of physical reality, certain limitations must be imposed on the use of geometrical optics if we expect to obtain reliable results. These limitations are:

(1) The wavefronts must be essentially plane or spherical, that is, the distances from the source must be large relative to the wavelength.

Fig. 3: (Left) Above—Tapered amplitude distribution with step approximation. Below—Diffraction pattern of step distribution. Fig. 4: Triangular amplitude distribution pattern







NOTE: 100% GAIN = APPROX. 65% OF MAXIMUM THEORETICAL GAIN.

PRIMARY PATTERN POWER LEVEL AT EDGE OF REFLECTOR	2	4	6	8	10	12	14	16	18	20	1ST NULL	1ST LOBE
GAIN PERCENT OF MAXIMUM	45	74	88	97	99	100	99	98	96	94	87	28

Fig. 5: Antenna gain as determined by feed pattern subtended

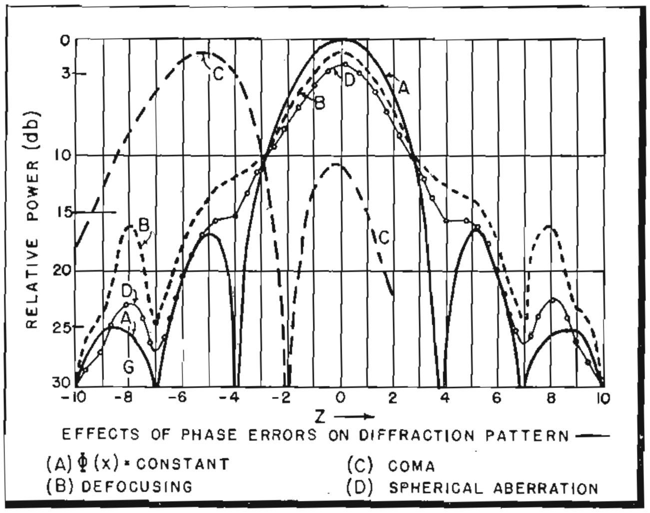


Fig. 6: Effects of phase errors on diffraction pattern

(2) There must be no rapid changes in the amplitude of the wave, such as occur at the edges of an aperture or other obstruction to the propagation of the wave.

Because the aperture introduces discontinuities in amplitude, geometrical optics cannot be applied beyond the aperture, and we must use physical optics to find the diffraction pattern.

As an example, let us consider a paraboloidal reflector antenna. If the source is at the focus, then all the rays will be reflected in a parallel beam. With uniform phase front, the diffraction patterns can be computed, and are shown in Fig. 1 for a circular aperture. Note that as the amplitude is tapered towards the edges of the aperture, the diffraction pattern is changed in several ways: the beam width at half power increases, the power gain decreases, and the minor lobes are reduced.

A similar set of data is given in Fig. 2 for rectangular aperture, for example, a cylindrical parabola and a line source.

Reducing Minor Lobes

A physical picture of the process by which the minor lobes are reduced when the amplitude distribution is tapered is the following. Let the amplitude distribution be represented by the inset curve of Fig. 3, and approximated by the steps indicated in the figure. We know that the diffraction pattern of an aperture with uniform amplitude and phase is given by

$$g(u) = (\sin u)/u$$

Each of the steps which approximate the curve of the amplitude distribution therefore gives a $(\sin u)/u$ pattern but the width of the pattern is inversely proportional to the width of the effective aperture. Thus, the small step produces a wide pattern, the next a somewhat narrower pattern, and finally the last step produces the narrowest pattern. Summing all these patterns up, as indicated in Fig. 3, we find that the resulting beam width is a little larger than we would expect with uniform amplitude, and the minor lobes are less. A comparison is afforded by the $(\sin u)/u$ pattern plotted to the same scale.

The effect of the tapered amplitude can be expressed mathematically in the following way. The diffraction integral may be written in the form

$$E(\theta) = \frac{a}{2}\int_{-1}^{1} A(\zeta)\, e^{iu\zeta}\, d\zeta \qquad (1)$$

where $A(\zeta)$ is the amplitude distribution and u is the angle variable. Let the amplitude distribution $A(\zeta)$ be expanded in a power series

$$A(\zeta) = \Sigma C_n \zeta^n \qquad (2)$$

then the diffraction integral becomes

$$E(\theta) = \Sigma (-i)^n C_n \frac{d^n}{du^n}\left(a\frac{\sin u}{u}\right) \qquad (3)$$

since it may be observed that

$$\frac{d^n}{dn^n}\left(a\frac{\sin u}{u}\right) = \frac{a}{2}\int_{-1}^{1} i^n \zeta^n e^{iu\zeta}\, d\zeta \qquad (4)$$

This result shows that for an even amplitude function in the aperture, the odd derivatives vanish, and resulting diffraction pattern will be characterized by reduced minor lobes.

If, however, the amplitude distribution is an asymmetric function, the resulting diffraction pattern will be characterized by a general distribution of energy. Consider, for example, the function $A(\zeta) = 1-\zeta$. The diffraction pattern is expressed by

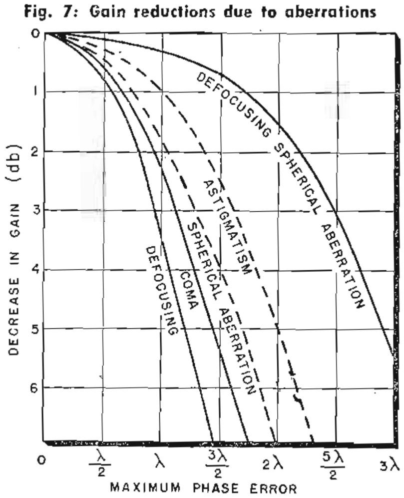
$$E(\theta) = a\left[\frac{\sin u}{u} - i\frac{d}{du}\left(\frac{\sin u}{u}\right)\right] \qquad (5)$$

The power pattern $P(\theta) = |E\theta|^2$ is plotted in Fig. 4. Notice that the minor lobes have now become merely shoulders.

Definition of Gain

A word about gain may be useful at this point. Gain is defined as the ratio of power radiated in a specified direction to the total average power radiated by the antenna. Maximum theoretical gain is that gain corresponding to the ratio of power in the maximum of the major lobe radiated from a uniformly illuminated aperture to the total

Fig. 7: Gain reductions due to aberrations



average power radiated, and is given by the equation

$$G = 4\pi A/\lambda^2 \quad (6)$$

where A is the geometric area of aperture.

The gain corresponding to the various aperture illuminations described above is perhaps most properly called "aperture gain," because the cases considered are, so far as microwave antennas are concerned, largely hypothetical. The absolute gain of a microwave antenna depends upon the manner in which it is illuminated or excited. Returning to the example of the paraboloidal reflector antenna, a small partially directive radiator illuminates the large reflector, forming a directive beam. This partially directive radiator, or antenna feed, has a radiation pattern called the primary pattern. As illustrated by Fig 5, the gain of a microwave antenna is a function of the relative amount of the primary pattern subtended by the focusing objective, since the power level at the edge of the objective is governed by the subtended angle.

Antenna Feed Pattern

This interdependence of gain and antenna feed pattern may be explained in terms of the amount of power spilled over the edges of the objective. Re-examining the defi-

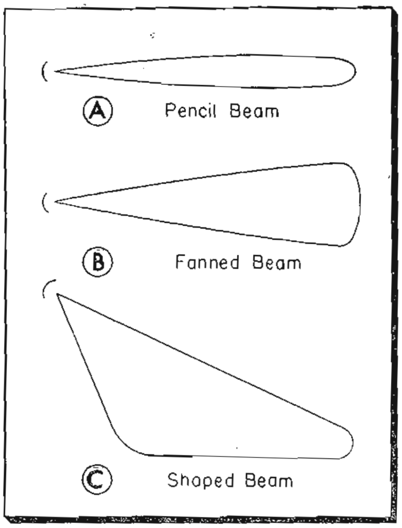


Fig. 8: Types of directive antenna patterns

nition of gain, we see it should now be stated

$$\text{Gain} = \frac{\text{power in maximum of major lobe}}{\text{total average power radiated by feed}} \quad (7)$$

Thus, since some of the power radiated by the feed is not rearadiated by the focusing objective, but is in fact spilled over, the absolute gain of the antenna is less than the aperture gain corresponding to the actual phase and intensity distribution in the aperture. Consequently, the maximum gain obtained with a microwave antenna of the type we are considering is about 65% of the maximum theoretical gain. It will be seen also, by reference to Figs. 1 and 2, that as the minor lobes are reduced by tapering of the amplitude distribution, this gain factor will also be reduced.

The reduction in gain which comes about when the minor lobes are reduced is caused by the increase in beamwidth This can be best explained, perhaps, by the following model. The radiation pattern of the antenna will be represented by a very flexible plastic bag containing a constant volume of fluid. Starting with the bag in the shape of a pattern corresponding to the maximum gain condition, it will be found

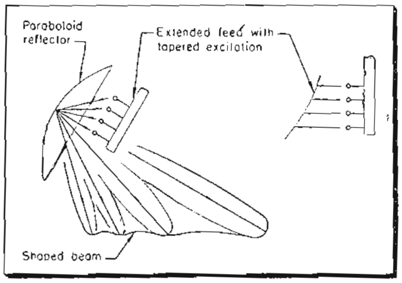


Fig. 9: Formation of a shaped beam by means of a feed array in a paraboloid

to have a sharp major lobe and rather high minor lobes. Now we squash the minor lobes down; but the volume which was represented in the minor lobes has to appear somewhere else, and it necessarily appears in the major lobe, making the major lobe broader.

Amplitude Distribution

When the gain of an antenna is about 65% of maximum theoretical gain, the amplitude distribution is tapered to 10 or 12 db at the edges of the aperture, and the minor lobes of the diffraction pattern are 19 to 20 db below the peak. If now the side lobes are reduced to 30 db below the peak, the gain of the antenna is only about 56% of maximum theoretical gain. If it is required that the minor lobes be more than 35 db down, the gain factor will be less than 50%.

To examine the effects of non-uniform phase functions in the aperture, let us consider the paraboloidal reflector antenna once again. If the source is moved a short distance from the actual focal point along the axis, the antenna will be defocused. Likewise, if the source is moved a short way from the actual focus in a direction perpendicular to the axis, the phase will be modified by the coma aberration. If we replace the paraboloid by a portion of a sphere, there will be some spherical aberration, which can be corrected to some degree by defocusing. Diffraction patterns for a circular aperture with uniform amplitude and the phase aberrations

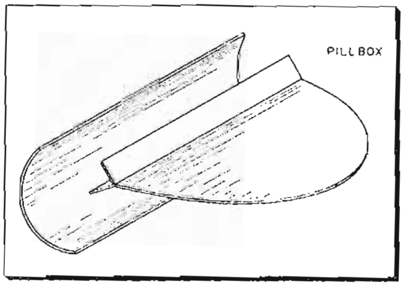


Fig. 10: Shaped cylinderical reflector

(A) constant, (B) defocusing, (C) coma, (D) spherical aberration, are plotted in Fig. 6. Curves showing the reduction in gain due to various amounts of the several aberrations shown are in Fig. 7.

Beam Shapes

With the foregoing as a background, let us examine the various directive antenna patterns required by the several types of radar systems. In general, the patterns (or beam shapes) can be grouped into three categories: (A) pencil beams, (B) fanned beams, and (C) shaped beams. These are depicted in Fig. 8. The term pencil beam is applied to a highly directive antenna pattern consisting of a single major lobe contained within a cone of small solid angle and very nearly circularly symmetric in cross-section. The fanned beam may be thought of as being developed by distorting the circularly symmetric pencil beam into a symmetric elliptical beam in cross-section. The shaped beam, while uniformly narrow in one plane like the fanned beam, is a pattern shape which is not characteristic of the normal diffraction lobe and must be produced by special techniques.

The pencil beam is, of course, the diffraction pattern of a circular aperture with sharply tapered amplitude in order to suppress the minor lobes. The fanned beam is most practically obtained by using a rectangular aperture, as we have seen in Figs. 1 and 2, the beamwidth is inversely proportional to the aperture dimension. Thus, using an

(*Continued on page* 165)

Effect of Filament Voltage on Vacuum

Reducing filament voltage increases tube life; decreases power sipation problems and d-c drift. A 2 to 1 reduction permits up

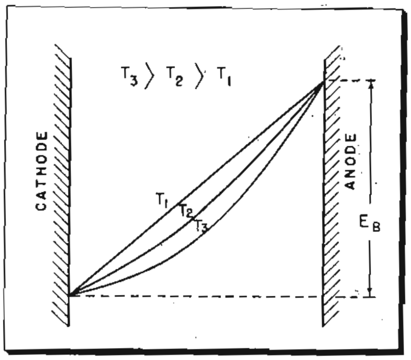


Fig. 1: Diode potential distribution curves

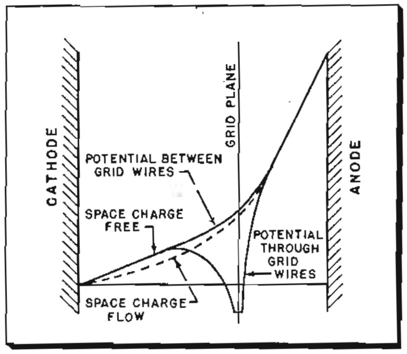


Fig. 2: Triode potential distribution curves

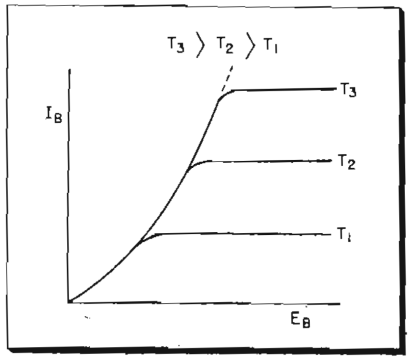


Fig. 3: Ideal high vacuum diode characteristic

By ARTHUR J. WINTER, Telecomputing Corp., Burbank, Calif.

IT is often said that the main disadvantage of any electronic device is that it contains vacuum tubes. Some of the common faults found with vacuum tubes are: short life spans, dc drift of operating potentials, and high filament power requirements. In electronic computers and other devices employing great numbers of vacuum tubes, tube failures occur often and greatly reduce the time such equipment is available for useful work. Another problem confronting the electronic designer is the dissipation of filament heat.

One method whereby the average life expectancy of a vacuum tube could be increased and the filament power drain reduced, would be to operate the vacuum tube at lower cathode temperature by reducing the filament voltage. An immediate objection is that the tube would not be able to handle as much power. This is quite true, but the majority of tubes are not operated as power amplifiers nor at high plate currents and often filament voltage may be reduced considerably before temperature saturation occurs. Another question that arises is what effect reduction in cathode temperature will have on the operation of the vacuum tube as a circuit element. A very common belief among electronic engineers is that the amplification factor of a tube decreases as it is cooled. According to electrostatic analysis, amplification factor μ is a constant which depends only on tube geometry. Therefore, μ should be independent of filament voltage. Actually neither is correct. Not only does μ vary with temperature, but it can actually be *increased by decreasing* filament voltage.

This paper was presented at

"WESCON–1952"

Western Electronic Show & Convention
August 27-29
Municipal Auditorium, Long Beach, Calif.

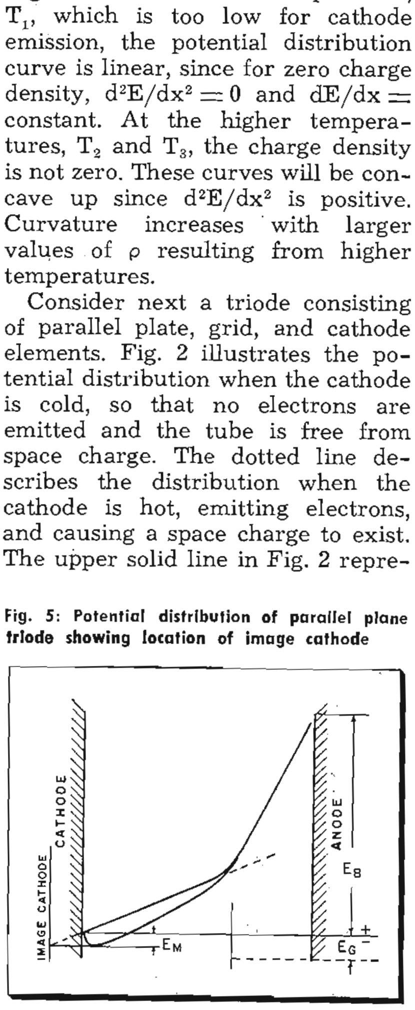
Theoretical Discussion

By noting the effect of cathode temperature on electron flow and potential distribution, a possible explanation for the increase in amplification factor may be obtained.

First, consider a diode consisting of a plane cathode and a parallel anode or plate. The electron density and the potential at any point in the interelectrode space are related by Poisson's equation $d^2E/dx^2 = \rho/e_o$, where ρ is the electron charge density in coulombs per cubic meter; e_o is the permittivity of space; and E is the potential in volts. Assuming that the electrons emitted from the cathode have zero initial velocities, the potential distribution for various cathode temperatures is shown in Fig. 1. At the lowest temperature, T_1, which is too low for cathode emission, the potential distribution curve is linear, since for zero charge density, $d^2E/dx^2 = 0$ and $dE/dx =$ constant. At the higher temperatures, T_2 and T_3, the charge density is not zero. These curves will be concave up since d^2E/dx^2 is positive. Curvature increases with larger values of ρ resulting from higher temperatures.

Consider next a triode consisting of parallel plate, grid, and cathode elements. Fig. 2 illustrates the potential distribution when the cathode is cold, so that no electrons are emitted and the tube is free from space charge. The dotted line describes the distribution when the cathode is hot, emitting electrons, and causing a space charge to exist. The upper solid line in Fig. 2 repre-

Fig. 5: Potential distribution of parallel plane triode showing location of image cathode



Tube Characteristics

supply requirements, heat dis-

to 1.5 times increase in gain.

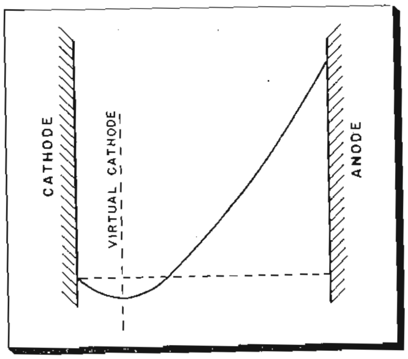


Fig. 4: Current flow limited by space-charge gives rise to a virtual cathode condition

sents the space-charge-free potential along a path midway between adjacent grid conductors. The lower solid line represents a path through the center of a grid conductor. When the cathode is heated, the escape of electrons moves the negative charge outside of the cathode where it becomes space charge. The flow of space charge is plate current.

Space Charge

The total amount of space charge is proportional to the slope of the space-charge-free curve at the cathode and is, therefore, determined by grid potential. From the theory of electrostatics, this slope is proportional to an equivalent voltage containing grid and plate potentials. This voltage is $(E_g + E_b/\mu)$, which is the grid potential that would produce the same electrostatic field at the cathode if the plate potential were zero. Thus, an equivalent diode may be derived with a plate potential of $(E_g + E_b/\mu)$ located at some point between the grid and plate of the triode.

Plate current as a function of plate voltage at different cathode temperatures for a theoretical diode is shown in Fig. 3. At the lower values of voltage before the curve flattens out, the plate current is related to plate voltage by the Langmuir-Childs or Three-Halves-Power Law. For a diode, $I_b = KE_b^{3/2}$ and for a triode $I_b = K(E_g + E_b/\mu)^{3/2}$. In this range the current is said to be space charge limited, since there are more electrons available from the cathode than are needed, and the current is limited only by the space charge. After the curve breaks, the current is temperature limited and the Langmuir-Childs relationship is replaced by Dushman's equation (*Physical Review,* June 1923, p. 623).

In a practical diode, the plate current-plate voltage relationship is slightly different than Fig. 3. The change from space charge saturation to temperature saturation is gradual, and after temperature saturation the current continues to rise slightly with plate voltage. The effect is particularly noticeable with oxide-coated cathodes. Below temperature saturation, deviations from the Three-Halves-Power Law, which states that plate current is independent of temperature, give the high temperature curves a slightly faster rising slope. These deviations are caused by the initial velocity of electrons leaving the cathode. Electrons emitted from a hot cathode leave the surface with an average velocity that is a function of temperature. It is this fact that is ignored in the electrostatic analysis.

An effect of initial velocity of the electrons is to create a negative dip in the potential distribution curve, as in Fig. 4. The bottom of this dip may be thought of as a virtual cathode located at a small distance from the real cathode and possessing a more negative charge. The point of zero potential gradient shifts to the bottom of this dip. Electrons that succeed in passing this point do so with a finite velocity. The effect is to increase the apparent anode voltage, which increases the current flow.

Langmuir has developed an expression which approximates the current flow between parallel planes when initial velocities give rise to such a virtual cathode.

$$I_b = 2.331 \times 10^{-6}\frac{(E_s - E_m)^{3/2}}{(s - x_m)^2}\left[1 + 2.66\frac{(E_T)}{(E_s - E_m)}\right]$$

where:

- s = Spacing between cathode and anode or, in a triode, spacing between cathode surface and intersection of space-charge-free and space-charge-flow lines.
- E_s = Anode voltage for a diode, or equivalent anode voltage, $-sdE/dx$ at $x = 0$, for a triode.
- x_m = Distance of virtual cathode from the cathode in cm.
- E_m = Potential of virtual cathode (always negative).
- E_T = Voltage equivalent of temperature $= T/11{,}600$. T in °K.

Dimensionless Parameters

A more complete solution in terms of dimensionless parameters is also presented by Langmuir, whereby it is not necessary to know E_m and x_m before I_b may be found. An analysis of these results shows that E_m is not always small; it can become significant at lower values of plate current.

An approximate solution for plate (*Continued on page* 150)

Fig. 6: Triode mutual conductance

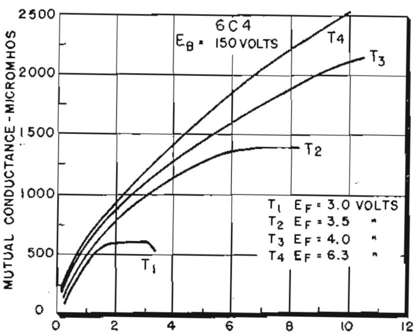


Fig. 7: Triode plate resistance

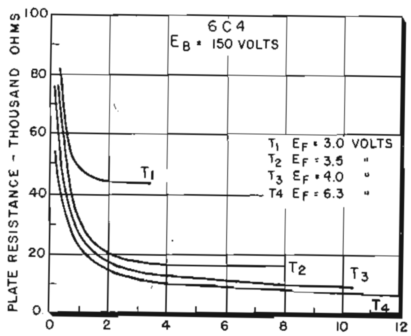
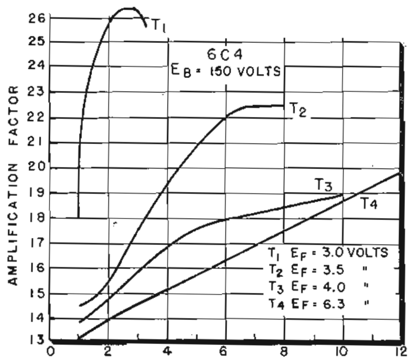


Fig. 8: Triode amplification factor



CUES for BROADCASTERS

Practical ways of improving station operation and efficiency

Carrier Warning Device From FM Tuner

PHILIP WHITNEY, Chief Engineer, WINC, Winchester, Va.

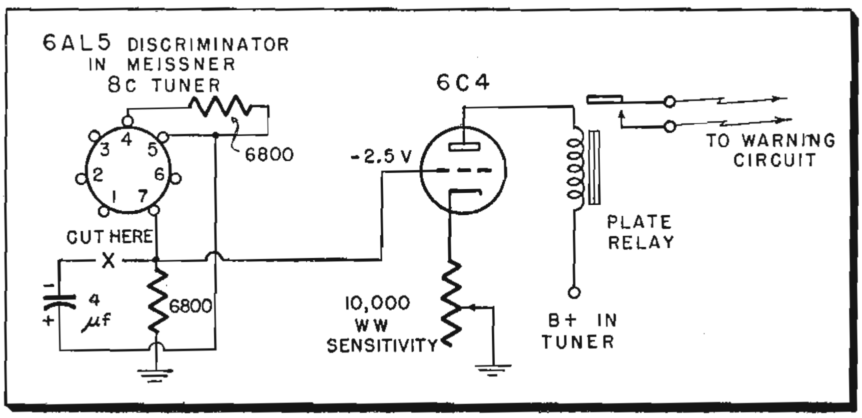
THIS circuit will monitor any FM station for "carrier off" condition by ringing a bell, or lighting a warning flasher at the operating or control positions. The audio output of the tuner may be applied to a 1000 cycle filter circuit and relay control for the tone warning circuit. A 6500 ohm plate relay is used but most types of plate relays up to 10,000 ohms are satisfactory.

Negative voltage developed in the discriminator stage of this particular tuner keeps the 6C4 relay control tube biased to cutoff. The critical point may be reached by adjustment of the sensitivity control. It was found that in the WINC application this control was not needed, but may be of advantage in some installations. It may be necessary in some remote locations to use a booster ahead of the tuner. Thus, a station 75 miles away can be monitored consistently. (It helps, of course, to use an efficient antenna.)

The relay and control tubes were mounted on the tuner chassis. An outlet plug on the rear of the chassis was utilized for the warning contact terminals. A 100 watt light above the operator at the control position increases room lighting perceptibly when the monitored station's carrier is interrupted. This immediately attracts his attention, and does not interfere with an open mike.

The filter condenser across the negative voltage supply was eliminated to reduce the time constant of the circuit. If needed, a 0.1 to 0.5 uf capacitor (paper) may be installed across the relay coil to prevent chatter.

Circuit changes and additions to Meissner Tuner provide carrier interruption indication



$$$ FOR YOUR IDEAS

Readers are invited to contribute their own suggestions which should be short and include photographs or rough sketches. Typewritten, double-spaced text is preferred. Our usual rates will be paid for material used.

Universal Microphone Plugs for Remote Pickups

MARVIN L. MOBERLY, Chief Engineer, WKLJ, Tomah, Wis.

ONE of the most terrifying experiences I have ever had was to discover, just a few seconds before going on the air at a remote pickup, that a mike cord with incorrect connections had been selected. This costly error could have been eliminated by mounting at least one large female and one large male connector and two small connectors on a metal chassis. These plugs can be paralleled and run to a plug on the back of the chassis. A small connector cord (either permanent or removable) can connect the plug chassis to the remote amplifier. With this assembly it makes no difference which cord is used as long as one end fits the connector on the mike itself.

If appearance is important the metal chassis can be dressed to look quite attractive or the chassis can be mounted inside a portable radio cabinet.

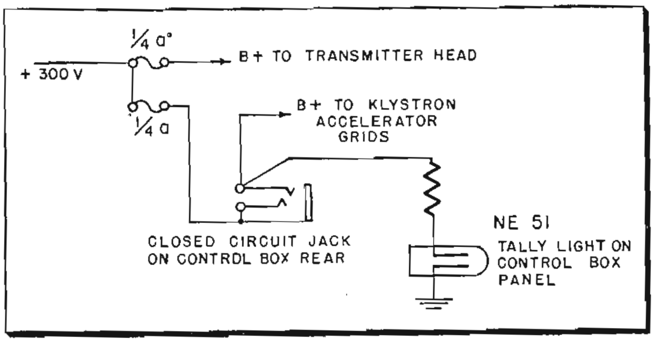
Sub-Midget Portable Remote Amplifier

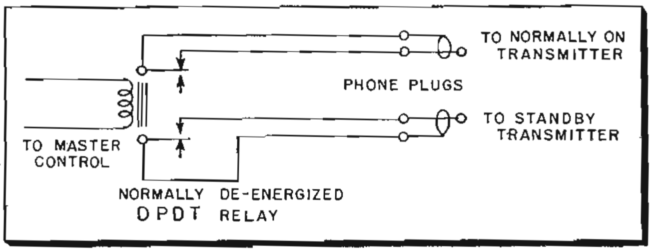
ROBERT S. HOUSTON, Chief Engineer, KBNZ, La Junta, Colo.

WITH the advent of new miniature remote equipment made possible by the manufacture of miniature tubes, there has been an increasing tendency to operate remotes of the danceband and sports variety without the benefit of an operator. Much of the equipment has been made small enough to be carried within range of the phone line. However, there seems to have been one piece of equipment which has been overlooked, inasmuch as it is not broadcast equipment. The new compact, self-contained hearing aids make wonderful sports and special events amplifiers. Output of these units approaches 100 mw, which is much higher than necessary for broadcast work. Thus with lower output, the distortion will be practically nil, while the tone will be rather crisp, characteristic of a crystal mike. Most of the units on the market have a form of tone control which can compensate in some measure for this characteristic high frequency response.

Since the output of these units is generally either fifteen ohms or 100,000 ohms, it will be necessary to provide a small matching transformer, which could be a line-to-voice-coil transformer, operated in reverse. In the model used by the author, separate batteries were required, so the output transformer was included in a small pack carried in the announcer's pocket. The regular headphone wire then went to this pack, with the phone line extending from the pocket to the line termination. Inasmuch as many remotes of this type do not use VU meters (the gain being ridden at the studio), it will be necessary to adjust the level only once for the person involved. Batteries can be expected to last about 100 hours, or longer with intermittent use. Since the original model was in almost constant use, a rechargeable flashlight storage cell was substituted for the "A" battery.

If desired, and there is room in the case, a crystal cartridge of higher quality and lower output could be substituted.





Rapid changeover circuit for microwave TV link gives protection against failure on the air.

Microwave STL Changeover Switching

ELMER C. FISCHER, Formerly Engineer, WEWS, Cleveland, Ohio

THE total dependence upon microwave studio-transmitter-links for TV programming, together with the usual inaccessibility of transmitter heads and cables for rapid servicing, led to the installation of a stand-by link transmitter, operating on the same frequency as the one in regular operation, with provision for instantaneous switchover.

Breaking the +300 v. to the klystron accelerator grids proved to be the best means of instantaneous switchover with no chance of oscillation while in the stand-by position. This was accomplished in the RCA links by installing an insulated closed circuit jack in place of the headset on the rear panel of the transmitter control box. (This headphone jack is duplicated on the front panel.) A neon tally lamp operating off the switched B plus was installed in the upper right hand corner of the front panel of the control box.

DPDT relay operated from master control was installed in a dust-proof box and connected to the two control boxes by means of flexible cords and phone plugs, in the closed circuit jacks. Removing a phone plug restores either control box to normal operation.

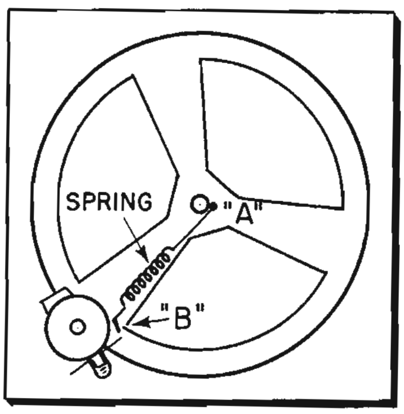
Upon changeover, there is a slight initial frequency drift but well within the AFC range of the receiver. Providing everything is properly tuned, and video fed to both control boxes, a changeover can be made during programming with only a slight bounce being noticeable.

Turntable Speed Modifications

C. W. KNAPP, Chief Engineer, KWOA, Worthington, Minn.

WE have found that the following modifications on the Presto 10-A turntable effect a more rapid change in record speed. The locknut used to secure the motor carriage in one of the two speed positions is unscrewed by backing out the handle. After removing the locknut, replace the handle, further in than normal, but not so close to the guide plate as to cause binding. Remove the turntable, but be careful not to lose the ball bearing, which sometimes sticks to the pivot of the turntable shaft.

Presto 10-A turntable modified to effect faster speed changes and auto selection



Secure one end of a spring 6 in. long and $\frac{3}{16}$ in. diameter to the turntable chassis with washers, and a $\frac{9}{32}$ screw, as shown at A in the diagram. Drill a hole in the extreme inside end of the motor mount assembly, as shown at B. Hook free end of the spring through this hole, temporarily. Replace turntable for trial; remove again, and adjust spring length, by clipping off a few turns at a time, until sufficient tension is obtained to hold motor shaft in the correct position. The end of the spring at "B" should be carefully adjusted so that in either position of the motor mount, the spring doesn't strike the turntable or chassis. Since it is common practice to disengage the motor shaft from the rubber tire during periods when turntable is not being used, a small round, rat-tail file is used to make a notch $\frac{1}{8}$ in. deep in the portion of the guide plate which extends between the two slots in the plate.

Speed change now can be accomplished without loss of time or use of more than one hand. Binding, which may occur in the carriage pivot, will ease up with use, so that speed change is simple and convenient. This modification was made at KWOA over three years ago, and no trouble has been experienced with slow starts, tire wear, or spring breakage.

Pickup Arm Lock for Phono Players

WAYNE WOODBURY, WTOD, Toledo, Ohio

MANY times playback heads and needles are damaged by being knocked out of their cradles, allowing the needle to strike a hard surface. This device for locking the pickup was made for an Audax Microdyne, but could be used, with modifications, on other arms.

On this type of pickup the fulcrum is offset slightly and a pin beneath the pickup arm protrudes through a hole in the arm when it is raised. An aluminum slider, made from an old transcription blank, fits the contour of the arm and covers the hole thus preventing the arm from being raised. In use, the slider is moved to the rear of the arm.

Adding Playback Feature to Portable Recorder

W. J. SULLIVAN, WALE, Fall River Mass.

USERS of the Minitape recorder may be interested in a modification which increases considerably the usefulness of the machine. Designed for in-the-field recording, the unit makes no provision for headphone playback of tapes, and a newsman is unable to check the recording without returning to the station's fixed recorder. Addition of a short jumper cord converts the unit into a completely self-contained playback amplifier.

For listening, the plug-in permanent-magnet erase head is removed, and a 6 in. single wire jumper (shielded) is patched from Pin #2 of this socket to Pin #3 of the microphone jack on the front of the recorder. Thus the playback head is (*Continued on page* 108)

TELE-TECH Directory of West Coast Electronic Manufacturers

Names, addresses, telephone numbers, chief engineers, and principal products for more than 300 leading producers

Acme Electronics, 300 N. Lake Ave., Pasadena 4, Calif., G. M. Ellis, RY 1-6325, Coils, Filters
Acra Instruments, 168 Vista Ave., Pasadena 8, Calif., R. E. Frazer, RY 1-7646, Optical Coatings
Advance Elec. & Relay, 2435 N. Naomi, Burbank, Calif., V. C. Huckabee, CH 0-8191, Relays
Aero-Sonic Mfg. 2015 Pontius Ave., Los Angeles, Calif., L. E. Bissell, AR 3-0634 Custom Test Equip.
Airborne Electronics, Van Nuys, Calif. R. E. Walser, ST 5-3867, Radio & Electronic Equip.
Allied Research & Eng'g, 1041 N. Las Palmas, Hollywood, M. A. Dike, HO 9-5107, Waveguide Components.
Allied Record Mfg., 1041 N. Las Palmas, Hollywood, Calif., R. L. Burgess, HO 9-5107, Transcriptions
Allison Labs., 419 Vista Del Llano Dr., Whittier, Calif. R. E. Allison, Audio Filters
Aloha Radio-Television, 330 W. Bdwy., Long Beach, Calif., H. Putnam, 747-16, Radios & Television
Alpar Mfg. Co., 466 St. Francis St., Redwood City, Calif., C. R. Parmenter, EM 6-4982, Towers
Altec Lansing Corp., 9356 Santa Monica Blvd., Beverly Hills, J. K. Hilliard, CR 5-5101 Audio Equip
American Electric Motors 4821 Telegraph Rd., Los Angeles, R. H. Cripps, AN 3-4175 HiF Alternators
American Electronecring, 5029 W. Jefferson Blvd., Los Angeles, R. A. Snyder, RE 2-9187 Guided Missile Comp.
American Helicopter, 1800 Rosecrans, Manhattan Beach, Calif., H. E. Roberts, OS 6-1138, Elect. Instr. Equip.
American Microphone Co., 370 S. Fair Oaks Ave., Pasadena, Calif., Wm. Vogel, RY 1-7444, Microphone Pickups
Ames Co., W. R., 150 Hooper St., San Francisco, Calif., Ubi Ferrari, MA 1-3700, Chassis, Cases
Ampex Electric Corp., 934 Charter St., Redwood City, W. T. Selsted, EM 8-1471, Magnetic Record Equip.
Anthony Mfg. Co., 2322 W. Slauson Ave., Los Angeles, Calif., Chas. Cruze, AX 1-0032, Coils, Transformers
Applied Electronics Co., 1246 Folsom St., San Francisco, C. E. DePuy, MA 1-2634, Marine Radio
Applied Physics Corp., 362 W. Colo St., Pasadena, Calif., R. E. Vaniman, SY 6-0197, Spectrophotometers
Audar, Inc., P.O. Box 438 M, Pasadena, Calif., E. W. Applebaum, SY 8-1588, Radios, Amplifiers
Audio Products Corp., 2265 Westwood Blvd., Los Angeles, J. C. Evans, BR 2-1524, Communications Equip.
Avery Adhesive Label Corp., 1616 S. Calif. Ave., Monrovia, Calif., R. S. Avery, RY 1-8197, Labels

Babcock Radio Eng'g., 7042 Woodley Ave., Van Nuys, Calif., B. V. Deltour, ST 5-8648, Mobile Transmitters
Bardwell & McAlister, 2950 N. Ontario St., Burbank, Calif., R. D. Hallock, ST 7-3431, Guided Missile Designs
Beckman Instruments, 820 Mission St., S. Pasadena, L. Pugh, Computers
Beckman & Whitley, 985 San Carlos Ave., San Carlos, J. C. Beckman, LY 3-4252, Meteoro. Equip.
Benchmaster Mfg., 1835 W. Rosecrans, Gardena, Calif., O. Wendell, ME 4-4967, Punch & Arbor Presses
Bendix Aviation, Pac. Div., 11600 Sherman, N. Hollywood, S. Leitch, ST 7-2651, Sonar, Radar, Telemetering
Benson-Lehner Corp., 2340 Sawtelle Blvd., Los Angeles, D. F. Rutland, BR 2-4629, Elect. Business Machines
Berkeley Custom Electronics, 2302 Roosevelt Ave., Berkeley, Calif., J. H. Minor, TH 3-4180, Amplifiers, Filters
Berkeley Scientific Corp., 2200 Wright Ave., Richmond, Calif., James Gordon, BE 4-6771, Electronic Instr.
Berlant Associates, 4917 W. Jefferson Blvd., Los Angeles, Calif., Paul Lett, PA 2196, Tape Recorders
Berndt-Bach, Inc., 7325 Beverly Blvd., Los Angeles, Calif., Walter Bach, YO 8294, Sound Film Cameras
Birdsell Mfg., 750 San Antonio Rd., Palo Alto, Calif., M. E. Hill, YO 7-9116, Transformers, Reactors
Birtcher Corp., 4371 Valley Blvd., Los Angeles, H. Finch, CA 2-9101 Tube Clamps
Bodde Screen Co., 8829 Venice Blvd., Los Angeles, Calif., B. M. Bodde Sr., TE 0-2812, Rear Projection Equip.
Bone Eng'g Corp., 701 W. Broadway, Glendale, Calif., C. M. Brown, Custom Electronic Equip.
Brown Electro-Measurement, 4635 S. E. Hawthorne Blvd., Portland, Ore., D. C. Strain, EA 6645, Test Equip.
Brubaker Mfg. Co., 9151 Exposition Dr., Los Angeles, Calif., S. F. Arn, TE 0-5313, Sonar, Delay Lines
Burton Electronic Mfg., 2353 Cotner Ave., Los Angeles, Calif., P. M. Robbins, BR 2-7438, Potentiometers
Burwood Corp., 4921 Exposition Blvd., Los Angeles, Calif., J. B. VanDerWerff, RE 2-6421, Quartz Crystals

Calbest Eng'g. & Electronics, 828 N. Highland Ave., Los Angeles, Calif., H. Fremont, HE 2119, Receivers
Califone Corp., 1041 N. Sycamore Ave., Hollywood, Calif., W. R. Smith, HU 2-2353, Transcription Players
Calif. Electronic Services, 21332 Ventura Blvd., Woodland Hills, Calif., R. G. Stewart, DI 8-1204, Noise Filter
Calresin Corp., 333 N. Santa Anita, Arcadia, Calif., W. C. Lockwood, DO 7-3504, Coating Compounds
Caltron Products, 1406 S. Hobart Blvd., Los Angeles, Calif., J. Yarrow, PA 2-4240, Amplifiers, Recorders
Calvidio Tube Corp., 5232 W. 104 St., Los Angeles, Roger Truman, OR 8-3979, TV Picture Tubes
Cameron Craft, 942 Brockhurst St., Oakland, Calif., W. F. Cameron, HU 3-3735, Wood Cabinets
Cannon Electric, 3209 Humboldt St., Los Angeles, Calif., Roger Bowen, CA 5-1251, Plugs & Connectors
Canoga Corp., 5955 Sepulveda Blvd., Van Nuys, Calif., G. E. Hewitt, ST 7-6160, Radar Test Equip.
Capitol Records, Inc., 5515 Melrose Ave., Los Angeles, Calif., E. H. Uecke, HO 9-8171, Transcriptions
Century Metalcraft, 14806 Oxnard St., Van Nuys, Calif., L. W. Mallach, ST 7-1178, Microwave Test Equip.
Chase Electronics Lab., 128 N. Fair Oaks Ave., Pasadena, N. C. Chase, SY 3-2660, Custom Elect. Equip.
Chattin Eng'g. Co., 1401 Middle Harbor Rd., Oakland, Calif., C. W. Chattin, Electro-Acoustic Equip.
Chemo-Vac Electronic Corp., 760 Reed St., Santa Clara, Calif., D. R. Bellis, CH 3-0111, Vacuum Capacitors
Cinema Eng'g. Co., 1510 W. Verdugo Ave., Burbank, Calif., A. Davis, RO 9-2381, Audio Equip., Resistors
Clary Multiplier Corp., 408 Junipero St., San Gabriel, R. E. Boyden, CU 3-2724, Elect. Business Mach.
Clear Beam TV Antennas, 100 Prospect Ave., Burbank, Calif., Willis Maupin, RO 9-2141, TV Antenna Access.
Coastwise Electronics, 322 N. Foothill Rd., Beverly Hills, H. M. Joseph, BR 2-3407, Test Equip.
Cole Instrument Co., 1320 S. Grand Ave., Los Angeles, H. N. Barnett, PR 2251, Test Equip.
Colortonics, Inc., 1311 Riverside Dr., Los Angeles, Geo. Young, CA 4161, Television Receivers
Computer Research Corp., 3348 W. El Segundo Blvd., Hawthorne, Calif., D. E. Eckdahl, OS 5-1171, Computer Equip.
Conley's Electronics, 11612 Ventura Blvd., N. Hollywood, Calif., D. L. Conley, ST 7-1919, Test Equip.
Conrac, Inc., 17217 Foothill Blvd., Glendora, Calif., J. G. Jones, FL 5-1241, Radio & TV Receivers
Consolidated Eng'g., 300 N. Sierra Madre Villa, Pasadena, J. R. Bradburn, RY 1-8421, Spectrometers, Computers
Consolidated Vultee Aircraft, 3302 Pacific Hiway, San Diego, Calif. Aircraft Radio & Electronic Equip.
Crittenden Transformer, 1220 Nadeau St., Los Angeles, R. M. Power, KI 6173, Transformers
Cryco, Inc., 1138 Mission St., S. Pasadena, Calif., E. W. Johnson, PY 1-1174, Quartz Crystals
C-S Mfg. Co., 4089 Lincoln Blvd., Venice, Calif., R. J. Collins, EX 9-3610, Loudspeakers

K-F Development, 867 Woodside Way, San Mateo, Calif., Paul Keeler, DI 3-8287, Precision Potentiometers
Kinevox Corp., 116 S. Hollywood Way, Burbank, Calif., L. H. Roos, RO 9-3291, Magnetic Recorders
Kwikheat Mfg., 3732 San Fernando Rd., Glendale, Calif., E. E. Wachter, CH 5-2376, Soldering Irons

Lansing Sound Inc., J. B., 2439 Fletcher Dr., Los Angeles, W. H. Thomas, OL 3-2545, Loudspeakers
Leach Relay Co., 5915 Avalon Blvd., Los Angeles, E. K. Neale, AD 8221, Relays
Lear, Inc., 11916 W. Pico Blvd., Los Angeles, K. Miller, AR 9-7765, Aircraft Radio, Magnetic Amplifiers
Lee Electric & Mfg., 2804 Clearwater St., Los Angeles, L. V. Lawhead Jr., NO 3-1295, Selenium Rectifiers
Lenkurt Electric, 1105 County Rd., San Carlos, Calif., G. M. Lebedeff, LY 3-2161, Carrier Equip., Filters
Lewis & Kaufman, 90 El Rancho Ave., Los Gatos, Calif., N. V. Bramley, EL 4-3540, Transmitting Tubes
Librascope, Inc., 1607 Flower St., Glendale, Calif., D. C. Webster, CH 5-2677, Computers, Magnetic Amps.
Lindberg Instrument Co., 1800 Harmon St., Berkeley, Calif., Chas. Ray, PI 5-3921, Phono Pickups
Litton Industries, 1001 E. Brittan, San Carlos, Calif., N. H. Moore, LY 3-3124, Magnetrons, Test Equip.
Lloyd's Enterprises, Box 313, Altadena, Calif., L. M. Jones, Test Equip.
Lockheed Aircraft Corp., Burbank, Calif., Aircraft Radio & Electronic Equip.
Loge Sound Engrs., 2171 W. Wash. Blvd., Los Angeles, J. M. Loge, PA 9178, Interoffice Comm. Systems
Low-Bar Products, 938 Pico Blvd., Santa Monica, J. T. Wehber, EX 6-5828, Synchros
Luther Electronics, 5767 W. Adams Blvd., Los Angeles, C. L. Johnson, WY-5826, High Voltage Condensers
Lynch Carrier Systems, 96 Jessie St., San Francisco, E. E. Combs, SU 1-1156, Telephone Carrier Equip.
Lynn Electronic Research, 9 W. Magnolia Blvd., Burbank, C. E. Lynn, RO 9-2864, Connectors, Electr. Hdw.

McColpin-Christie, 3410 W. 67 St., Los Angeles, S. L. Christie, PL 3-2607, Power Supplies
McCormick-Selph Assoc., Palo Alto Airport, Palo Alto, Calif., Don McCormick, Ceramic-to-metal seals
McLaughlin, J. L. A., 367 Bird Rock Ave., LaJolla, Calif., GL 5-4596, Signal Splitter
Magna Electronics, 9810 Anza Ave., Inglewood, Thos. Gibney, DR 8-1784, Amplifiers, Phonographs
Marco Industries Co., 207 S. Helena St., Anaheim, Calif., F. A. Harrington, 7245, Indicator Light Assem.
Maseo Products, 2119 S. Sepulveda Blvd., Los Angeles, B. Mathews, BR 2-2481, Timers
Magnasyno Mfg., 5717 Cartwright Ave., N. Hollywood, W. H. Stutz, SU 3-6413, Magnetic Film Recorders
Miller Co., J. W., 5917 S. Main St., Los Angeles, J. W. Miller, AD 3-4297, Coils, Chokes, Filters
Miller Corp., Wm., 325 N. Halstead Ave., Pasadena, Calif., Geo. Downs, RY 1-6317, Analog Computers
Mission Elec. Mfg., 132 W. Colo St., Pasadena, Calif., J. R. David, RY 1-6604, Elec. Motors, Blowers
Mitchell Camera Corp., 666 W. Harvard, Glendale, Calif., G. P. Mitchell, CH-5186, Motion Picture Equip.
Mole-Richardson, 937 N. Sycamore Ave., Hollywood, Calif., M. A. Hankins, HI 8305, Photographic Ltg. Equip.
Monitor Products, 815 Fremont Ave., S. Pasadena, H. E. Blasier, PY 1174, Quartz Crystals
Morgan Instruments, 21420 Valerio St., Canoga Park, Calif., H. C. Morgan, DI 8-5771, Geiger Counters
Morrow Radio Mfg. Co., 1047 S. Commercial St., Salem, Ore., B. Gainsforth, Frequency Converters
Moseley, Francis L., 1136 N. Las Palmas, Hollywood, Calif., E. E. Austin, HO 9-0261, Servomechanisms
Moviola Mfg. Co., 1451 Gordon St., Los Angeles, Calif., M. Serrurier, GR 3178, Film Editing Equip.
Mullenbach Elec. Mfg. Co., 2300 E. 27 St., Los Angeles, Lee Coe, LO 5-5331, Coils, Resistors, Transformers

Nat'l. Electronics Mfg., 314 W. 58 St., Los Angeles, C. Blaker, PL 1-5166, Cinema Television
National Technical Laboratories, Pasadena, Calif., Test Equipment
Neomatic, Inc., 9010 Bellanca Ave., Los Angeles, T. R. Welch, OR 8-3814, Subminiature Relays, Solenoids
Newcomb Audio Products, 6824 Lexington Ave., Hollywood, Don Warner, HO 9-5381, PA Systems, Trans. Players
Northern Radio, 314 Bell St., Seattle, Wash., L. G. Reynolds, SE 2519, Communication Equip.
Northrop Aircraft, Inc., 37 E. Broadway, Hawthorne, Calif., Aircraft Radio & Electronic Equip.

O'Brien Electric, 6514 Santa Monica Blvd., Hollywood, F. O'Brien, HI 1117, Sound Systems
Olesen Co., Otto K., 1534 N. Cahuenga Blvd., Hollywood, S. M. Stevens, GL 5194, Sound Systems
Olson & Lipps, 5485 W. Wash. Blvd., Los Angeles, C. V. Olson, WA 4141, Recording & Playback Heads
Olympic Instrument Labs., Cove, Wash., C. Crecelius, VA 2121, Wire & Cordage Meters
Oregon Electronic Mfg., 2232 E. Burnside St., Portland, Ore., C. W. McPherson, EM 9292, Custom Electronic Equip.
Owen Labs, 412 Woodward Blvd., Pasadena, Calif., R. P. Owen, SY 6-5167, Oscilloscope Accessories

Pacific Electricord, 3217 Exposition Pl., Los Angeles, John Alesi, AX 3-7205, Cable Assemblies
Pacific Mercury TV Mfg., 5955 Van Nuys Blvd., Van Nuys, Stanley Cutler, ST 7-2676, TV & Radio Receivers
Pacific Optical Corp., 5965 W. 98 St., Los Angeles, John Rype, CA 2-7171, Optical Instruments
Pacific Transducer Corp., 11921 W. Pico Blvd., Los Angeles, G. A. Argabritz, AR 9-6129, Audio Equip.
Pacific Universal Prods., 168 Vista Ave., Pasadena, Calif., R. E. Frazer, SY 5-2571, Optical Coatings
Packard-Bell Co., 12333 W. Olympic Blvd., Los Angeles, C. A. Nichols, AR 7-6721, Radio-TV Receivers
Palmer, Inc., M. V., 4002 Fruit Valley Rd., Vancouver, Wash., H. C. Lambert, VA 5-2894, Amplifiers, Filters
Panoro Mirrors, 2058 Los Feliz Blvd., Los Angeles, G. B. Keim, NO 1-2141, Special Mirrors
Pantek Co., 1411 Manhattan Ave., Manhattan Beach, Calif., E. Swarthe, Airborne Instruments
Parsons Co., Ralph M., 689 S. Fair Oaks Ave., Pasadena, Calif., Chas. Coughenour, Aircraft Nav. Equip.
PCA Electronics, Inc., 6368 DeLongpre Ave., Hollywood, D. H. Allen, GR 2196, Delay Lines, Transformers
Pederson Electronics, Lafayette, Calif., Rudy Pederson, 3434, Power Supplies, Amplifiers
Peerless Electrical Prods., 6920 McKinley Ave., Los Angeles, A. A. Emlen, TH 4175, Transformers, Magnetic Amps.
Penta Labs., 216 N. Milpas St., Santa Barbara, Calif., R. L. Norton, 2-3909, Special Purpose Tubes
Perkin Eng'g. Corp., 345 Kansas St., El Segundo, Calif., Philip Diamond, 1366, Power Supplies
Pfleger Products, 3901 W. 54 St., Los Angeles, R. A. Pfleger, AX 2-8313 Panels, Terminal Boards
Phaestron Co., 151 Pasadena Ave., S. Pasadena, Calif., P. Chamberlin, CL 6-2171, Resistors, Meters, Relays
Photographic Products Inc., 6916 Romaine St., Hollywood, Wm. Carroll, HI 8151, Instrumentation Cameras
Pioneer Electronics Corp., 2232 Bdwy., Santa Monica, V. DeLucia, EX 5-9904, TV Picture Tubes
Pioneer Tool Co., 5008 W. Jefferson Blvd., Los Angeles, R. W. Eunson, RE 3-8289, Chassis Punches

Cubic Corp., 2840 Cannon St., San Diego, Calif., R. C. Werner, BA 0511, Microwave Components
Cyclotron Specialties, Morega, Calif., Electronic Computers & Accessories

Dallons Laboratories, 5066 Santa Monica Blvd., Los Angeles, R. Stearns, OL 1951, Radio Crystals
Dalmotor Co., 1375 Clay St., Santa Clara, Calif., Ralph Herzog, AX 6-5958, Motors & Generators
Dalmo Victor Co., 1414 El Camino, San Carlos, W. F. Gates, LY 3-3131, Radar Ant., Intercomm. Devices
Davis Electronics, 4313 W. Magnolia Blvd., Burbank, Calif., Ed. Lucas, RO 9-2621, Antennas
DeCoursey Eng'g. Lab., P.O. Box 235, W. Los Angeles, Harry Kimball, AR 3-2530, Coils, Filters, Equalizers
Delta Electrical Instrument, 2700 S. Hill St., Los Angeles, W. S. Richards, PR 0053, Meters
DeMornay-Bonardi, 3223 Burton Ave., Burbank, Calif., G. Fonda-Bonardi, RO 9-2049, Waveguides, Microwave Equip.
Dielectric Labs., 1275 Riverside Dr., Los Angeles, J. C. Nailen, CA 9387, Attenuators, Capacitors
Dollar Co., Robt., Comm. Equip. Div., 50 Drumm St., San Francisco, J. Hannaford, YU 2-4479, Transmitters, Receivers
Dollar Co., Robt., Vacuum Tube Div., 947 Broadway, Redwood City, C. C. Conner, EM 8-3961, Vacuum Tubes
Douglas Aircraft, Santa Monica, E. F. Burton, EX 4-3241, Electronic Data Recorders
D & R Ltd., 402 E. Gutierrez St., Santa Barbara, Calif., R. L. Dawley, Magnetic Amplifiers
Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena, D. D. Dressen, SY 3-0691, Custom Electronic Equip.
Dunkle Coil Co., 2506 W. 8th St., Los Angeles, W. A. Dunkle, DU 7-6149, Coils, Reactors, Transformers

Edix Eng'g. Co., 10495 Scenario Lane, Los Angeles, Mark Herrell, Film & Tape Editing Equip.
Eitel-McCullough, Inc., San Bruno, Calif., O. H. Brown, JU 8-1212, Transmitting & Receiving Vacuum Tubes
Electrical Communications, 765 Clementina St., San Francisco, E. H. Cogill, KL 2-1947, Code Senders
Electrical Eng'g. & Mfg., 4612 W. Jefferson Blvd., Los Angeles, Gerhard Mauric, RE 3-0151, Motors, Generators
Electrical Service Co., 1271 Mission St., San Francisco, F. Boyce, UN 1-2245, Photo Electric Controls
Electro-Cap, Inc., 1269 Riverside Dr., Los Angeles, Calif., E. Fearman, CA 2-9417, Capacitors
Electro Circuits, Inc., 401 E. Green St., Pasadena, Calif., D. C. Erdman, RY 1-8328, Ultrasonic Equip.
Electro Development, 6014 W. Washington Blvd., Culver City, Mart Berge, VE 8-0508, Min. Rotary Switches
Electro Eng'g. Works, 6021 College Ave., Oakland, Calif., J. J. Halloran, OL 3-1588, Transformers, Chokes
Electromagnetic Research, 3210 Winona Ave., Burbank, Calif., R. F. Blaine, RO 9-3351, Antenna Test Equip.
Electronic Eng'g., 180 S. Alvarado, Los Angeles, R. B. Bonney, DU 2-7353, Plug-in Circuits
Electronic Mfg. Corp., 227 W. Chestnut Ave., Monrovia, Calif., C. A. Warne, EL 8-6149, Communications Equip.
Electronic Medical Foundation, 2452 Van Ness Ave., San Francisco, H. Saine, GR 4-0056, El. Medical Equip.
Electronic Specialty Co., 3456 Glendale Blvd., Los Angeles, W. D. Gibbs, NO 2-2168, Aircraft Electr. Equip.
Electronic Windings Co., 3001 Verdugo Rd., Los Angeles, L. H. McCarron, CA 2-0138, Relay Coils
Electrotechnic Corp., 15601 Arrow Highway, Azusa, Calif., A. P. Stuhrman, FL 7-1281, Communications Equip.
Emsco Derrick & Equip. Co., 6811 S. Alameda St., Los Angeles, Calif., A. A. Ashton, JE 5261, Towers
Engineered instruments, 815 Soto St., Hayward, Calif., D. R. Callow, LU 1-6432, Chokes, Coils, Relays
Extruders, Inc., 3232 W. El Segundo Blvd., Hawthorne, Calif., A. O. Bedard, OR 8-4071, Plastic Tubing

Faber Mfg. Co., Merle, 35 Stillman St., San Francisco, M. F. Faber, EX 2-7302, Metal Tube Parts
Fischer & Co., R. A., 517 Commercial St., Glendale, Ralph DeVries, CH 5-2746, Electro-Medical Equip.
Fisher Research Lab., 1961 University Ave., Palo Alto, Calif., G. Fisher, DA 2-4646, Marine Radio Equip.
Flippen Mfg. Co., 132 S. Main St., Orange, Calif., D. B. Withall, KI 3-1317, Flanges, TV Antenna
Ford Eng'g. Co., 129 E. "A" St., Upland, Calif., A. S. Voak, 322, Precision Potentiometers

Gaertner Radio Co., 3612 Maple Ave., Los Angeles, E. C. Rau, AD 3-8452, Power Supplies
Gardner Elect. Mfg., 4227 Hollis St., Emeryville, Calif., S. M. Gardner, OL 2-7600, Transformers
Genisco, Inc., 2233 Federal Ave., Los Angeles, R. E. Brown, AR 9-8913, Analog Digital Converters
Gertsch Products, 11846 Miss. Ave., Los Angeles, L. S. Cutler, BR 2-1795, Test Equip.
Giannini & Co., G. M., 254 W. Colo St., Pasadena, Calif., A. J. Klose, RY 1-7153, Prec. Potentiometers
Gilfillan Bros., 1815 Venice Blvd., Los Angeles, H. G. Tasker, DU 7-5131, Aircraft Equip.
Girard-Hopkins, 1000 40th Ave., Oakland, Calif., J. C. Hopkins, KE 2-8477, Capacitors
Glasscraft Co., 5210 E. Olympic Blvd., Los Angeles, J. T. Voorhees, AN 9-7249, Picture Tubes
Globe Electrical & Mfg., 11019 Buford Ave., Inglewood, R. E. Peterson, OR 8-4273, Terminal Boards, Relays
G & M Equip. Co., 7315 Varna Ave., N. Hollywood, Calif., N. D. Farnell, SU 3-6240, Test Equip.
Gonset Co., 801 S. Main St., Burbank, Calif, W. W. Smith, CH 0-2139, Mobile Comm. Equip.
Good, Inc., Don, 1014 Fair Oaks Ave., S. Pasadena, Calif., Don Good, RY 1-1884, TV Filters, Twinlead
Goslin Elec. & Mfg., 2921 W. Olive Ave., Burbank, Calif., A. J. Goslin, RO 9-3025, Aircraft Transformers
G W Associates, P.O. Box 2263, El Segundo, Calif., G. Underberger, El Segundo 370, Microwave Components

Hadley, Robert M., 5112 S. Hoover St., Los Angeles, A. H. Hadley, AD 4-0131, Transformers
Hallen Corp., 3503 W. Olive Ave., Burbank, Calif., Roger Anthes, CH 8-6976, Magnetic Film Recorders
Hallett Mfg. Co., 1601 W. Florence Ave., Inglewood, V. W. Balzer, OR 8-4751, Diesel Elec. Generators
Harder Co., Donald C., 2031 Chatsworth Blvd., San Diego, D. C. Harder, Toroidal Coil Winder
Helipot Corp., 916 Meridian Ave., S. Pasadena, Calif., A. O. Beckman, SY 1-2164, Precision Potentiometers
Heller & Assoc., Herman S., 8414 W. 3rd St., Los Angeles, H. S. Heller, WE 3-6371, Magnetic Recorders
Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif., Brunton Bauer, DA 5-4451, Test Equip.
Hoffman Labs., Inc., 3761 S. Hill St., Los Angeles, J. A. Rhoads, RI 7-9661, TV Sets, Radar, Sonar
Hoffman Radio Corp., 6200 S. Avalon Blvd., Los Angeles, C. Wasmansdorf, AD 3-3151, TV Receivers, Radar
Holt Audio Industries, 5014 N. Encinita Ave., Temple City, L. C. Dale, AT 7-2902, Amplifiers, Loudspeakers
Hopkins Eng'g. Co., 2082 Lincoln Ave., Altadena, Vernon Moore, SY 8-1185, Radio Interference Filters
Houston-Fearless Corp., 11801 W. Olympic Blvd., Los Angeles, H. W. Houston, BR 2-4331, TV Studio Equip.
Huggins Labs., 700 Hamilton Ave., Menlo Park, Calif., R. A. Huggins, DA 2-0346, Vacuum Tubes, Components
Hughes Res. & Devel. Labs., Culver City, Dr. S. Ramo, TE 0-7111, Airborne Radar Systems, Guided Missiles
Hughey & Phillips, 4075 Beverly Blvd., Los Angeles, M. Witthaus, NO 3-2247, Tower Lighting Equip.
Hunt & Piper, 7045 Romaine St., Hollywood, Calif., A. Chernine, HE 2326, Lighting Equip., Mike Booms
Hycon Mfg. Co., 2961 E. Colo St., Pasadena, R. F. Crisp, RY 1-7611, Test & Guided Missile Equip.
Hycor Co., 11423 Vanowen St., N. Hollywood, Calif., R. E. Schlegel, ST 7-6129, Resistors, Coils, Filters

Inet, Inc., 3655 S. Main St., Los Angeles, Calif., R. A. Rall Jr., PL 3-2583, Power Supplies
Int'l. Rectifier, 1521 E. Grand Ave., El Segundo, Calif., Eric Lidow, 1890, Selenium Rectifiers
Int'l. Research Assoc., 2221 Warwick, Santa Monica, W. G. Hornbostel, TE 0-4415, TV Receivers, Microphones
Int'l. Telemeter, 2000 Stoner Ave., Los Angeles, L. N. Ridenour, AR 8-1268, Subscription TV, Computers

Janco Corp., 3111 Winona Ave., Burbank, Calif., T. A. Andrew, RO 9-2107, Aircraft Parts
Jennings Radio Mfg., 970 McLaughlin Ave., San Jose, Calif., J. E. Jennings, CY 2-4025, Vacuum Capacitors

Kaar Eng'g. Corp., 2995 Middlefield Rd., Palo Alto, J. M. Kaar, DA 3-9001, Radiotelephones
Kalbfell Labs., 1090 Morena Blvd., San Diego, D. C. Kalbfell, W. 6359, Test Equip., Filters
Kaye-Halbert, 3623 Eastham Dr., Los Angeles, Fred Miller, TE 0-4891, Television Receivers
Kelnor Mfg., 222 Kearny St., San Francisco, Fred Miller, DO 2-2996, Soldering Irons

Ports Mfg. Co., 3265 Belmont Ave., Fresno, M. P. Ports, 3-6728, Name Plates, Panels
Precision Crystal Lab., 2223 Warwick Ave., Santa Monica, W. Rogers, TE 0-5049, Quartz Crystals
Precision Radiation Instruments, 2235 S. LaBrea, Los Angeles, L. Norman, YO 5143, Geiger Counters
Prescott Television, 7350 Beverly Blvd., Los Angeles, B. W. Reagan, WE 3-7193, Custom TV & Sound Equip.
Product Associates, 318 W. Olympic Blvd., Los Angeles, A. W. Carlson, RI 7-4519, Magnetic Recorders
Professional Electronics, 180 E. Calif. St., Pasadena, Calif., E. P. Shultz, SY 6-8643, Test Equip.
PSP Eng'g. Co., 8420 Otis St., S. Gate, Calif., Walter Sellers, LO 5-8195, Aircraft Solenoids

Radio Labs., 1846 Westlake N., Seattle, Wash., L. R. Jacobson, AL 8777, Marine Radio Telephones
Radiophone Co., 600 E. Evergreen, Monrovia, Calif., R. C. Lord, EL 8-2586, Radio Transmitters, Receivers
Radio Specialty Mfg., 2023 S.E. 6th St., Portland Ore., H. Sterne, EA 8123, Quartz Crystals
Rainbo Record Mfg., 4335 W. 147 St., Lawndale, Calif., Fritz Jensen, OR 8-3489, Recording Discs
R-C Scientific Instrument, Playa del Ray, Calif., L. R. Curtis, EX 6-7540, Radiation Detectors
Recorders Labs., 6916 Santa Monica Blvd., Hollywood, R. L. Burgess, HU 2-1251, Transcriptions
Remler Co. Ltd., 2101 Bryant St., San Francisco, H. A. Greene, VA 4-3435, Electronic Equipment
Repath Co., Paul R., 641 E. 61 St., Los Angeles, P. R. Repath, AD 3-7262, Shield Cans & Cases
Resdel Eng'g., 2351 Riverside Dr., Los Angeles, P. Korelich, NO 6809, Radar Systems, Missile Guid. Units
RISCO, 265 Minna St., San Francisco, H. N. Kalb, EX 2-7820, Telephone Carrier Equip.
Robinette Co., W. C., 802 Fair Oaks Ave., S. Pasadena, Calif., W. C. Robinette, PY 1-1594, Servomechanisms
Roesch Co., D. J., 2200 S. Figueroa St., Los Angeles, Robt. Sanders, RI 7-9655, TV Receivers
Rollin Co., 2066 N. Fair Oaks Ave., Pasadena, Calif., J. E. Stankey, RY 1-7134, Test Equip.
Rutherford Electronics, 3707 S. Robertson Blvd., Culver City, J. S. Johnson, TE 0-4362, Test Equip.
Rutishauser Corp., 490 S. Fair Oaks Ave., Pasadena, R. G. Madsen, SY 3-4340, Test Equip.
Ryan Aeronautical, Lindbergh Field, San Diego, Bruce Smith, WO 6681, Guided Missile Systems

Salesmaster Corp., 3717 W. 54 St., Los Angeles, L. G. MacKenzie, AX 1-6200, Endless Magnetic Tape Reproducers
San Fernando Electric Mfg., 12900 Foothill Blvd., San Fernando, D. Rubendall, EM 1-8681, Capacitors
Sargent-Rayment Co., 212 9th St., Oakland, L. W. Rayment, GL 1-7045, Radio Tuners & Amplifiers
Schott Co., Walter L., 3225 Exposition Pl., Los Angeles, Frank Hurd, AX 3-7201, Antennas, Radio Hdw.
Semco Eng'g. & Mfg. 8407 S. Hoover St., Los Angeles, Geo. Korkos, PL 2-7657, TV Receivers
Sequoia Process Corp., 894 Douglas Ave., Redwood City, Calif., J. B. Meikle, EM 6-7259, Hook-up Wire
Shelby Instrument Co., 321 W. 7th St., Long Beach, Calif., M. Nazak, LO 7-6300, Sub-min. Electr. Equip.
Sierra Electronic Corp., 1050 Brittan Ave., San Carlos, Paul Byrne, LY 3-2104, Test Equip.
Slate & Assoc., Claude C., 11370 W. Olympic Blvd., Los Angeles, F. E. Dine, BR 2-4504, Servo Amplifiers
Smith Mfg. Co., Nathan R., 105 Pasadena Ave., S. Pasadena, N. R. Smith, AL 1141, Coils, Transformers
Solar Mfg. Corp., 2660 E. 46 St., Los Angeles, W. G. Delp, LO 8-2124, Capacitors
Stancil-Hoffman, 1016 N. Highland, Hollywood, J. Chybinski, HI 7461, Tape & Film Magnetic Recording Equip.
Standard Electronics Mfg., 11861 Teale St., Culver City, M. E. Lippman, EX 7-4248, Potentiometers
Statham Labs., 12401 W. Olympic Blvd., Los Angeles, M. Di Giovanni, BR 2-6286, Transducers
Stephens Mfg. Corp., 8338 Warner Dr., Culver City, R. L. Stephens, VE 9-7578, Audio Equip.
Stoddart Aircraft Radio, 6644 Santa Monica Blvd., Hollywood, A. T. Parker, HI 9294, Test Equip.
Stone & Smith, 5965 Alcoa Ave., Los Angeles, S. H. Brown, JE 7144, Sonar Equip.
Symphony Radio & TV., 825 W. Pico Blvd., Los Angeles, Samuel Solat, PR 5158, Resistors

Tartak-Stolle Electronics, 2979 N. Ontario St., Burbank, H. C. Hornickel, RI 7-9134, Transformers, Yokes
Taylor Fibre Co., LaVerne, Calif., E. G. Howard, Vulcanized Fibre, Laminated Plastics
Technical Assoc., 140 W. Providencia Ave., Burbank, H. A. Glassford, RO 9-1994, Radiation Instruments
Techno Instrument Co., 6666 Lexington Ave., Los Angeles, R. C. Moody, GL-3304, Recording & Analyzing Sys.
Tektronix Inc., P.O. Box 831, Portland, Ore., R. Ropiequet, CY 2-2611, Cathode-ray Oscilloscopes
Telecomputing Corp., 138 E. Santa Anita Ave., Burbank, W. D. Caldwell, RO 9-1161, Elect. Computing Equip.
Telefex, 5919 Hollywood Blvd., Hollywood, Calif., Miss Donna Fargo, HO 9-6211, Rear Screen Projectors
Teletronic Labs., 1835 W. Rosecrans Ave., Gardena, Calif., L. A. Burkhardt, ME 9-1131, Test Equip.
Tempo T-V Products, 2450 Ramona Blvd., Los Angeles, Gregory Lieb, AN 3-4240, Antenna Towers & Access.
Tetrad Co., 4054 Ocean Park Ave., Venice, Calif., W. T. Hoimes, EX 7-2159, Chokes, Coils, Transformers
Thermador Electrical Mfg., 5110 District Blvd., Los Angeles, J. W. Wardell, KI 6131, Chokes, Reactors
Thermo Instruments Co., 1166 El Camino Real, Belmont, Calif., D. M. Comb, LY 3-5139, Capacity Actua. Relays
Thor Transformer & Electronics, 750 San Antonio Rd., Palo Alto, H. J. Birdsell, YO 7-9116, Transformers
Topping Mfg. Co., 90 Ramona Ave., Son Francisco, J. Topping, Cabinets
Tower Sales & Erecting Co., 6100 N.E. Columbia Blvd., Portland, Ore., C. H. Fisher, TR 7303, Bdcst. Ant. Towers
Transco Products, 12210 Nebr. Ave., Los Angeles, R. G. Kenway, BR 2-5687, Co-Axial Cable Switches
Transformer Engineers, 161 E. Calif. St., Pasadena, R. C. Olesen, RY 1-6906, Transformers
Transport Products, Santee, Calif., D. M. Stanler, HI 4-7661, Microwave Calorimeters, Relays
Triad Transformer Mfg., 4055 Redwood Ave., Venice, Calif., E. M. Keillor, TE 0-6456, Transformers, Reactors
Tri-Dex Co., P.O. Box 1207, Lindsay, Calif., K. B. Howard, 2-4051, Coils, Toroids
Trutone Electronic Eng'g., 812 N. Highland Ave., Los Angeles, H. M. Cohen, HI 1202, Radios, Audio Amplifiers
Tubing Seal Cap, Inc., 808 W. Santa Anita, San Gabriel, F. W. Livermont, AT 9-5111, Metal Stampings
Turner & Co., W. R., 4831 W. Jefferson Blvd., Los Angeles, W. R. Turner, RE 2-7137, Small Electric Motors

Ungar Electric Tools, 615 Ducommun St., Los Angeles, A. R. Knowles, MA 7885, Soldering Irons
U. S. Eng'g., 521 Commercial St., Glendale, Calif., A. F. Bell, CH 5-1911, Electronic Hdw.
Universal Electronics, 2012 S. Sepulveda Blvd., Los Angeles, Chas. Keller, AR 9-7803, Power Supplies
Universal Microphone, 424 Warren Lane, Inglewood, Calif., J. L. Kane, OR 8-4978, Microphones, Stands

Vacuum Tube Prods., 506 S. Cleveland, Oceanside, Calif., C. L. Giles, 6567, Cathode Ray Tubes
Varian Assoc., 990 Varian St., San Carlos, S. F. Varian, EM 8-3944, Klystrons, Nuclear Resonance Apparatus
Vector Electronics, 3352 San Fernando Rd., Los Angeles, R. R. Scoville, CL 7-8237, Plug-in Adapters
Victorlite Industries, 5350 Second Ave., Los Angeles, AX 8305, Studio Visual Projector

Walkirt Co., 145 W. Hazel St., Inglewood, Calif., H. W. Beckwith, OR 8-2873, Pulse Circuit Components
Weingarten Electronic Labs., 7556 Melrose Ave., Los Angeles, R. Weingarten, WA 5405, Custom Radio
W. Coast Electric Mfg., 10008 S. Main St., Los Angeles, R. W. Worthington, PL 5-1138, Solenoids
West Coast Electronics, 5873 W. Jefferson Blvd., Los Angeles, Calif., W. C. Ennis, PR 5041, Custom Electronic Equipment
Western Gold & Platinum, 587 Bryant St., San Francisco, D. C. Davis, SU 1-2065, Precious Metals
Western Insulated Wire, 2425 E. 30 St., Los Angeles, E. H. Lewis, JE 7103, Cords & Cables
Westline Prods., 600 E. 2nd St., Los Angeles, J. Bishop, TR 2641, Labels
Wildberg Bros., 742 Market St., San Francisco, I. I. Wildberg, DO 2-3505, Precious Metals
Williams Ship-Radio Co., 4306 Menthone St., San Diego, R. R. Williams, B-3097, Marine Transmitters
Wilson Engineering Corp., 2989 Middlefield Rd., Palo Alto, J. C. Wilson, DA 5-3759, Electronic Assembler
Wolfe Co., Franklin C., 3644 Eastham Dr., Culver City, P. F. Smith, TE 0-4618, Hermetic Sealing

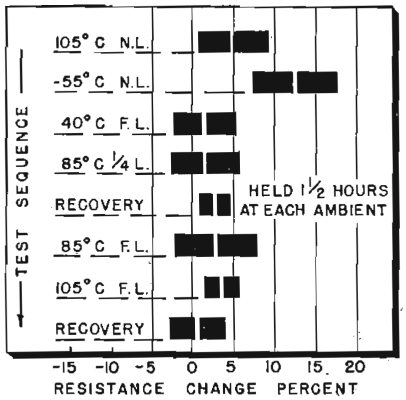


Fig. 1: Ambient effects of ½-watt composition resistors: 0.047, 0.1, 0.51, 1 & 2 meg (5 each)

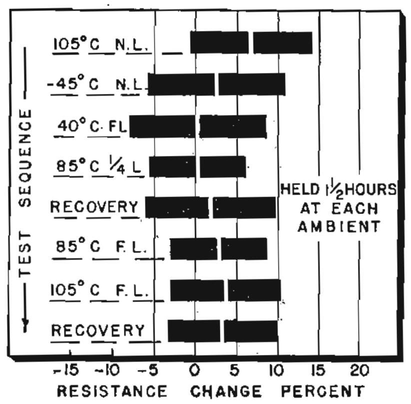


Fig. 2: Ambient effects of ½-watt composition resistors: 0.01, 0.1, 1, 5.1 and 20 K (5 each)

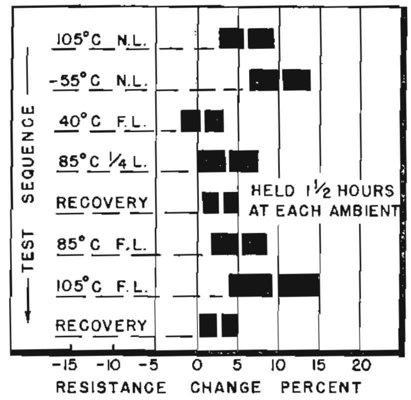


Fig. 3: Ambient effects of 1-watt composition resistors: 0.047, 0.1, 0.51, 1 & 2 meg (5 each)

Stability Characteristics of

Extensive tests conducted on units of different values in ½, 1, temperatures, (2) more pronounced value changes in 2 watt units,

By C. K. HOOPER
Westinghouse Electric Corp.
Baltimore, Md.

OF the several different forms of resistors available, one of the most commonly used in electronic equipment is the composition type. This type consists of an essentially homogeneous mixture of resistance material and binder enclosed in an insulating tube. It is supplied in a wide range of resistance values, is suitable for operation up to relatively high frequency, is small and generally available in standardized ratings and sizes. Its major limitations are instability, limited power dissipation, and noise. With these limitations taken into consideration, however, composition resistors constitute a very useful class of components.

Joint Army and Navy Specification JAN-R-11 describes standardized ratings and characteristics of composition resistors. Resistors covered by JAN-R-11 are available in ¼, ½, 1 and 2 watt ratings and cover a resistance range of from 10 ohms to 20 megohms.

Except for applications where electrical noise is a factor the most important consideration in selecting composition resistors is usually that of stability. Stability implies the characteristic of a resistor to maintain constant resistance over long periods of time and to be relatively unaffected by temperature, load voltage, humidity, shock, vibration and other effects.

In particular, composition resistors may show a considerable change in resistance with load and ambient temperature. It is this characteristic which is discussed in this paper.

The following is a summary of one electronic equipment manufacturer's study of the stability characteristics of composition resistors of various sizes and ratings. It covers various conditions of ambient temperature, load and time, both within and beyond the limits of specification JAN-R-11.

For both the ½ and 1 watt ratings, 10 different resistance values ranging between 10 ohms and 2 megohms were tested. Five resistors of each resistance value and wattage rating of each manufacturer's type were included. In the case of the 2 watt ratings, six different resistance values were used ranging from 1,000 to 100,000 ohms. In this case two resistors of each value and of each manufacturer were tested.

Resistance measurements were made using the volt-ammeter method and the resistors were operated at rated current or voltage when the resistance measurements were made.

The resistors were mounted in a box in which the ambient temperature could be adjusted from −50°C to +150°C. Provision was made so that rated load (or rated voltage for some of the higher resistance values) could be applied either continuously or on an on-off duty cycle. The humidity was not controlled during these tests.

The resistors were subjected to two basically different types of tests. The first consisted of varying the ambient over a wide range (from −50°C to 105°C) and maintained the temperature constant at various values only long enough (about 1½ hours) to insure that a steady temperature condition had been obtained within the resistors. The resistors were subjected to various load conditions during these tests.

Resistance measurements were made before the start of this test and at various ambient and load conditions and again at the conclusion of the test. This first test follows somewhat along the lines of the variable ambient test in paragraph F-3c (8) in JAN-R-11, although it is modified somewhat and also extends the ambient range beyond the specification limit.

Second Test Results

The second test using new resistors consisted of operating the resistor in a 40°C ambient and with a repeating duty cycle of 1-½ hours on at rated load and ½ hour off for an elapsed time of 500 hours. Resistance readings were made at intervals throughout this test. In addition, at the conclusion of the 500-hour run, the ambient was raised to 85°C, other conditions remaining the same, and held at this temperature for 250 hours. An additional 250 hours was then run under the same

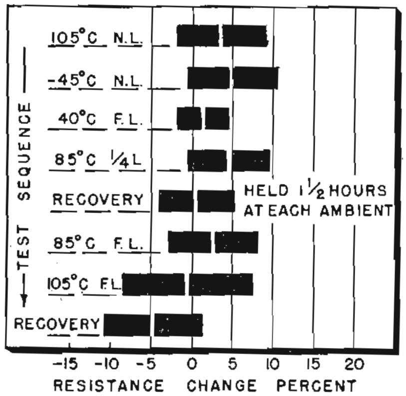


Fig. 4: Ambient effects of 1-watt composition resistors: 0.01, 0.1, 1, 5.1 and 20 K (5 each)

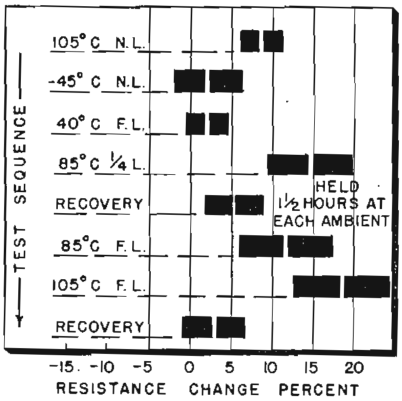


Fig. 5: Ambient effects of 2-watt composition resistors: 1, 3, 10, 22, 47 and 100 K (2 each)

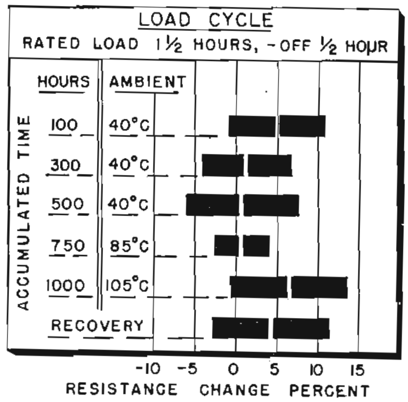


Fig. 6: Load life test of ½-watt composition resistors: 0.01, 0.1, 1, 5.1 and 20 K (5 each)

Standard Composition Resistors

and 2 watt sizes show (1) adverse effects of operation in high ambient (3) inadvisability of using these components in voltage divider applications

conditions except that the temperature was maintained at 105°C. At the conclusion of this test resistance measurements were made after the resistors had been allowed to return to room temperature. These readings were taken on the ½ and 1 watt ratings only since the deviation of 2 watt resistors was very large and a recovery measurement would have shown little change.

The following curves and charts summarized some of the most important data which was obtained from these charts.

Data Presentation

The method of data presentation decided upon was that of plotting bar graphs in which the length of the bar and its position is based upon a normal distribution of data most closely approximating the actual distribution. The relation to the normal distribution is as follows: The center space of each bar corresponds to the location of the mean or average of the data obtained in a particular test, while the length of the bar from end to end is equal to plus and minus one standard deviation. Standard deviation is a convenient and commonly used measure of the spread or scatter of the values above and below the average. Specifically one standard deviation is defined as the root mean square of the individual deviation from the average. Also assuming a normal distribution, about 68% of all values are contained with the limits of plus and minus one standard deviation.

Fig. 1 applies to ½ watt resistors from 47 K to 2 megohms. The load and ambient conditions are as indicated, and the resistors were subjected to the various conditions in the sequence of top to bottom. The changes in resistance are expressed in percent of the actual measured initial values and are not based on the normal rating. A plus change indicates an increase in resistance while a minus change indicates a decrease.

At an ambient of 105°C for 1-½ hours duration, and no load, the resistance values had changed from their initial value to give an average increase of about 4.5%. The change in resistance was distributed around this average value so that 68% of all values fell within the range of from +0.5% to +8.5%. Stated another way, one standard deviation corresponds to a resistance change of 4.0%. The performance under other conditions for this same group of resistors is shown on this same curve.

It will be noted that the recovery after completion of this group of tests was such that the average change was less than 0.5% and one standard deviation was equal to about 3%.

Fig. 2 shows the results of a similar test on ½ watt resistors, except the resistance values were within the range of from 10 ohms to 20 K. It will be seen that except for the low ambient conditions the average values were of the same general order as for Fig. 1. However, that there was more scattering is evident from the generally greater values of standard deviation.

Figs. 3 and 4 apply to 1 watt resistors and otherwise correspond to the resistance values and conditions of the ½ watt resistors in Figs. 1 and 2, respectively.

It will be seen that there is not a great deal of difference in the characteristics of 1 watt units as compared with ½ watt resistors, although in the high resistance range full load, operation at 105°C showed a definite increase in resistance. (About 10% average with one standard deviation equal to 5.5%).

2-Watt Unit Results

Fig. 5 shows the results of a similar test applied to 2 watt resistors having a resistance range of from 1000 to 100,000 ohms. Some significant results for the 2 watt units are:

(A) There is considerably more change at high ambient conditions, both at reduced load and full load, than for the ½ and 1 watt resistors.

(b) The deviation or scattering about the average value is about the same as for the ½ and 1 watt readings.

(c) Although high ambient temperature affects the resistance values to a considerable degree, the recovery when the ambient is returned to normal is quite good, being in the same order as that of the ½ and 1 watt units.

Fig. 6 shows the results of a life

(*Continued on page* 144)

Fluid Magnetic

Device used extensively in airborne electro-mchani-
silicon iron of 40 micro-ohm-cm. Next thixotropic lu-

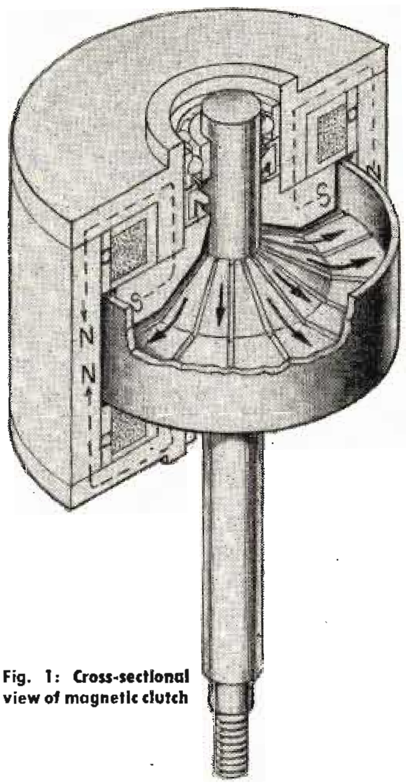


Fig. 1: Cross-sectional view of magnetic clutch

By G. A. WALTERS
& A. P. NOTTHOFF, Jr.
Dalmo Victor Co.,
San Carlos, Cal.

THE fluid magnetic clutch was originally developed by Mr. Jacob Rabinow and his associates at the National Bureau of Standards in 1948. Its unique features make it particularly well adapted to many of the electro-mechanical problems encountered in development of light-weight airborne equipment. Dalmo Victor has, for the past three years, undertaken a rather extensive program to develop and improve fluid magnetic clutch designs and has successfully adapted its principles to many servo and other type problems, where fast acting, proportional clutching action is required.

In principle, the operation of the fluid magnetic clutch is quite simple. The basic unit consists of terminal clutch surfaces coupled through a magnetically controlled fluid medium consisting of powdered iron in an oil lubricant. In some designs the oil is omitted and powdered iron with a dry lubricant is substituted. As the magnetic field within the coupling fluid is increased, the magnetic particles bind the clutching surfaces against movement parallel to their surface.

A cross-sectional view of a typical clutch most extensively investigated at Dalmo Victor is shown in Fig. 1. Photographs of various assembled units along with a disassembled unit are shown in Figs. 2 and 3. Slippage in the non-actuated position is allowed between concentric cylindrical surfaces. The design is characterized by a double cup, low inertia, output rotor. The stator is an encompassing section containing two energizing coils, one on either side of the double cup rotor. They are connected so that the magnetic fields caused by passing current through them produce opposing fields such that the flux lines of the magnetic field thread the cylindrical cup sections of the rotor at right angles to its perimeter. The gaps between the couple section of the rotor and the encompassing stator sections are filled with the magnetic fluid. The magnetic shear stress introduced by exciting the coils is concentrated at the outer radius, thus producing a maximum torque.

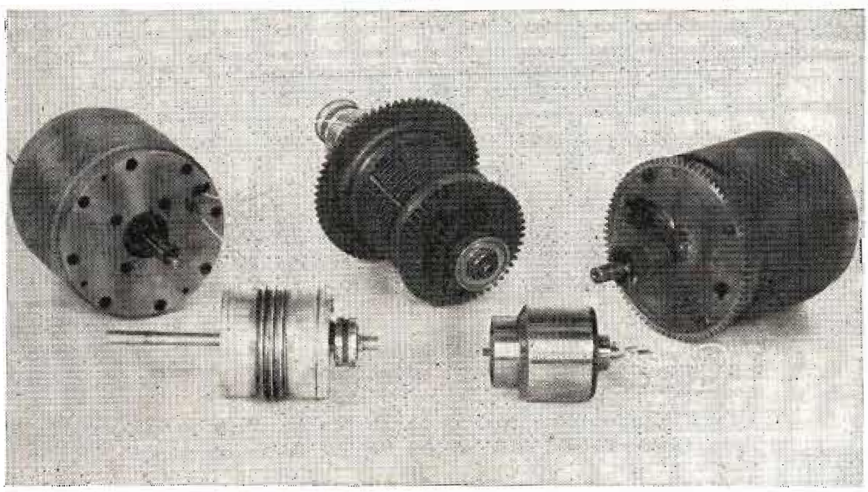
Sensitivity, linearity, and other operating characteristics are similar with either wet or dry mixture. Typical curves of torque output as a function of coil voltage are shown in Fig. 4. In general, fluid magnetic clutches will produce 4 to 5 lbs. in. torque for each cubic inch of volume or 15 to 20 lbs. in. of torque per lb. weight. These values are considerably better than can be realized by other types of proportional control clutches such as eddy current, friction, etc. The torque-to-current ratio, while nearly linear for small values of coil current, tends to show the usual hysteresis characteristic encountered in magnetic controls. In servo designs where linearity of response is a requisite, the non-linear characteristics are eliminated through proper biasing and avoiding operation near saturation. In that all clutches are limited to unidirectional control, the normal servo application requires operation of clutches in pairs.

Design Criteria

Pertinent design criteria for the manufacture of clutches has been reasonably well established. The permeability of the most generally used mixtures of carbonyl iron and oil is approximately eight times that of air. Flux densities within the mixture as high as 12,000 gauss are acceptable. In general, carbonyl E (9 micron sizes) powder mixture in combination with orsil BF-1, 6:1 by weight, has proven most satisfactory. Both carbonyl TH (5 micron) and SF (3 micron) hase been tested. With all other conditions similar, the torque obtainable for a given current was 5% to 10% less than that obtainable with the larger particle size.

Gap dimensions between clutching surfaces is not particularly critical; however, a dimension of 0.032 in. has become standard. Smaller gaps

Fig. 2: Typical fluid magnetic clutch assemblies have double cup rotor and encompassing stator



Clutch for Servomechanisms

cal systems shows increased current-torque time response with high resistivity bricants augment stability. Labyrinth separators solve seal deterioration problem

cause increased viscous drag whereas larger gaps introduce losses in the magnetic circuitry resulting in overall lowered sensitivity.

Seal and Lubricating Fluid

The major problems encountered with the use of fluid magnetic clutches has been, and remains, the design of a satisfactory seal and the development of a stable lubricating fluid. Final sealing is normally accomplished by means of a contact-type rubber lipseal; however, if solid particles come in contact with this lipseal, its operational life decreases rapidly. Two principles are used to eliminate this possibility; a labyrinth type permanent magnet seal is used for separating the magnetic particles from the oil. In the clutch shown in Fig. 1, this consists of a conical section of alnico placed about the shaft of the rotor next to the web section supporting the cylindrical clutch surface. Its principle is quite simple. As the magnetic fluid attempts to travel from the outer diameter towards the seal, the magnetic particles are attracted and held in suspension upon the surfaces of the permanent magnet. The effectiveness if this type of seal is more or less limited to static conditions. Under dynamic conditions other forces are sufficiently large to overcome the forces produced by such magnetic traps.

Under dynamic conditions the overall arrangement of the clutch is so established that centrifugal forces draw the mixture away from the control gaps about the cylindrical clutching surfaces. Through proper channeling of adjacent radial surfaces in which relative motion is incurred, a pumping action is enhanced to augment this outward radial flow. Flow lines are diagrammatically shown in Fig. 1.

The development of a fully satisfactory lubricant medium for use in the fluid magnetic clutch has not as yet been found. Monometric organic silicon lubricants are satisfactory for limited life applications of 200 to 300 hours. Some of the less volatile kerosene base oils, particularly those with thixatropic tendencies exhibit excellent characteristics and produce higher operating life; however, their shelf life is quite poor. Mineral and vegetable oils have been used with various degrees of success. In general, these too break down after 100 to 200 hours of operation.

Dry Clutch Used

To circumvent this problem, the dry magnetic clutch has been used. While the characteristics of this clutch are similar to those exhibited by clutches employing wet mixes, an additional problem is introduced, i.e., rapid oxidation of the fine iron particles. The magnetic properties of iron oxide particles are poor compared to those of the base metal, thus, the maximum available torque of a given clutch is radically reduced with time. This characteristic is shown in Fig. 5. Various dry agents have been mixed with the iron particles to prevent oxidation. To date, they have not proven satisfactory. Magnetic materials other than iron have also been used, but unfortunately, they do not exhibit the desirable magnetic characteristics of iron.

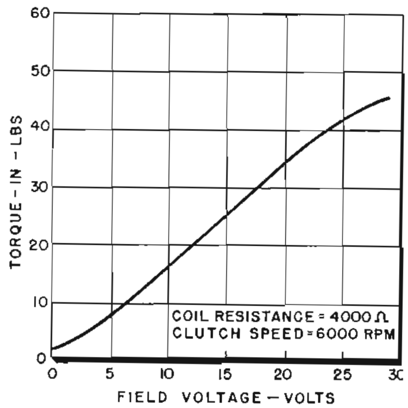
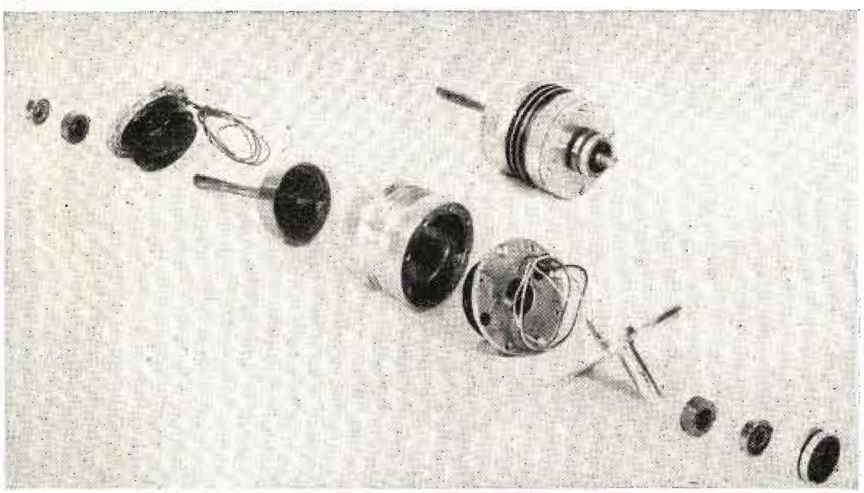


Fig. 4: Dry clutch sensitivity characteristic

While the applications for fluid magnetic clutches are quite varied, they are primarily used as the control element for servo-mechanisms. High electrical-to-mechanical power amplification with acceptably linear proportional control is readily obtainable. This simplifies the gain, power and compensating requirements of the associated electronic equipment. As previously mentioned, it is normally necessary in servo applications to use two similar clutches in back-to-back operation for a given drive system. Such a design offers an added advantage in removing backlash from the associated gear train. That is, all gear reduction except that required in the last stage is introduced between the initial drive motor and the magnetic clutch assembly. Both output pinions from the magnetic clutch assembly are used to drive a common sector. Note that with both clutches driven in opposite directions and with a small biasing voltage applied to each to increase the minimum drag, an anti-backlash gear system evolves. To maintain the

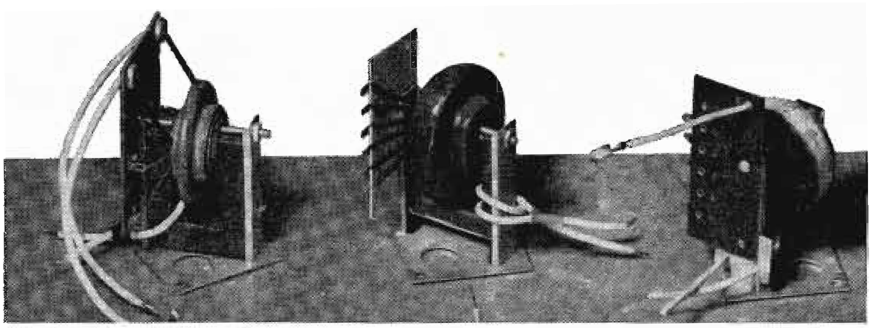
(*Continued on page* 156)

Fig. 3: Exploded view of clutch shows how stator's two energizing coils mount on both sides of rotor



Improved

Design criteria for supply requirements



Horizontal television output transformers, manufactured by Tetrad, of the type discussed in the text

By BYRON M. COLE, Brubaker Mfg. Co., Inc.
9151 Exposition Drive, Los Angeles 34, Calif.

ONE of the major problems in early TV receiver design was that of obtaining sufficient horizontal sweep. When using electrostatically deflected cathode-ray tubes (up to the 10 in.) this problem was not too severe, but the growing demand for larger and larger screens using magnetically deflected tubes, made horizontal sweep one of the major design problems.

The first receivers using magnetic deflection incorporated so-called "brute force" circuits, which were extremely inefficient. As receiver design progressed, it became apparent that more efficient horizontal circuits were essential if the receivers were to be priced low enough to reach the mass market.

The first major post-war set, the RCA 630 TS, utilized a war-developed circuit called the "booster-damper." Actual reflection of the electron beam theoretically requires negligible power because of the extremely small mass of the electrons making up the beam to be deflected. Therefore, any power introduced into the horizontal sweep circuit is dissipated mainly as wasted heat energy. With the use of booster-damper circuits and high-efficiency transformers with sponge iron cores, the losses could be decreased in the order of 30%.

Transformer Cores

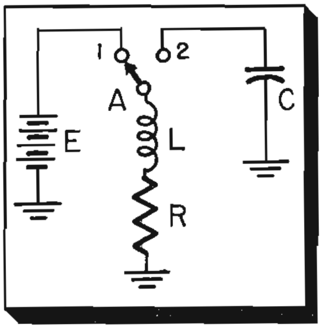
Although the sponge iron core was vastly more efficient than previously used silicon steel transformer cores, it still represented an appreciable loss. During World War II, Philips Labs in Holland developed a new ceramic type of material with excellent magnetic properties. It is interesting to note that the entire development of this material took place while the research engineers were under German control, and the project was kept completely secret from the German forces in control of the laboratories.

Basically, this material developed by Philips is a combination of ferrite, Fe_3O_4, in conjunction with a metal such as magnesium. The engineers coined the trade name "Ferroxcube," with a Roman numeral following to indicate the metal used with the ferrite.

After its introduction into this country by Philips, several American manufacturers, notably Stackpole Carbon Co. and the General Ceramics Co., started large-scale production. The material first produced in quantity was equivalent to the Philips Ferroxcube IV. At that time, technical problems prevented quantity production of Ferroxcube III, which had shown better properties for horizontal sweep transformers. This material was marketed by Stackpole as Ceramag 5, and coated with a red dye. This is the core material that was used by General Electric for their universal horizontal sweep transformer.

This paper was presented at
"WESCON–1952"
Western Electronic Show & Convention
August 27-29
Municipal Auditorium, Long Beach, Cal.

Fig. 1: (l) Basic sweep generation circuit for horizontal deflection. Fig. 2: (r) Current waveform



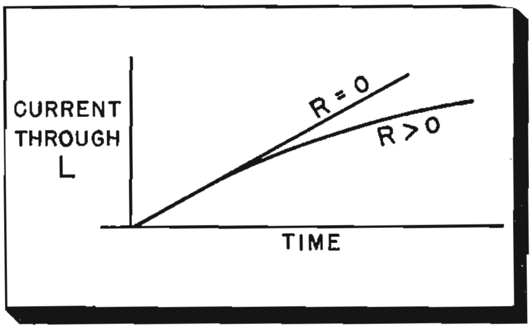
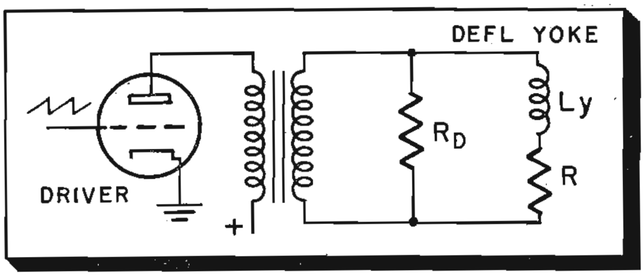
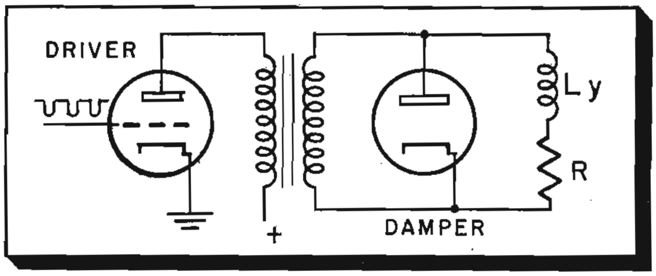


Fig. 3: (l) Waveform and transformer arrangement in prewar circuits. Fig. 4: (r) Modification of circuit used in Fig. 3 utilizes damper tube





Horizontal TV Sweep Circuits

horizontal sweep systems, including practical method for estimating power and an illustration of characteristics needed in flyback transformer

The use of this material for sweep transformer cores permitted a 10 to 15% saving in power and provided cooler operation. The introduction of picture tubes with deflection angles up to 70° (as compared to 53° for the 10BP4) made it almost mandatory to use this new material. Use of this material permits adequate deflection with full second anode potential, and this is possible with a single output tube, a damper, and a rectifier.

Before discussing the method of sweep transformer design let us briefly review the operation of booster damper types of horizontal sweeps.

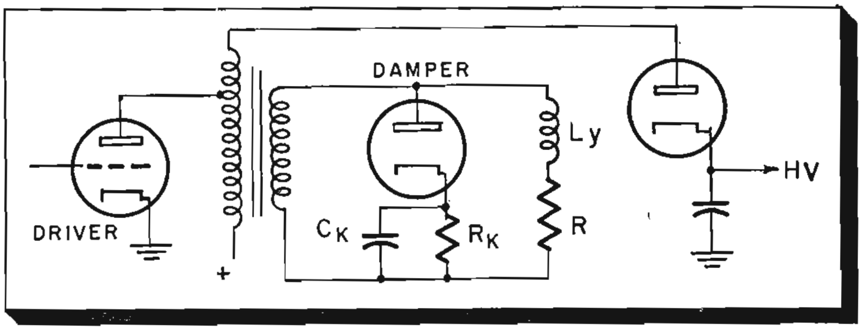


Fig. 5: Interference during retrace eliminated by biasing damper. Tertiary winding steps up voltage

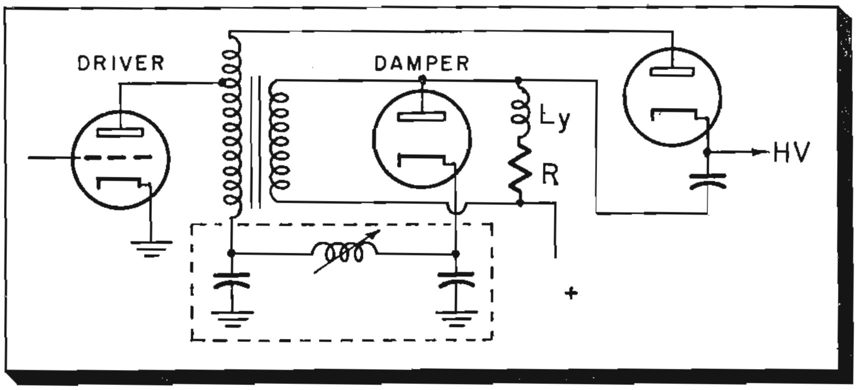


Fig. 6: Modified version of Fig. 5 feeds energy back to driver. Boxed section is linearity network

Basic Sweep Circuit

The basic sweep generation circuit for horizontal deflection is indicated in Fig. 1. When switch A is suddenly moved to position 1, the current through L and R will increase from zero to a maximum determined by E and R. If R is zero, this current will increase to an infinite value in a linear manner. That is, a perfect sawtooth is generated. The presence of resistance changes the current waveform from a sawtooth to an exponential which closely approximates the sawtooth for small values of resistance. This is illustrated in Fig. 2. This sawtooth current passing through the deflection coils provides linear horizontal sweep.

When switch A (Fig. 1) is moved to position 2, the energy stored in the inductance is rapidly transferred to capacitor C. Since the rate of current change is very rapid during this interval, a very high positive pulse is developed across L and C. This voltage is equal to L(di/dt), and is the positive half of the sine wave whose frequency is determined by the effective inductance and capacitance in the circuit.

This basic factor is used in all horizontal sweep circuits. In the simplest designs using the circuit of Fig. 1, an average dc current will always flow through the inductance L since E has only one polarity. This would be extremely undesirable since the sweep would not start at the extreme left side of the crt and sweep directly across its face, but might instead start at the center of the tube and then sweep in only one direction. Adjusting the focus coil to center the picture would cause neck shadowing and many other undesirable effects.

Blocking Capacitor

These effects can be eliminated by the use of a blocking capacitor (as used in direct drive systems), or by inserting a transformer between the battery and the deflection coil inductance. The circuit of prewar receivers utilized the transformer scheme as shown in Fig. 3. The grid of the driver tube in Fig. 3 was usually fed by a sawtooth waveform to minimize the effect of the tube characteristics. However, a waveform of the type shown in Fig. 4 also could have been used if desired. In Fig. 3, the driver tube conducts for the entire sweep period and is only non-conducting during the retrace (oscillatory) interval. This results in very high power dissipation in the driver tube. In addition, a resistor (R_d) is required to damp out the oscillations developed when the driver tube is off (corresponding to switch A of Fig. 1 in position 2).

Further engineering replaced the damping resistor, R_d, by a vacuum tube damper as indicated in Fig. 4. This tube would conduct only during the sweep interval as did R_d.

In Fig. 5, a biased damper tube damps out the oscillations without interfering during the retrace interval. An additional tightly coupled tertiary winding is utilized to step up the voltage obtained during retrace. This stepped-up voltage is then available crt second anode voltage. This design represents a major step forward since is eliminates the bulky, expensive, dangerous 60-cycle high voltage supplies required with the circuits of Figs. 3 and 4.

It was found necessary to incorporate a cathode resistor and bypass capacitor in the damper tube circuit in order to obtain the necessary voltage across the deflection coil wind-

(*Continued on page* 124)

Expanded Technical Program at

8th Annual NEC Meet

Chicago again plays host to the much anticipated National Electronics Conference, convening Sept. 29 through Oct. 1, 1952, at the Sherman Hotel. A greatly expanded technical program offers 99 papers covering servomechanisms, tubes, audio, measurements, TV, components, waveguides, transistors, radar, circuits, computers, antennas, recording and management. Eye-catch-exhibits by more than 75 manufacturers and institutions will be one of several highlights of the meeting.

On the social side, NEC is offering three luncheons featuring prominent speakers, an evening banquet, and a full social program for the ladies.

Registration information may be obtained from Karl Kramer, Executive Secretary, National Electronics Conference, 852 E. 83 St., Chicago 19, Ill.

Listed below is the technical paper program, giving dates, titles, authors and their respective company affiliations.

TECHNICAL PAPERS PROGRAM

MONDAY, SEPTEMBER 29

I—Servomechanism Theory

"THE APPLICATION OF NONLINEAR TECHNIQUES TO SERVOMECHANISMS" by K. C. Mathews and R. C. Boe, Cook Research Laboratories, Chicago, Ill.

"A STUDY OF THE TRANSIENT RESPONSE OF A SINGLE POINT NONLINEAR SERVOMECHANISM" by K. N. Burns, University of Illinois, Urbana, Ill.

"SERVO SYSTEM COMPARATORS" by M. Cooperstein, Sylvania Electric Products Inc., Bayside, N. Y.

"SYNTHESIS OF COMPENSATION NETWORKS FOR CARRIER-FREQUENCY SERVOMECHANISMS" by R. S. Carlson and J. G. Truxal, Purdue University, Lafayette, Ind.

"INTER-STAGE CIRCUIT SYNTHESIS" by L. Weinberg, Hughes Aircraft Co., Culver City, Calif.

II—High Frequency Electron Tubes

"DESIGN FEATURES OF A NEW 14.5-17.5 KMC REFLEX KLYSTRON" by G. C. Dalman, Sperry Gyroscope Co., Great Neck, L. I., N. Y.

"AUTOMATIC FREQUENCY CONTROL OF HIGH POWER KLYSTRONS" by T. A. Wilson, Hughes Aircraft Co., Culver City, Calif.

"GENERAL DESIGN CONSIDERATIONS OF A CAVITY-TYPE POWER AMPLIFIER" by W. S. Elliott, Collins Radio, Cedar Rapids, Iowa.

"AN INVESTIGATION OF A SPACE HARMONIC TRAVELING WAVE AMPLIFIER" by P. Lally, Sperry Gyroscope Co., Great Neck, L. I., N. Y.

"OPERATION OF THE TRAVELING-WAVE TUBE IN THE DISPERSIVE REGION" by L. A. Roberts and S. F. Kaisel, Stanford University, Stanford, Calif.

III—Audio

Program prepared in cooperation with the IRE Professional Group on Audio.

"HIGH POWER AUDIO AMPLIFIERS" by L. F. Deise and H. J. Morrison, Westinghouse Electric Corporation, Baltimore, Md.

"ANALOG FOR LOUDSPEAKER DESIGN" by J. J. Baruch and H. C. Lang, Massachusetts Institute of Technology, Cambridge, Mass.

"A CERAMIC VIBRATION PICK-UP OF HIGH SENSITIVITY" by E. V. Carlson, Shure Brothers, Inc., Chicago, Ill.

"DIRECT MEASUREMENT OF THE EFFICIENCY OF LOUDSPEAKERS BY USE OF A REVERBERATION ROOM" by H. C. Hardy, H. H. Hall and L. G. Ramer, Armour Research Foundation, Chicago, Ill.

"INTERFERENCE EFFECTS IN MAGNETIC RECORDING HEADS" by A. H. Mankin, Shure Brothers, Inc., Chicago, Ill.

IV—Industrial Measurements

"A DIFFERENTIAL X-RAY ABSORPTION GAUGING SYSTEM OF HIGH SENSITIVITY" by G. M. Ettinger, Standard Electronic Research Corp., New York, N. Y.

"AUTOMATIC METAL GAUGING USING X-RAYS" by J. F. Howell, General Electric Co., Milwaukee, Wis.

"ELECTRONIC CIRCUIT PROBELMS IN ELECTROMAGNETIC FLOW MEASUREMENTS" by W. R. Hogg, E. Mittelmann and D. S. Schover, Consulting Engineers.

"NON-DESTRUCTIVE NUCLEAR MEASUREMENTS OF WAVEGUIDE PLATING THICKNESS" by H. V. Watts, C. A. Stone, and L. Reiffel, Armour Research Foundation, Chicago, Ill.

V—Magnetic Amplifiers & Servo Applications

"A CRITICAL COMPARISON OF METHODS OF ANALYSIS OF MAGNETIC AMPLIFIERS" by L. A. Finzi and G. F. Pittman, Jr., Carnegie Institute of Technology, Pittsburgh, Pa.

"COMPENSATION OF A MAGNETIC AMPLIFIER SERVO SYSTEM" by H. H. Woodson, A. E. Schmid and C. V. Thrower, U. S. Naval Ordnance Laboratory, Silver Spring, Md.

"THE USE OF SERVO TECHNIQUES IN DESIGNING AMPLITUDE-STABILIZED OSCILLATORS" by A. W. Dickson, Southwest Research Institute, San Antonio, Tex.

"THE DESIGN OF A STABILIZED CAMERA-MOUNT" by P. J. Herman, Goodyear Aircraft Corporation, Akron, Ohio.

VI—Television

"EFFECTS OF NOISE ON NTSC COLOR STANDARDS" by C. H. Jones, Westinghouse Electric Corporation, East Pittsburgh, Pa.

"AN APPLICATION OF AUTO-CORRELATION THEORY TO THE VIDEO SIGNAL OF TELEVISION" by M. B. Ritterman, Sylvania Electric Products, Inc., Flushing, N. Y.

"A 42-Tube COMPATIBLE COLOR TELEVISION RECEIVER" by K. E. Farr, Westinghouse Electric Corporation, Sunbury, Pa.

"DESIGN OF VIDEO AMPLIFIERS FOR OPTIMUM TRANSIENT RESPONSE" by W. K. Squires and H. L. Newman, Sylvania Electric Products, Inc., Buffalo, N. Y.

"LOW POWER BLOCKING OSCILLATORS" by J. R. Clark, Purdue University, Lafayette, Ind.

VII—Equipment & Components Reliability

"RELIABILITY—WHAT ARE WE STRIVING FOR?" by W. D. McGuigan, Standford Research Institute, Stanford, Calif.

"ASPECTS OF ELECTRONIC EQUIPMENT RELIABILITY" by Victor Harris, Vitro Corporation of America, Silver Spring, Md.

"ELECTRONIC FAILURE PREDICTION" by J. H. Muncy, National Bureau of Standards, Washington, D. C.

"SOME EXAMPLES OF COMPONENT UNRELIABILITY IN MILITARY EQUIPMENT" by O. C. Eliason, Bell Telephone Laboratories, Murray Hill, N. J.

"THE STRESS-STEP METHOD OF OBTAINING SHORT-TERM LIFE RATINGS ON ELECTRONIC COMPONENTS" by A. P. Jerencsik and W. T. Sackett, Jr., Battelle Memorial Institute, Columbus, Ohio.

VIII—Waveguides

"ELECTROMAGNETIC PROPAGATION THROUGH WAVEGUIDES OF RHOMBICAL CROSS-SECTION" by W. B. Swift and T. J. Higgins, University of Wisconsin, Madison, Wis.

"ELECTROMAGNETIC TRANSIENTS IN WAVEGUIDES" by G. I. Cohn, Illinois Institute of Technology, Chicago, Ill.

"CUT-OFF FREQUENCY FOR CIRCULAR WAVEGUIDES CONTAINING TWO COAXIAL DIELECTRICS" by R. D. Teasdale, Radio Corporation of America, Camden, N. J.

"DUO-DIELECTRIC COAXIAL WAVEGUIDE" by R. E. Beam and D. A. Dobson, Northwestern University, Evanston, Ill.

"HIGH POWER DELAY LINE FOR A TRAVELING WAVE AMPLIFIER OR OSCILLATOR" by J. F. Hull and G. Novick, Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

TUESDAY, SEPTEMEBR 30

IX—Transistors

"JUNCTION TRANSISTOR CHARACTERISTICS AT MEDIUM FREQUENCIES" by L. J. Giacoletto, Radio Corporation of America, Princeton, N. J.

"PROPERTIES OF JUNCTION TRANSISTORS" by K. D. Smith, Bell Telephone Laboratories.

"A TRANSISTOR REVERSIBLE BINARY COUNTER" by R. L. Trent, Bell Telephone Laboratories.

"A LOOK AT RUSSIAN RADIO AND ELECTRONICS" by G. B. Devey, Office of Naval Research, Washington, D. C.

X—Radar & Radio Navigation

"CONTINUOUS INDICATING LORAN" by R. Williams, Sperry Gyroscope Co., Great Neck, L. I., N. Y.

"AUTOMATIC TRACK-WHILE-SCAN RADAR RANGE SYSTEM" by H. L. Schauer, Cook Research Laboratories, Skokie, Ill.

"A QUALITY FACTOR FOR RADAR CATHODE-RAY TUBE PRESENTATIONS" by A. F. Bischoff, General Electric Co., Schenectady, N. Y.

"PHASE AND GAIN STABILIZATION IN MATCHED CHANNEL RECEIVERS" by

(Continued on page 187)

Sponsors of the Eighth National Electronics Conference are:

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Computing with

Servo-Driven Potentiometers

Examination of linearity and loading effects in analog systems shows how errors may be eliminated. Practical circuit techniques include restriction of potentiometer range, preloading, and unloading with feedback amplifiers

By F. R. BRADLEY & R. D. McCOY*
Reeves Instrument Corp., 215 E. 91 St., New York 28, N. Y.

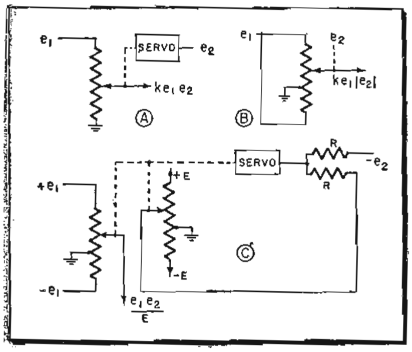


Fig. 1: Servo-driven potentiometer multiplier types: (A) basic, (B) absolute, (C) follow-up

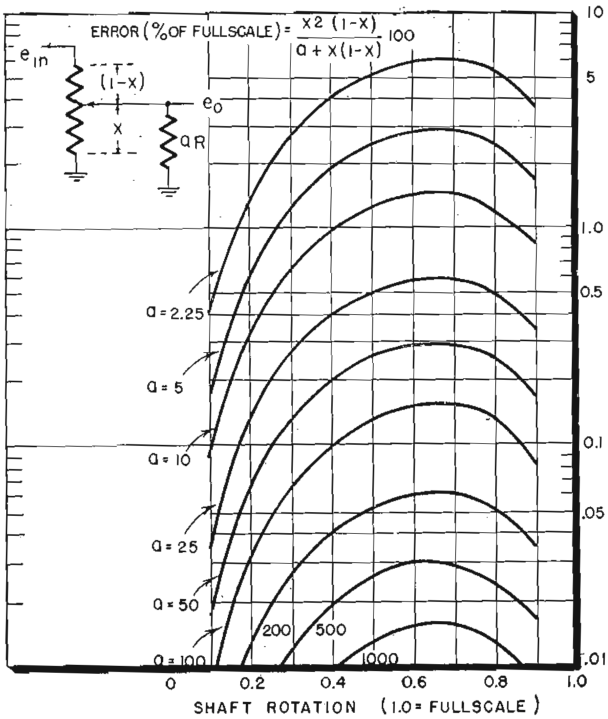
ALTHOUGH electronic multipliers of very good accuracy have recently been developed (see Bulletin RICO-10 for Reeves Electronic Multiplier EM-101), in analog computation the primary method of performing nonlinear operations continues to be the servo. This article will touch briefly on the important considerations involved in computing with servo-driven resistance potentiometers including a good deal of material on the unloading problem and a discussion of the most effective ways of using feedback amplifiers to achieve multiplication and division in a manner that is almost completely free of loading error.

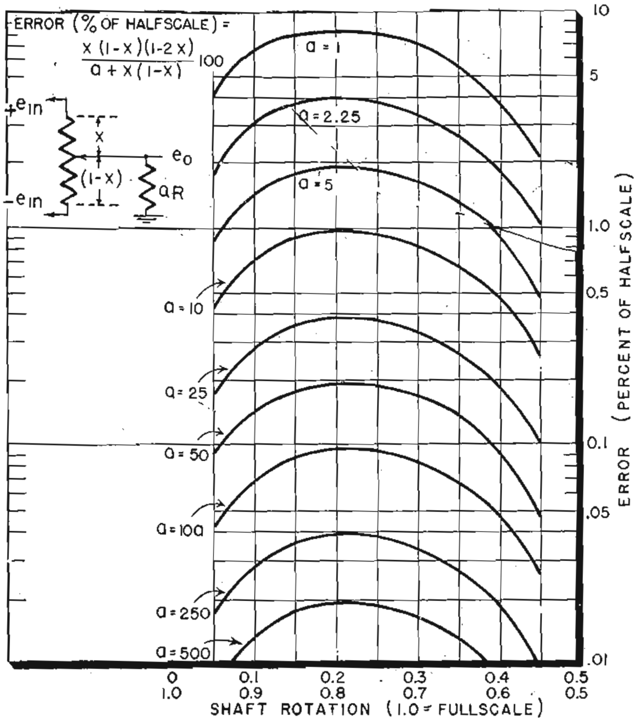
The procedure for multiplying variables consists of exciting a servo-driven potentiometer with one variable voltage and positioning the potentiometer arm in accordance with the other variable voltage (see Fig. 1a). The voltage at the arm is proportional to both voltages and accordingly to their product. The proportionality constant is equal to the reciprocal of the full scale value of e_2. Fig. 1c shows, in block diagram form, a potentiometer follow-up type of servo multiplier, called a four-quadrant multiplier since both variables can change signs. An occasionally helpful device is indicated in Fig. 1b where an absolute value term is generated.

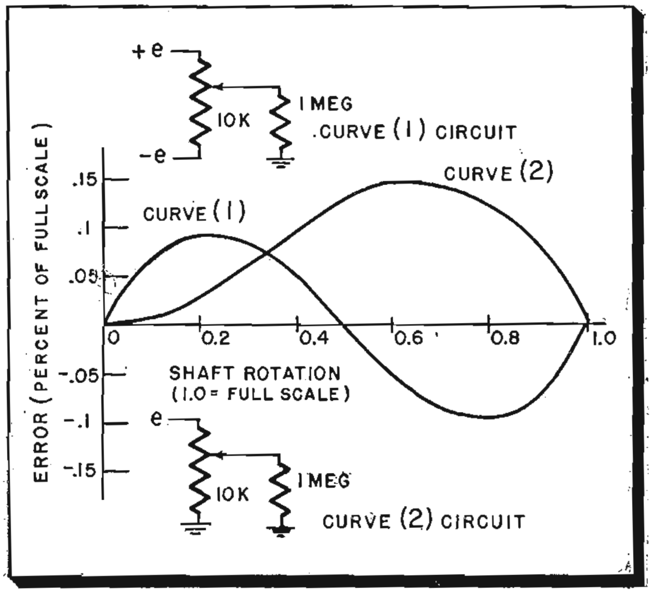
Note that the potentiometers of Figs. 1b and 1c are center-tapped and that the center-tap is grounded. This serves to minimize potentiometer linearity errors by establishing three points on the potentiometer at the correct potential instead of two. The grounded center-tap is particularly desirable in applications where the computer operates at low levels of the variables since at low levels the scale factor error is relatively large compared to the signal;

*Mr. Bradley is presently with Hillyer Instrument Co., 54 Lafayette St., New York 13, N.Y.

Fig. 2: (l) Curves of output error as a function of load and shaft rotation for the circuit shown. Fig. 3: (r) Curves and circuit similar to Fig. 2







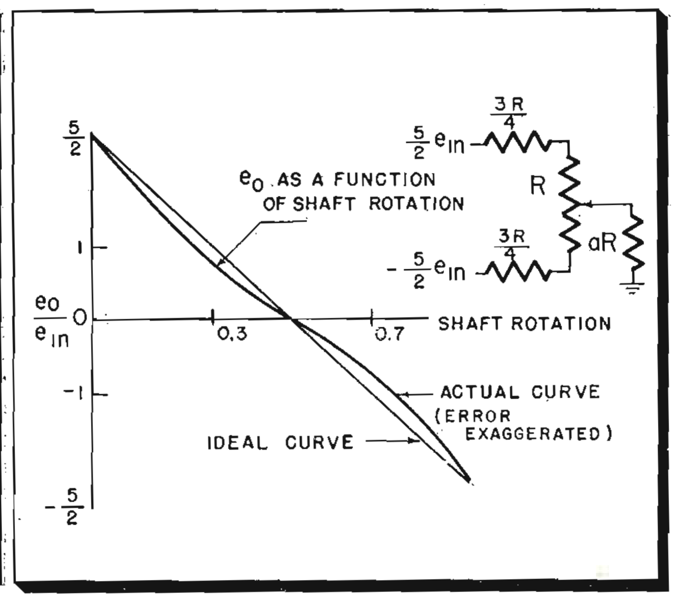


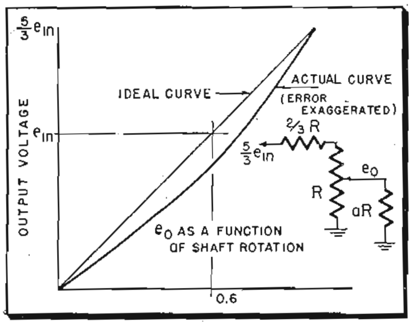
Fig. 4: (l) Loading error as a function of shaft rotation. Note linear segment of curve (1). Fig. 5: (r) Restricted range loading error curve

the center tap provides accuracy near zero where it is needed.

The grounded center-tap is desirable in ac computers for an additional reason. A characteristic of wire-wound potentiometers, particularly helical potentiometers, is stray capacitance between the winding and the core wire of the winding, and stray inductance due to the winding itself. (Much useful related data is given in the catalog "Helipot Precision Potentiometers.") This capacitance and inductance effect produces a quadrature voltage in the computing signals which has a detrimental effect upon computing accuracy. Grounding the center-tap reduces the average and maximum resistance to ground from the potentiometer arm (average over the potentiometer range), and also the stray reactance to ground, materially reducing the quadrature component.

Linearity: Computing potentiometers, as a class, are characterized by the high accuracy with which the resistance division is some specified function of shaft rotation. In multiplication, for example, the overall resistance tolerance is relatively insignificant; the computing is accomplished with the linear relationship between resistance division and shaft rotation. Multi-turn or helical potentiometers are now commercially available in linearity tolerances of ±0.025%. This means that it is possible to draw a straight line from which the resistance division as a function of shaft rotation will not vary by more than 0.025%. By special, and very expensive means, it is possible to achieve linearities of the order of 0.001%. This linearity is too expensive to obtain for use in anything but a standard, but potentiometers of 0.01% linearity can be obtained by special selection and, if necessary, external resistance padding at a number of taps.

Fig. 6: Restricted range loading error curve for curve (2) of Fig. 4 using 0 to 0.6 region



Resistance Tolerance

The resistance tolerance is, for most applications, not critical. For use as a voltage divider the tolerance does not matter and in feedback application (see Fig. 10) the associated components can easily be adjusted to compensate for any variations.

It is occasionally necessary that one limit of the potentiometer travel be at a specified voltage, say ground, i.e., that the theoretical line from which the linearity error is determined, pass through the point (0,0). Care should be exercised in the purchasing of potentiometers for these applications inasmuch as linearity accuracies are normally specified in terms of the best theoretical line than can be drawn rather than the best line through a given point. Also, in this case, potentiometer end resistance (the resistance between the moving contact and the end terminal when the contact is at the end of its travel) should be less than the linearity tolerance.

Resolution and Noise: In any wire-wound resistance the change in voltage as the contact moves along occurs in steps due to the individual turns of wire. The best obtainable resolution is slightly better than the reciprocal of the number of wire turns because of interpolation by the brush wiper. This also sets a lower limit to the linearity tolerance, which cannot be less than half the voltage step which occurs. In practical cases, therefore, greater linearity accuracies are feasible in the higher resistance units where more turns of smaller diameter wire are used in multi-turn potentiometers. The steps which occur in resistance division as the contact moves from turn to turn are referred to as resolution noise, and are the absolute lower limit of potentiometer noise.

There is an additional component of noise due to changes in contact resistance as the contact moves from turn to turn due to foreign material, changes in pressure or other minute variations. A primary source of noise is oxidation or corrosion of the resistance wire due to atmospheric conditions. Once its resistance mandrel has become oxidized, a potentiometer is normally no longer useful although it may sometimes be salvaged by a careful buffing operation using a medium hard felt buffing wheel with no abrasive and holding the potentiometer so that the buffing wheel turns in the direction in which the wire is wound.

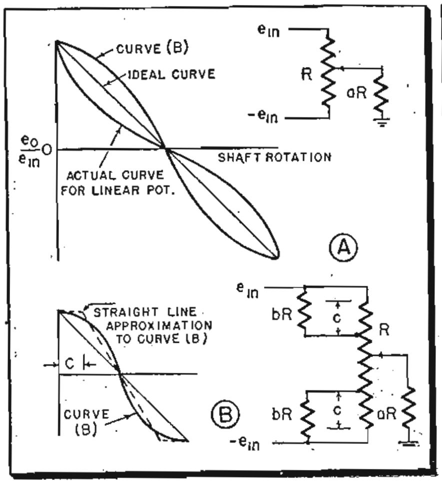
Loading Effects

Loading error is the error in voltage division of a potentiometer due to the finite magnitude of the impedance into which the potentiometer works. This error must be less than the linearity tolerance of the potentiometer if the potentiometer is to be properly used, otherwise a less linear (and less expensive) potentiometer should have been specified. Obviously, within reason, the potentiometer should be as small as its source voltage is capable of driving and the load resistance should be as large as practicable. In cases where this is not sufficient to reduce loading error to an allowable limit, other means must be found. Fig. 2 is a family of curves indicating the percent of full scale error in output voltage as a function of load resistance and of shaft rotation for the potentiometer circuit shown.

Fig. 3 is a similar family of curves for a different method of potentiometer excitation. Note that the error of Fig. 3 is percent of *half* scale. In each case the output voltage is reduced in absolute magnitude by the loading effect. Note that the error changes sign at the center of the potentiometer. If the potentiometer of Fig. 3 has a grounded center-tap, the circuit reduces to two circuits of the type indicated in Fig. 2.

Reducing Loading Error

There has been some investigation of the effects of loading (See "Reducing Potentiometer Loading Error," by L. A. Nettleton and F. E. Dole, *Review of Scientific Instruments*, May, 1947), but rather little information about methods for appreciably reducing loading error other than that of using some sort of buffer amplifier having the requisite high input impedance and a closely specified gain (the specified gain to preserve computing accuracy). The remainder of the discussion will be devoted to three methods of reducing loading error by an appreciable factor without the use of a buffer amplifier and a fourth method using feedback amplifiers which virtually eliminates loading effects and is superior to the buffer amplifier approach.



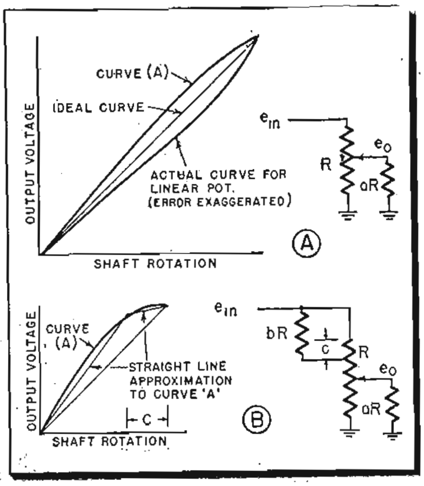


Fig. 7: (l) (A) Curve (2) of Fig. 4 and theoretical curve. Error compensated by preloading (B) with padding resistor. Fig. 8: (r) Similar preloading for curve (1) of Fig. 4 requires two resistors (B)

Potentiometer Follow-Up Servos: In the case of potentiometer follow-up servos, there is a particularly simple means of eliminating loading error. It consists of loading the follow-up potentiometer in the same manner as the associated multiplying potentiometers are loaded. Then the follow-up potentiometer, in the process of nulling the input voltage, is itself offset by an amount sufficient to compensate for the loading (as are all the multiplying potentiometers). Note that a linearly calibrated servo dial does not then indicate the correct input quantity.

Restriction of Range: A very effective means to minimize loading error is to restrict the potentiometer range. If, as is occasionally possible in computing applications, the input voltage can be made larger by a factor, or if the output voltage can be reduced by a factor, it is possible to place resistors in series with the potentiometer in such a manner that the loading error is a relatively linear function of shaft rotation. This can best be illustrated by graphical means. Fig. 4 is a plot (in linear coordinates) of the loading error as a function of shaft rotation for a specified case using the two previously considered methods of potentiometer excitation. It may be observed that from 0.3 to 0.7 (shaft rotation) curve (1) has a fairly linear segment. A circuit is set up as in Fig. 5 where the input voltage is larger by a factor of 2.5 (if e_{in} were not changed the output voltage would be reduced by the same factor). This restricts the potentiometer to an almost linear loading error range which gives a relatively linear output voltage as a function of shaft rotation, as indicated in Fig. 5. In the case given and for a=10, a maximum deviation from linearity of 0.22% (of *half* scale) is obtained by restricting the range.

The technique can similarly be applied to curve (2) of Fig. 4 using the region from 0 to 0.6 (shaft rotation) as indicated in Fig. 6 to obtain a maximum non-linearity of approximately 0.2%.

(*Continued on page* 189)

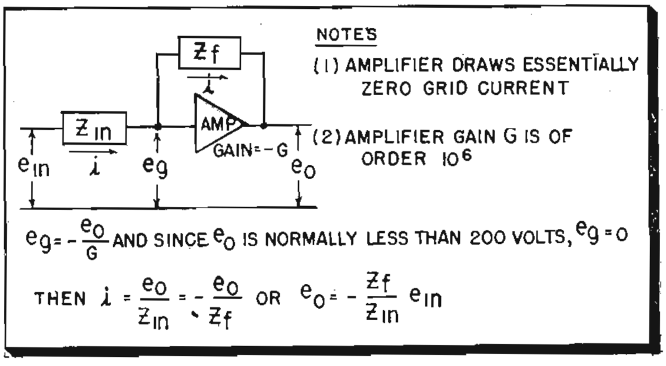
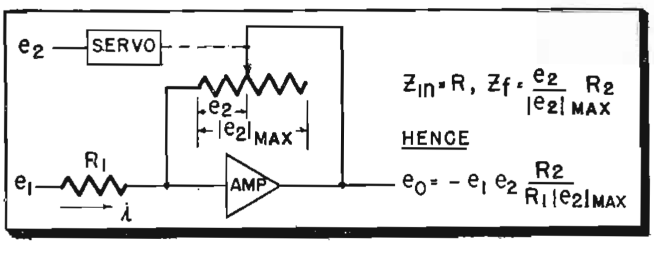


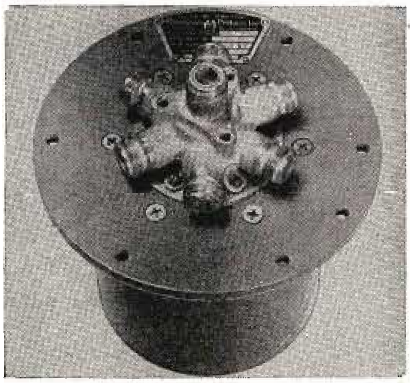
Fig. 9: (l) Basic analog circuit has high-gain phase inverting amplifier with feedback. Fig. 10: (r) Zero source impedance multiplying circuit depends on virtual ground at amplifier input



NEW EQUIPMENT for Designers and Engineers

Coaxial Switch

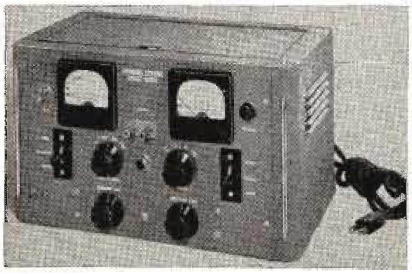
A high performance r-f coaxial switch is actuated by a 115 v., 60 CPS ac motor and meets ground military performance speci-



fications. At frequencies to 10,750 MC, this switch has a maximum VSWR of 1.5 and 0.2 db insertion loss. At 3,000 MC, crosstalk is in excess of 55 db. Power handling capabilities are 100 watts continuous cw at 3,000 MC. Actuation time is less than 1.0 sec., with a minimum life of 50,000 cycles—**Thompson Products, Inc., Electronics Division, 2196 Clarkwood Road, Cleveland 3, Ohio**—TELE-TECH.

Diode Tester

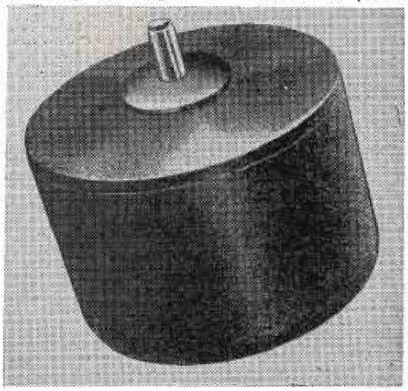
The new CRC diode tester tests both forward and back characteristics under static and dynamic conditions. Where large numbers of diodes are used in plug-in form, it



can also be used for periodic circuit checks to detect potential diode failures before they occur. Occupying a space less than one-half cubic foot, it will accomodate diodes with forward currents of 0 to 100 ma and back currents of 0 to 1,000 μa. Forward voltage is measured to an accuracy of 2% and back current to 3%. The tester is adaptable to high speed, volume testing and operates on 115 v., 60 CPS current, using 100 watts or less.—**Computer Research Corp., 3348 W. El Segundo Blvd., Hawthorne, Calif.**—TELE-TECH

Stepping Positioner

The Roto-Stepper (stepping positioner) has sufficient torque to drive many low torque mechanisms. It will rotate in unlimited clockwise and/or counter-clockwise directions. It is a solenoid-operated mechanism normally rotating in 2° increments (other



increments if desired). Suitable for operating indicators, potentiometers, selsyns, synchros, switching deviees and many other low-torque mechanisms, it features a 24 v. system, long-life solenoids and can be ordered in the following combinations with or without shaft output: shaft output, shaft output with potentiometer output, shaft output with potentiometer output and homing segments; shaft output with potentiometer output, homing segments and internal auto-cycling. It responds to a maximum of 720 impulses per minute with min. pulse length of 0.05 secs. (up to 30 pulses per second, depending on torque). Torque output varies with pulse rate approximately 12 in. oz. at 12 pps. Current is 0.6 amps max. at rated voltage at 25°C. Torque detent spring prevents reverse rotation of output shaft for torque not exceeding 1.5 oz. in. Acceleration meets specs during ±6G steady state acceleration in 3 major axes for 15 minutes max. Vibration meets specs during 0.020 in. double amplitude sinusoidal vibrations of 10 to 55 CPS along three major axes for 15 minutes max.—**G. M. Giannini Co., Pasadena, Calif.**—TELE-TECH

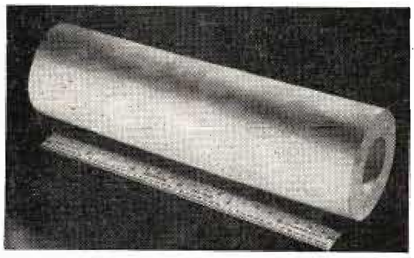
Magnetic Memory Components

Two saturable reactors for magnetic memory units are useful for computer applications. Weighing less than four grains each,

the complete reactor measures less than 0.25 in. diameter and 0.052 in. thick. The coil is wound on a ferritic core and is impregnated with potting compound. Part No. A1137 stores information in 8 μsec and reads out in 3 μsec. Read-in or read-out require 7 x 10^{-7} watt-sec. Part A1138 stores information in 0.8 μsec and reads out in 0.5 μsec, requiring only 4 x 10^{-7} watt-sec.—**Jacobs Instrument Co., Bethesda, Md.**—TELE-TECH

Discharge Capacitor

A new type ultra-high speed discharge capacitor has the characteristics of 30 ft. of solid coaxial transmission cable. The size



of the tube is 2 in. in diameter and 6½ in. long. When used in the same manner as the coaxial cable, charged to 10,000 v. and discharged across a spark gap, the capacitor tube improves light intensity 900 times. It is made of hi-K ceramic (K-2000), silvered inside and out. It has a capacitance rating of at least 0.024 μf., and immersed in transformer oil is rated at a working voltage of 20,000 v. dc. The unit has a decay time, peak-to-peak, of 2 x 10^{-7} sec., a rise time, zero-to-peak, of 2 x 10^{-7} sec., and 50% of peak limits occur in a period of 1.8 x 10^{-7} sec. Leakage resistance is in excess of 10,000 megohms, and dielectric strength is approximately 35 v. per mil.—**Centralab Division of Globe-Union Inc., 900 East Keefe Ave., Milwaukee 1, Wisconsin**—TELE-TECH

Precision Resistors

Series "E" Hycor precision resistors are designed for use in applications requiring accuracy, stability and long life under con-

ditions of extreme temperature variation plus moderately high humidity. For a slight additional cost they are supplied "tropicalized" against extreme humidity and fungus growths. The resistors are noninductively wound on nonhygroscopic ceramic bobbins with resistance wire having the lowest temperature coefficient available. Resistances of over 800 ohms are wound with "Evanohm" alloy; those under 800 ohms are wound with "Manganin." Both Alloys produce exceptionally low thermal EMF against copper. Standard tolerance is 1%. Tolerances up to 0.05% may be supplied at additional charge. Resistors wound with alloys having special temperature coefficients are available upon request.—**Hycor Company, Inc., 11423 Vanowen St., North Hollywood, Calif.**—TELE-TECH

Band Pass Filter

Model 310-A adjustable band-pass filter with unity pass gain and 24 db/octave slopes outside the pass band is useful in the audio

and ultrasonic frequency range for noise measurements, harmonic and frequency analysis. A peaking factor is used to reduce the attenuation at the cut-off frequencies. Both the high and low cut-off frequencies are independently adjustable from 20 CPS to 200 KC. This provides maximum flexibility of adjustment of both the band center frequency and the band width. The unit measures 12 x 7 x 8 in. and sells for $275.00. —**Krohn-Hite Instrument Co., 580 Massachusetts Ave., Cambridge 39, Mass.**—TELE-TECH

Hermetically Sealed Relay

A new, hermetically sealed miniature relay meets Joint Air Corp and Navy specification ANE-19, and will withstand pres-

sures without leakage up to 85,000 ft. It will also withstand 10 G's vibration with a minimum available power of 500 mw. Coil resistances are available up to 16,000 ohms. Relays are available either in SPDT or DPDT with contact material either pure silver rated at 1½ amps or Palladium rated at 3 amps.—**Advance Electric and Relay Co., 2435 N. Naomi Street, Burbank, Calif.**—TELE-TECH

Cinch SUB-MINIATURE SOCKETS

(Shown enlarged twice)

. . . STANDARD IN COMMERCIAL USE . . . SERVE MILITARY NEEDS

The CINCH sub-miniature socket insures positive electrical contact, holds tubes securely in place, permits easy maintenance and replacement, yields maximum insulation resistance and minimum high frequency loss. And provides manufacturers of electrical controls, transmitters, receivers, transceivers, airbourne equipment, etc., and hearing aids . . . a labor saving chassis installation which serves terminal board functions while permitting designers to obtain maximum space afforded by the standard flat base tubes. For mounting perpendicular tubes, retainer rings and saddles are available, when socket cannot be staked. Available in quantities because CINCH's extensive and modern molding facilities for mica filled low loss bakelite. Contacts silver plated beryllium copper. For the Standard sub-miniature socket in quantity, quickly,

CONSULT CINCH.

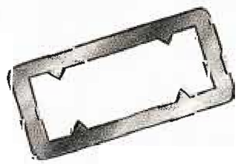
(Above) Small button sub-minar 8 pin with saddle shown enlarged twice.

Sub-miniature (above right, shown enlarged twice) for Small button Sub-minar 8 pin base T3 tubes mounted perpendicular to chassis.

Five pin stem type (above) for mounting tubes parallel to chassis and for printed circuits.

Five, six and seven pin stem type for tubes vertically mounted. (below)

RETAINING RINGS AND ALL SUB-MINIATURE SOCKETS SHOWN ENLARGED TWICE



Cinch ELECTRONIC COMPONENTS

CINCH MANUFACTURING CORPORATION

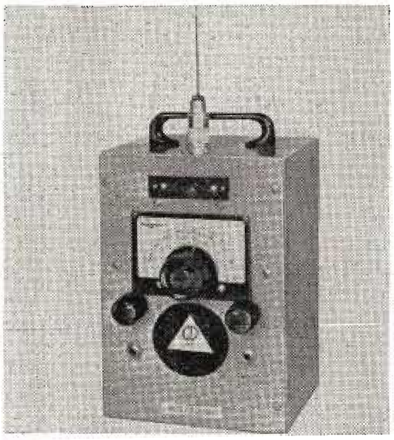
1026 South Homan Ave., Chicago 24, Illinois

Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.

Cinch components are available at leading eletronic jobbers— everywhere.

Portable Transceiver

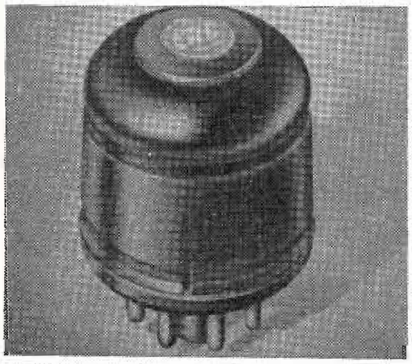
A complete transmitting and receiving set, weighing 7 lbs., can be plugged into an ordinary 110 v. receptacle or into the cigar



lighter of an automobile. The range covers up to 40 miles. The new CD 144 is so compact in design it measures only 6½ x 6 x 9½ in. and is equipped with a 19 in. whip antenna. There is a jack suitable for coupling to other antennas. The unit contains complete line isolated power supply and vibrator, a built-in noise limiter, and crystal controlled transmitter using the newest miniature tubes. Its two-meter band is calibrated for 143.8 to 148.1 MC—**Deltronic Co., 9010 Bellanca Ave., Los Angeles, Calif.**—TELE-TECH

Ferro-Resonant Flip-Flop

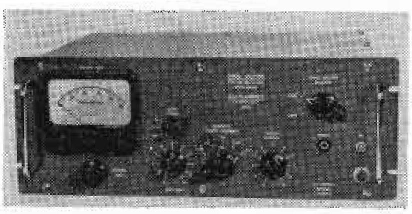
A new, model MC, 100 KC ferro-resonant flip flop is said to have the durability, economy of power, and low heat dissipation of the



saturable reactor, and at the same time is small, simple and inexpensive. It will operate on approximately 10% of the power needed by a vacuum tube, and can deliver more than 90% of the input energy as usable output, since copper and core loss are the only causes of power consumption. By using non-dissipating reactive elements the problem of heat dissipation is virtually eliminated. The new MC flip flop will not wear or burn out, and can be mounted in any circuit. It is also immune to high acceleration and shock.—**Applications Division, Computer Research Corp., 3348 W. El Segundo Blvd., Hawthorne, Calif.**—TELE-TECH

Signal Splitter

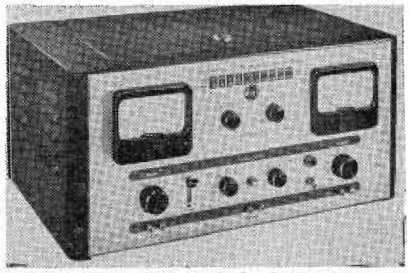
Signal-splitter type MCL-10-VBX is a selectable single-side-band converter, rejecting the side-frequencies containing the unwanted carrier. Low r-f intermodulation distortion and variable bandwidth is featured. Up to seven selectivity switch positions in either sideband, provide a total of 14 useful single-sideband-widths of from 100 CPS out to 10,000 CPS for reception of CW to broadcast-quality AM transmissions through jamming. It will separate two car-



riers on the same "assigned" frequency and attenuate the unwanted one 60 db when the frequency difference is only .005% at carrier frequencies of 15 MC or more. Distortion caused by selective-fading and high-percentage modulation is greatly reduced by means of carrier accenter circuit which raises the signal's carrier 20 db above the sidebands.—**J. L. A. McLaughlin, P. O. Box 529, La Jolla, Calif.**—TELE-TECH

Intermodulation Meter

Model IM-3B intermodulation meter features compactness, simplified operation, high stability, and reduced weight. It is provided with high impedance input terminals for bridging at any point within an amplifier. Consequently, the contribution of any stage to the total intermodulation factor may be readily determined. A vacuum-tube voltmeter is provided, having a flat frequency response throughout the range of the instrument, and a sensitivity of 10 mv full scale. The lowest full-scale intermodulation reading is 1%, and the inherent intermodulation of the instrument is less than



0.1%. Price is $650.00 f.o.b. Santa Barbara, Calif. Special models for telemetering applications are available at additional cost.—**D & R, Ltd., 402 E. Gutierrez Street, Santa Barbara, Calif.**—TELE-TECH

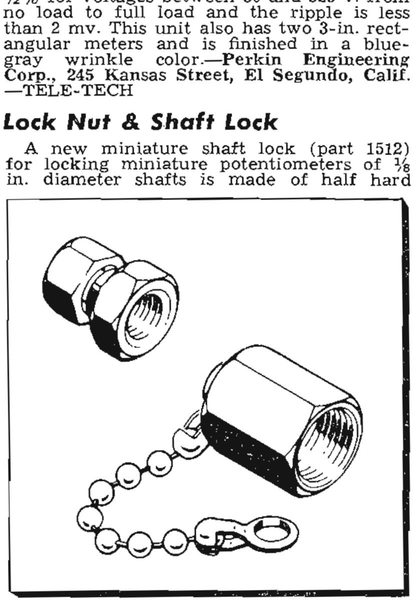
Power Supply

A continuously variable 0-325 v. electronic regulated dc power supply (Model M30) has a dc current rating of 150 ma and also

is equipped with a low voltage ac output of 6.3 v. at 6 amps. Voltage regulation is within ½% for voltages between 30 and 325 v. from no load to full load and the ripple is less than 2 mv. This unit also has two 3-in. rectangular meters and is finished in a blue-gray wrinkle color.—**Perkin Engineering Corp., 245 Kansas Street, El Segundo, Calif.**—TELE-TECH

Lock Nut & Shaft Lock

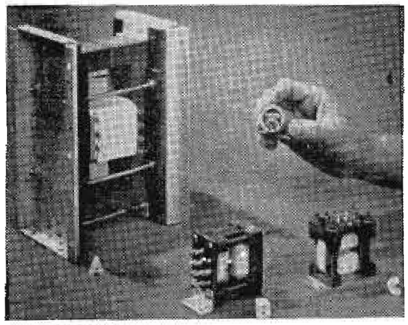
A new miniature shaft lock (part 1512) for locking miniature potentiometers of ⅛ in. diameter shafts is made of half hard



brass, nickel plated. It is an exact miniature of standard shaft lock (part 1510) which is for ¼ in. diameter shafts. A new lock nut and dust cap (part 1514) can be used with the standard shaft lock (1510). A chain prevents dropping or misplacing nut while making adjustments. It is also made of brass and nickel plated.—**U. S. Engineering Co., 521 Commercial St., Glendale 3, Calif.**—TELE-TECH

Ferrite-Core Transformers

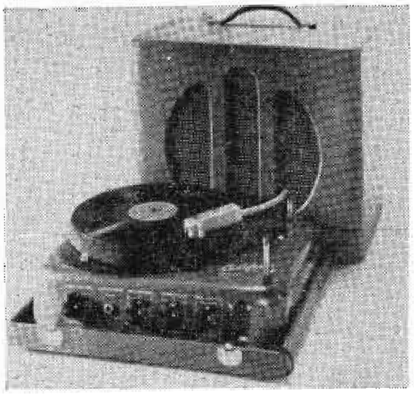
New design techniques based on ferrite magnetic cores and tetrafluoroethylene insulation have resulted in a line of specialized



transformers giving application advantages: (1) where r-f circuitry requires impedance matching over a wide impedance and/or frequency range, and (2) where r-f or audio applications require electrostatic shielding between windings, extremely high voltages, or especially small dimensions. A grid-driving transformer (A in photograph) with 600-ohm input for 3 kw, 1350 v. rms, 2.24 amp has an output of 4500 v. rms across 6750 ohms. Response is flat within 0.1 db from 30 KC to 1.2 MC and efficiency at 30 KC is 98%. A high-voltage grid-driving transformer (B in photograph) with 50-ohm input for 2.5 watts, 11.1 v. rms has a double 100-v. rms output from two windings separated by 3300 v. rms. Response is flat within ± 1.5 db from 30 KC to 2 MC. A push-pull output transformer (C in photograph) with 4-watt input and output to a 50-ohm line has a response which is flat within 1 db from 20 KC to 1 MC. Line-balancing transformer (shown in hand) has a 500-ohm unbalanced input to 500-ohm balanced output. Response is flat within ±3 db from 13 KC to 4.5 MC. In these types the core material and insulation used combine high efficiency with low leakage inductance and low distributed capacitance resulting in roughly a four-times increase in voltage-handling capacity over an equivalent conventional iron-core transformer. Leakage reactance of these types runs approximately 10% that of equivalent conventional transformers. Size and weight are generally less than those of conventional types. Functionally, the transformers are capable of operation with internal temperatures up to 160°C and their construction makes them impervious to damage by moisture absorption or fungus attack.—**Sierra Electronic Corp., 817 Brittan Ave., San Carlos, Calif.**—TELE-TECH

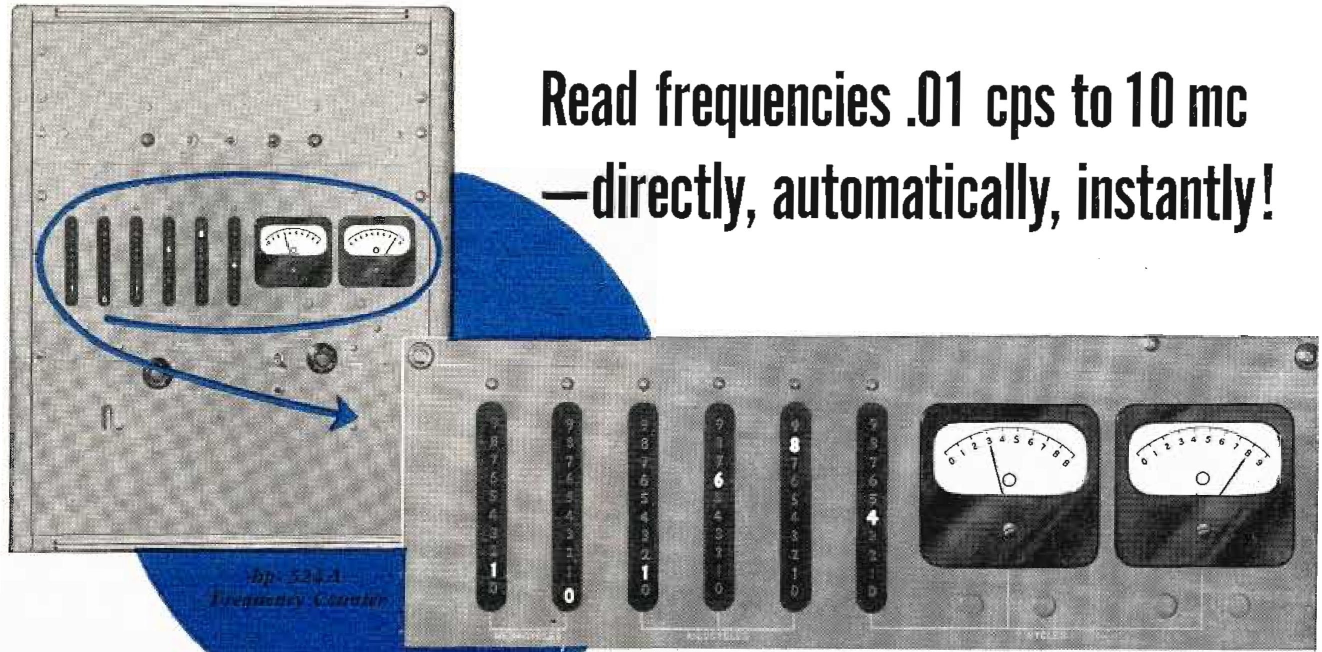
Transcription Players

To enhance the tone quality of 12MU-P2 and 12MUV-P2 transcription players, increased bass emphasis at 50 CPS and bass



compensated volume controls are incorporated on the new players. Other features include: low weight, 3-speed heavy duty weighted turntables, and adjustable needle pressure wrist-action pickups, for 7 to 17 in. recordings. The 12MUV-P2 is equipped with an improved adaptation of Califone patented "Varipole" variable speed control which provides a continuous control of the turntable speed from 25% below normal to 10% above normal with full torque over the entire range. Model 12MU-P2 is priced at $109.50, and the model 12MUV-P2 at $122.50 —**Califone Corp., 1041 N. Sycamore Ave., Hollywood 38, Calif.**—TELE-TECH

Read frequencies .01 cps to 10 mc —directly, automatically, instantly!



Unknown counted, displayed instantly, directly on front panel. Example counted here, 10,168,438

- **Measures frequency or period**
- **Direct reading, no calculations**
- **No complex equipment set-up**
- **Easy for non-technical personnel**
- **Accuracy 1/1,000,000 ±1 count**

-hp- 524A FREQUENCY COUNTER is the first commercial equipment to display directly and instantly any unknown frequency from .01 to 10,000,000 cps. It performs all functions of a frequency standard, interpolating system and detector; in frequency determination work, it eliminates need for amplifiers, oscillators, multivibrators and oscilloscopes. The instrument has a wide variety of uses including transmitter and crystal frequency measurement, filter characteristic determination, oscillator calibration, r.p.m. determination (to 600,000,000 r.p.m.) frequency drift, random events per unit time, etc. It also serves as a precision frequency standard.

FREQUENCY, PERIOD READINGS

For high frequencies, *-hp-* 524A counts and displays unknown frequencies over time intervals of 10, 1, 0.1, 0.01, and 0.001 seconds. Counting and display periods are equal and automatically cycled. Count is displayed repetitively, or "held" by pressing "manual" button.

For low frequencies, the instrument measures period or duration of one low-frequency cycle in microseconds. A 10 cps sample is taken to establish this period. As in frequency counting, periods may be displayed repetitively or "held".

CIRCUIT

-hp- 524A operates on pulse counting techniques. Unknowns are applied through a wide-band squaring amplifier to a fast gate controlled by a time base generator. When the gate is open, unknown is applied to counting circuits. When gate is closed, circuits remember and display frequency in cps or period in microseconds. Time base circuits are controlled by a high-stability crystal oscillator.

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

BRIEF SPECIFICATIONS

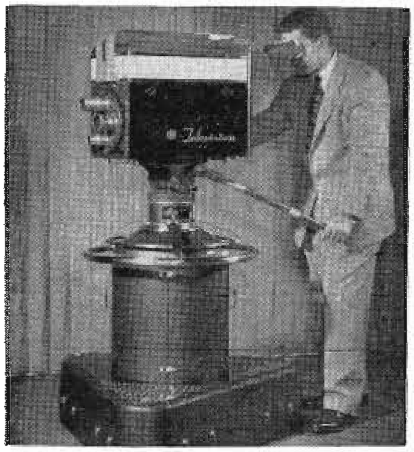
COUNTING RATE: 10 mc maximum.
PRESENTATION: 8 places, direct reading.
COUNT PERIOD: 0.001, 0.01, 0.1, 1, 10 sec.
LOW FREQUENCIES: Permits low frequencies to operate as time base. Duration of one cycle is displayed in microseconds.
ACCURACY: ± 1 count ± 2/1,000,000 per week. (Higher accuracy external standard may be employed.)
PERIOD MEASUREMENT: Within 0.3% up to 300 cps: within 1 μsec between 300 cps and 10 kc.
EXTERNAL 100 KC TIMING CIRCUIT: For higher accuracy. Requires 1 v across 50,000 ohms shunted by 30 μμfd.
INPUT VOLTAGE: 1 v peak minimum.
INPUT IMPEDANCE: Approx. 100,000 ohms, 30 μμfd shunt.
CONNECTORS: Standard BNC type.
POWER SOURCE: 115 v, 50/60 cps, 400 watts.
SIZE: Approx. 28" high, 21¾" wide, 14" deep. Weight 115 lbs. Shipping weight 175 lbs.
PRICE: $2,000.00 f.o.b. factory.
Data Subject to Change Without Notice

hp ELECTRONIC MEASURING INSTRUMENTS

HEWLETT-PACKARD COMPANY 2456-T PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.

TV Camera Pedestal

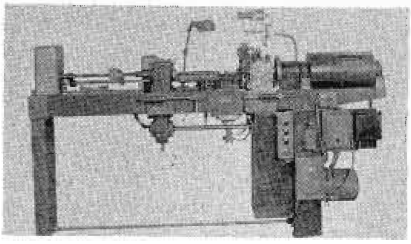
Model PD-3 TV camera pedestal facilitates smooth, running dolly shots, raising and lowering of the camera while on the air,



and smooth horizontal and vertical panning when used with the Houston-Fearless friction head. A steering wheel, which is directly below the camera at all heights, guides the three sets of dual wheels. Two types of steering are available: synchronous steering (all wheels are locked parallel and turn simultaneously for tracking in a straight line.); tricycle steering (steer only forward wheels with steering wheel, back wheel is free). Change may be made instantly from one type of steering to the other without displacement of camera. The camera is carefully counter-balanced with adjustable weights. No cranking is required. Both raising and lowering or drag adjustment can be made anywhere in the 360° position of the pedestal without stooping or bending.—**Houston-Fearless Corp., 11805 W. Olympic Blvd., Los Angeles 64, Calif.**—TELE-TECH

Grid Winder

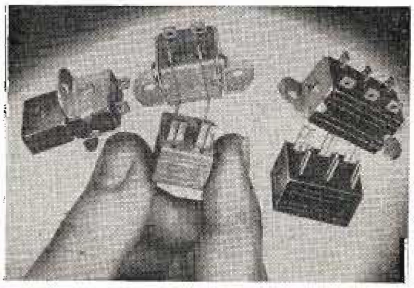
Model 1998 automatic precision grid winder for 500 tpi and over makes grids up to ⅞ in. diameter or width. Operating speed is



1000 rpm, both right and left hand. Spool carriage rides in own two bearings and is dynamically balanced. Lubrication is provided by automatic Bijur system, and mandrel head, draw spindle and cam shaft drives are sealed and run in oil bath. Pneumatic cutter rises, cuts and recedes automatically, leaving mandrel completely accessible. Instant clutch-gear operation and exact registry by always-engaged lead screw and nut are assured. Hysteresis-magnetic brake controls wire tension. Other features include precision adjusted knives, side wire swaging, and smooth leg gapping, constant and variable pitch.—**Kahle Engineering Co., 1309A Seventh St., N. Bergen, N.J.**—TELE-TECH

Miniature Connectors

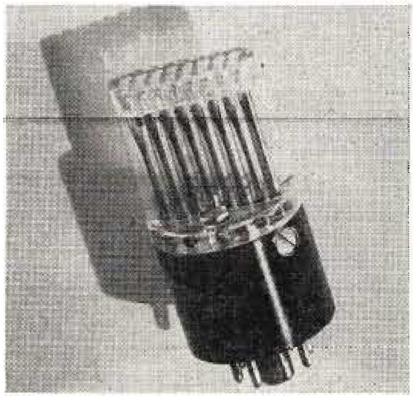
The new "Varicon" miniature connectors are rated at 30 amps. at 110 v., withstanding



voltage between closest terminals of 4000 v. Voltage is rated at 1330 v. Using only four basic components, it is possible to assemble male and female connectors with any required number of contacts. The connectors can be furnished assembled by Elco or can be put together by the user to suit his own requirements. Stocking only the four components, the user can produce finished connectors on a mass production basis and yet makes changes in the number of contacts or polarity of any connectors as needed. Male or female application is only a matter of assembly since the components for each are identical. In instances where more than one connector with the same number of contacts is to be used, control over polarity is achieved by many possible variations in the arrangement of contacts. The number of contact variations or combinations multiplies with the increased number of contacts used. Capacitance is negligible. Contact resistance is .0001 ohms and contact spacing is suitable for 300 ohm lines of brass, phosphor bronze on berrylium copper, all silver plated. Body sections are of molded phenolic in general purpose or mica filled and alkyd resins.—**Elco Corp., 190 W. Glenwood Avenue, Philadelphia 40, Pa.**—TELE-TECH

Adapter

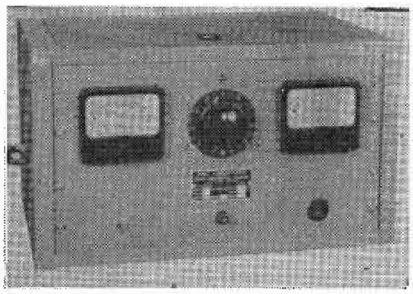
An Adapter for production testing of subminiature tubes fits the standard octal tube socket, and has provision for sub-miniature



tubes having up to eight leads of the "in line" type. Modifications or individual requirements may be specified.—**General Electrosonics, 32 W. 22nd St., New York 10, N. Y.**—TELE-TECH

Power Supply

Model MS168B power supply is rated at 0-30 v. and 15 amps., continuously with a ripple of less than 1% and a voltage regula-



tion of ± ½ v. from no-load to full-load. Selenium rectifiers and a magnetic amplifier circuit for voltage regulation are utilized. The cabinet is flexibly designed so that it is suitable for either 19 in. rack panel or bench cabinet mounting. Other features include 4½ in. rectangular meters, a continuously variable transformer and an 8 ft. heavy-duty line cord.—**Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.**—TELE-TECH

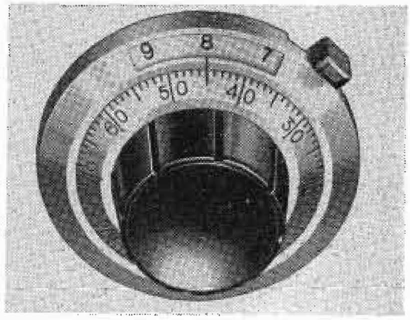
FOR MORE INFORMATION

on New Equipment for Designers and Engineers

See pages 106 and 184

Instrument Dial

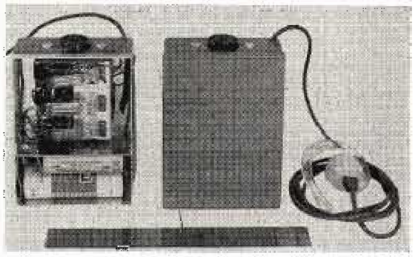
A new dial (model RA) for use with multi-turn instruments, especially helical potentiometers, features jump gearing of



the secondary dial, a large black nylon knob that eliminates hand capacitance, a vibration-proof lock, complete pre-assembly at the factory, and compact space-saving proportions. Numerals are of optimum size, recessed, black on satin chrome dial surfaces. To simplify readings, only three numbers of the secondary (outer) dial are visible at one time. They remain stationary until the primary dial, which is coupled directly to the potentiometer shaft, is about to complete a single revolution. At this point a jump gear automatically engages to turn the secondary dial to the next digit. Thus, the outer dial shows which turn the slider is on; the inner dial shows the position of the slider within a particular turn. When used with a 10-turn instrument such as the model A Helipot, direct reading of slider travel to three decimal places is immediately shown, and readings to four places can be readily interpolated.—**Helipot Corp., South Pasadena, Calif.**—TELE-TECH

VHF Paging Receivers

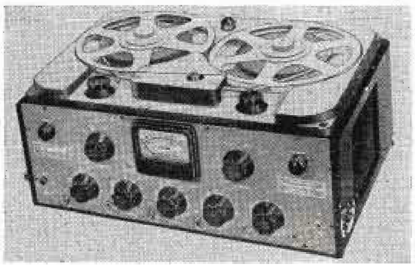
Two miniature AM receivers designed to operate between 25 and 50 MC will find use in paging, cueing, police and fire services.



Four-tube super-regenerative circuit provides sensitivity equivalent to 2 v at 50 ohms. Miniature "B" battery life is reported as over 100 hours. The 12-oz. model measures 1¼ x 2⅞ x 4 in., and uses the earphone cord as an antenna. The 8-oz. unit measures ⅞ x 1¾ x 4½ in. and is particularly suited for one-way radio paging. Transmitting and automatic announce equipment are also available.—**Budelman Radio Corp., 375 Fairfield Ave., Stamford, Conn.**—TELE-TECH

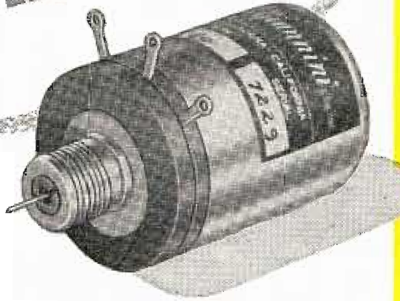
Dual Track Tape Recorder

Model 70 Tapesonic recorder has three speeds: 3.75, 7.5 and 15 ips. Rewind time for 2500 ft. reel is under one minute. Unit plays



5, 7 and 10.5 in. NAB reels, with frequency range of 40 to 15,000 CPS at 15 ips. Flutter and wow are 0.1% at 15 ips, 0.2% at 7.5 ips, and 0.25% at 3.75 ips. Push-pull nine tube amplifier delivers 12 watts to 8 in. speaker. Mixing channels for mike, radio and phono input are included. Mounted in portable carrying case measuring 16 x 23 x 11 in., device weighs 54 lbs. Price is $298.50.—**Premier Electronic Labs., 382 Lafayette St., New York 3, N. Y.**—TELE-TECH

AVAILABLE FOR IMMEDIATE DELIVERY!



MICROTORQUE*
POTENTIOMETER

You are now assured immediate delivery of the Microtorque* Potentiometer. As a new service to customers, a complete stock of resistance values as listed, is maintained to assure immediate delivery for prototypes, experimental work or emergency production. The Microtorque* is the solution where remote indicating, low torque (.003 oz. in.), jewel bearings and instrument quality are required.

SPECIFICATIONS

LINEARITY: ± 0.5% of total resistance.

MAXIMUM OPERATING SPEED: 100 rpm.

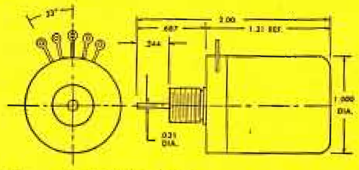
ACCELERATION: Will withstand 50G steady state acceleration in best axis.

VIBRATION: Will withstand 0.06" double amplitude sinusoidal vibration from 10 to 55 cps in best axis.

AMBIENT TEMPERATURE: Will function mechanically from −54° C. to + 71° C.

MOMENT OF INERTIA: 2×10^{-4} oz-in.^{2} (approx.)

TEMPERATURE COEFFICIENT OF RESISTANCE: .0006/° C. Max.



Following Microtorques* are available from stock in quantities of six or less:

RES. OHMS	STARTING TORQUE IN-OZ.	TURNS OF WIRE TYPE 2	TYPE 9	CURRENT** MA.	PRICE***
250	.006	350	450	57	$45.00
1,000	.004	500	650	28	$40.00
2,000	.004	700	750	20	$40.00
5,000	.003	900	1200	14	$40.00
10,000	.003	1,000	1300	10	$40.00
25,000	.003	1,000	1300	7	$45.00

**Must be de-rated for ambient temperature over 60° C

***Prices apply to quantities of six or less. For quotation on larger quantities or specialtypes, please write

Above Microtorques* are available in the following two types
Type 2: 270° ± 10° Electrical Rotation, Mechanical Rotation Limited by internal stops

Type 9: 354° Min. Electrical Rotation, Mechanical Rotation Continuous Brush does not short ends of coil

Giannini also produces potentiometers of various types, including non-linear functions, and tapped windings

Other Giannini Potentiometers that are available on special order; soon to be stocked.

Syncromount

Linear and functional outputs. Ball bearings; 1/4" shaft, 0.1 oz. in. torque. 500 to 100,000 ohms. 1.125" diameter x 1.16" long.

Rectipot

Straight-line motion along axis. Linear or functional outputs. 200 to 60,000 ohms. 5 sizes, 1" diameter from 2.33 to 6.54" long.

Syncromount JUNIOR

Linear and functional outputs. .078 shaft — miniature ball bearings. 7/8" diameter x 1" long, .01 oz. in. torque. 500 to 100,000 ohms.

Foremost manufacturer of toroidally-wound potentiometers. Where linearity, stability, rigidity, power dissipation and precision are required, toroid windings are outstanding performers.

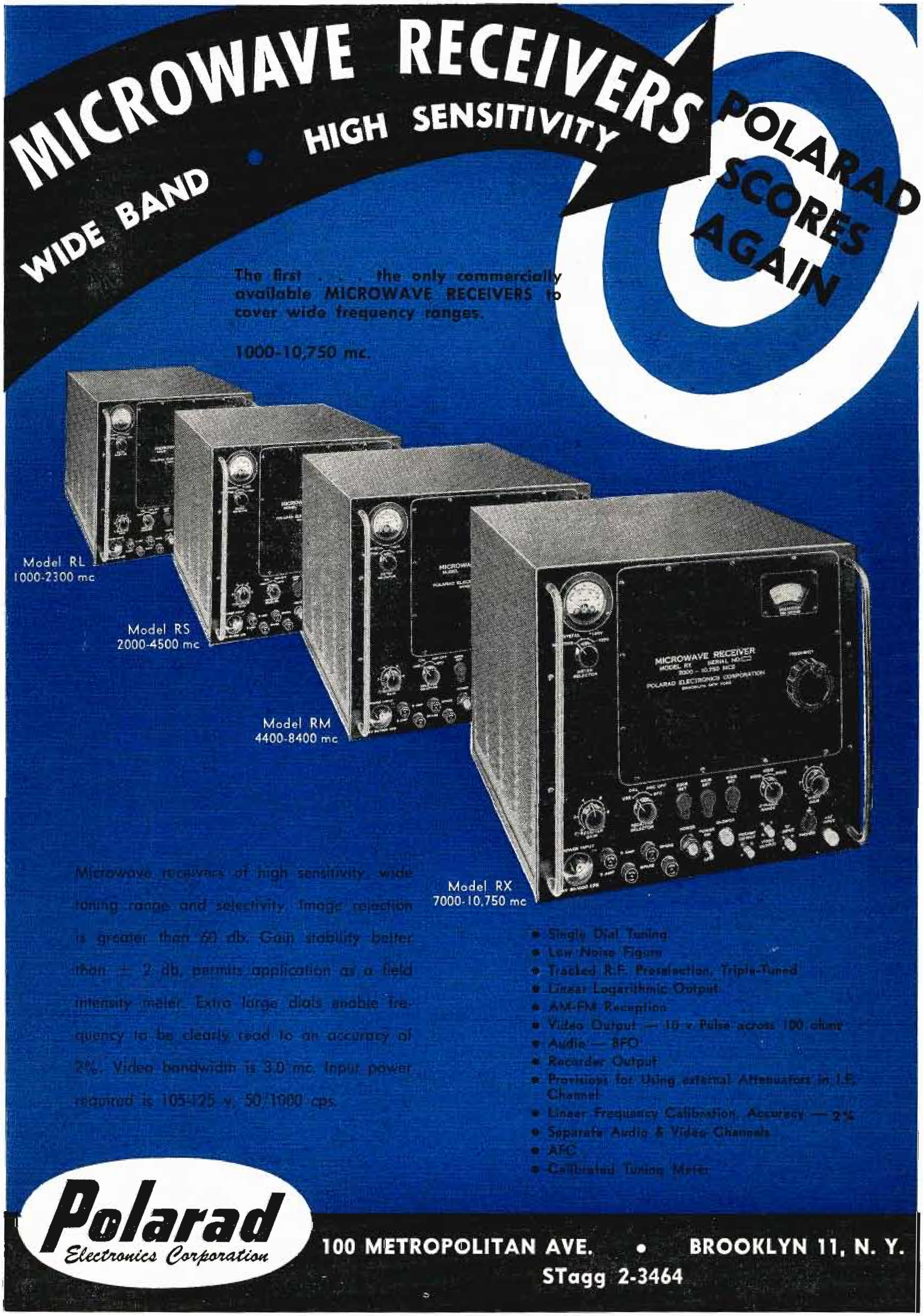
Giannini

INSTRUMENT QUALITY

POTENTIOMETERS

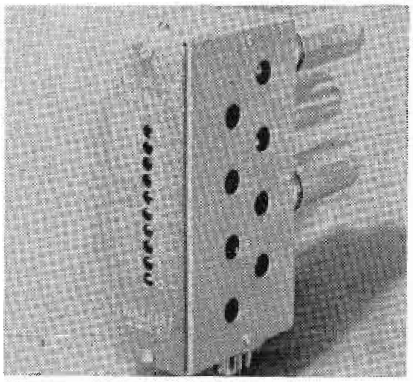
*MICROTORQUE—*T.M. REG. 1952

G. M. GIANNINI & CO., INC. PASADENA 1, CALIF. EAST ORANGE, NEW JERSEY


MICROWAVE RECEIVERS
WIDE BAND • HIGH SENSITIVITY
POLARAD SCORES AGAIN
The first . . . the only commercially available MICROWAVE RECEIVERS to cover wide frequency ranges.
1000-10,750 mc.
Model RL
1000-2300 mc
Model RS
2000-4500 mc
Model RM
4400-8400 mc
Model RX
7000-10,750 mc
MICROWAVE RECEIVER
POLARAD ELECTRONICS CORPORATION
Microwave receivers of high sensitivity, wide tuning range and selectivity. Image rejection is greater than 60 db. Gain stability better than ± 2 db, permits application as a field intensity meter. Extra large dials enable frequency to be clearly read to an accuracy of 2%. Video bandwidth is 3.0 mc. Input power required is 105-125 v, 50/1000 cps.
• Single Dial Tuning
• Low Noise Figure
• Tracked R.F. Preselection, Triple-Tuned
• Linear Logarithmic Output
• AM-FM Reception
• Video Output — 10 v Pulse across 100 ohms
• Audio — BFO
• Recorder Output
• Provisions for Using external Attenuators in I.F. Channel
• Linear Frequency Calibration, Accuracy — 2%
• Separate Audio & Video Channels
• AFC
• Calibrated Tuning Meter
Polarad
Electronics Corporation
100 METROPOLITAN AVE. • BROOKLYN 11, N. Y.
STagg 2-3464

Scaler

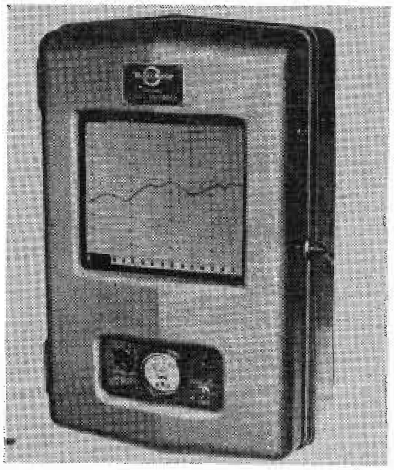
A new scale of ten scaler operates to over one million ± 1 operations per sec. Several circuit innovations have facilitated



the attainment of 1 MC operation at a minimum power consumption, utilizing only four dual triode tubes. External reset is possible through application of a negative pulse, and may be accomplished either automatically or by manual means. Octal plug-in construction is featured in the type M2444 1 MC decade which has incorporated ten illuminated positions allowing direct decimal count indication. Successive decades can be cascaded giving an unlimited counting capacity without any count indication. The unit is 1½ in. wide, 2 11/16 in. deep and plugged-in height is 5 in.—**The Walkirt Co., 145 West Hazel St., Inglewood, Calif.**—TELE-TECH

Depth Recorder

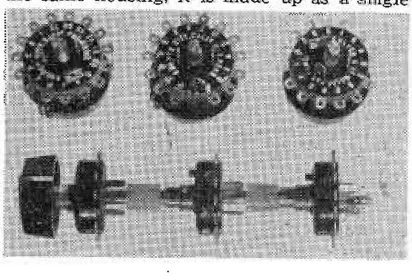
Model DR-7A depth recorder for navigation and detecting location of fish by sonar operates at 50 KC. Self-contained re-



corder produces continuous trace on roll of graph paper. Plug-in connectors permit rapid replacement, and unit is available for all standard ship voltages. Rugged power pack incorporates inexpensive vibrator. Compact sending and receiving transducer is supplied in bronze or steel chests for non-drydock removal, but may be obtained in wood fairing for external hull mounting. Five other models cover depths up to 400 fathoms. Company is also manufacturing telemetering systems, airborne radar and servomechanisms.—**Pacific Div., Bendix Aviation Corp., 11600 Sherman Way, N. Hollywood, Calif.**—TELE-TECH

Rotary Switch

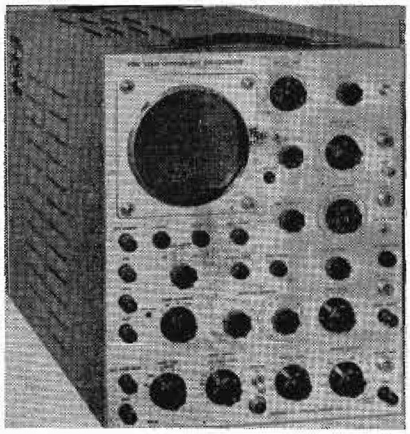
A tiny rotary switch is fully enclosed in a housing ⅝ in. in diameter x ¼ in. thick. In the same housing, it is made up as a single



pole, 15 position or as a 2 pole, 7 positions per pole or as a 3 pole, 5 positions per pole. It is designed for low current applications with great shock resistance. This is accomplished by molding in nylon plastic all metal or moving parts. All are of non-shorting type. They are suitable for tandem mounting. Weight of the switch is 1/10 oz.—**Electro Development Corp., 6014 W. Washington Blvd., Culver City, Calif.**—TELE-TECH

Oscilloscope

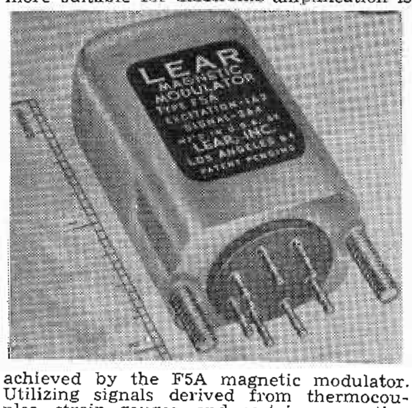
Type 524-D oscilloscope is a precision laboratory oscilloscope with specialized television features. A variable sweep delay circuit provides a zero to 25 millisec. delay. Delayed sweeps, triggered by any line sync pulse throughout the picture, are available through the entire sweep range of 0.01 sec/cm to 0.1μ sec/cm. Field selector permits switching from one field of the frame to the other at will. An internal sync separator permits triggering from sync pulses of the composite video signal. In the new sweep magnifier, the center of the sweep remains fixed and the sweep is expanded to right and left of center. Magnifications of three times and ten times are provided, permitting detailed examination of sync and equalizing pulses. A 60 CPS sine wave sweep has front panel phasing control and amplitude control. An internal time mark generator modulates the trace brightness. Pips spaced 1 μsec., 0.1 μsec., 0.5 μsec. and 200 pips per television line are available. The new amplitude calibrator



produces a variable duty cycle square wave, accurate within 3%. The calibrator is continuously variable through 7 ranges, from 0.05 v. to 50 v. Duty cycle is adjustable from 1% to 99%. More than 6 cm undistorted deflection is available on a flat faced CRT. Accelerating potential is 4 kv. Vertical sensitivity dc to 10 MC—0.15 v/cm, 2 CPS to 10 MC—0.015 v/cm. Risetime is 0.04 μsec. and a signal delay of 0.25 μsec. is provided. All dc voltages are electronically regulated.—**Tektronix, Inc., P. O. Box 831, Portland 7, Ore.**—TELE-TECH

Magnetic Modulator

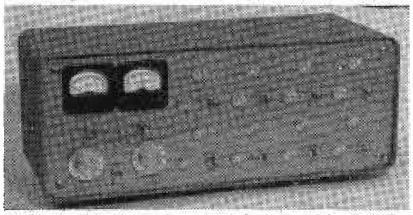
Accurate and stable conversion of low-level d-c signals into proportional a-c signals more suitable for electronic amplification is



achieved by the F5A magnetic modulator. Utilizing signals derived from thermocouples, strain gauges, and certain computing devices, the F5A is easily substituted in any application where stable conversion of low dc signal to ac is required or advantageous. The magnetic modulator offers low distortion, almost unlimited life, extreme linearity with stability; is shockproof, hermetically sealed, magnetically shielded; has fast response, operates over a wide frequency range, and is virtually unaffected by humidity and temperature changes.—**Lear, Inc., 11916 West Pico Blvd., Los Angeles 64, Calif.**—TELE-TECH

Bridge Balance

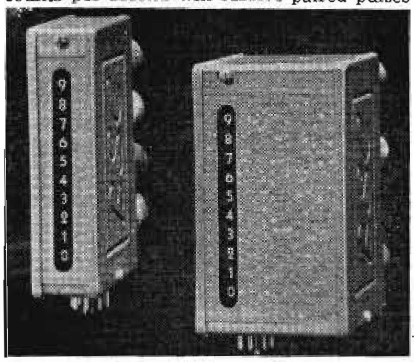
A new 8-channel bridge balance (type 8-108) may be used for direct recording of the output of a wide variety of strain gages



and strain-gage type pickups without the use of amplifiers. Used together with CEC's 5-114 or 5-116 recording oscillographs, the 8-108 offers a complete, relatively low-cost recording measurement system susceptible of operation by less-experienced personnel. Up to eight 120- to 350-ohm strain-gage bridges or strain-gage-type pickups, comprising four active arms, may be connected to the instrument. If fewer active arms are used, dummy gages can be easily added externally. Voltage across each bridge can be adjusted individually and continuously from the level of the supply voltage—28.5 v. dc maximum—down to a minimum of 2.0 on a 350-ohm, four-arm bridge and 1.1 v. on a 120-ohm, four-arm bridge. Each channel is provided with its own front-panel voltage control, and the channel selector switch connects any desired channel to the voltmeter circuit. The ability to adjust voltage individually on each bridge allows pickups of different resistance value to be used simultaneously, while maintaining on each, optimum wattage dissipation. Drift problems are thereby minimized. The same 30-v. full-scale voltmeter is connected to the supply voltage through the channel-selector switch. Provision is also made to monitor and record the supply voltage by means of a 7-238 galvanometer. A locking potentiometer on the rear panel allows adjustment of galvanometer deflection from 1.0 to 2.1 in. for any supply voltage from 22.0 to 28.5 v. A connector is provided for the monitoring galvanometer.—**Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.**—TELE-TECH

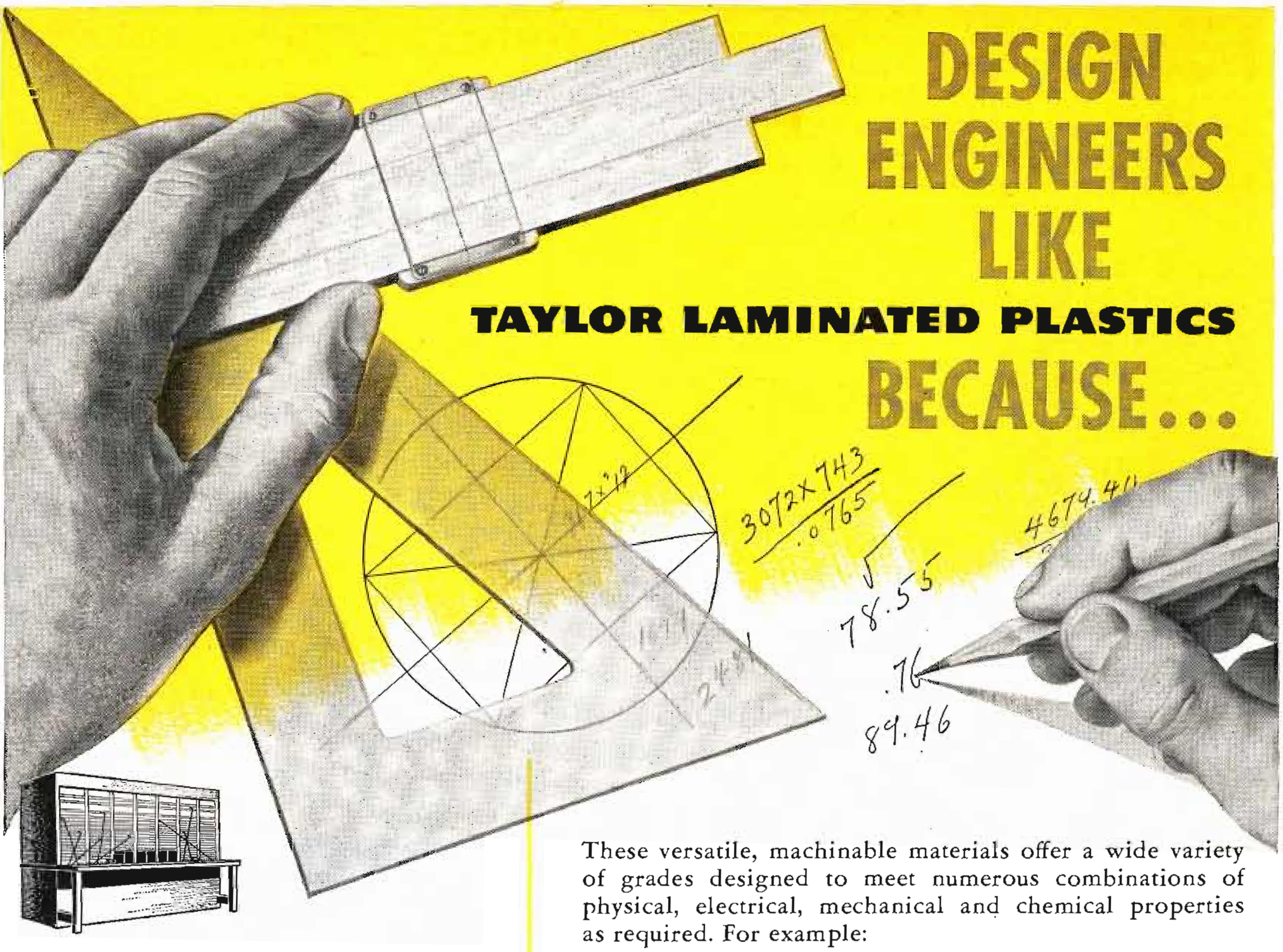
Decimal Counting Units

Direct-reading, electronic counters capable of operating at speeds up to 1,000,000 counts per second will resolve paired pulses



separated by as little as 0.8 μsec. Each counter is a plug-in unit. Units of the same model designation are completely interchangeable. The decimal counting unit counts from 0 to 9 and presents an illuminated numerical reading on the front panel. No interpolation is necessary. The tenth pulse resets the counter to 0 and simultaneously generates one pulse, which may be applied to the input of a following counter or other device. Reset to 0 of one or more units is accomplished by momentarily opening the grid return circuit. Any number of these units may be connected in cascade to create an electronic counter or scaler having any desired number of decimal places. In the model 700A and the model 705A, four binaries are connected in cascade, making a scale-of-sixteen, which is permuted to a scale-of-ten by two resistor-capacitor "feed-back" networks. Models 706A and 707A consist of a four-stage binary scale-of-sixteen that is permuted to a scale-of-ten. Permutation is obtained by effectively adding 2 counts and subtracting 8 counts through a system of diodes which are used as interstage couplings and clamps.—**Berkeley Scientific Corp., 2200 Wright Ave., Richmond, Calif.**—TELE-TECH

DESIGN ENGINEERS LIKE TAYLOR LAMINATED PLASTICS BECAUSE...



In the communications industry . . .

Parts made from Taylor Laminated Plastics are doing vital jobs in panel boards, insulation blocks and thousands of allied applications because of their excellent electrical characteristics and their resistance to moisture absorption. Have you considered these basic materials for making *your* product better?

This 62-page Taylor catalog describes how the many Taylor Laminated Plastics are made, how and where they're used, and more important, how you can use these basic materials to make your product better . . . at lower cost! Write today for a copy of catalog TT 9.

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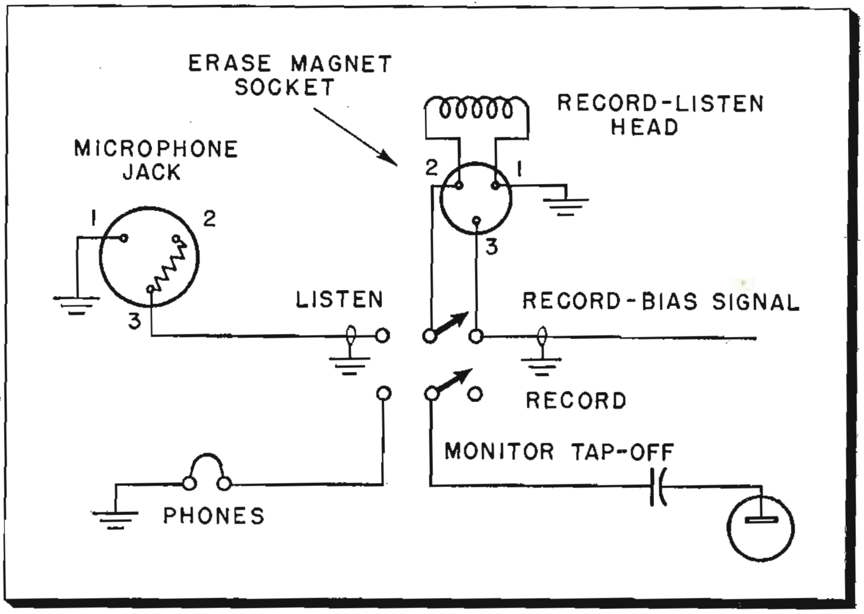
VULCANIZED FIBRE • TAYLOR INSULATION

PHENOL, SILICONE & MELAMINE LAMINATES • FABRICATED PARTS

CUES for BROADCASTERS

(Continued from page 85)



Minitape modification provides playback feature and aids monitoring by simple circuit change

fed into the microphone input and whatever is on the tape can be heard on headphones plugged into the monitor jack. Output level is more than adequate for cueing or checking.

To reduce the slight amount of vibrator hash in the phones, a *shielded* jumper cord, with the proper plugs at either end, can be used. Before recording, the cord must be disconnected and the erase head and microphone must be replaced. To avoid distortion, the headphone plug must be removed from its jack when recording.

Instead of connecting this external cord when converting the unit from record to playback, it is convenient to install a double-pole, double-throw switch on the front of the panel near the microphone jack. *But the PM erase head must be removed before playback!*

This head may be left off permanently by stations which use pre-erased tapes for a better signal-to-noise ratio.

Transmitter Control for Sequential Operation Conelrad

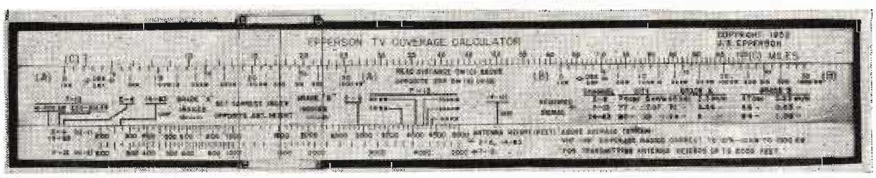
L. L. DAWKINS, Assistant Chief Engineer, WPTF, Raleigh, N. C.

THERE are doubtless, many engineers at broadcast stations designated as control centers for Conelrad civil defense operation who are trying to evolve a fool-proof method of keying for sequential operation of two or more transmitters.

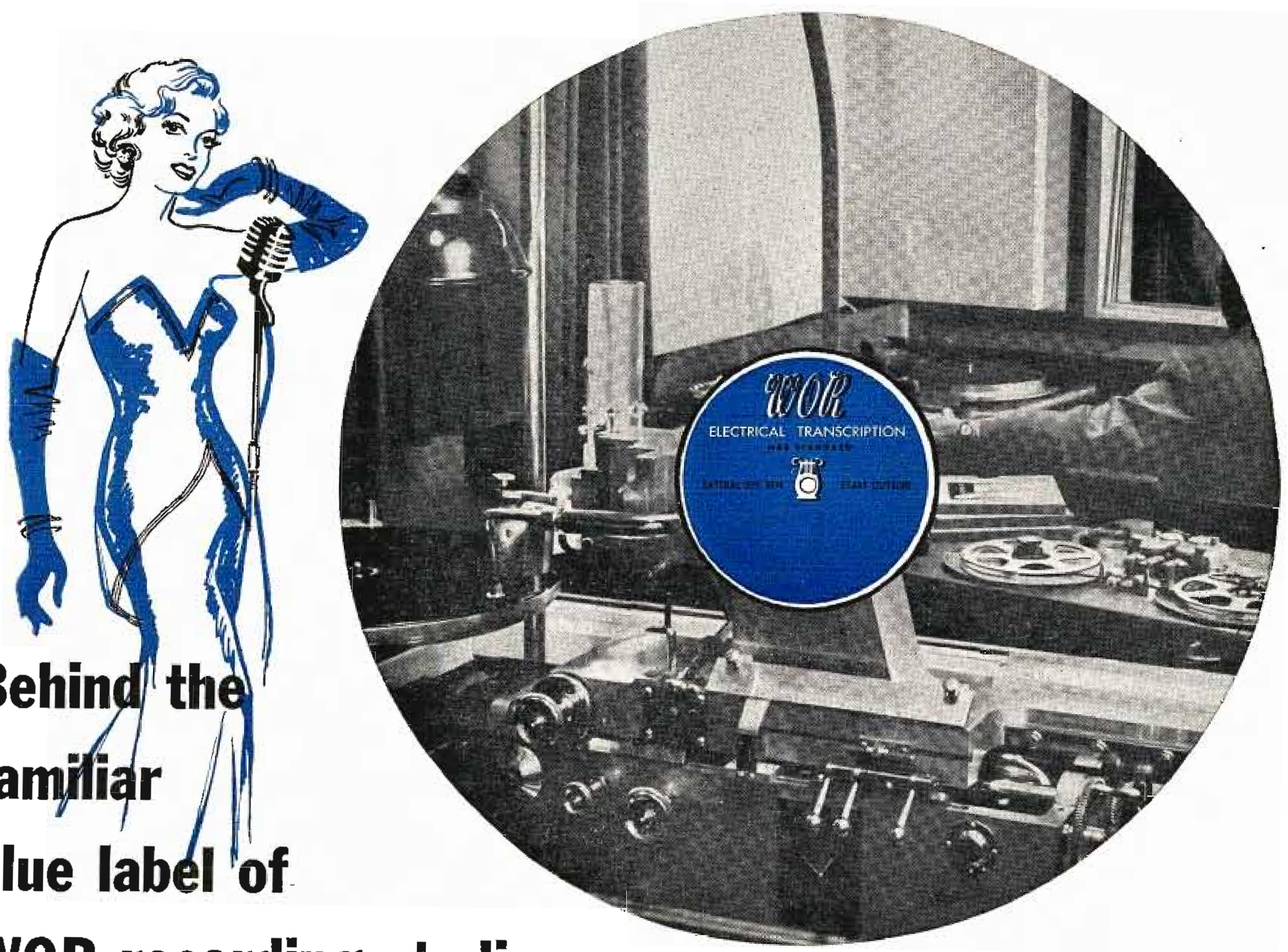
At WPTF we found a ready-made and happy solution. The City officials of Raleigh lent WPTF a traffic signal light controller. Furthermore, the city maintenance department adjusted the controller to give four 15-second operations per minute with a three second overlap. Two sets of contacts were paralleled for each of the four segments to insure against contact failure.

This arrangement was tested for three hours recently and performed perfectly. Apparently it would operate for months without trouble.

TV COVERAGE CALCULATOR for VHF and UHF CHANNELS



J. B. Epperson, chief engineer, Scripps-Howard Radio Inc. has developed a TV coverage calculator slide rule which quickly shows the approximate Grade "A," Grade "B" and city coverage for all VHF and UHF television channels. The calculator has been designed on the basis of the new FCC Rules and Regulations governing TV stations as contained in the sixth report and order of the FCC. Accuracy in most cases is within 5% of the FCC charts. For further information, Mr. Epperson may be addressed at Box 228, Berea, Ohio.



Behind the familiar blue label of WOR recording studios...

the finest in modern sound recording methods and equipment

Radio stations from coast to coast recognize this label as the mark of a top quality transcription. One that can be depended on to meet or exceed the extremely high broadcast standards of sound quality.

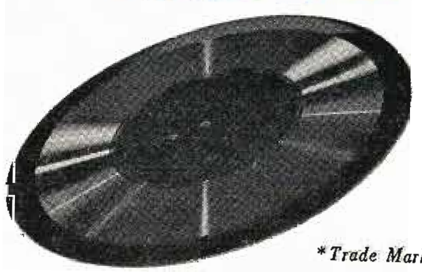
To maintain this reputation, WOR Recording Studios, one of the largest in the world, use the finest and most costly tape and disc recording equipment obtainable. And—what's equally important—their engineers have found that Audiotape and Audiodiscs are an ideal combination for meeting the exacting requirements of broadcast transcription and commercial recording work. This same record-making combination is also being used with outstanding success by America's leading producers of fine phonograph records.

With Audiotape and Audiodiscs, you can achieve this same sound perfection in *your* recording work, too. Their consistent, uniform quality is the result of more than 12 years of specialized experience by the only company in America devoted solely to the manufacture of fine recording media, both tape and discs.

...including

audiotape*

and **audiodiscs***



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TELE-TECH's NEWSCAST

New Raytheon Missile Computer

RAYDAC—the Raytheon Digital Automatic Computer—successfully completed final acceptance tests and is on its way to the Naval Air Missile Test Center at Point Mugu, Cal. It will be used there as an "intelligence center" to analyze the huge volume of information gathered in flight tests of guided missiles. The accompanying diagram illustrates how the computer will be utilized in the flight test system.

RAYDAC has 5000 vacuum tubes, 18,000 germanium diodes, 15 panels totaling 44 ft. in length and consumes 25 kw. The computer is of the four-address type, using serial transmission of digits, serial-parallel acoustic mercury delay line internal storage, parallel arithmetic computation, magnetic tape external storage, and has a basic pulse rate of 3.77 MC. It operates in the binary system with a basic precision of 31 binary digits including the sign, and word length is 36 digits.

The internal memory consists of 32 delay lines, each 32 words long, thus providing 1024 cells of one word each. The external memory consists of four tape-handling mechanisms, each of which can store 3150 blocks of 32 words each for a total of 403,200 words. The computer is self-sequenced, computes a typical numerical problem at the rate of 1600 operations per second, and has 31 built-in operations. To assure accuracy of the Navy's missile computations, a check pulse indicating correct operation must be delivered to the sequencing circuits before RAYDAC will complete its work and present it on the output printer.

First UHF-TV Station

GE has announced that it will supply the nation's first high-power UHF television station to WHUM-TV in Reading, Pa., before the end of the year. Its effective power of 261 KW will make it the world's most powerful. The station is expected to be "on-the-air" very soon after receiving the equipment in December.

The company's contract with Eastern Radio Corporation (WHUM-TV) is in excess of $450,000 and provides for equipment to permit telecasting of live talent studio shows, remote events, film and network programs on channel 61 in the new UHF band.

WHUM-TV will cover most of eastern Pennsylvania, and parts of Delaware, New Jersey and Maryland. There are about 750,000 families in the area, many of them presently without television service.

The UHF transmitter to be supplied has a power output of 12KW, using a new klystron, developed for General Electric by Varian Associates of San Carlos, Calif.

HOW NAVY WILL USE RAYTHEON'S DIGITAL COMPUTER

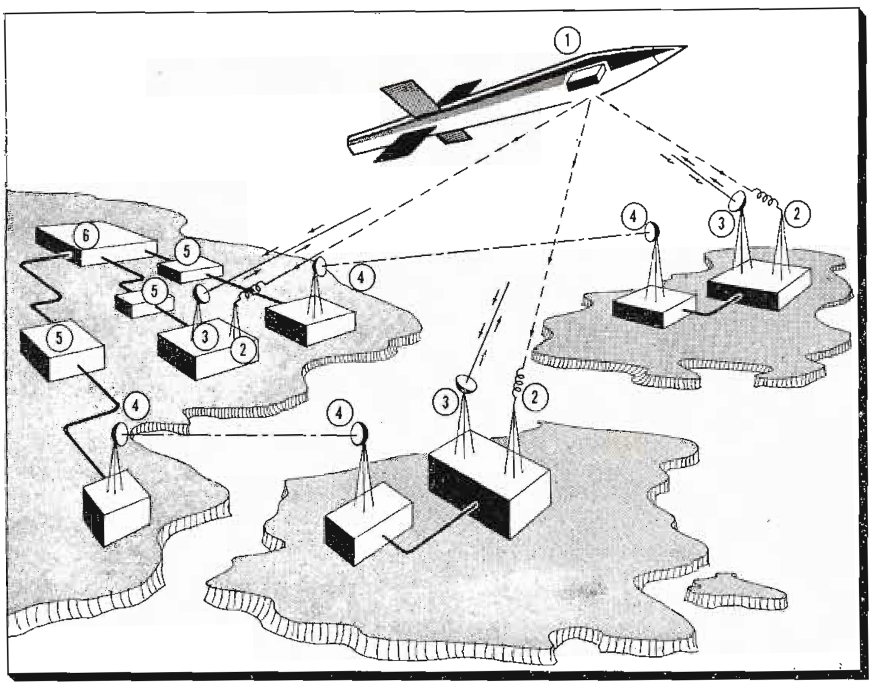


Diagram shows how miniature radio transmitters (1) in missile send coded signals to ground receiving stations (2) describing velocity, fuel consumption, engine temperature, angle of ascent and descent, and other data. Additional information is picked up by ground radar stations (3) which observe missile's speed, flight path and altitude. The gathered data is relayed over microwave links (4) to tape recording centers (5). This information is coded and fed to the computer (6) for solution.

Coming Events

September 8-12—ISA, 7th National Instrument Conference and exhibition, Cleveland Auditorium, Cleveland, Ohio.

September 10-12—AIEE, Participation in Centennial of Engineering, Congress Hotel, Chicago, Ill.

September 20—IRE Conference, Cedar Rapids Section, Roosevelt Hotel, Cedar Rapids, Iowa.

September 22-25—NEDA, 3rd National Convention. Ambassador Hotel, Atlantic City, N. J.

September 29-October 1—Eighth National Electronics Conference and Exhibition, Sherman Hotel, Chicago, Ill.

October 5-10—SMPTE, 72nd Convention, Hotel Statler, Washington, D. C.

October 13-17—AIEE, Fall General Meeting, New Orleans, La.

October 13-15—RTCM, Fall Assembly Meeting, Hotel Roosevelt, Washington, D. C.

October 21-23—1952 RTMA-IRE Fall Meeting, Syracuse, N. Y.

October 29-November 1—Audio Fair, Sponsored by AES, Hotel New Yorker, New York, N. Y.

November 5-7—IMS, 16th Annual Time and Motion Study Clinic, Sheraton Hotel, Chicago, Ill.

November 7—IRE, Microwave Professional Group Symposium on Microwave Circuits, Auditorium, Western Union Telegraph Co., 60 Hudson St., New York, N. Y.

November 21-22—IRE, Kansas City Section, 4th Annual Regional Papers Technical Conference, President Hotel, Kansas City, Mo.

December 10-12—IRE-AIEE Computers Conference, Park Sheraton Hotel, New York, N. Y.

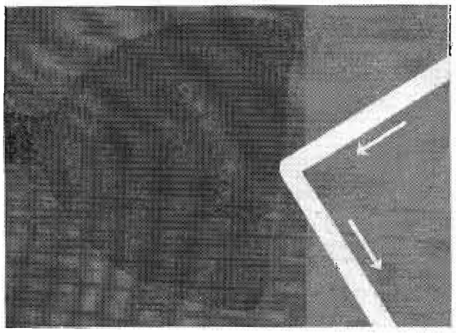
January 14-16—IRE-AIEE Meeting on High Frequency Measurements, Washington, D. C.

AES: Audio Engineering Society
AIEE: American Institute of Electrical Engineers
IRE: Institute of Radio Engineers
IMS: Industrial Management Society
ISA: Instrument Society of America
NEDA: Nat'l Electronic Distr. Assoc.
RTCM: Radio Technical Commission for Marine Services
RTMA: Radio-Television Mfrs. Assn.
SMPTE: Soc. of Motion Picture and TV Engineers

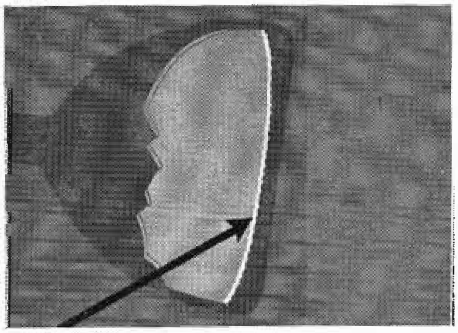
"Sales wants a no-glare image, with needle-sharp focus... how can I provide both features?"

G-E CYLINDRICAL-FACE TUBES BANISH GLARE, WHILE *PRESERVING PICTURE DETAIL!*

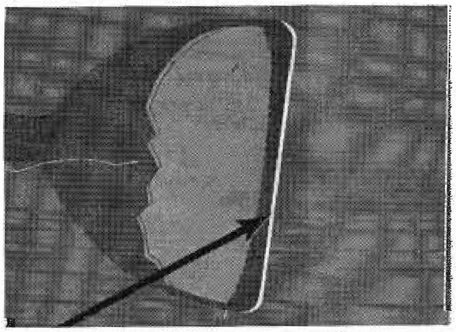
Now available, a picture tube with a vertically straight face! Spherically convex tubes, when tilted, cannot deflect all light down and away.



ROOM LIGHTING IS DEFLECTED DOWN! Light from ceiling lamps, table lamps, or windows is bent to the floor. Here a G-E Cylindrical is shown from the side in normal tilted mounting position. No light beams reach the viewer's eyes.



INTERNAL REFLECTIONS ARE REDUCED! The inner, or screen face of a G-E Cylindrical is stippled. Stippling wards off reflections, yet permits a picture surface which is fine-grained and uniform. The image has highest quality and rich contrast.



FOCUS AND DETAIL MAINTAINED! Tube's outer face is smooth and polished. Consequently, there are no glass-surface irregularities to refract and magnify . . . as can be the case with etched-face tubes. Viewers see the image in sharpest focus.

An extensive line of G-E Cylindrical-face Picture Tubes offers you *the right type* for that new TV chassis you're designing.
Phone . . . wire . . . write for complete information!
Tube Department, General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

162-1A5

Bigger Than Ever...WESCON 1952

The 1952 Western Electronic Show and Convention (WESCON) opened its doors on August 27-29 at the Municipal Auditorium in Long Beach, Cal. Sponsored by the West Coast Electronic Manufacturers' Association (WCEMA) in conjunction with the IRE, the admission-free meeting featured 26 Technical Sessions, 12 IRE Professional Groups, and exhibits of well over 300 product makes in WCEMA's eighth annual show.

Integrated with WESCON's pyramiding growth, WCEMA has made vast organizational strides in the past few years, as indicated by the recently published August 1952 Product List and Membership Roster.

In 1951, WCEMA joined hands with the IRE 7th Region to put on a combined Western Electronic Show and Convention. A joint eight-man Board of Directors and year-round General Business Manager were appointed to operate and administer the show and convention. Directors for WESCON 1952 are: Chairman R. G. Leitner, Packard-Bell Co.; H. W. Grove, West Coast Electronics Co.; L. B. Ungar, Ungar Electric Tools; W. D. Hershberger, U. of Cal.; R. A. Huggins, Huggins Labs.; J. W. Landells, Westinghouse; N. E. Porter, Hewlett-Packard Co.; and L. J. Black, U. of Cal.

The accompanying table shows WESCON's auspicious growth during the past four years. The 1953 undertaking in San Francisco's Civic Auditorium is expected to surpass even these impressive figures. Headquarters for WESCON 1953, after Oct. 2, 1952, will be 108 Ninth St., San Francisco, Cal.

For a detailed listing of technical papers and company exhibits at WESCON 1952, see pages 68 and 114, August 1952 TELE-TECH.

WCEMA Show's Consistent Growth

	1949	1950	1951	1952
Number of manufacturers exhibiting:				
Eastern	53	66	77	98
Western	23	30	43	64
Number of representatives exhibiting:	28	23	21	26
(Mfg. lines shown by Rep)	(160)	(174)	(182)	(226)
Number of publishers exhibiting:	3	2	5	5
No. of Governmental educational exhibits:	3	9	5	2
Total number of exhibitors: (Includes Reps but not their lines shown)	110	130	151	195
Number of exhibit booths:	120	162	170	220
Number in attendance: (Including attendance at IRE conventions).	6,396	7,345	8,745	10,000 (Est.)

IRE 7th Region Convention's Climb

	1949	1950	1951	1952
Number of technical sessions:	11	11	13	26
Number of technical papers:	36	46	54	125
No. of technical symposiums and panels:	1	2	2	3
Total registrations:	760	945	1,112	2,000 (Est.)

CODE NO.	ADVERTISER	INFORMATION ON
100	Adams & Westlake Co.	Relays
101	Advance Elec. & Relay	Relays
102	Advance Ins. Wire & Cable	Wire & cable
103	Aerovox Corp.	Sealed resistors
104	Aircraft Radio Corp.	UHF signal generators
105	Aircraft Transformer	Open transformers
106	Air Marine Motors, Inc.	Variable fans
107	Airtron, Inc.	Waveguides
108	Alden Products Co.	Lights, fuseholders
109	Allied Radio Corp.	Duplex speakers
109A	Allied Radio Corp.	Equipment catalogue
110	Altec Lansing Corp.	Duplex speakers
111	American Elec. Heater	Soldering irons
112	American Microphone Co.	Microphones
113	American Phenolic Corp.	Connectors
114	Amperex Electronic	Transmitting tubes
115	Amperite Co., Inc.	Relays, regulators
116	Ampex Electric Corp.	TM tape recorders
117	Anchor Industrial Co.	Picture tubes, sleeves
118	Andrew Corp.	Antennas
119	Applied Science Corp.	Sampling switches
120	Arco Electronics Inc.	Capacitor kits
121	Arma Corp.	Precision controls
122	Arnold Engineering Co.	Tape-wound cores
123	Arrow Electronics Inc.	Electronic equipment
124	Astron Corp.	Capacitors
125	Atlas Sound Corp.	Microphone stands
126	Audio Devices, Inc.	Recording tape & discs
127	Audio & Video Products	Tape recording booklet
128	Barry Corp.	Shock test service
129	Bell Telephone Labs	Technical information
130	Bendix Aviation Corp.	Precision synchros
131	Berkeley Scientific	Personnel
131A	Berkeley Scientific	Frequency measurements
132	Berndt-Bach, Inc.	Sound cameras
133	Bing Crosby Enterprises	Recorders, tapes
134	Birtcher Corp.	Tube clamps
135	Blonder-Tongue Labs	Personnel
136	Bodnar Industries Inc.	Lighting plates
137	Bomac Labs	Gas tubes, parts
138	Brady Co.	Wire markers
139	Breeze Corp.	Shielding, clamps
140	Broadcast Eq. Spec. Corp.	Portable recorders
141	Burnell & Co.	Audio filters
142	Bussmann Mfg. Co.	Fuses, holders
143	Cannon Elec. Development	Plug accessories
144	Carter Motor Co.	Converters, dynamotors
145	Carbonneau Industries	Speakers
146	Century Lighting, Inc.	Lighting equipment
147	Century Metalcraft	Microwave equipment
148	Chicago Condenser Corp.	Impregnated capacitors
149	Cinch Mfg. Co.	Mica components
150	Cinema Engineering Co.	Equalizers, filters
151	Circle Mfg. Co. Inc.	Coaxial connectors
152	Cleveland Container Co.	Phenolic tubing
153	Clippard Instrument	Coils, comparators
154	Communication Prod.	Automatic dehydrators
155	Conn. Tel. & Elec. Corp.	Handsets, headsets
156	Consol. Engineering Corp.	Test instruments
157	Cornell- Dubilier Elec.	Capacitors
158	Cornish Wire Co.	Cord sets
159	Crest Laboratories, Inc.	Miniature transformers
160	Crest Transformer Corp.	Sealed transformers
161	Daven Co.	Wire wound resistors
162	DeJur Amsco Corp.	Phasing potentiometers
163	Dial Light Co. of America	Pilot lights
164	DuMont Labs., Allen B.	Picture tubes
164A	DuMont Labs., Allen B.	Transmitters
165	D-X Radio Products Co.	Coils, crystals
166	Eisler Engineering Co.	Glass machines,welders
167	Eitel-McCullough, Inc.	Tubes
168	Electra Mfg. Co.	Deposited resistors
169	Elec. Tower Service, Inc.	Antenna towers

Use these cards to get data on ADVERTISED PRODUCTS

Here is a list of the major offerings by advertisers in this issue of TELE-TECH. If you want literature or further information on any of these products, simply enter the code numbers on the postage-free cards on the opposite page.

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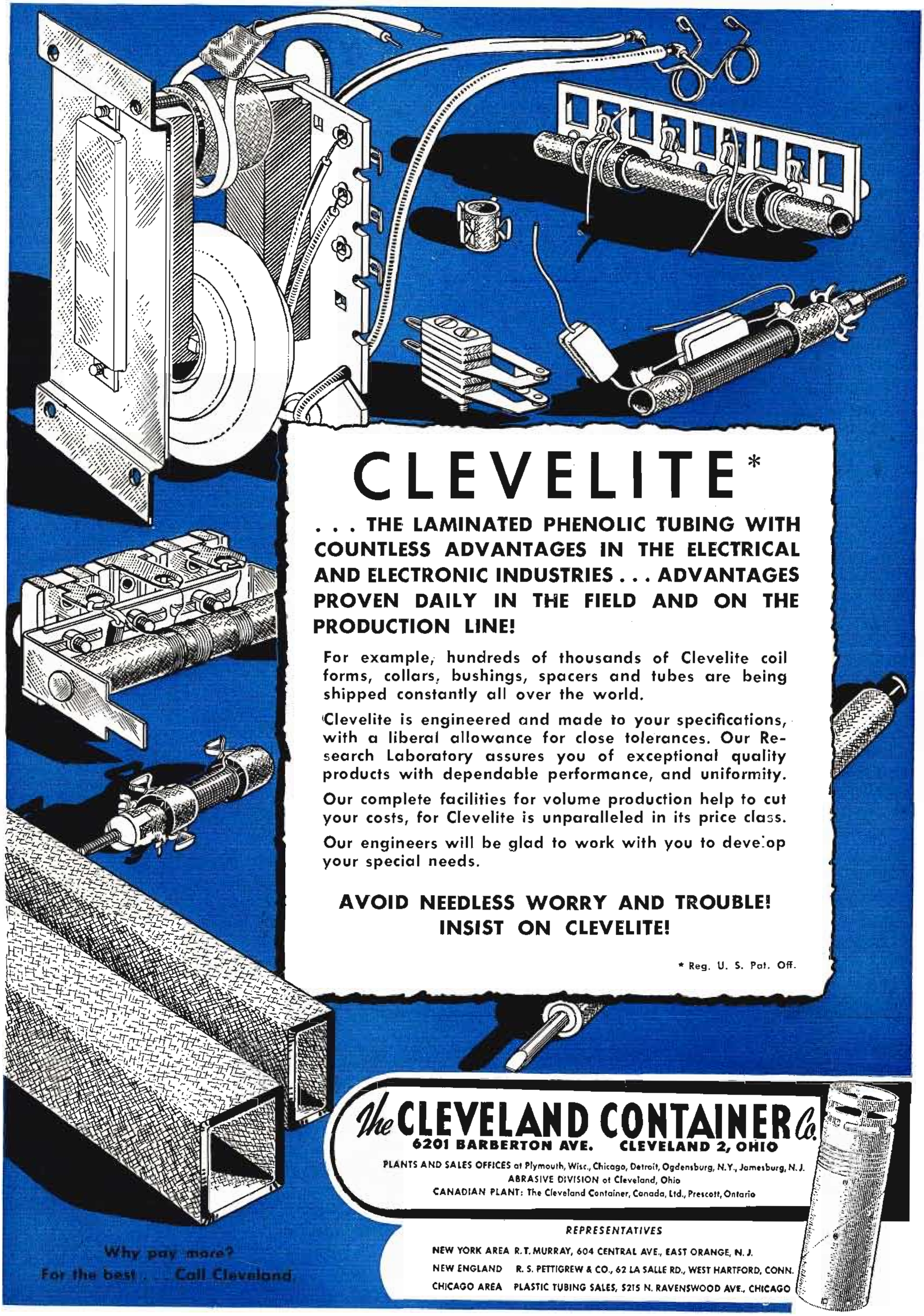
170	Electro-Motive Corp.	Mica capacitors
171	Electron-Radar Prods.	Microwave equipment
172	Electronic Mechanics	Insulating materials
173	Electronic Transformer	Transformers, filters
174	Federated Metals	Rosin core solder
175	Fugle-Miller Labs	Standardized coils
176	Federal Tel. & Radio	Microwave equipment
177	Gates Radio Co.	Broadcast transmitters
178	General Electric Co.	Transformers
179	General Precision Lab.	TV Camera chain
180	General Radio Co.	Oscillators
181	Gertsch Products Inc.	VHF frequency meters
182	Giannini & Co., Inc.	Potentiometers
183	Goslin Elec. & Mfg. Co.	Transformers
184	Grant Pulley & Hardware	Electronic slides
185	Graphite Metallizing	Brushes, contacts
186	Gray Research & Dev. Co.	Research facilities
187	Green Instrument Co.	Engravers
188	Gries Reproducer Corp.	Plastic parts
189	Guardian Elec. Mfg. Co.	Relays
190	Guthman, Edwin I. & Co.	TV receiver components
191	Hastings Instrument Co.	Personnel
192	Heath Co.	Test equipment
193	Helipot Corp.	Potentiometers
194	Heppner Mfg. Co.	Ion traps
195	Hermetic Seal Products	Seals, headers
196	Hewlett-Packard Co.	Frequency counters
197	Hoffman Radio Corp.	TV equipment
198	Houston Fearless Corp.	TV Camera pedestals
199	Hudson Radio & TV Corp.	Equipment catalogue
200	Hughes Res. & Dev. Labs	Personnel
201	Hughey & Phillips	Tower lighting
202	Hycon Mfg. Co.	Personnel
203	Hycor Co., Inc.	Wire wound resistors
204	Hytron Radio & Elec.	Rectifiers tubes
205	International Rectifier	Selenium diodes
206	Instrument Wire Co.	Magnet wire
207	Jennings Radio Mfg. Co.	Vacuum capacitors
208	JFD Mfg. Co.	Trimmer capacitors
209	Johnson Co., E. F.	Xmitting accessories
210	Jones, Howard B., Div.	Plugs, sockets
211	Kahle Engineering Co.	Grid winders
212	Kay Electric Co.	Instruments
213	Kenyon Transformer Co.	Power transformers
214	Kepco Labs, Inc.	Power supplies
215	Keystone Products Co.	Power transformers
216	Kierulff Sound Corp.	Speakers
216A	Kierulff Electronics	Distributor catalogue
217	Kinetix Instrument Co.	Synchros, transformers
218	Knights Co., James	Crystals, monitors
219	Krohn-Hite Instrument	Oscillators, filters
220	LaPointe-Plascomold	TV towers
221	Littelfuse, Inc.	Fuses
222	Lockheed Aircraft Corp.	Personnel
223	Mallory, P. R. & Co.	Paper capacitors
224	Measurements Corp.	Signal generators

Refer to page 211 for page no. of advertisers.

CODE NO.	ADVERTISER	INFORMATION ON
225	Melpar, Inc.	Personnel
226	Mepco, Inc.	Wire wound resistors
227	Methode Mfg. Corp.	Tube sockets
228	Miller, J. W. Co.	I-F transformers
229	Motorola, Inc.	Mobile transmitters
230	Mycalex Corp. of Amer.	Mica insulation
231	National Company, Inc.	Coil forms
232	National Moldite Co.	Coil forms
233	NRK Mfg. & Engineering	Microwave assemblies
234	Nat. Vulcanized Fibre	Laminated plastics
235	Oregon Electronics Mfg.	Power supplies
236	Par-Metal Products	Racks, chassis
237	PCA Electronics Inc.	Pulse transformers
238	Perkin Engineering Corp.	Power supplies
239	Phalo Plastics Corp.	Shielded cables
240	Phaostron Co.	Voltmeters
241	Philco Corp.	Microwave systems
242	Photocircuits Corp.	Printed circuits
243	Polarad Electronics	Microwave receivers
244	Polytechnic Res. & Dev.	R-F test equipment
245	Precision Paper Tube	Coil bobbins
246	Product Development	Antennas
247	Radio Cores, Inc.	Threaded cores
248	Radio Corp. of America	Deflection tubes
248A	Radio Corp. of America	TV stations
248B	Radio Corp. of America	Personnel
249	Radio Materials Corp.	Ceramic capacitors
250	Radio Receptor Co. Inc.	Selenium rectifiers
251	Ray-Par, Inc.	Flyback transformer
252	Radio Shack Corp.	Tape recorders
253	Rauland Corp.	Pictures tubes
254	Raypar Inc.	Coils, chokes
254A	Raytheon Mfg. Co.	Subminiature Tubes
255	Rek-O-Kut Co.	Turntables
256	Relay Sales	Relays
257	Sangamo Electric Co.	Impregnated capacitors
258	Sarkes Tarzian, Inc.	TV tuners
259	Shallcross Mfg. Co.	Decade resistances
260	Solar Mfg. Corp.	Ceramic capacitors
261	Sprague Electric Co.	Electrolytic capacitors
262	Stackpole Carbon Co.	Coil forms
263	Stancil-Hoffman Corp.	Tape recorders
264	Stupakoff Ceramic & Mfg.	Seals
265	Sylvania Elec. Products	Stamped circuits
265A	Sylvania Elec. Products	Electronic components
266	Synthane Corp.	Plastic parts
267	Taylor Fibre Co.	Laminated plastics
268	Technology Instrument	Potentiometers
269	Tektronix, Inc.	Oscilloscopes
270	Telechrome, Inc.	Color TV equipment
271	Telecomputing Corp.	Graph plotters
272	Tel-Rad Mfg. Co., Inc.	Deflection yokes
273	Tensolite Insul. Wire	Insulated wire
274	Ungar Electric Tool Co.	Electric tools
275	University Loudspeakers	Speakers
276	U.S. Engineering Co.	Electronic hardware
277	Vectron, Inc.	Spectrum analyzer
278	Waterman Products Co.	Portable oscilloscopes
279	Weckesser Co.	Cable clips
280	Westinghouse Elec. Corp.	Transformer cords
281	Wheeler Insulated Wire	Selfpowered telephones
282	Western Gold & Platinum	Ceramic insulators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. . . THE LAMINATED PHENOLIC TUBING WITH COUNTLESS ADVANTAGES IN THE ELECTRICAL AND ELECTRONIC INDUSTRIES . . . ADVANTAGES PROVEN DAILY IN THE FIELD AND ON THE PRODUCTION LINE!
For example, hundreds of thousands of Clevelite coil forms, collars, bushings, spacers and tubes are being shipped constantly all over the world.
Clevelite is engineered and made to your specifications, with a liberal allowance for close tolerances. Our Research Laboratory assures you of exceptional quality products with dependable performance, and uniformity.
Our complete facilities for volume production help to cut your costs, for Clevelite is unparalleled in its price class.
Our engineers will be glad to work with you to develop your special needs.
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WASHINGTON
News Letter

Latest Radio and Communications News Developments Summarized by TELE-TECH's Washington Bureau

TV "PRODUCTION LINE"—The FCC has swung into full speed on the granting of the new television stations in the present frequency channels and in the ultra-high-frequency portion of the spectrum allotted to video. However, the processing of the more than 700 applications for new television stations will necessarily be time-consuming, since, for every new TV station granted, around a half dozen applicants have to be notified that they are mutually exclusive on a channel with another station. The TV station applicants then wait for 30 days and practically all try to amend their applications for another channel. In practically all instances of applications which have to be amended to use another channel, the FCC is forced to set them for hearing. During the fall months the Commission, it is expected, will be able to act on around 15 applications a week.

SHOULD FULFILL QUALIFICATIONS—While the educational television applications have been slow in being filled with the FCC, the tempo of interest of universities and colleges and state school systems has been heightened by the warnings of veteran FCC Chairman Paul A. Walker and the educators' chief proponent, Commissioner Frieda B. Hennock, so that the Commission anticipates the end-result of a very substantial number of applications for the 242 non-commercial educational TV channel assignments. Two FCC Commissioners—Rosel H. Hyde and Robert F. Jones—have strongly presented their views that educational institutions must fulfill fully the legal and financial qualifications for television stations, just as is required of commercial telecasters.

COSTS ARE HIGH—FCC Chairman Walker has driven home in addresses before numerous educational groups the "facts of life" about television, pointing out that the costs of a single educational TV station are very high. But he expressed recently the aim of the FCC that "since these channels are for the benefit of all the people, the Commission envisions that there will be the highest degree of cooperation (with the FCC) between all the educational institutions for their support, planning and use."

FUNDS SLASH HITS MOBILE RADIO—While the FCC staff for the processing of television station applications has been increased under the $6.4 million appropriation for the current (1953) fiscal year, a budget slash of more than 10% under last year's funds allocation will hit hard the functioning of the FCC Safety and Special Radio Services Bureau, which handles the mobile radio activities of the Commission. The monthly application backlog in mobile radio services, whch has been hovering above the 10,000 mark during the past year, is expected to soar greatly above that figure and may even reach a total of approximately 30,000 by June 1, 1953, according to the estimates of top FCC officials. Besides the slowing down of the application processing, there will be a delay, it is anticipated, in the establishment of a Radio Amateur Civil Emergency Service. In addition the implementing of international agreements in the aviation and marine radio fields will also be retarded from completion.

McFARLAND ACT—Under the McFarland Act revising the procedures of the FCC, which became effective with President Truman's signature, marked changes in the FCC's conduct of adjudicatory cases are now required by the statute. A major effect of the McFarland Act is the separation of the staff from the commissioners in contested cases or cases where the FCC is acting on an individual application. The provisions of the McFarland law are designed to meet long-standing Congressional and other criticisms that the FCC staff has had a dominant role in the decisions of the agency. The act requires the FCC to report periodically to Congress all cases not disposed of within specified time limits, along with a listing of the reasons why action has not been completed, and this objective of the new statute should certainly aid in expediting the completion of new television station applications.

ENGINEERS PROTEST NARTB PROPOSAL—Broadcasting station engineers, in order to uphold the requirements and qualifications of the radio engineering profession, have inundated the FCC with protests respecting the proposal of the National Association of Radio and Television Broadcasters that the Commission relax station operation rule requirements and permit remote operations of some stations under certain conditions. The proposed NARTB rule would allow temporary operation of a broadcasting station up to 120 days without a first-class operator at the transmitter, but a first-class technician must be employed full time to handle equipment failures. The majority of the critical comments from engineers contend that there is no shortage of qualified first class engineers, but the salaries are at too low a level among small stations. The engineers asked the FCC to tighten technical operator requirements and technical regulations.

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Editor

AMPEREX
AIR-COOLED TUBE
AX9904-R/5924

"...Offers a maximum in kilowatts per dollar..." HARRY R. SMITH, Manager, Television Engineering, Standard Electronics Corporation

STANDARD ELECTRONICS CORPORATION
(A SUBSIDIARY OF CLAUDE NEON, INC.)
TELEVISION AND BROADCAST TRANSMITTERS AND AUXILIARY EQUIPMENT
AMERTRAN ELECTRONIC TRANSFORMERS AND TRANSTATS

TELEPHONE - BIGELOW 3-5540
BIGELOW 3-4444

285 EMMET STREET
NEWARK 5, N. J.

April 23, 1952

Mr. Sam Norris, Pres.
Amperex Electronics Corp.
25 Washington St.
Brooklyn 1, New York

Dear Mr. Norris:

As you know we have been working with the Amperex Type AX9904-R vacuum tube in the development of the various Standard Electronics television broadcast transmitters. The tube is being used in the currently manufactured Model TH653 and TL 653 Transmitters in both the aural and visual sections.

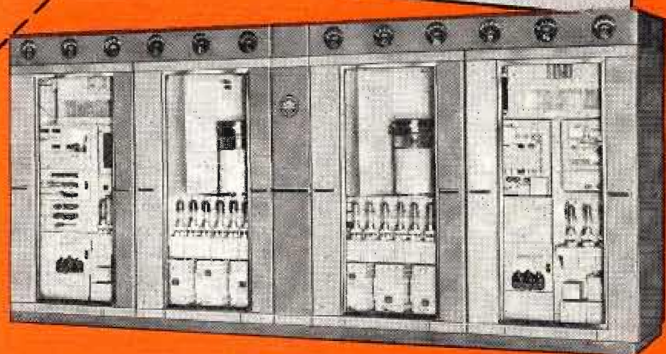
I believe you will be interested in knowing that we are very well satisfied with the performance of this tube as a broad band linear amplifier on all V.H.F. television channels. The low interelectrode capacitance and low internal impedance of the AX9904-R permit power output levels of 5KW and more, with band widths in excess of 5 megacycles. These conditions are readily obtainable from a single tube operating well within its published tube characteristics. The moderate cost of the tube leads us to believe that it offers a maximum in "kilowatts per dollar".

Yours very truly,

Harry R. Smith
Harry R. Smith
Mgr. Television Engineering

HRS:hg

STANDARD ELECTRONICS CORPORATION uses this tube in Models TH653 High Band and TL653 Low Band Transmitters and also in their new 20 Kilowatt Transmitter, built on the exclusive S-E ADD-A-UNIT PRINCIPLE, and with special S-E features that insure dependable operation, maximum convenience, and minimum maintenance.



FEATURES INCLUDE . . . 14 MC band width at 220 MC . . . outputs of 5.7 KW . . . thoriated tungsten filament . . . non-emitting grid . . . disc type grid seal for mimimum inductance . . . minimum capacitance . . . and PROVEN long life.

Write for complete data sheets.

This tube is also available in a Water-Cooled Version, Type AX9904-5923.

Re-tube with AMPEREX

AMPEREX ELECTRONIC CORP.
230 DUFFY AVENUE, HICKSVILLE, LONG ISLAND, N. Y.
In Canada and Newfoundland: Rogers Majestic Limited
11-19 Brentcliffe Road, Leaside, Toronto, Ontario, Canada
Cable: "AMPRONICS"

UHF-VHF Antenna Filter

A unique application for printed circuit constants, illustrated in the accompanying photograph of the "Ultra Q-Tee" multi-frequency antenna system, has been developed by Vee-D-X, La Pointe-Plascomold Corp., Rockville, Conn. The antenna is designed to operate simultaneously in the ranges of 54-88, 174-216 and 470-890 MC. The operating elements in the VHF range (54-216 MC) are composed of the total antenna minus the UHF V-type receiving element. In the UHF range (470-890 MC.) the V operates independently, and the VHF high channel director (directly behind the V) serves as a reflector throughout the UHF range. This arrangement cancels back pickup and minimizes lobe response at right angles to the plane of the V, thus increasing horizontal directivity and gain in the UHF range.

Broad Response

The broad response of the VHF section is made possible through the separation of two sections of the composite driven element with single-section filters shown at the left of the photograph. These filters are printed on XXXP phenolic sheet 1/32 in. thick. The anti-resonant or insertion frequency is 195 MC. The Q of the dielectric material and the L/C ratio of the individual constants are arranged to provide a high series insertion loss in the range of 174-216 MC to isolate the low channel VHF element. In the range of 54-88 MC, these filters are practical short circuits, allowing operation of the low channel receiving element (54-88 MC) and reflector combination.

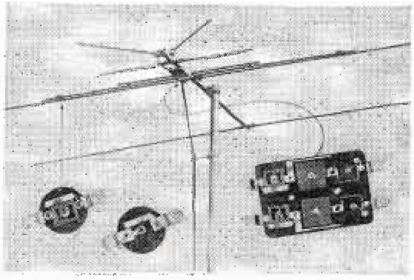


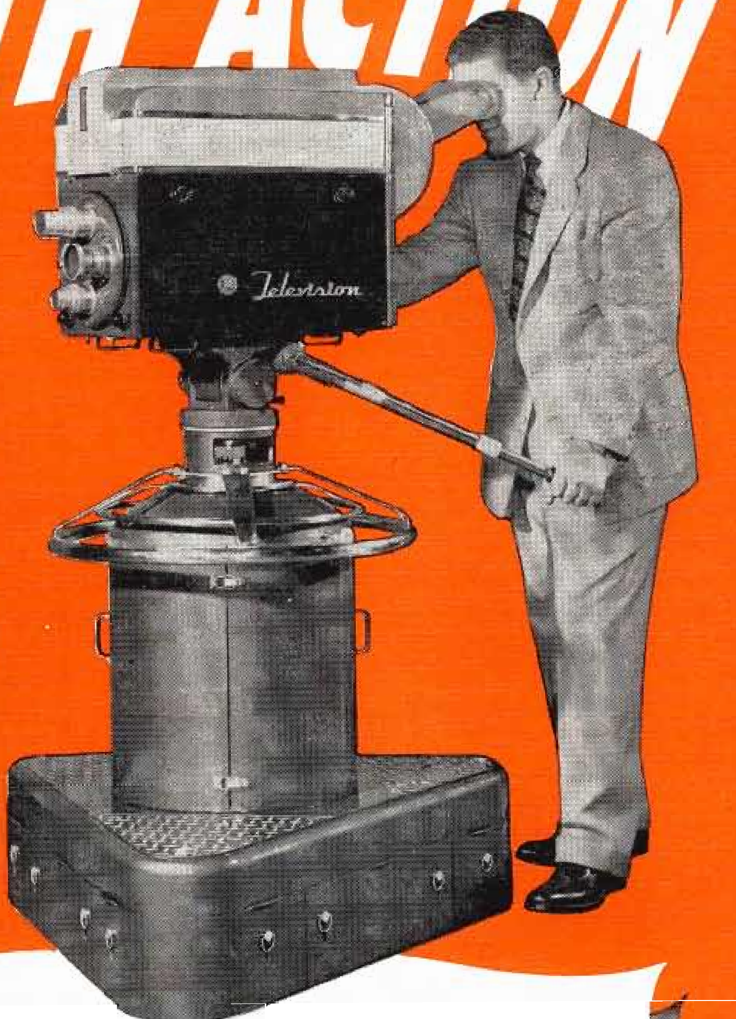
Fig. 1: Combination UHF-VHF antenna system uses printed filter (l) to isolate low channel VHF element at 174-216 MC. Six-section coupling filter (r) permits operation of UHF and VHF antennas to a single transmission line

Coupling Filter

The operation of the three independent sections of the antenna to a common transmission line without interaction is accomplished through the use of a six-section coupling filter mounted on the boom between the UHF and VHF antenna feed points. It will be noted that the transmission line is connected at the junction of UHF

(*Continued on page* 185)

SMOOTH ACTION



NEW

Houston-Fearless

TV CAMERA PEDESTAL

Camera is raised quickly, easily by lifting on steering wheel.

New smooth action... new stability... new convenience and ease of operation are offered in the new Houston-Fearless Television Camera Pedestal, Model PD-3. Camera is accurately counter-balanced, making it possible to raise and lower quickly, smoothly by simply lifting or pressing on steering wheel, even with pedestal in motion. Three pairs of dual-wheels assure smoother rolling-dolly shots. Two types of steering: for straight tracking or sharp turning. All controls are within easy reach of cameraman for maximum convenience. Dependable Houston-Fearless quality throughout. Makes possible better, more showmanlike productions in any studio. Write for details today.

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International RECTIFIER CORPORATION

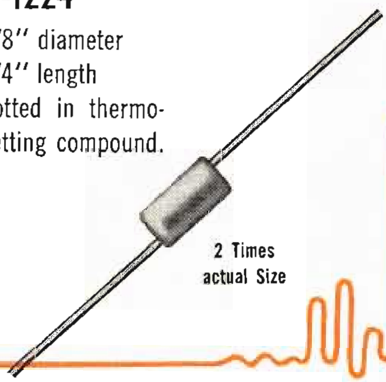
EL SEGUNDO CALIFORNIA

Selenium Diodes

TYPE T SERIES

D-1224

1/8" diameter
1/4" length
Potted in thermo-setting compound.



2 Times actual Size

TYPE T SERIES

D-1224

RMS applied voltage, max.	26 volts per cell
Peak inverse voltage	60 volts per cell
RMS input current, max.	500 microamperes
DC output voltage	20 volts per cell
Voltage drop at full load	1 volt per cell
DC output current, avg.	200 microamperes
DC output current, peak	2.6 milliamperes
Max. surge current	10 milliamperes
Reverse Leakage at 10V RMS	0.6 microampere
Reverse Leakage at 26V RMS	3 microamperes
Frequency max. CPS	200 KC

Also available in 2-cell Diodes.

TYPE U SERIES

D-1290

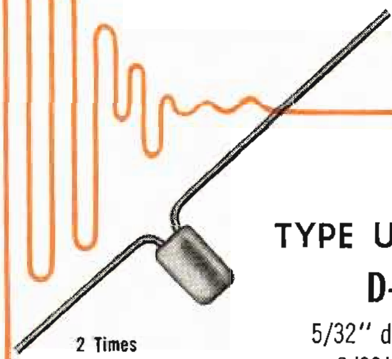
RMS applied voltage, max.	26 volts per cell
Peak inverse voltage	60 volts per cell
RMS input current, max.	3.75 milliamperes
DC output voltage	20 volts per cell
Voltage drop at full load	1 volt per cell
DC output current, avg.	1.5 milliamperes
DC output current, peak	20 milliamperes
Max. surge current	80 milliamperes
Reverse leakage at 10V RMS	2.4 microamperes
Reverse leakage at 26V RMS	12 microamperes
Frequency max. CPS	100 KC

Also available in 2, 3 and 4-cell Diodes.

TYPE U SERIES

D-1290

5/32" diameter
9/32" length
Potted in thermo-setting compound.



2 Times actual Size

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TV Sweeps

(*Continued from page* 93)

ing during the sweep interval. The cathode bias keeps the damper cut off during the sweep interval except when oscillations occur following the retrace. This circuit helps to reduce the "ringing" effects which had been present in the original designs, but is still quite inefficient because of the dissipation of energy in R_k.

The next step, then, was to use this energy for some useful purpose. This was accomplished as shown in Fig. 6, feeding this energy back to the drive tube. Figs. 5 and 6 may be represented by the bridge circuit of Fig. 7. In this bridge circuit, one half of the sweep is provided by the driver tube with the other half provided by the damper tube. Battery A is actually the B+ supply while battery B is obtained from energy stored in the circuit inductances. The damper tube is shown as a triode to indicate the similarity to push-pull operation. In practice, certain corrective networks as described by Schade[1] may be used in conjunction with a diode damper to give a triode characteristic and provide the non-linearity required for flat-face tubes. A network of this type, known as a "linearity network," is shown in the dashed box of Fig. 6.

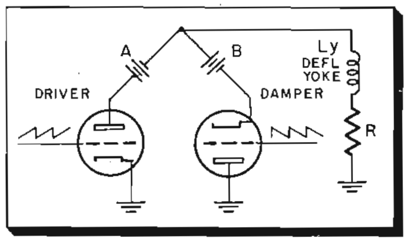

Fig. 7: Bridge circuit represents circuits of Figs. 5 & 6. Battery A is actual B+ supply while battery B is energy stored in inductances

The peak plate current (and therefore the peak sweep current) is determined by the rate of rise of plate current through the transformer primary. This may take place in two ways. The first method is to utilize the driver tube simply as a switch (e.g., have square wave applied to its grid). Assuming negligible internal plate resistance, the rate of rise of plate current will be determined by the available plate voltage and transformed deflection coil inductance (providing the primary inductance of the transformer deflection coil inductance). In this case, the basic equation $E=LI/T$ may be applied. As shown in Fig. 2, if R is very small, a perfect linear sawtooth current will be obtained. Ac-

(*Continued on page* 126)

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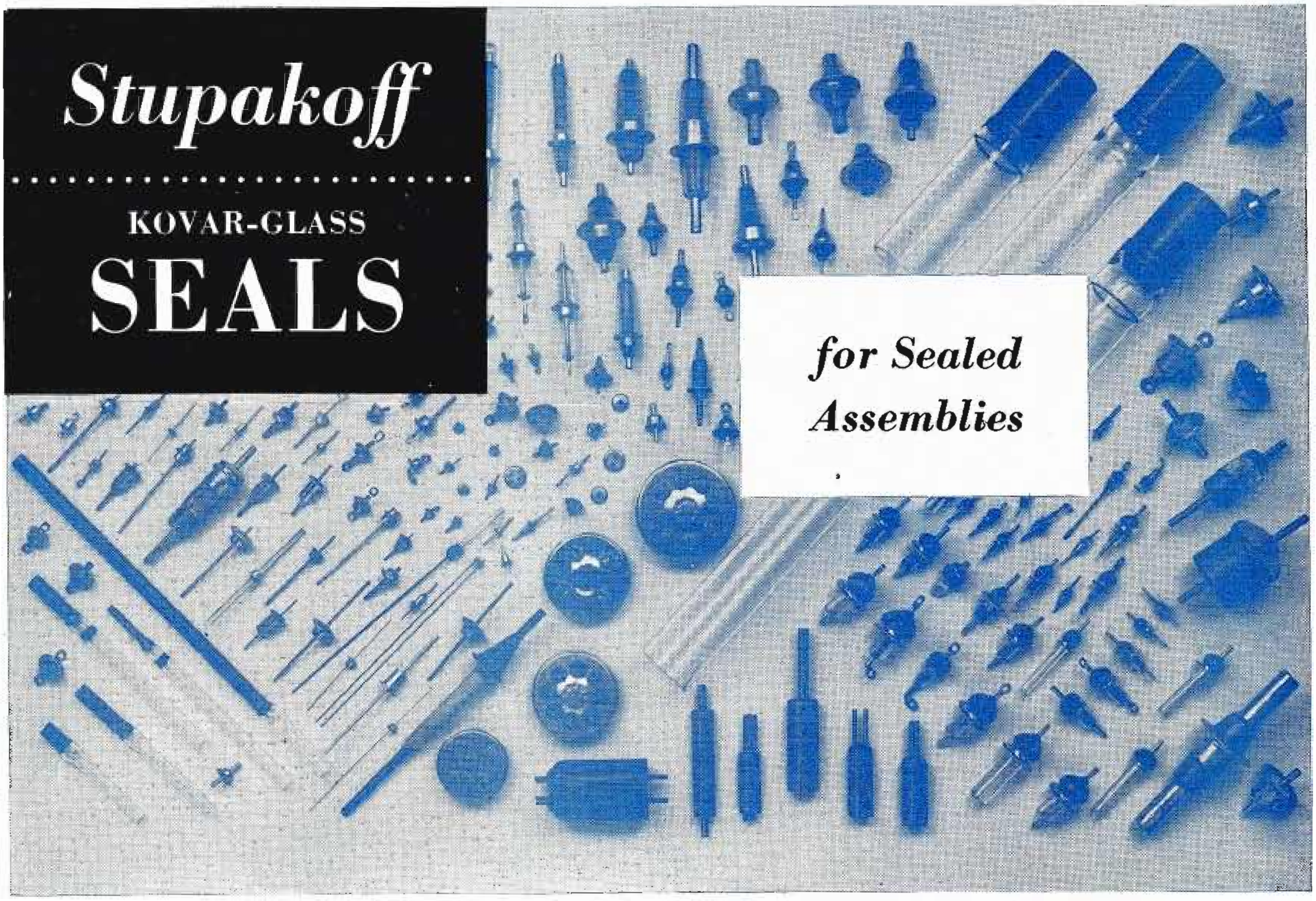

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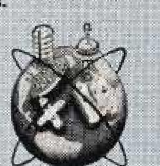

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tually the plate resistance of the driver varies during the sweep interval in such a manner that the plate voltage is relatively constant. The voltage used for this equation is the supply voltage less the drop across the sweep tube.

In most cases, the rate of change of current is always less than has been indicated above so that some control is available. In this case a sawtooth voltage applied to the grid of the driver tube is used to control shape and amplitude.

Since the required peak to peak current in the deflection coil is fixed by the reflection sensitivity of the coils, the anode voltage, and the crt characteristics, the turns ratio between the primary and secondary windings on the transformer (N_1/N_2 in Fig. 8) must be sufficiently great so that the peak available current from the driver tube can deliver the required deflection current when transformed. In direct drive systems this ratio becomes unity.

Once the turns ratio is determined by these factors, the effective transformed inductance and the peak plate current may be determined and the required supply voltage may be calculated.

In booster damper circuits of the type described by Schade[1], the driver tube conducts for only slightly over one-half of the total cycle. When utilizing this type of circuit it is then possible to use almost twice the turns ratio that can be used with conventional brute force drive. With the use of ferrites, this conduction period is almost 50% of the total, due to the extremely small losses in the ferrites.

The high voltage may be derived during the oscillatory interval when the inductance oscillates with stray capacity. It must be kept in mind that the oscillating frequency when the coefficient of coupling is almost unity,

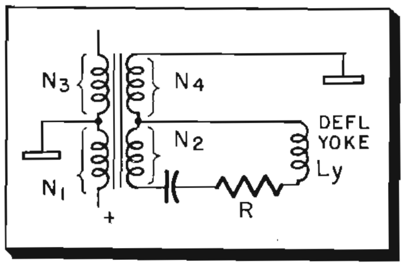

Fig. 8: Winding nomenclature and transformer arrangement for producing secondary damping

as is the case with ferrites, is determined by the stray capacity (which is in the neighborhood of 20 to 25 μμf) and the effective inductance

(*Continued on page 128*)

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Export Division: Rocke International Corp., 13 E. 40th St., N. Y. C. In Canada: Charles W. Pointon, 1926 Gerrard St. East, Toronto from the top of the high voltage winding to ground. This inductance is equal to $[(N_1+N_3)/N_2)]^2L_y$ (Fig. 8). The oscillation must occur in approximately 7.5 μsec, or less, in order to prevent fold over of the pattern. It may be readily shown that the high voltage is independent of the number of turns (N_3) provided that the effective stray capacity due to the driver tube, etc., is only one or two μμf when transformed to the top

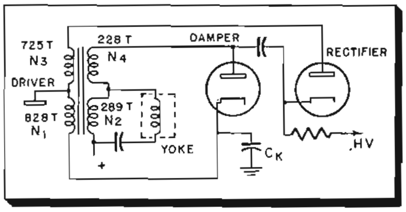


Fig. 9: Using same winding nomenclature, altered circuit of Fig. 8 produces primary damping

of the high voltage winding. (i.e., after reaching a certain value of N_3, additional turns will not increase the high voltage, but simply increase the flying time.) This analysis is shown below.

$$\text{High Voltage} = NL_y \frac{di_y}{dT}$$

$$= NL_y \frac{I_y}{2} \times 2\pi f$$

$$= \frac{NL_y I_y \pi K}{\sqrt{L}}$$

$$\text{Effective } L = \frac{N^2 L_S L_y}{L_S + L_y}$$

$$\text{High Voltage} = \frac{NL_y I_y \pi K}{\sqrt{\dfrac{N^2 L_S L_y}{L_S + L_y}}} = \frac{L_y \pi K}{\sqrt{\dfrac{L_S L_y}{L_S + L_y}}} I_y$$

$$\text{High Voltage} = K' I_y$$

$$N = \frac{N_1 + N_3}{N_2} = \text{Turns Ratio}$$

L_y = Yoke Inductance

I_y = Peak-Peak Yoke Current

$$T = \text{Retrace Time} = \frac{1}{2f}$$

f = Retrace Oscillation Freq.

$$f = \frac{1}{2\pi\sqrt{LC}} = \frac{K^*}{\sqrt{L}}$$

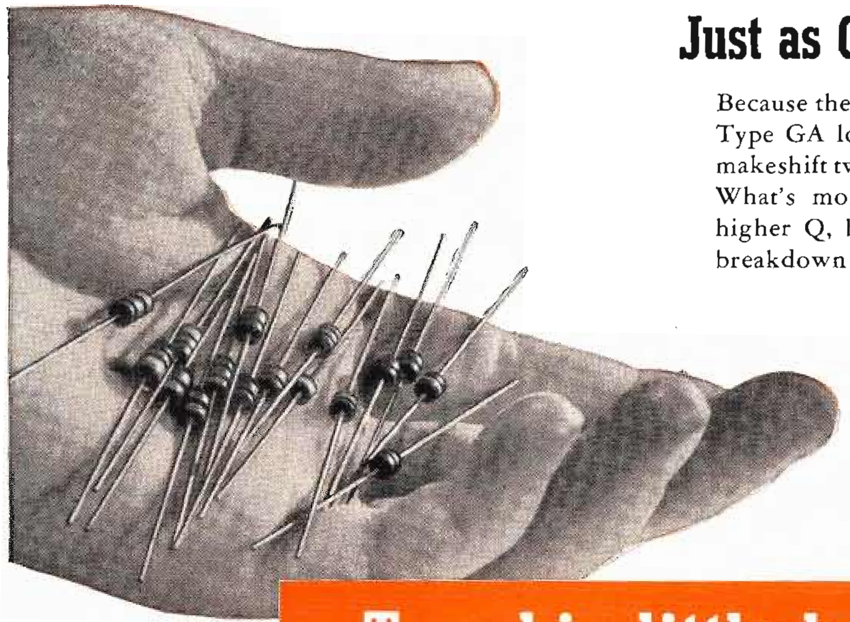
$$i_y = \frac{I_y}{2} \sin 2\pi ft$$

L_S = Transformer Inductance of N_2 Winding

It is therefore theoretically impossible to obtain more than a cer-

(Continued on page 131)

*Assuming a constant value of C. This is approximately true when $[N_1/(N_1+N_3)]^2C_a$ is small compared with other stray capacity. C_a is total stray capacity from plate of driver to ground.



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Because they're so much easier to install, Stackpole Type GA low-value capacitors cost no more than makeshift twisted-wire "gimmicks" in the long run. What's more, they offer much greater stability, higher Q, better insulation resistance and higher breakdown voltage. They are far superior mechanically and eliminate the inductive characteristic common to twisted wires.

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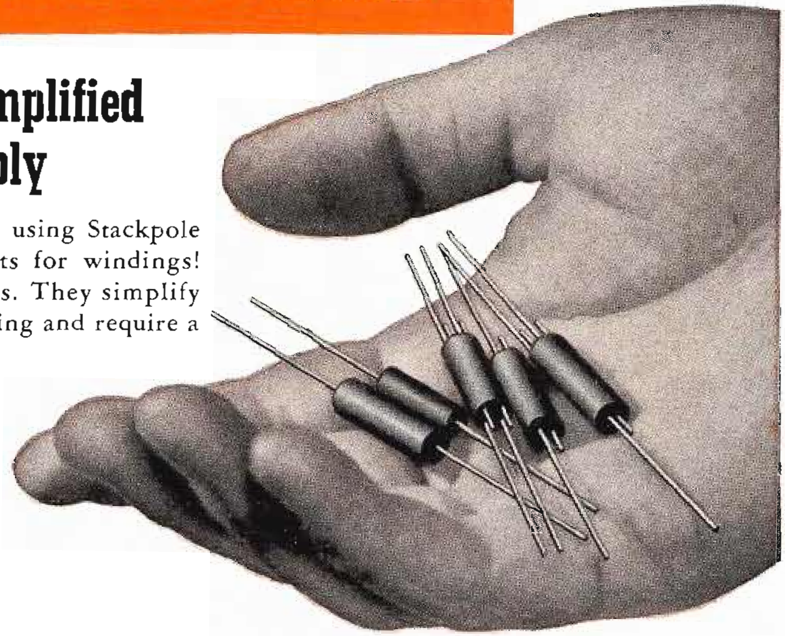

Chances are you'll gain in several ways by using Stackpole Molded Coil Forms as mechanical supports for windings! They cost little. They permit smaller coils. They simplify equipment assembly with point-to-point wiring and require a lot fewer soldered connections. Forms are available with iron core sections that increase Q materially while decreasing the amount of wire needed for a given inductance. Stray magnetic fields are greatly reduced.

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tain voltage, I_yK' which is a function of the peak-to-peak yoke current required for maximum deflection. Use of voltage multiplier circuits may increase the possible voltage, but care must be taken that the total stray capacity, when combined with the effective inductance, will keep the retrace period below 7.5 μsec (which corresponds to approximately 70 kc).

If there were no losses in the circuit, the driver and damper tubes

(*Continued on page* 132)

New Insulating Material

The Carborundum Co., Niagara Falls, N. Y. announces a trademarked "Fiberfrax." Made from aluminum oxide and sand, its manufacture involves the same type of electric-furnace melting that produces aluminum oxide abrasives. No critical materials, such as platinum, are required in the production equipment.

When solid aluminum silicate (right) is melted and subjected to a blast of air, fluffy cotton-like "Fiberfrax" fiber (left) is produced. In samples shown, weights are equivalent.

The unique combination of properties of "Fiberfrax" fiber opens up a host of industrial and defense uses. In the Electronic Industries it can replace or be combined with critical asbestos in many electrical and thermal uses; it can be bonded into insulating panels that will not only resist fire and prevent heat loss, but will also deaden sound. As a filter, "Fiberfrax" fiber can improve the efficiency of gas and fume filtration. Its inertness makes possible cleaning and reuse of the material without loss of filtering efficiency. Studies of potential use indicate that the material may be suitable as the strength-supplying component in formed plastic laminates like radomes, and for vibration dampening. As manufactured it weighs only two lb. per cubic foot. Basically the product is a vitreous ceramic, rather than crystalline. At the present stage of progress, "Fiberfrax" fiber is not available in spun, woven or filament form, although mixtures with other fibers permits carding and spinning. It should be noted that when fibrous glass was first introduced it was only available in bulk, so other forms of "Fiberfrax" fiber may eventually be commercially practicable.

in Fig. 6 would each conduct exactly half of the total time. This would permit unity turns ratio between the driver and damper tubes. Actually, losses do occur and the turns ratio must be modified to compensate for these losses. This may be readily visualized if it is noted that all of the driver tube plate current must pass through the damper tube (as in Fig. 6). Since losses would require higher peak currents through the damper tube, this tube must conduct for a shorter period of time so that both average damper and drive plate currents are equal. This means that the ratio $N_1/(N_2 + N_4)$ in Fig. 8 must be greater than 1.

Step-Down Ratios

Greater step-down ratios require more current flow through the damper with correspondingly higher resistive drop. This, in turn, causes increased nonlinearity since the effective R in Fig. 1 is increased.

It should be noted that there is a dc voltage developed across R_k in Fig. 5. This voltage is equal to LI_y/T, where L is the deflection coil inductance, I_y is the peak-to-peak sweep current and T is the total time for one horizontal line. If, as in Fig. 8, the damper is connected across more turns than the deflection yoke (N_4 plus N_2 compared to N_2) an appreciably larger dc voltage is developed across C_k. This voltage due to the sweep action is the so-called "boost" voltage. From our previous discussion, it is evident that increasing this voltage permits a larger ratio with a corresponding decrease in driver plate current and, consequently a decrease in losses. It is possible to obtain a total boost voltage equal to twice the power supply voltage.

As an illustration of a typical transformer design, the following procedure might be used for a 16TP4. When using a common deflection yoke with a horizontal winding inductance of 10.3 mh, the required deflection current with 14 kv high voltage is about 860 ma peak-to-peak. With ferrite core, the average coefficient of coupling is about 0.99 compared to values of 0.95 for a typical powdered iron core. This greatly simplifies transformer design since the leakage inductance may be neglected in much of the design.

The magnetomotive force generated by N turns of wire with I amperes flowing may be expressed as: $H = 0.4\pi NI$. The flux density in gauss is $B = \phi/A = H/AR$, where $R = l/\mu A$.
R is reluctance, l is flux path length in cm, μ is permeability, and A is the

effective cross-sectional area of the flux path in sq. cm.

It should be noted that the value of R is the sum of the reluctances in the ferrite path and the air gap. The inductances of a coil is $(N\phi/I) \times 10^8$, where flux, ϕ, is BA or, $L = BAN/I \times 10^8$. Solving for N, $N = (LI \times 10^8)/BA$

As shown by Friend[2], a coefficient of coupling of 0.99 provides maximum deflection when the transformer secondary inductance is approximately four to seven times the inductance of the deflection yoke. The value of four will be used for this design since it requires least wire. Then, $L_s = 4L_y = 4 \times 10.3$ mh $= 41.2$ mh. It should be noted that this inductance is required with maximum core flux density.

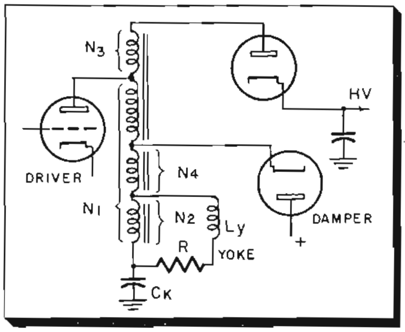

Fig. 10: Circuit for design for 70° deflection

When using Ferroxcube III U-cores with 9/16 in. square cross-section and maximum flux density of 3000 gauss,

$$N_S = \frac{L_S(I_Y/2)10^8}{\mu A} = \frac{(41.2\times10^{-3})(430\times10^{-3})10^8}{3000\,[(9/16)(2.54)]^2} = 289 \text{ Turns.}$$

Assuming sinusoidal current during the flyback interval, the voltage across the yoke,

$$E_Y = L(dI_Y/dT) = LI\,\omega\cos\omega t$$

I_Y = Max. Current = ½ Peak-to-Peak Current

$$\text{Max. } E_Y = (LI_Y/2)(2\pi f) = LI_Y\pi f$$

For f = 70 KC, L = 10.3 mh, I_Y = 860 ma

$$\text{Max. } E_Y = 10.3\times10^{-3}\times860\times10^{-3}\times\pi\times70\times10^3 = 1{,}950 \text{ v.}$$

To remain within peak rating on the damper tube plate (3500 v. for 6W4GT).

$$\frac{N_2+N_4}{N_2} = \frac{3500}{1950} = 1.79$$

$$N_2+N_4 = 1.79N_2$$

$$N_4 = 0.79N_2 = (0.79)(289) = 228 \text{ Turns}$$

Experience indicates the optimum value for

$$\frac{N_1}{N_2+N_4} = 1.6. \text{ Then, } N_1 = 828 \text{ Turns}$$

(*Continued on page 202*)

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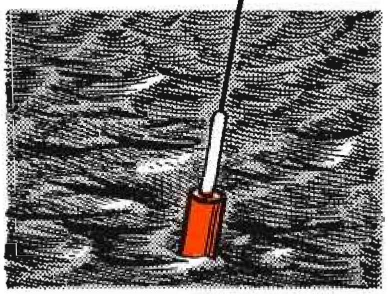

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Suspensions

(*Continued from page* 57)

counteracted and ultimately cancelled by increasing temperatures so that the analogy between the present migratory polarization on the one side and ferromagnetism and ferroelectricity on the other side is emphasized.

Semiconductive Suspensions

So far we have been dealing only with controllable or nonlinear reactances, either in the form of ferroelectrics and saturable reactors in the atomic and molecular field, or in the form of colloidal capacitors. Now, let us go a step further ahead and let us turn into the field of resistivity.

In the first instance, we consider a semiconductive suspension, i.e., we replace the former high-dielectric and insulating particles with semiconductive power such as fine graphite, lampblack, titanium dioxide, etc., or we use commercially available colloidal suspensions such as "Oildag," "Castordag," and "Glydag."

All these suspensions show a fibration similar to that of electric fluids, but exhibits a certain conductivity when the fibers produce semiconductive connections between the electrodes. In other words, the initially high resistivity, at a critical degree of fibration and, therefore, at a critical voltage, instantaneously drops to a finite value when the fibers begin to bridge over from one electrode to the other.

Such a threshold resistivity may well be expected according to the foregoing considerations. An additional phenomenon, however, emphasizes the significance of this conductivity because once this point has been reached the resistivity is nonlinear.

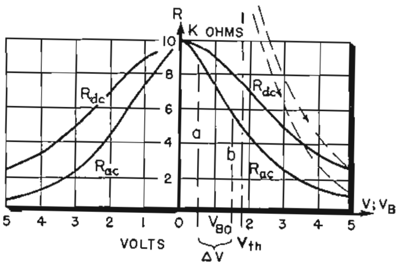

Fig. 5: Voltage effects on ac-dc resistances

For practical purposes, two resistivities must be taken into consideration, namely a dc resistivity according to the ratio of the applied dc field to the passing current density, and a differential or ac resis-

(*Continued on page* 136)

tivity corresponding to the momentary slope of the current-density versus field-strength characteristic at any arbitrary point of operation. two typical examples reveal the relationship between the dc resistance R_{dc} and the ac resistance R_{ac} of the colloidal resistor and the applied voltage V (Fig. 5). As has been pointed out before, the initial resistance is infinitely high. But at a threshold voltage V_{th}, R_{dc} and R_{ac} assume initial values according to the fibration. This transient may be illustrated by two virgin curves. Once the fibers are formed, in other words, once the suspension is polarized, the fibers retain their formation but both resistances increase at

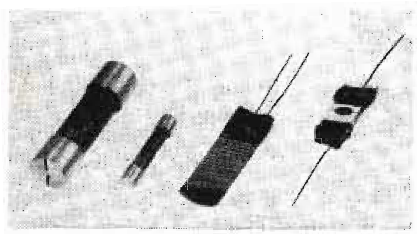

Fig. 6: Wire and mirror type polaristors

lower voltages until they both reach the same zero value R_0.

At this point of our considerations it must be emphasized that only the fibration shows the relaxation time of the migratory polarization, while the nonlinearity exhibits a surprisingly good frequency response up into the microwave region. Whether this resistive control effect may be explained by electrostatic attraction between the innumerable links in connection with some microphonic action of the transient contacts, or by electrostriction, or by some type of field emission of electrons under the very high field gradients between adjacent particles is open to conjecture.

Be that as it is, the practical application of colloidal resistors depends on their voltage sensitivity which can be defined as the maximum slope of the R_{ac} curve occurring at the point of inflection or under the optimum bias V_{B0}, respectively. This slope, which for simplicity is called "Nonlinearity," can easily be evaluated from any given R_{ac} curve by means of the formula

$$NL = \frac{2}{\Delta V} \quad \frac{a-b}{a+b}$$

where ΔV denotes the voltage difference between two ordinates having the lengths a and b, and being equidistant from V_{B0}. Thus the example shown in Fig. 5 yields $NL = -0.47$, which means the differential resistance decreases at the

(*Continued on page 138*)

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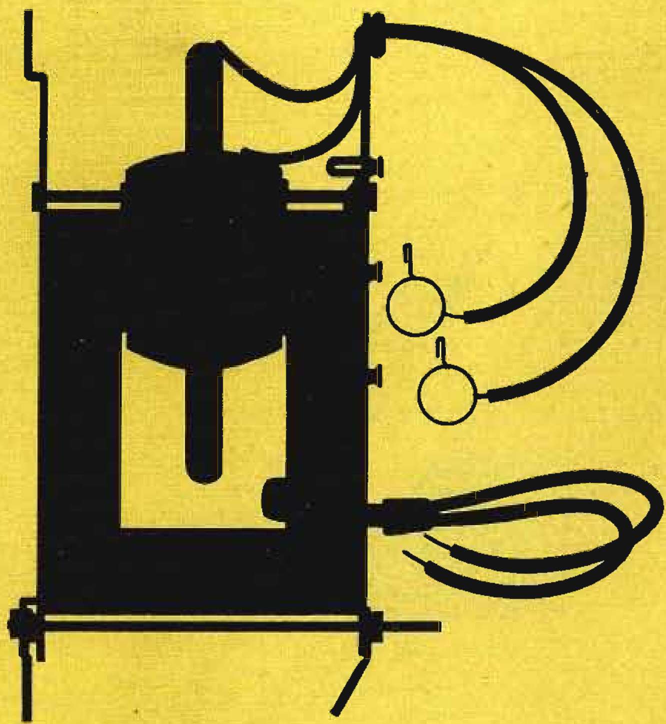

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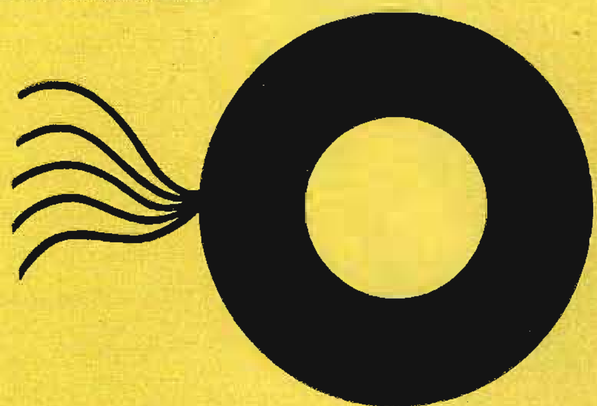

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rate of 47% when the bias is changed by one volt.

The liquid resistors are very unstable, and at the same time, micropronic. Both disadvantages can be eliminated by converting the liquid suspensions into solid colloids without destroying their fibration. For this purpose, acrylate plastics, known under the trade names "Castolite," "Plasticast," etc., have been found to be very suitable. These are thermo- or cold-setting plastics, originally a syrup-like fluid which solidifies either under a moderate heat treatment or often the addition of catalysts. Hence, replacing the carrier oil by fluid plastics and permitting the suspension to polymerize in an

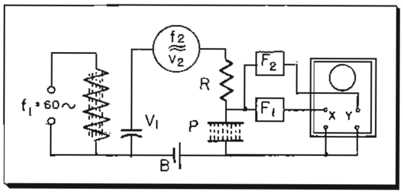

Fig. 7: Oscilloscope set-up for obtaining current-voltage characteristic of a polaristor

ac or dc field, allows the production of solid varistors, the so-called "Polaristors."

Fig. 6 shows two types of polaristors. One type (the three units on the left) contains two wire electrodes which are bifilarly wound around an insulating strip or rod. The type at the right, the so-called "mirror Polaristors," is a mirror whose silver layer is divided by a microscopically fine slot into a pair of electrodes. electrode arrangements are coated with graphite- or lampblack-plastic suspensions which, during application of a suitable polarizing field, are hardened by means of the specified hardener or by means of the prescribed heat treatment.

Various cross-sections of the conductive path cover an extensive range of zero resistance and permissible power dissipation while the nonlinearity depends on the electrode separation, provided a certain power, mix ratio, and prepolarization is given.

The polaristors, of course, are more stable and reliable than the former liquid types and not microphonic because the fibers, according to their state of polarization, retain their arrangement throughout the hardened plastic.

Testing of Polaristors

The simplest method of testing any nonlinear resistor is an oscillographic representation of its current versus voltage characteristic. Since the non-

(*Continued on page* 140)

linearity is evaluated by means of the derivative of the I-V curve, an oscillographic R_{ac} characteristic is more advantageous because such an oscillogram permits R_0 as well as NL to be evaluated instantaneously even during the formation process. At the same time, the applied ac voltage provides the polarization.

As is well known from vacuum tube technique, the derivative of a current-voltage characteristic is obtained by means of an intermodulation method. The basic schematic of a suitable arrangement is shown in Fig. 7. The polaristor P under test, in series with a fixed resistor r, forms a nonlinear attenuator which is fed simultaneously by two frequencies, namely a fundamental frequency f_1 of 60 CPS with high amplitude V_1, and by an intermediate frequency f_2, e.g. 100,000 CPS, at a much lower voltage V_2. The voltage drops across P are impressed upon both inputs of the CRO, but the X-deflection is produced only by the 60-cycle component after the i-f component is filtered out by the low-pass filter F_1. Only the i-f component produces the Y-deflection after the 60-cycles are filtered out by the high-pass filter F_2.

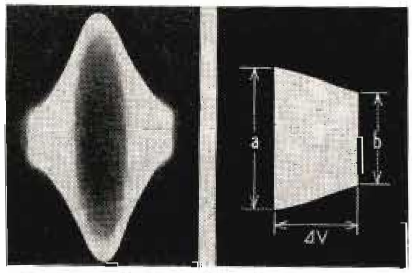

Fig. 8: (a) Hexagonal i-f oscillogram of R_{ac} characteristic. (b) I-F trapezoid is formed when polaristor operates under suitable bias

The hexagonal oscillogram shown in Fig. 8a illustrates the R_{ac} characteristic in the form of the Y envelopes. As soon as the polaristor operates under a suitable bias, e.g., under the optimum V_{B0} produced by the battery B in Fig. 7, the i-f oscillogram assumes the form of the trapezoid shown in Fig. 8b. If the X-sensitivity of the CRO is known, the nonlinearity can easily be evaluated with the aid of the aforementioned formula.

Measurements of the most sensitive mirror polaristors gave nonlinearities as high as 16, which approach the nonlinearity of germanium diodes. Since this value is by all means not optimum, further development may yield even higher values.

The broad range of the significant

(*Continued on page* 142)

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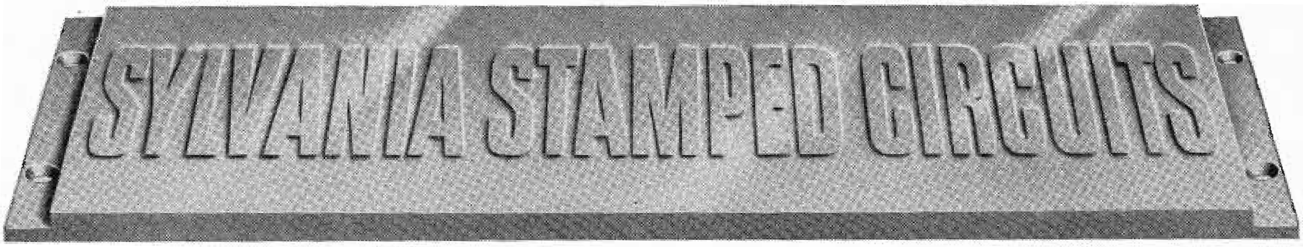

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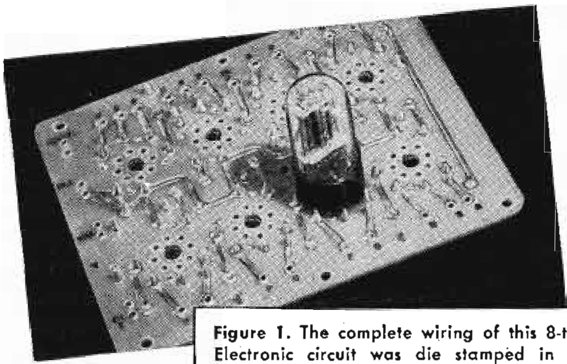

Figure 1. The complete wiring of this 8-tube Electronic circuit was die stamped in one operation. Its 90 connections soldered in another.

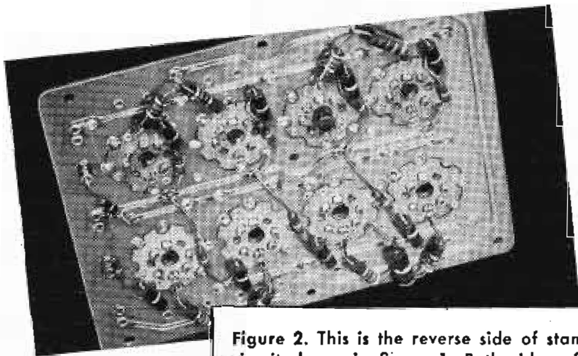

Figure 2. This is the reverse side of stamped circuit shown in figure 1. Both sides of the circuit were stamped in one operation.

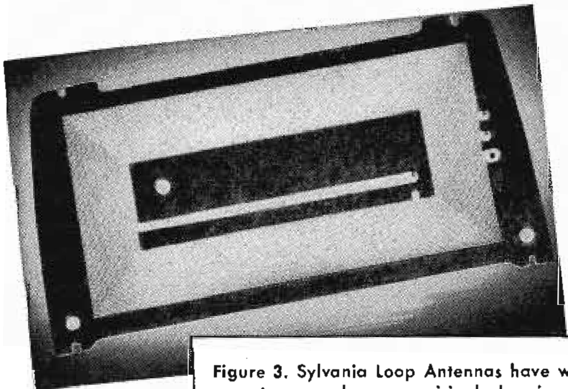

Figure 3. Sylvania Loop Antennas have wide acceptance and are surprisingly low in cost. They assure better reception.

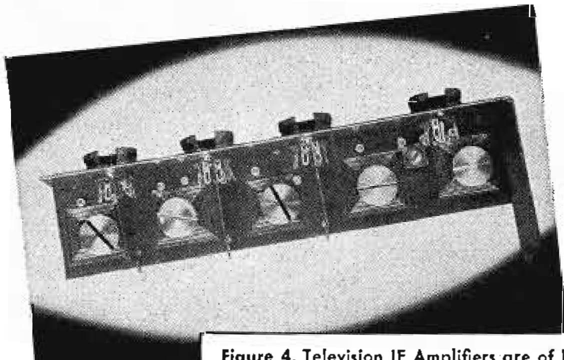

Figure 4. Television IF Amplifiers are of high, uniform quality. These stamped inductances have no variation with heat change, and have a relatively high "Q".

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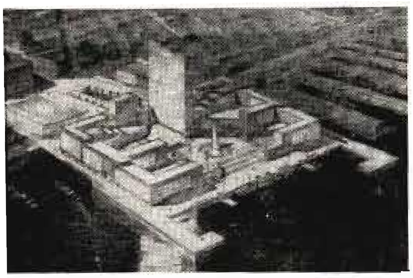
The broad analogy between ferromagnetics and ferroelectrics on the one hand and the described colloidal suspensions on the other hand is more than an academic problem. Nobody knows to which target further studies and developments may lead. The most striking point of view is the fact that we are completely free to intermix a great variety of powders with various properties instead of confining ourselves to natural or synthetic substances with all their limitations.

West Coast Radio and Electronic Exports Increase

In spite of severe restrictions encountered in some foreign markets, the dollar volume of radio and electronic export from West Coast manufacturers has shown a marked increase, according to O. C. Hansen of Frazer & Hansen Ltd., exporters and engineers, 301 Clay St., San Francisco, Cal. Prior to World War II, California exports consisted primarily of transmitters, sound and testing equipment, radio receivers, parts and accessories.

Since that time the character of radio and electronic exports has changed. Demand for home receivers and components for these sets has dwindled because of foreign government restrictions on imports designed to protect local manufacturers and to conserve dollar exchange. In addition, political reasons have eliminated countries such as China from the list of markets.

More than offsetting this loss, an excellent market has developed in Europe. Defense activities have stirred demand


Artist's sketch of World Trade Center in San Francisco. Construction due to start next year

for equipment of a highly technical nature. Unaffected by the restraints suffered by home receiver exports, high fidelity sound equipment for theaters and broadcast stations have continued

(*Continued on page* 203)

Composition Resistors

(*Continued from page 89*)

test on ½ watt resistors within the range of 10 ohms to 20 K. The resistors were operated at a continuously repeated duty cycle of 1-½ hours on at full rated load and ½ hour off. The ambient temperature was maintained at 40°C during the first 500 hours corresponding to the test conditions of paragraph F-3c (3) of JAN-R-11. A new lot of resistors were used for these life tests.

The figure shows a somewhat greater increase in resistance during the first part of the test than at the end of the 500-hour period. While these tests would not justify a generalization of this point, it does appear that most of the change may take place in a relatively short operating period.

As shown on Fig. 6, the test was then continued under the same load cycling conditions except that the ambient temperature was maintained at 85° for 250 hours and then at 105°C for an additional 250 hours. Here it will be noted that 85°C operation does not produce any significant change but that a definite increase in both average value and random variation does occur during the 105°C operating period. A further interesting point is that the changes produced during the 105°C period are apparently permanent in that recovery values obtained at normal room temperature are very

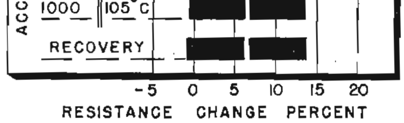


Fig. 7: Load life test of 1-watt composition resistors: 0.01, 0.1, 1, 5.1 and 20 K (5 each)

little different from the values obtained at 105°C.

Fig. 7 gives the results obtained from a life test similar to that shown on Fig. 6 except that 1 watt resistors are used. The entire performance in this case is quite similar to that shown on Fig. 6, except perhaps there is some slight increase in scat-

(*Continued on page 146*)

Advancement in Emergency Communication

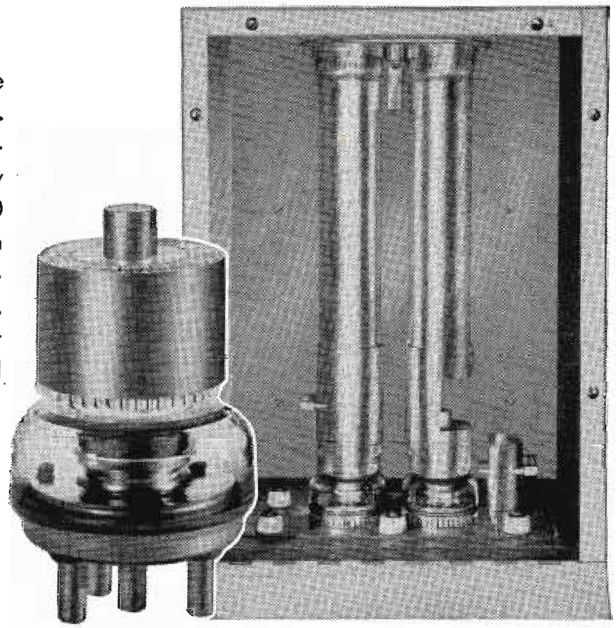
Eimac tubes fill key sockets In continuous service transmitters

REL type 757C transmitter

New and unique in civil emergency communication systems is the New York City Fire Department's five borough radio network planned to meet the threat of any emergency, including atomic attack. Transmitters designed by Radio Engineering Laboratories to give continuous operation are significant contributions to this electronic accomplishment.

Eimac's 2C39A triode is utilized in REL's type 757C point-to-point radio relay transmitter operating in continuous around the clock service at 900 mc. The 2C39A is used in two stages —as a tripler from 150 mc. to 450 mc. and as a doubler from 450 mc. to 900 mc. The 2C39A is a natural to serve in REL's 757C where it can perform as a frequency multiplier at ultra high frequencies with excellent operating efficiency. This compact, rugged, high-mu tube is designed for a variety of uses as a power amplifier, oscillator or frequency multiplier wherever dependability and durability are demanded.

Two Eimac 4X500A's give dependable performance in the REL type 715 emergency service transmitter. These external-anode tetrodes are in the power output stage of the final amplifier in each of the New York City Fire Department's eight main station 350 watt transmitters. Operating in the 150 mc. region the 4X500A's meet the challenge of 24-hour performance. Designed for application the 500 watt 4X500A has small size and low inductance leads which permit efficient operation at relatively large outputs well into VHF.



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313

tering. In any case there is a marked difference in the stability at 105°C ambient as compared with 85°C.

The life performance of 2 watt resistors covering the range of 1000 to 100,000 ohms is shown in Fig. 8. Here the stability characteristics at 40°C for 500 hours is not entirely inconsistent with those obtained for ½ and 1 watt ratings.

The resistance changes at 85°C are also not inconsistent, although the trend toward a decreasing aver-

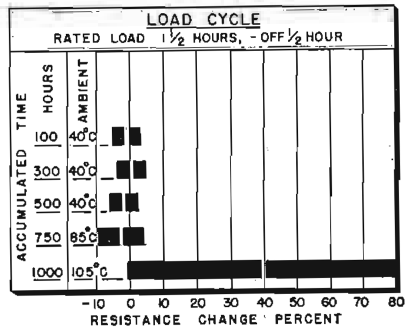

Fig. 8: Load life test of 2-watt composition resistors: 1, 3, 10, 22, 47 and 100 K (2 each)

age value is not readily explained. Operation in 105°C ambients is seen to have an extremely serious effect with an average increase about 40% and one standard deviation being equal to 41%. Recovery tests were not taken but random measurements showed most of these resistors to have been permanently damaged.

These curves represent the performance of resistors of one particular manufacturer. Corresponding tests were taken however, at the same time on resistors of other manufacturers. The stability characteristics were found to be quite similar, particularly for normal conditions of load and ambient temperature as defined by JAN-R-11. For temperatures above the rated values the stability performance as shown on these curves is generally somewhat better than that of other resistors tested.

Conclusions

Summarizing from the results obtained, the following conclusions may be made:

1. Short time exposure to high ambient temperature, (105°C at no load) has as much or even greater effect on resistance as full load operation in 40°C ambient.
2. Short time exposure to high ambient (105°C) at full rated load produces a more marked effect in 2 watt ratings than in

(*Continued on page* 148)

the 1 watt and ½ watt sizes For all sizes however the recovery at normal room temperature is quite good.

3. The random distribution (i.e. magnitude of one standard deviation) is too great to permit reliance on these resistors as voltage dividers where any degree of accuracy is required. This is true even though all resistors in a divider are subjected to the same temperature changes.
4. The ability of resistors of this type to withstand exposure to high ambient temperatures is greater for the ½ and 1 watt ratings than for the 2 watt ratings. For long time operation at high ambient conditions (105°C) the 2 watt units changed to the extent that entirely unsatisfactory equipment performance would probably be the result.

Various other resistor types and processes are being developed and some are now available for general use. Test similar to those described herein will be useful in evaluating their comparative characteristics.

This paper was first presented at the AIEE-IRE-RTMA Symposium on Progress in Quality Electronic Components, May 5-7, 1952, Washington, D. C.

Hot Sprayed Aluminum Provides R-F Shielding

Shown below is an interior view of newly erected panel block type building at Jennings Radio Manufacturing Co. in San Jose, Calif. In addition to

being fire resistant, structure has also been made radiation proof by applying .005-in. hot sprayed aluminum coating on walls and ceilings. Grounding the sprayed aluminum shield and use of dual section filters in each leg of the power line, effectively isolates r-f induction heating apparatus used in manufacture of vacuum capacitors.

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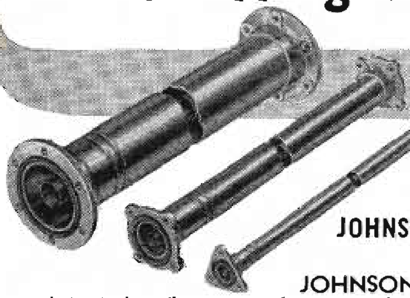

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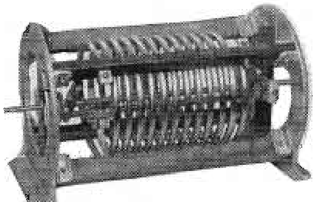

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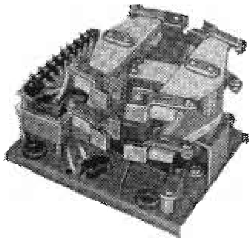

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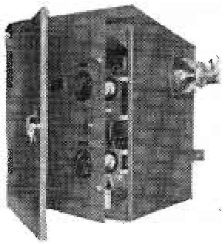

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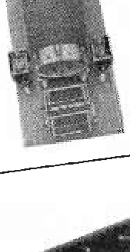

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Low Voltage Filaments

(*Continued from page* 83)

current flow between cylindrical elements is

$$I_b = \frac{K}{S}\left[E_s - E_m + \frac{3E_T}{8}\left(\log\frac{2E_a}{3E_T}\right)\right]^{3/2}$$

This equation is derived from the approximation that the effect of initial velocity is to reduce the space charge at any point.

Consider now the effects of increased cathode temperature on the parameters discussed above. When the cathode temperature of a triode vacuum tube is increased slightly,

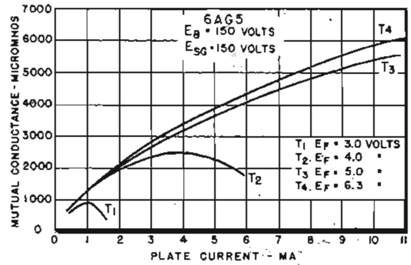


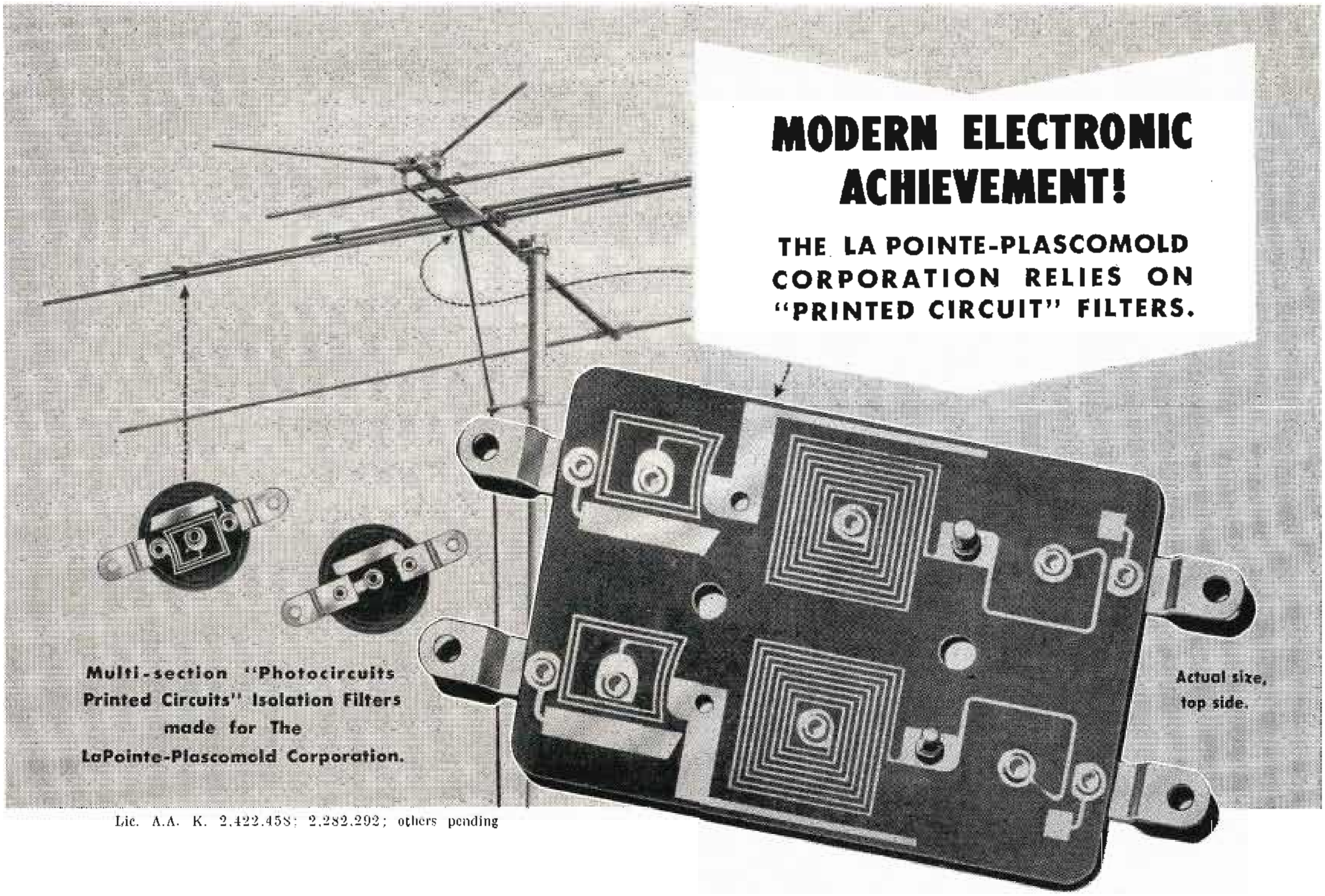
Fig. 9: Pentode mutual conductance

the velocity of electrons emitted from the cathode is increased. The voltage, E_m, of the virtual cathode will increase. The location of the virtual cathode, for all practical purposes, remains at the surface of the cathode. The velocity of electron flow through the grid will increase due to the decrease in charge density, ϱ, since velocity is equal to current density.

These effects seem to be equivalent to what would occur if the zero potential curve were extended beyond the plane of the cathode until it intersected the potential of the virtual cathode at an imaginary plane, which could be called an image cathode. This is the plane from which the electrons apparently are emitted. Fig. 5 illustrates the location of the image cathode. Also, it is evident that the relative spacing between grid and cathode has increased in a greater proportion than between plate and cathode. This, of course, leads to the conclusion that the amplification factor of the tube has been reduced. Conversely, operation of a vacuum tube at reduced temperatures should result in increased grid control over electron flow and an increase in amplification factor.

A medium μ miniature triode, the 6C4, and a sharp cut-off pentode, the 6AG5, were selected for the purpose of measuring the effects of filament voltage upon their characteris-

(*Continued on page* 152)



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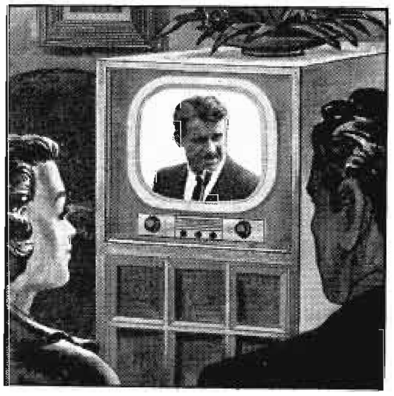


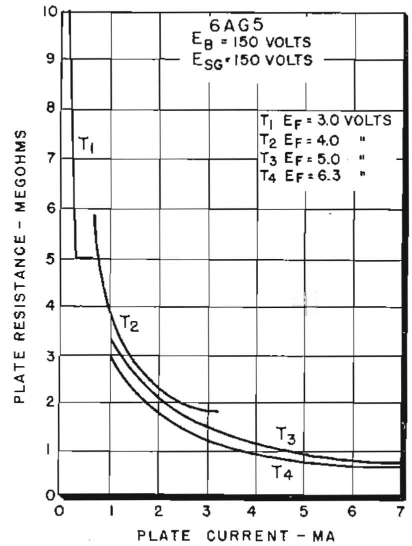


Fig. 10: Pentode plate resistance

tics. Both of these tubes are designed to operate from 6.3 volt filament supply. Mutual conductance and plate resistance were the quantities that were directly measured. Mutual conductance was determined from the relation $G_m = \frac{\delta I_b}{\delta E_g}\Big|_{E_b}$ and plate resistance from $r_p = \frac{\delta E_b}{\delta I_b}\Big|_{E_b}$. The incremental variations in E_g for the measurement of G_m, and in E_b for the measurement of r_p, was obtained from the 1000 cycle square wave generator.

For the triode, G_m, r_p, and μ, as a function of plate current at various filament voltages, are shown in Figs. 6, 7, and 8 respectively. Amplification factor was computed from the relation, $\mu = g_m\, r_p$. For the pentode only G_m and r_p are plotted, since μ is not commonly used in pen-

(Continued on page 154)

TABLE I

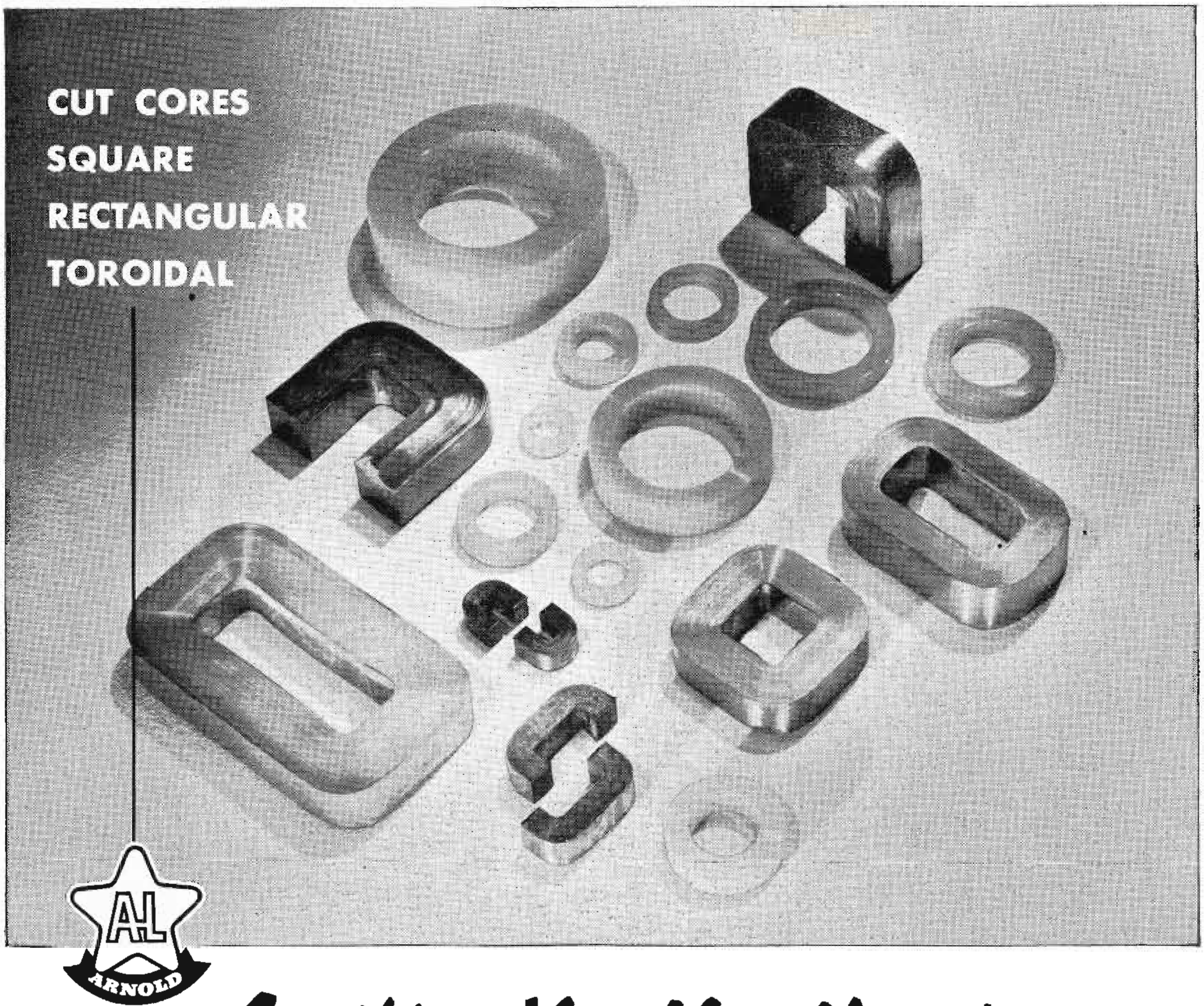
GAIN OF TRIODE AMPLIFIER (6C4)

E_f volts rms	Z_L ohms	I_b ma	Voltage Gain
6.3	100K	1.0	10.2
4.0	100K	1.0	10.6
3.5	100K	1.0	11.1
3.0	100K	1.0	12.6

TABLE II

GAIN OF PENTODE AMPLIFIER (6AG5)

E_f volts rms	Z_L ohms	I_b ma	Voltage Gain
6.3	1 meg	1.0	950
5.0	1 meg	1.0	975
4.0	1 meg	1.0	1010



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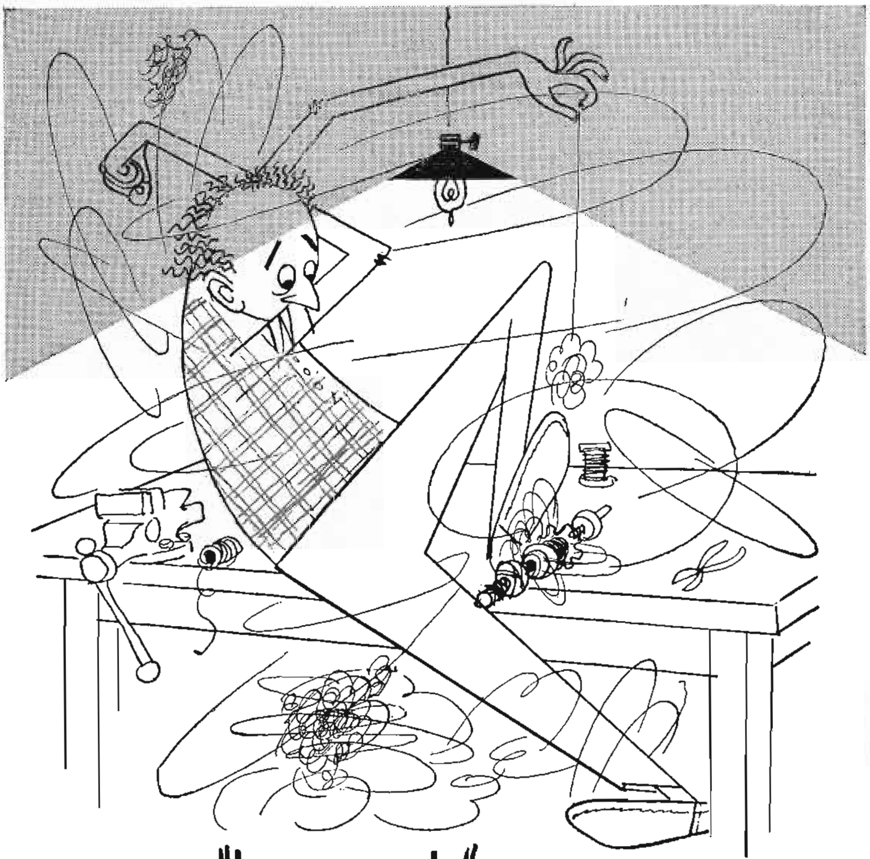
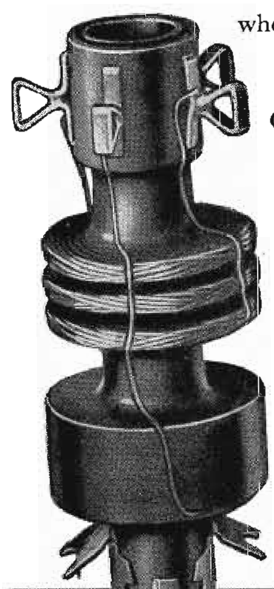




tode circuit analysis. Figs. 9 and 10 are G_m and r_p respectively, as a function of plate current for various filament voltages. Fig. 11 is r_p plotted against grid bias.

Table I illustrates how the 604 will operate as a voltage amplifier at different voltages. These values were computed from the curves and experimentally verified. The point of operation was arbitrarily chosen at 1 ma of plate current. At lower values of plate current, below the range of the experimental curves, even greater differences in amplification resulted from changes in fila-

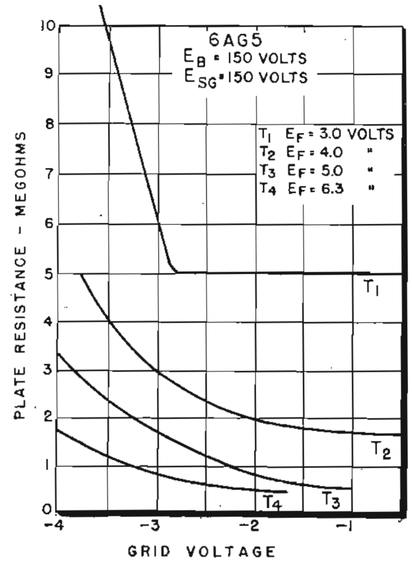


Fig. 11: Pentode plate resistance

ment voltage. The greatest increase in amplification obtainable was approximately 1.5.

In Table II, the voltage gain of the 6AG5 is shown for various filament voltages. Here too, even greater increases in gain result from reduction in filament voltage when the tube is operated at lower plate currents.

In a vacuum tube which is operating below temperature saturation the effect of decreasing the filament supply voltage is: to increase the amplification factor, to increase the plate resistance, and to a lesser extent decrease mutual conductance. The overall result in a voltage amplifier is to increase the gain. Increases of 1.5 in voltage amplification have been measured by operating at approximately one half rated filament supply voltage.

It is the opinion of the author that further study will reveal that operation of vacuum tubes with reduced filament supply voltages has a beneficial effect upon such important factors as: tube life, drift of dc amplifiers, tube noise, and stability of dynamic characteristics.

Magnetic Clutch

(Continued from page 91)

power handling capacity of a given size clutch at a maximum, the last stage reduction should be as great as possible. That is, the fluid magnetic clutch, like all clutches, is a torque converter transfer device and should be run at maximum allowable speed. For most clutches of conventional design, this should be limited to 1000 rpm.

Time Lag

In many servo applications, the time lag between application of voltage to the clutch and development of clutch torque is a critical factor. This lag may be separated into the two parts; namely the lag between application of voltage and development of

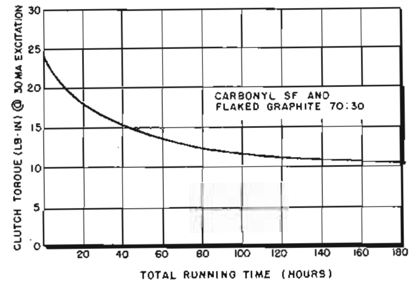


Fig. 5: Life characteristic of dry clutch

current in the coil, and the lag between development of current in the coil and torque at the output shaft.

The first factor is in most cases very small, i.e., the 1/r time constant is less than 1 millisecond. Hence the primary lag is caused by eddy currents which oppose the build-up flux. With a soft iron core, the time lag varies from 40 to 70 milliseconds, depending upon the clutch size.

The following derivation reveals the critical factors in this time lag between current and flux build-up. For simplicity, the simple cylindrical solenoid shown in Fig. 6 is considered. The symbols used are defined as follows:

A_1 = Cross-sectional area of iron in flux path
A_2 = Cross-sectional area of iron in eddy current path
ρ = Resistivity of iron
L_1 = Length of flux path
L_2 = Length of eddy current path
i_1 = Current in coil
i_2 = Current in eddy current path
F = Net mmf in flux path
ϕ = Total flux
R = Reluctance of flux path
μ = Permeability of flux path
n = Number of turns in coil
e_2 = emf in eddy current path
R_2 = Resistance of eddy current path
K_1, K_2 = Constants

The magnetomontive force is

$$F = \phi R, \quad (1)$$

(Continued on page 158)

but since the mmf depends on the difference between coil excitation current and opposing eddy current,

$$F = \frac{A\,\pi\,(ni_1 - i_2)}{10} \qquad (2)$$

where

$$i_2 = \frac{e_2}{R_2} = \frac{K_1\, d\phi/dt}{\rho\, L_2/A_2} = \frac{K_1 A_2}{\rho L_2}\,\frac{d\phi}{dt} \qquad (3)$$

also

$$R = \frac{L_1}{\mu A_1} \qquad (4)$$

Combining 1, 2, and 3

$$R\phi + \frac{4\pi K_1 A_2}{10\,\rho L_2}\,\frac{d\phi}{dt} = \frac{4\pi ni}{10} \qquad (5)$$

or

$$R\phi + L\frac{d\phi}{dt} = \frac{4\pi ni}{10} \qquad (6)$$

where

$$L = \frac{4\pi K_1 A_2}{10\,\rho L_2} \qquad (7)$$

For a step input i_1

$$\phi = \phi_{max}\,(1 - \epsilon^{-t/T}) \qquad (8)$$

where T is the lag time constant and

$$\phi_{max} = \frac{4\pi n\, i_1}{10\,R} \qquad (9)$$

and

$$T = \frac{L}{R} = \frac{4\pi\mu\, K_1 A_2 A_1}{10\,\rho\, L_2 L_1} \qquad (10)$$

Since for a given configuration

K_1, A_1, A_2, L_1, and L_2 are fixed,

$$T = K_2\,\mu/\rho \qquad (11)$$

Hence, it may be concluded from Eq. 11 that for a given flux configuration, clutch lag is dependent upon

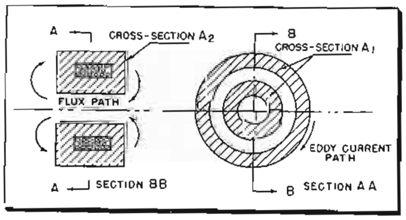


Fig. 6: Cylindrical solenoid used to derive time lag between coil current and shaft torque

permeability and resistivity of the clutch core material. For efficient design of the magnetic circuit, it is essential to maintain a high value of permeability; hence the only practical means of reducing time constant lies in increasing resistivity. One method of accomplishing this lies in laminating the core material in sections perpendicular to the eddy cur-

(*Continued on page* 160)

rent path. Unfortunately, the cylindrical configuration of the clutch shown in Fig. 1 does not lend itself to such lamination. Therefore, a search for a core material having high resistivity along with magnetic properties comparable to that of iron was instigated. It appears that the 2.5% silicon iron commercially available for relay cores most nearly fulfills the requirements. The comparison of the character of this alloy with iron is given in Table I.

TABLE I

	Iron	2.5% Silicon Iron
Maximum permeability	5,000	7,000
Saturation flux density (Gauss)	21,000	18,000
Resistivity (Micro-ohms-cm)	10	40

The relatively lower value of resistivity for soft iron compared to that for silicon iron indicates that a clutch constructed of the latter material should have its resulting time constant reduced by a factor of 4. Two similar clutches were constructed; the first having a soft iron core, the second, a silicon iron core. Actual measurements indicated a time constant of 60 milliseconds, for the first compared to 30 milliseconds for the second, i.e., a reduction of 2:1. The discrepancy between the experimentally measured value of improvement compared to that expected is primarily brought about by the fact that many parts of the clutch, were, for mechanical reasons, constructed of steel. In addition, the exact behavior of the fluid-filled gap within the magnetic path is somewhat difficult to analyze. The change in time constant is appreciable and where this factor is of importance the silicon iron core is desirable.

Purpose of Report

The purpose of this report has been twofold: First, to acquaint the reader with the present state of the art in the development of magnetic clutches, and secondly, to emphasize the most pertinent problems requiring additional research. Present development using labyrinth type magnetic particle separators in combination with forced flow of the magnetic fluid away from the seal by cylindrical pumping action appears to offer the best overall solution to the seal problem. Various thixotropic lubricating mixtures are presently being developed that appear to be sufficiently stable for the most critical of clutch applications.

While many of the pertinent design criteria for establishing an optimum clutch design have not been fully established, it is equally true that clutches manufactured using presently available, techniques will satisfactorily fulfill many clutch requirements in electro-mechanical devices which cannot be adequately fulfilled through the use of any other torque proportioning device.

Overcoming Major Problem

The major problems, seal life and mixture stability, are well recognized and can be overcome through proper maintenance procedures.

The assistance of Messrs. Glenn Fisher and John Heins for preparation of data and design of experimental models presented in this report is appreciably acknowledged.

Walkie-Pushie-Lookie

(*Continued from page* 66)

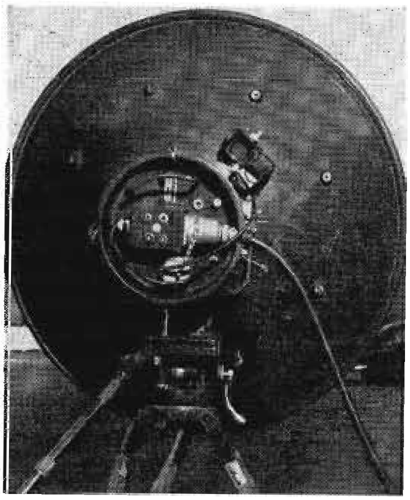
equipment has operated up to about one mile and is very good at one-half mile.

The walkie-pushie-lookie camera was completed in time to be used at the Rose Bowl game at Pasadena, Cal., on Jan. 1, 1952 and the pro bowl game at the Los Angeles Coliseum on Jan. 15.

At both games normally good pictures were obtained from the unit, even after it had been in steady operation for over two hours.

It was also used recently on a telecast of the "Emmy" Award Dinner at the Ambassador Hotel in Los Angeles, where the unit's designer, John Burrell, received an "Emmy" for its development.

Fig. 6: Parabolic antenna has receiver mounted on bracket. Optical gun sight aids positioning



Pulse Power

(*Continued from page 55*)

wattmeter bridge which may be a part of the CW generator or attached thereto.

If the pulse and notch can be made to appear simultaneously on the scope, several advantages are obtained. The scope presentation does not depend upon any scope grid as a reference since the powers into the crystal are approximately the same (equal during measurement); hence, the crystal sensitivity and constancy of calibration are quite unimportant. One such system which accomplishes this simultaneous indication and at the same time provide a direct reading of power level is shown in Fig. 1.

Microwave Pulse Path

The microwave pulse enters the hybrid T and, under conditions of matched loads, divides equally between the bolometer and crystal arms. The power from the reference generator also divides equally between the side arms. The synchronizing pulse (which may come from the pulse generator circuits, from a sampling probe in the incoming line, or generated locally) serves to start the scope sweep and, through the delay network, to key the modulator which turns off the reference oscillator for a short interval determined by the modulator adjustments. When properly set up, the reference oscillator is inoperative during the pulse. The scope presentation is a notch with a pulse riding at the base of the notch. The bolometer bridge reads one-half the peak pulse power.

Several design problems are encountered in a system of this type, the chief one being in providing matched loads for the T network. The bolometer element with its holder does not provide a perfect match, and neither does the crystal branch. One solution is to pad each arm to reduce reflection problems. This solution is not too satisfactory since the attenuation required would decrease the signals and reduce the system sensitivity. One solution which seems to be satisfactory is to make the reflection coefficients of each side arm the same, thus providing cancellation at the center of T.

E-Plane Junction

Fig. 2 shows the spreading of a wavefront into the side arms from the E plane junction; The side arms are out of phase. Fig. 3 shows cancellation of waves at the magnetic plane junction for reflected waves out of phase. Fig. 4 shows the spreading of a wavefront into the side arms from the magnetic plane junction; the side arms are in phase. Fig. 5 shows cancellation of reflected waves at the electric plane junction for in phase waves. For phase relations other than 0 or 180°, and for unequal amplitudes, there will be some coupling between the E and H arms.

Experimental data shows that the H-plane arm has a lower vswr over a wider frequency band than the E-plane arm. The obvious choice then for the input to the wattmeter is the H-plane arm. Reflections from the side arms due to reference generator power only make the power transfer a little less efficient. Measurements have shown that even

Fig. 8: Model 100X portable pulse wattmeter

for a 2:1 mismatch in the side arms, the vswr at the H-arm input was less than 1.5 with an average of 1.35.

Since, as stated previously, the side arm loads are not perfect (the barretter mount shows a maximum vswr of 1.45), reflections will occur from these terminations. To provide cancellation of this energy, the crystal arm must also reflect some energy. This may be accomplished by using a tunable crystal holder or a broadband-type holder with overall characteristics similar to that of the barretter mount.

Experiments have shown, Fig. 6, that the crystal arm can be made to follow quite closely the characteristics of a barretter mount. The energy lost out of the E arm for power into the H arm is seen to be less than 1.5% over an 8.7-9.5 KMC band under certain conditions. Also shown on Fig. 6 is a plot of E-arm energy vs. frequency where an adjustable bias was provided to vary the crystal impedance to reduce the E-arm power to a minimum. This could be made a feedback system to provide broadband T balance. As can be seen, the

(*Continued on page* 164)

bias has a noticeable effect. However, since the power loss to the E-arm was quite low, the bias is used only in special cases where close balance is required and mechanical tuning is inconvenient.

The admittance of a crystal rectifier varies with input power and in so doing, will upset the balance conditions in the T. With proper bias and a properly tuned crystal holder, the vswr can be made quite independent of signal input.

Some of the requirements of the system are quite flexible; the sensitivity of the crystal and its variation with power is not too important as long as it is sensitive enough to give an adequate scope presentation. The video amplifier design need not be complicated; the only requirement is that the pulse be allowed to reach its full amplitude. A square pulse may approach a triangular pulse as a minimum condition.

Reference Generator

The frequency of the reference generator is not critical and operation is quite satisfactory if the frequencies are within 50 MC of each other. Frequency correspondence is easily found by placing the pulse out of the notch and adjusting the reference generator frequency control for a beat.

Notch operation is not the only way the system may be used. The modulator may be so adjusted that the reference generator operates as a pulse generator. Under these conditions the two pulses are made equal, and the generator is then switched to CW in order to read the power level. While the notch method is more accurate and convenient, the pulse method is also useful for some applications.

Two designs from the basic system have been made. One is a rack mounting model complete with frequency meter, wattmeter bridge, and T balancing system, Fig. 7. The other is a portable model, Fig. 8. The nominal range of the portable meter is 0.02 to 20 mw. This range may be extended by the use of attenuators.

These instruments are capable of generating pulses or notches of 0.25 to 9 μ sec in width. The delay is adjustable to 5 μ sec. The sync pulse required can be of almost any shape and requires an amplitude of 15 v. peak or greater. When properly used, the overall accuracy of the system is better than 0.5 db. Several of these units are in use at Convair Plants and in the field. Their performance has been quite satisfactory.

Optical Antennas

(*Continued from page* 81)

antenna whose aperture is long in the horizontal dimension and narrow in the vertical dimension, the resulting pattern will be sharp in the horizontal plane and broad in the vertical plane.

The process of forming a shaped beam can be visualized as a defocusing process, as opposed to the exact focusing for the pencil beam. As we have seen in Fig. 6, the diffraction pattern is distorted if the phase in the aperture is not uniform; thus, if the beam is defocused in some controlled way, the rays emerging from the aperture will not be collimated but will be distributed through a range of angles with a variable density dependent upon the nature of the defocusing.

Beam shaping can be accomplished by disposing an array of elementary sources in a line in or near the focal plane of a reflector and by exciting them in the proper phase and intensity. See Fig 9. The results, however, are not always eminently satisfactory because of the beam spreading in the perpendicular plane caused by astigmatism. Consequently, this method of beam shaping is most readily applied where

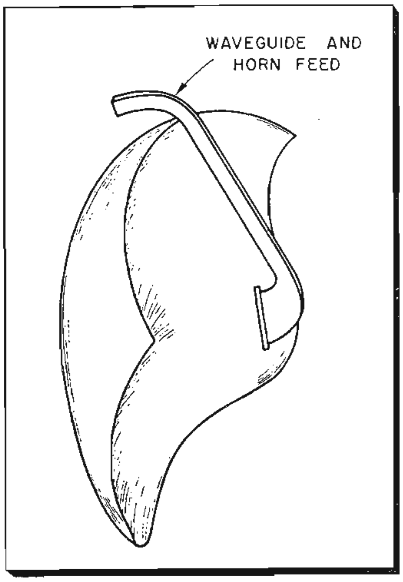


Fig. 11: Doubly curved reflector

the required shaping of the beam is confined to small angles.

A successful procedure, based upon the law of conservation of energy and geometrical optics, has been developed for the calculation of shaped beam antennas to produce a specified pattern. The fundamental theorem in the method is that a one-to-one correspondence may be

(*Continued on page* 166)

established between each point in the aperture and each direction in the far-field pattern, so that the power through a certain small portion of the aperture may be equated to the power radiated in a certain wedge-shaped volume of space. This method was originally formulated by L. J. Chu for the calculation of line-source and cylindrical-reflector antennas. The mathematical relationships establishing this one-to-one correspondence may be obtained by evaluation of the diffraction integral using the method of stationary phase. The results are expressible in a pair of differential equations:

$$-\frac{\delta 2\psi(S,\theta)}{\delta S\,\delta\theta} P(\theta)\,d\theta = 2\pi A^2(S)\,dS \quad (8)$$

and

$$\frac{d}{dS}\psi\ (S,\theta) = 0 \quad (9)$$

in which $\psi\ (S,\theta)$ is the phase function, $P(\theta)$ is the specified pattern for which the antenna is to be computed, and $A(S)$ is the amplitude distribution in the aperture or on the antenna surface.

Eq. (8) is the energy balance equation. It relates the power flow $A^2(S)$ through a small portion of the aperture to the power radiated in certain volume of space. Eq. (9) states that the major contribution to the far field pattern in a given direction θ is made by the part of the antenna in which the phase difference between the various rays in the direction θ is a minimum.

For the line-source and cylindrical reflector these equations reduce to

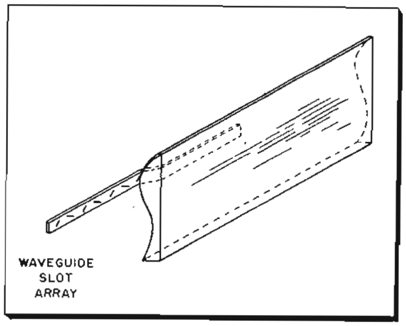


Fig. 12: Dielectric shaped cylindrical lens

$$P(\theta)\ d\theta = 2\pi\ I(\alpha)\ d\alpha \quad (10)$$

and

$$\frac{d\varrho}{p d\alpha} = \tan\left(\frac{\alpha+\theta}{2}\right) \quad (11)$$

where p and α are the polar coordinates of the cylindrical reflector, and $I(\alpha)$ is the power pattern of the line source.

As an example, suppose that it is desired to calculate the shape of an antenna reflector which focuses all the energy from a point source feed into a parallel beam. Then the angle θ is constant and the constant can be made zero. Therefore, the reflector curve is given by the integration of Eq. (11):

$$\log_e \frac{\rho}{\rho_0} = \int_{\alpha=1}^{\alpha=2} \tan(\alpha/2)\, d\alpha \qquad (12)$$

This yields

$$p = \frac{2\varrho}{1 + \cos\alpha} \qquad (13)$$

which is the equation of a parabola of focal length ϱ_0. The formulation has therefore led to an obvious result.

Some of the types of shaped-

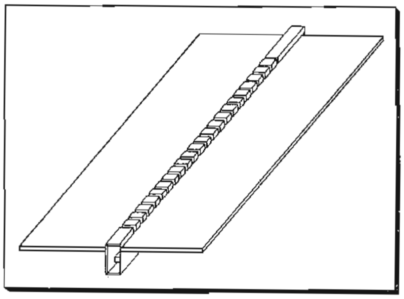
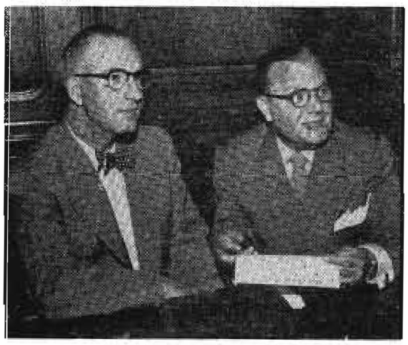


Fig. 13: Endfire slot array in ground plane

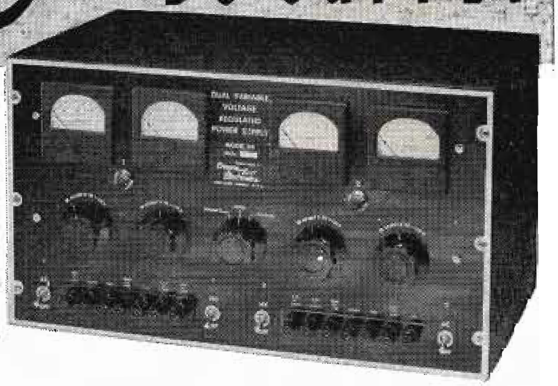
beam antennas to which this method of calculation has been applied are shown in Fig. 10 through 13. They are (10) line-source and cylindrical reflector, (11) doubly curved reflector and point-source feed, (12) line-source and cylindrical lens, and (13) progressive-phase array.

Communications Milestone

Dewey Meade (right), Acting Mayor of San Francisco, reads a congratulatory message from Frank G. Serrao, Acting Governor of Hawaii, on the 40th anniversary of the first American commercial trans-ocean radiotelegraph service. With him, is James T. Chatter-



ton, Vice President in charge of West Coast activities for Mackay Radio and Telegraph Company. It was the establishment of San Francisco-Honolulu radiotelegraph link by Mackay's predecessor, Federal Telegraph Company, that paved the way for the world-wide radiotelegraph network which today joins the United States with the rest of the world.



Subminiature Transceiver

(*Continued from page* 69)

quenched detector for both VHF and UHF detectors, allowing the quench oscillator tube to be dropped. This meant more battery power could be expended in the transmitter section to increase power. A low temperature electrolytic was developed by the P. R. Mallory Co. for use at temperatures of –55°C. New microphone-loudspeaker specifications went out to the microphone manufacturers.

The capacitor-coil combination was discarded in favor of slug tuning, thereby increasing the impedance of the plate, to the high value necessary for doubler operation. The coil forms are injection molded in Cerex No. 250X plastic which has excellent electrical characteristics, and good dimensional stability. The tube manufacturers redesigned and ruggedized the tubes to meet the needs of the equipment more closely. The brackets, boards and parts layouts were changed to break down the assembly into sub-assemblies.

It had been jokingly mentioned that the volume of a package of Pall Mall cigarettes be used as a goal for size reduction. The joke backfired. Management said, "Okay, go ahead and try." Thus, it was decided to undertake the development of a subminiature receiver-transmitter in a case of the approximate size of a pack of king-size cigarettes.

The AN/URC-4 was to be taken as a criterion for performance. Partly to enable comparisons between the two equipments to be made more easily and partly because it was hoped that the Hoffman Acorn could eventually be sold for the same purpose as the AN/URC-4, it was decided to design the Hoffman Acorn to operate at the same frequency as the URC-4.

The Hoffman Acorn receiver-transmitter comes in two versions, VHF and UHF. Although the equipments described here are made for 121.5 MC and 243 MC, these units can easily be designed to operate from 75 to 150 MC, and 120 to 300 MC, respectively.

VHF Version

In its present form the Hoffman Acorn VHF receiver-transmitter is mounted in a water tight case whose size, exclusive of projections, is 3.5 x 2.75 x 1.5 in. The quarter-wave whip antenna consists of seven sections of matched tubing which telescopes completely into the case when not in use. A snap ring at the tip of the antenna locks it in the case when in the collapsed condition. A push-button at the bottom of the case releases the antenna for extension. Two pushbuttons on the left side of the case provide control of the receiver and transmitter. A four terminal water tight connector provides terminals for battery connections.

The receiver utilizes a CK6050 connected as a self-quenched superregenerative detector working into a two-stage audio amplifier. The same audio tubes are used as a modulator for the transmitter. The entire audio amplifier and dc cir-

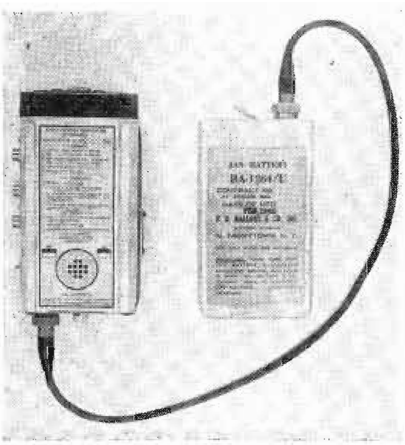


Fig. 3: URC-4 with battery supply can easily be slipped into operator's pocket. Circled perforations at left for combined mic-speaker

cuits for the receiver are printed. The printed circuit consists of a ceramic wafer 2 x 13/16 in.

The transmitter consists of a CK6050 used as a Miller oscillator at 60.75 MC and a 5851 doubler-final amplifier capable of an r-f output of 250 mw. Resonant grid chokes are used in the grid circuits of the oscillator and final amplifier. Bias is developed by means of grid leak resistors. The final tank is a pi circuit feeding the antenna through a coupling capacitor. A choke resonant near the output frequency is in series with the B+ lead to the pi tank.

The tuned circuits utilize no capacities except those of the tubes, with the exception of the antenna matching capacitor of the final pi tank. Tuning is accomplished by means of threaded ferrite slugs in the coil-forms.

UHF Version

The UHF version is similar in external appearance to the VHF unit, with the exception of a shorter four-section whip antenna. The receiver is separately quenched, using an additional CK6050 as a quench oscillator at 180 KC. Separate quenching is employed because at low battery

(*Continued on page* 170)

voltages a self-quenched detector becomes erratic at 243 MC. The transmitter and audio circuits are similar to those in the VHF version; an additional 5851 doubler stage is used to bring the output frequency up to 243 MC. A carrier power output of 150 mw is developed by this unit.

Both the VHF and UHF units were designed to operate from a battery pack providing 90 v. B– and 1.3 v. A+ for minimum size. The battery pack would still be larger than the unit itself but would be considerably smaller than the 135 v. pack of the URC-4. Later, as smaller B cells were developed by the battery manufacturers, and by reducing the A battery life to 40 hours, it was possible to make a battery pack of approximately the same size case as the receiver-transmitter.

With such a small case size, the number and type of applicable tubes and circuits were greatly limited. To reduce the number of tubes in the transmitter section, the oscillator, using a CK5676, was designed to operate at 60.75 MC using a CR-23/U fifth overtone crystal, which was low in activity as compared to crystals at lower frequencies. A natural mistake in designing an oscillator using such a crystal is in providing for so much feedback that the crystal is not really controlling the oscillator, and unstable operation results. Hence, this oscillator had to be carefully designed to have enough feedback to permit strong oscillation and adequate drive to the final amplifier with the crystal in the circuit, but still meet the requirement that when the crystal is replaced by its equivalent capacity the circuit would not oscillate. The doubler-final using a N.U. 2115, 8-pin subminiature pentode was capacitively coupled to the oscillator and link coupled to the antenna.

The audio amplifier requirements presented some extremely difficult problems. No subminiature filamentary type audio tubes known to us had enough power capabilities to modulate the transmitter to 100%. Several good miniature tubes were available but space prohibited their use. However, Raytheon Mfg. Co. came to our rescue. Their laboratories had been experimenting with a line of high power filamentary subminiature audio power output tubes. We were able to get some sample QF-721 tubes to try in our audio amplifier. Our first audio amplifier using a CK 527 speech amplifier and the QF-721 as the power output stage was still somewhat short of our needs, but with the cooperation of the Raytheon engineers in tailoring subsequent development of this tube to our needs, an amplifier with very fine modulation capabilities was eventually developed.

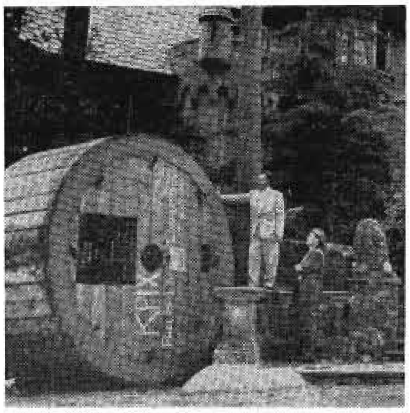
The foregoing work was done on breadboard. Before such a small receiver-transmitter could actually be built, a program of special component development was necessary.

A subminiature microphone had to be developed. The result of this program was a 5 ohm PM dynamic microphone-speaker of 9/16 in. diameter and 5/8 in. length. The diaphragm of this first mic-speaker was too small for good coupling to air when used as a speaker, so the diameter in the region of the diaphragm was increased to 3/4 in. and the impedance was changed to 10 ohms. A companion microphone transformer giving a voltage gain of 40 db in an envelope size of 1/2 x 5/8 in. was also developed.

(*Continued on page* 172)

New KPIX Installation Uses Styroflex Cable

Installation of a GE TV transmitter and wide beam antenna at their new site atop Mt. Sutro overlooking San Francisco has increased the service area of KPIX from 1680 to 5236 sq. mi. Mounted 1350 ft. above sea level, the low gain antenna is reportedly the first in the nation designed to telecast from the side of a tower. Another innovation in the $100,000 project is the installation of the Styroflex cable antenna feed line—first of its kind on the West Coast. This unusual cable, manufactured by Phelps Dodge Copper Products Co., 40 Wall St., New York, N. Y., was described for the first time in Nov. 1951 issue of TELE-TECH page 42. The cable's coaxial construction features an aluminum outer sheath separated from the center conductor by a tape helix of polystyrene. Flexibility, minimum reflectivity and small attenuation are among its chief assets.



Mammoth reel of Styroflex cable gets the once-over after delivery to new KPIX installation in the Sutro Forest. Cable will feed antenna

An audio transformer was designed which is both a modulation transformer for transmitting and an audio output transformer for receiver use. It has an envelope size of ¾ x ⅝ x ⅝ in. Two tantalum electrolytic capacitors are used in this equipment: a 10 µf, 25 WVDC capacitor of ¼ in. diameter and ½ in. length for QF-721 audio amplifier bias bypass, and a 25 µf, 100 WVDC type, ⅜ x ⅞ in. for the B+ filter.

The first hand-built samples of the Hoffman Acorn produced power outputs similar to those of the URC-4 into a non-reactive phantom antenna, but the poor radiation efficiency of the whip antenna working against practically nothing in the way of ground prevented the Acorn from comparing favorably in regards to actual communication capabilities.

Receiver Performance

The receiver, however, performed excellently giving sensitivities as low as 2 µv for a 6 db signal-to-noise power ratio. Sensitivity of 4 µv could be obtained without any particular care being taken in adjustment.

The first sample units proved that a successful subminiature receiver-transmitter could be built. But now a program of redesign had to be instituted to develop a unit that could be built by production methods. Also, further changes were necessary to increase the power output, provide better antenna coupling and improve the audio response at low frequencies.

The first problem to be tackled was to increase the r-f output to the antenna. The use of chokes in the grid circuits of the oscillator and doubler-final with bypass capacitors in shunt with the grid resistances improved the oscillator stability, and increased grid bias on the tube grids. This resulted in high tube efficiencies and greater grid drive to the final, which produced a decided improvement in output power but still not enough to overcome the handicap of the whip antenna.

Chokes self-resonant at a frequency slightly higher than the oscillator frequency proved to be the most effective. Tests showed that self-resonances and coil Q were more important factors than the actual amount of inductance present.

Although a pi tank circuit is generally not recommended for doubler operation, it was decided to attempt such a circuit in order to improve the coupling to the antenna. Little could be done with the conventional tank which had an operating Q of

25, a value of about 21 being desirable for doubler operation.

In order to compute the circuit constants of the pi tank, the exact impedance of the whip antenna in its case had to be found. Slotted line measurements proved that the impedance and radiating characteristics of the whip antenna varied widely with position and proximity effects. The antenna impedance when the case was held close to the face, as it would be when operated, was 4 —j33 ohms. However, the impedance of the rather long antenna feed line from the final tank reduced the apparent reactive component to the point where the apparent impedance to the tank circuit was approximately 5—j10 ohms.

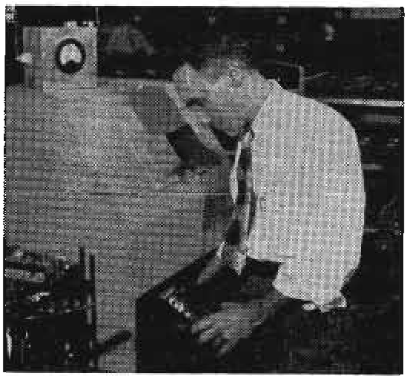
The pi tank adapted consists of the slug tuned coil, the tube capacitance, being the entire input capacitance, a matching capacitor at the output end of the coil and a choke, self-resonant at 125 MC, in the B+ feed line.

These changes in the transmitter section doubled the r-f output to 250 mw when the tank was matched to the 50 ohm phantom antenna. The radiated output now compared very favorably with that of the AN/URC-4.

Audio circuitry was changed so as to enhance the low frequencies, especially in the receiver because the mic-speaker, when used as a speaker could not couple to air as well at the low frequencies. The final result was an audio system that was capable of a highly intelligible and crisp output in receiver and 100% modulation of the carrier with good frequency response from 400 to 3000 cycles for transmitting. It had been

(*Continued on page* 174)

PHOSPHORESCENT FUNGICIDE



"Violet-ray" inspection point on AN-PRC-6 assembly line at the Emerson Radio and Phonograph Corp., 111 Eighth Ave., New York 11, N. Y. Each protected miniature radio transmitter-receiver is sprayed with phosphorescent fungicidal acid. Glow produced in presence of ultra-violet reveals effective area of coating which prevents fungus growths in climates where this condition prevails.

originally intended to have the receiver capable of producing about 70 mw of audio output power, but it was discovered that greater intelligibility resulted when less audio output was used and the operator held the speaker closer to his ear.

Now that the 121.5 MC receiver-transmitter had been developed to a point to show its practicability, it was proposed to design a UHF version to operate at 243 MC.

The transmitter section presented no great problems electrically. An additional doubler was incorporated into the transmitter section.

The antenna was cut to a quarter wavelength at 243 MC. Because the dimensions of the case were a greater part of a wavelength at 243 MC than at 121.5 MC, the radiation efficiency of the UHF whip was a good deal greater than that of the 121.5 MC whip. The radiation impedance of the UHF whip antenna in its case is 19.5—j22 ohms. With the antenna lead through the transmit switch, the impedance to the final tank is approximately 20—j10 ohms.

The receiver detector for the UHF version presented quite a problem. A self-quenched detector using a CK5676 could be made to work at 243 MC when the full battery voltages were used, but under end-of-life battery conditions, it ceased to oscillate. The only other type detector capable of the sensitivities necessary that could be built in the small space was a separately quenched super-regenerative detector. This meant the addition of another tube and components. The transmitter section was already as small as we could make it, so the only answer was to try to reduce the size of the audio amplifier section.

A printed circuit version on the audio amplifier was designed and proved to be very satisfactory. It was capable of 60 db gain and had a frequency response very close to that of the component form amplifier.

In addition, with but two screws needed for mounting the printed circuit and ten connections, the assembly time and cost had been reduced considerably. The additional cost of the printed circuit is nearly offset by the saving in tooling costs for terminal boards and mounting brackets which would have been needed for the component form.

At the writing, Hoffman engineers realize that the subminiature field is still in its infancy. Although many techniques have been discovered and smaller components developed in the past few years, they remain almost insignificant with respect to developments possible in the future.

Back-Pack TV

(*Continued from page* 65)

frequency or any other 60-CPS source at the control point.

The modulator output feeds the crystal-controlled UHF transmitter. The grounded-grid power amplifier, a 5876 pencil triode, operates at 593.96 MC, and provides two watts output. At the control point, the UHF transmission is received, the horizontal sync pulses separated (no vertical sync is transmitted), the sound information removed, and horizontal and vertical pulses added to the video from a local generator.

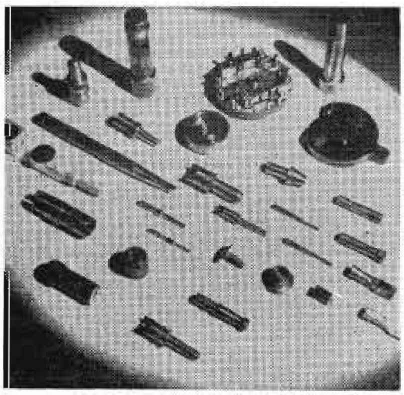
Power is supplied by silver cell storage batteries of 60-ampere-hour capacity. Voltages of 150 and 250 v. dc for the plate circuits are generated by a dynamotor. Total power consumed is about 150 watts with an efficiency of about 60%. The rechargeable batteries will operate the complete walkie-lookie for 1.5 hours on a single charge.

The pack weighs 50 lbs. and the camera about 7 lbs. Compact construction is indicated by the small camera size: 9 x 6.5 x 3 in., exclusive of the three-lens turret.

The walkie-lookie's successful operation at the Chicago political conventions a short while ago appears to foreshadow an increasing use of TV's new roving eye—the walkie-lookie.

Tellerium Copper Parts

Addition of tellerium to pure copper greatly increases ease of machining while not materially reducing its electrical conductivity. The machinability approaches that of free-cutting brass and conductivity is appr. 90% that of pure copper. Material may also be hot worked extensively or severely cold



worked. Photo shows representative group of products now made at Chase Brass & Copper Co., Waterbury 20, Conn., subsidiary of Kennecott Copper Corp. Commercial supply is in hard or half hard temper in the form of rod and bar.

VHF-UHF Tuner

(*Continued from page* 59)

to group the r-f, i-f, and local oscillator portions of the wiring. The r-f tuning elements are represented schematically as parallel-wire lines with one line grounded while the other line is augmented with lumped inductance.

Fig. 3 is a view of the tuner with its shield in place, while Fig. 4 is a view of the bottom, showing the wiring.

The tuner is actually constructed of six sub-assemblies. From right to left, in Figs. 3 and 4 we have: 1) Local oscillator and its tuning element; 2) VHF single-tuned circuit element; 3) R-F amplifier chassis; 4) Primary of VHF-UHF double-tuned circuit; 5) Secondary of VHF-UHF double-tuned circuit; and 6) UHF i-f amplifier and VHF mixer chassis. A centrally driven shaft rotates the short-circuiting sliders and also operates the r-f switch at the grid of the i-f amplifier-mixer tube.

The printed circuit tuning elements are the chief factor responsible for the small size and low cost of the tuner. A more detailed description of the printed circuits follows.

Fig 5A is a front view of the printed circuit in sub-assembly number 4 mentioned above. The printing is made upon polystyrene and represents the inner conductor of a coaxial cable. The outer conductor is the shield cup placed around the polystyrene discs and visible in Figs. 3 and 4.

The short-circuiting slider makes contact between the printed line at a radius of 1.5 in. and a silver plated cover plate which is attached to the shield cup.

The wide line in Fig. 5A belongs to the UHF section. A loop provides the necessary length to resonate initially at 890 MC. As the short-circuiting slider moves away from this loop, the resonant frequency of the line decreases until 470 MC is reached. After traversing a short gap, the slider makes contact with the start of the narrow section of line, which represents the channel 13 position. An external adjustable inductance serves as an initial tuning adjustment for channel 13. Six printed frequency jump loops between channel 13 and 7 are designed so that the preselector tracks with the higher frequency of the local oscillator tuning element.

The relatively long length of line needed to jump from channel 7 (177 MC) to channel 6 (85 MC) is printed on a second polystyrene disc placed behind the aforementioned disc. A view of the second disc is given in Fig. 5B. Frequency jump loops between each of the channels 6 to 3 are printed on the disc of Fig. 5A while the jump loop between channels 3 and 2 is on the disc of Fig. 5B. The latter disc also carries the loop which inductively couples energy into or out of the UHF line.

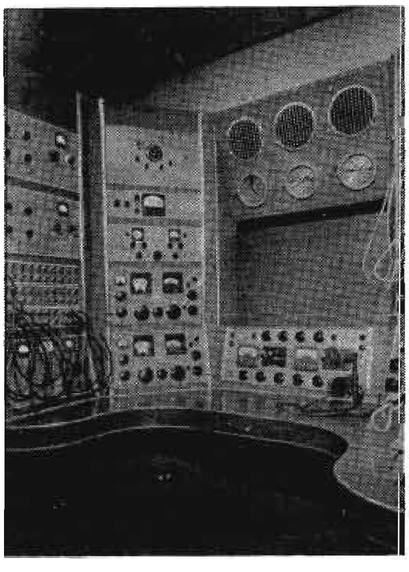
Necessary Isolation

It is necessary to isolate electrically the printed line of one disc from that of the other in the VHF region. This is accomplished by sandwiching a thin ground plane between the discs. The basic assembly, without rivets, connecting wires or cover plate, is shown in Fig. 5C. The double-tuned effect is accomplished by capacitively coupling the line of sub-assembly number 4 to that of sub-assembly number 5. Coupling takes place at several points along the lines, so that the effective size of the coupling capacitance automatically increases as the short-circuiting slider rotates toward the lower frequencies. Fixed or adjustable tuning capacitance and local oscillator injection points are also positioned at several points along the lines.

Fig. 5D is a front view of the local oscillator printed circuit, which must track with the r-f tuned

(*Continued on page* 178)

PRESIDENTIAL COMMUNICATIONS CAR



View of control console in new presidential communication car "General Albert J. Meyer." Named after first Chief Signal Officer, car was designed by Transportation Corps and equipped by Signal Corps. Included in control console are four Hammarlund Super-Pro 600 receivers having range of 540 KC to 54 MC. Clocks show local, Eastern, Greenwich Mean time.

circuits. In the UHF region, as r-f signal circuits vary from 890 to 470 MC, the oscillator frequency must go from 467 to 257 MC so that the second harmonic is always 44 MC above the r-f signal. The tracking problem is related to the change in line length needed to go from some upper frequency, f_u, to some lower frequency, f_l. For ¼ wavelength resonance, the change in line length is given (in inches) by

$$\Delta l = 2950K \left(\frac{f_u - f_l}{f_u f_l}\right)$$

where f_u and f_l are in MC, and K is the velocity of propagation relative to that of air. If $K = 0.8$, for example, the length of line needed to go from 890 to 470 MC is

$$\Delta l = \frac{(2950)\ (0.8)\ (420)}{(890)\ (470)} = 2.37 \text{ in.}$$

For the oscillator, on the other hand, the length of line needed to go from 467 to 257 MC is

$$\Delta l = \frac{(2950)\ (0.8)\ (210)}{(467)\ (257)} = 4.12 \text{ in.}$$

One might increase the radius of the oscillator line by a factor of 1.74 so as to achieve the proper line lengths. In the PRD tuner, however, the UHF r-f and oscillator lines have equal length. Tracking is accomplished by loading the UHF oscillator line at five points with trimmer condensers. The five protuberances in Fig. 5D mark the location of these trimmer capacitors.

VHF Section

In the VHF section, where the oscillator operates 44 MC above the r-f, the oscillator line becomes shorter than the r-f line. From channel 13 to 7 for example, the r-f line is 2.25 in. long while the oscillator line is only 1.5 in. The oscillator line in this region is the unbroken section of Fig. 5D. The corresponding r-f section, as mentioned previously, contains jump loops which increase its actual length.

The length of the line leading to the channel 13 position of the oscillator is printed on a second polystyrene disc placed behind the main disc. A view of the second disc is given in Fig. 5E. Frequency jump loops between each of channels 6 and 2 are printed on the disc of Fig. 5D, while the jump loop between channels 7 and 6 is on the disc of Fig. 5E. The latter printing also includes lines for inductively coupling energy out of the oscillator. A thin ground plane electrically isolates the printing of one disc from that of the other. The basic assembly, without rivets, connecting wires or cover plate, is shown in Fig. 5F.

The local oscillator short-circuiting slider makes contact with a B plus ring which is at r-f ground, as shown in the schematic. This construction accomplishes automatic B plus switching to the 6J6 and 6BQ7 r-f amplifier.

Figs. 3 and 4 show a drive mechanism that has been used with the tuner. A drive system, now being considered, allows 24 detent positions to be preset anywhere over the tuning range. The detent positions are 15° apart mechanically and promise to alleviate two objections to the continuous method of tuning, i.e., crowding of the UHF channels and tuning noise caused by sliding contacts.

Performance Evaluation

The VHF section displays performance characteristics of tuners with cascode r-f amplifiers. Laboratory models are capable of yielding noise factors of 5 db on channel 2. Gain, image rejections ratio, i-f rejection, etc., are equivalent to competitive cascode tuners.

The UHF section offers a noise figure of 14 to 15 db. The theoretical value may be somewhat lower than this, depending upon the value assumed for the mixer conversion loss and is probably attainable after optimization of all couplings from antenna to cascode i-f amplifier grid. Measured image rejection ratio and gain agree satisfactorily with theoretical calculations.

From an electrical point of view the design is optimized for overall performance. Some few words may be included regarding the absence of a grounded grid r-f amplifier for the UHF section. The addition of such an r-f amplifier would probably offer an additional 10 db of oscillator radiation reduction at the antenna with optimized noise factors varying from 10 to 13 db. Use of a grounded grid UHF amplifier offers the disadvantage that if this same amplifier is operated grounded grid for VHF, the advantage of cascode operation are lost. Installation of a separate cascode amplifier for VHF represents an expensive solution to recover these advantages.

Mechanically, or perhaps more exactly, electromechanically, the PRD combination design has the disadvantage of using a sliding contact for tuning. Sliding contacts are greeted with mixed emotions by the industry. Undoubtedly, a non-contacting tuner is possible and preferable. It does appear, however, as though a non-contacting combination design will be more expensive than the one described in this paper. Experience indicates that a well designed sliding contact can give completely satisfactory service.

Acknowledgement is made to Stanley Johnson who conceived the basic mechanical design and to R. A. Lebowitz who was extremely helpful in working out the details of the oscillator section.

Subscription TV—

(*Continued from page* 20)

some of the artificial controls which are now keeping costs up.

Second, I doubt whether elimination of objectionable programs is a valid argument in favor of subscription television. Generally speaking, the loudest objections to present programs are based on the dislike of some element in the program itself such as high emphasis on crime, poor taste in comedy, etc. But these factors are not inherent in the program because it is broadcast free of charge and there is no guarantee of their absence if the viewer pays for the program. They depend rather on the influence of public acceptance on the people who produce entertainment to be presented on television, and that influence will operate to produce good or bad programs under any system of television. In fact all of us can remember many incidents in which the motion picture industry—whose product would, I gather, be the chief source of programs under subscription television—has been criticized for the same objectionable elements being found in some present television programs.

General Electric Co. CHESTER H. LANG
Schenectady, N.Y.

Won't Cure Public's Bad Taste

I have had some discussion with Mr. Glen McDaniel, President of the Radio-Television Manufacturers Association, on your editorial, and with his permission am quoting from a letter I received today from him about it, which very eloquently summarzies his views on the editorial, with which I entirely agree.

"I think Dr. Caldwell's editorial is a good one because it takes a realistic view of some of the serious difficulties that lie in the path of the development of subscription television as a service to the public. I have never thought it was practical for channels to be assigned exclusively to subscription television because that would do so much violence to the American concept of free radio. As to showing subscription shows at intervals between free television programs, the editorial mentions the fact that this would pose a serious problem to the broadcaster because it would put a 'chill' on a station's audience. This is one of the most serious practical difficulties in developing subscription television. A broadcaster makes his living by carefully building up a partnership, and I have never talked to a broadcasting executive who had any enthusiasm for interspersing paid programs between free programs.

"I do not agree with the tone of the editorial with relation to the quality of programs. Subscription television is not to be welcomed as an answer to 'public dissatisfaction' with television programs. If the public is dissatisfied with any program, the program soon goes off the air. People who criticize television programs are usually criticizing the level of taste of the great American public. You are not going to get people to stop looking at crime shows and wrestling matches just by putting an art exhibit on television for a dollar fee. I do not think subscription television will in the slightest restrain the cheapness and bad taste that is criticized in television programs.

"Where subscription television is desirable is that by offering better programs to the minority who appreciate them it can in time help bring about better listening habits and better taste on the part of the public at large. The other point is that it will fulfill a demand which is not now being fulfilled because of the necessity on the part of advertising sponsored television of pleasing the greatest number of viewers."

ROBERT C. SPRAGUE
Sprague Electric Co. President
North Adams, Mass.

A Vital Shot-in-Arm for TV!

Your valued editorial on Subscription-TV in July TELE-TECH hit the nail on the head when it said "the whole industry may have to re-examine its sights and look anew into subscription-TV—as a tonic, if not a life-saver!"

Those who for some time have given the deteriorating economics of television their earnest and concerned attention, are now convinced that it will take a radical kind of cure to bring the patient back to normal health.

Subscription-TV, and particularly the Subscriber-Vision system which we at Skiatron have developed and perfected, will give television that vital shot-in-the-arm. Because of the very nature of the expanding TV medium, pay-as-you-see viewing must inevitably be a part of tomorrow's television structure.

To the broadcaster it will, for the first time, offer a degree of economic stability. His newly-found "box office" not only will free him from the whims of sponsors and agencies but at the same time will be a source of vast new revenue.

To the audience, which has already indicated its willingness to pay for good shows, it will open new vistas of TV programming, providing entertainment which no commercial advertiser could afford today. And control over TV content will be passed along to where it really belongs—the television viewer.

At Skiatron we are confident that the F.C.C. will eventually authorize one or several systems of subscription-TV as being in the public interest. We are quite certain that Subscriber-Vision, already acclaimed as the simplest and most economic of the toll TV systems devised so far, will be widely accepted.

I would like to take issue with just one point in your editorial—the implication that the subscription-TV code can be broken and the signal "pirated." I can't speak for other systems, of course, but I would like to assure your readers that at Skiatron we have come up with a unique coding system that is absolutely fool-proof. It is an accomplishment in which our staff takes great and justifiable pride.

ARTHUR LEVEY
President

Skiatron Electronics &
Television Corporation
30 E. 10th St., New York

Build Bigger Audiences for TV

I am delighted to discover that you are so "pro-unneutral" about subscription television. And I am particularly interested in your development of the thought that we might use some of the unneeded new UHF channels for exclusive subscription stations. That is a relatively new thought and I will certainly be interested in any editorial reaction you get to it—especially from the F.C.C. In this same regard, I am glad to see you point out that the "F.C.C. must eventually take the broader view in the 'public interest, convenience and necessity' and give full opportunity for the commercial tests of the various methods proposed for subscriber-TV."

I would disagree only with your sentence in which you say: "Practical broadcasters don't see much merit in this latter plan, since the limited audiences of paid periods would offer little attraction for adjoining or following sponsors." Actually I don't disagree with you, but I disagree with the myopic broadcasters who think that subscription shows will have small audiences. Some of them will, of course, and so do some of the commercial programs! But what do you think the size of the subscription audience might have been to the recent Indianapolis Race, the Derby, or the Walcott-Charles fight? And if the Chicago Phonevision test is any clue, there will be some mighty big audiences built up during the evening hours for movies and other good subscription programs, where the commercial boys can hook on either fore or aft. And if subscription-TV bears out my hopes that a lot of people will tune in to daytime educational shows, then I think we might even build some good adjacencies for good commercial programs during the dog-hours.

MILLARD C. FAUGHT
342 Madison Ave., New York 17

LETTERS

on Other Subjects
Begin on Page 197

Chart for Relating Power Levels in Radio Links

A source of minor annoyance to radio engineers is the practice of rating transmitter output in watts, receiver input in µv, and propagation loss in db. The chart below, published by Lenkurt Electric Co., San Carlos, Cal., can be used to convert watts or µv to dbm (db above or below 1 mw), and also to show receiver input for a given transmitter power and total transmission loss.

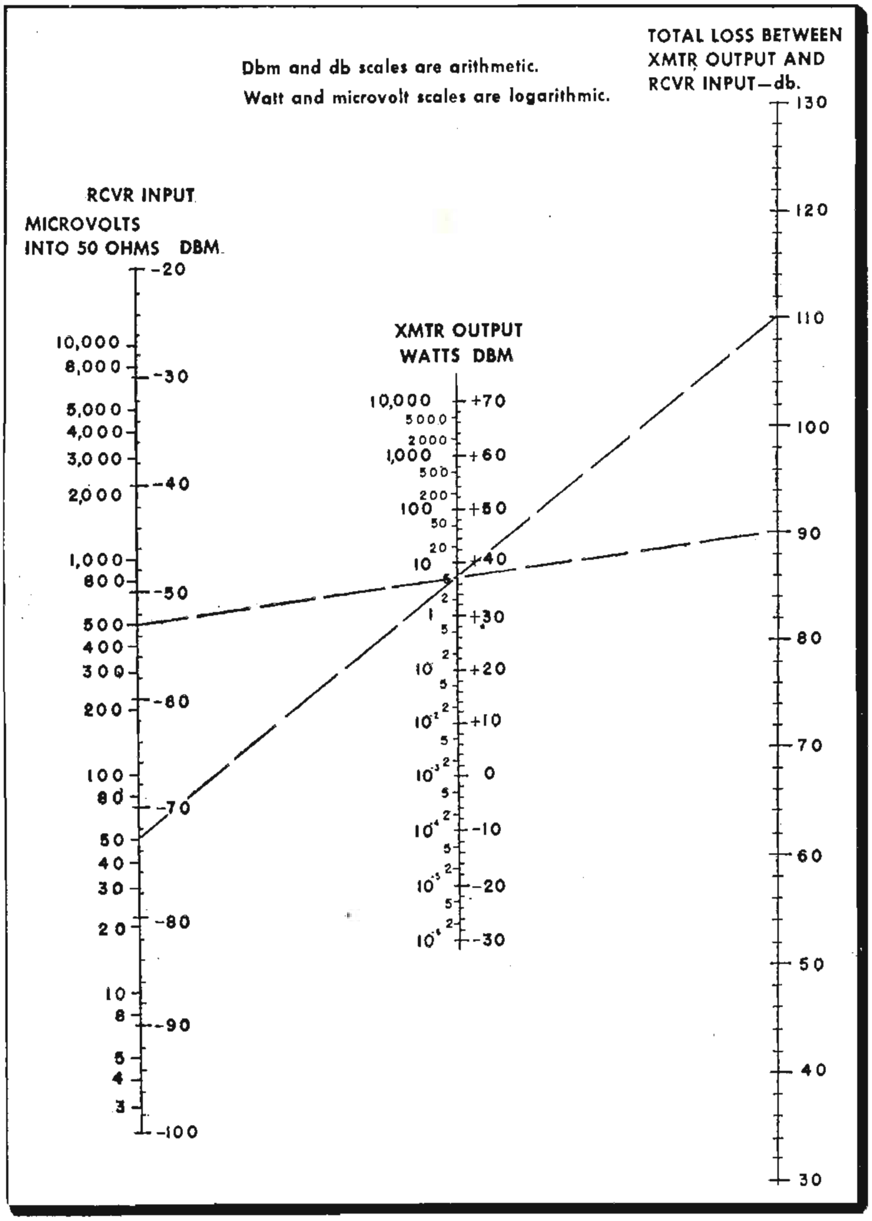
In order to convert µv into 50 ohms to a dbm value, the two figures are read from opposite sides of the scale on the left. To change watts to an equivalent dbm value, both sides of the center scale are read.

The two dotted lines connecting the three scales show how the nomograph is used for determining receiver input level or transmitter output level when the total loss is known. For example, if the transmitter output is 5 watts and losses are 90 db, a straight-edge connecting these two points on the center and right scales will show that receiver input will be 500 µv. Or, put another way, with a different problem, if the minimum permissible receiver level is 50 µv, and transmitter output is 5 watts, the total loss can not exceed 110 db.

Two New Companies

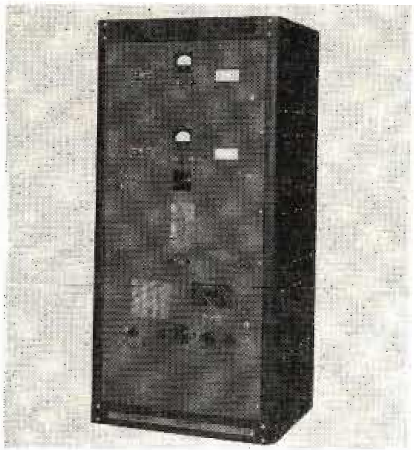
Alden Products Co., 117 N. Main St., Brockton, Mass., has announced the formation of two licensee companies. One, the Alden Electronic and Impulse Recording Equipment Co., will operate in the field of monitoring, multi-trace recording and recorders using the electrosensitive Alfax paper. The second firm, Alden Systems Co., will handle facsimile equipment, particularly units designed for production control and internal factory communications.

Nomographic chart relating transmitter output, receiver input, and total losses between them



AM Communications System

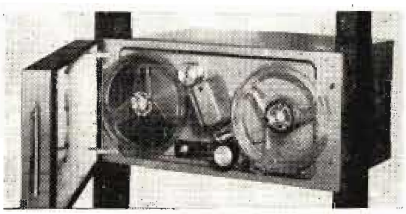
Communications system designed primarily for aircraft traffic comprises four equipment tracks. Top: N516E single-channel



transmitter operates in 200 to 400 KC range. In addition to AM voice transmission, provision is made for automatic six-tone keyer for homing code signals. Next to top: N510E five-channel AM transmitter operates in 1.5 to 6 MC band with 100 watts output. Power input is 450 watts transmitting, 90 watts standby, from 115 v., 60-cycle source. Center: Transmitter power supply. Next to bottom: N612E eight-channel, three-band receiver covers 550 KC to 15.9 MC. Sensitivity is 2 to 4 μv input for 250 mw output. Selectivity for 7, 15 and 22 KC off resonance is 20, 40 and 60 db down. Power consumption is 68 watts, 115 v. ac. Bottom: Space for second receiver.—**Northern Radio Co., 314 Bell St., Seattle 1, Wash.**—TELE-TECH

Airborne Recorder

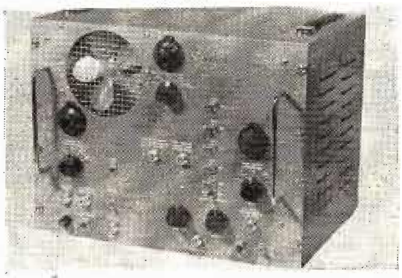
Model S-3097 is an airborne recorder capable of handling frequencies between 200 and 100,000 CPS. Essentially, it is a simplified version of model 307, designed for FM/FM telemetering of guided missile and



aircraft data. The unit records only, and the two speeds provided give seven minutes recording time at 30 in./sec. and three minutes at 60 in./sec. At the higher speed frequency response is within ± 3 db from 400 to 80,000 CPS; at the lower speed, within ± 3 db from 400 to 40,000 CPS. A one volt signal into a 100,000 ohm record imput impedance gives full recording level with less than 1% total distortion. Weighing about forty-five lbs., this aircraft recorder requires 8¾ in. of rack space and is 16 in. deep. Required power input is 2 amps of 24 v.dc and 1½ amps of 115 v. 400 cycle ac.—**Ampex Electric Corp., 934 Charter St., Redwood City, Calif.**—TELE-TECH

Pulse Generator

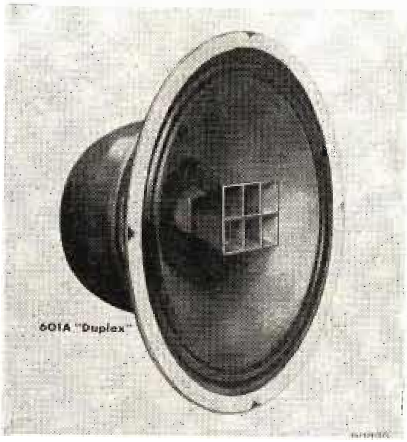
Model B-2 Pulse Generator is an instrument for the generation of pulses of variable width, amplitude, delay, and repetition rate,



with very accurate control of all factors by means of helical potentiometers. It features duty factors as high as 25%, and repetition rates as high as 100 KC. An internal oscillator provides rates from 10 CPS to 100 KC in four decade ranges. It may be externally triggered, or used in single pulse operation. The main pulse may be delayed from 0 to 10,000 μsec from the synchronizing pulse in five decade ranges. The main pulse is variable in width, from 0.2 μsec to 1,000 μsec in four decade ranges, has a rise time of 0.02 μsec, a fall time of 0.05 μsec to 0.1 μsec (depending on width), and maximum amplitude of 100 v. into an open circuit. The internal impedance of the main pulse output is 100 ohms.—**Rutherford Electronics Co., 3707 South Robertson Blvd., Culver City, Calif.**—TELE-TECH

Duplex Loudspeakers

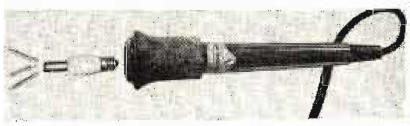
Both the 601A and 602A duplex loudspeakers are complete two-way systems with a dividing network providing a smooth



crossover at 3,000 cycles. All of the tones from 30 to 3,000 CPS are reproduced by the highly efficient cone speaker, with a 3 in. aluminum edgewound ribbon voice coil. Those from 3,000 to 22,000 CPS are reproduced by the high frequency unit through an exponential horn designed to give smooth distribution over a wide horizontal angle. Three steps are provided on the network for adjustment of high frequency level. The two speakers are similar in construction with the exception that the 601A has a 12 in. cone while the 602A has a 15 in. cone, and a larger magnet. Because of this larger magnet, the efficiency of the 602A is 2 db higher than the 601A and, due to the larger cone, the reproduction of frequencies below 50 CPS is somewhat better. Both speakers, however, will reproduce all of the fundamental tones down to 30 CPS. The 601A and 620A loudspeakers have a power rating of 20 watts nominal, 30 watts peak. Network impedance is 8 ohms.—**Altec-Lansing Corp., 9352 Santa Monica Blvd., Beverly Hills, Calif.**—TELE-TECH

Heating Elements

Developed for precision soldering, models 535 and 1235 feature screw-in heating elements into which any of three Elkaloy Tip-



lets (pencil, offset, or chisel tip) may be threaded. Model 535 is for general soldering and model 1235, employing a 40-watt heating unit is for production line soldering. The tip material Elkaloy 'A' is an alloy which is said to require no special tinning procedure, and will not oxidize as rapidly as copper.—**Ungar Electric Tools, Inc., Los Angeles 54, Calif.**—TELE-TECH

FOR MORE INFORMATION

on New Equipment for Designers and Engineers

See pages 98 and 100

Tape Recorder

The "Synchrotone" permits the synchronous recording of two different sound events on the same tape, without acutally mixing

the sounds on the tape. The two recordings may be made simultaneously, or separately. Each may be erased (or made inaudible temporarily), corrected, changed in relative volume, or copied—without affecting the other. Yet both may be played back together, in perfect synchronism. Model VM58 operates at 7.5 in./sec. and has a 30-minute recording time and frequency response to 7,000 CPS. Model VM58-S operates at 3.75 in./sec. and provides 60 minute recording with 5000 CPS response. Both models have automatic erase heads, fast forward and rewind, separate radio and microphone inputs for each channel, separate output channels plus a dual output for mixing both channels. —**Magnetic Recording Industries, 30 Broad St., New York 4, N.Y.**—TELE-TECH

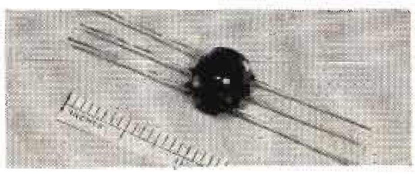
25-Watt Audio Amplifier

The Classic 25 amplifier is one of 8 completely new designs incorporating every practical operational feature. The remote

control unit included is finished in brushed brass. Features of the Classic 25 include: distortion reduced to lowest limits without reserve power sacrifice; frequency response from below 10 to over 100,000 cps; newly-developed "Audi-balance" permits perfect balance of output tubes. Six inputs are provided for radio, TV, tape recorder, crystal and magnetic (2) pickups. "Fletcher-Munson" compensated volume control maintains perfect aural balance.—**Newcomb Audio Products Co., 6824 Lexington Ave., Hollywood 38, Calif.**—TELE-TECH

Pulse Transformer

MPT 101-B miniature pulse transformer mensures 7/16 x 7/16 x 3/8 in. and weighs less than 0.1 ounce. The small size and light



weight permit direct mounting with leads to the chassis in which it is used. Two, three and four windings can be designed into these units for coupling purposes. If required, these transformers may be built of Class "H" materials for continuous 200°C operation, and hermetically sealed to withstand MIL-T-27 humidity tests. Units with two, three, and four windings, with or without center-taps, are obtainable to fit circuitry requirements. Other features include fast rise time, flat top, and minimum decay, thus providing good waveform for pulse techniques. The standard frequency response, from 100 KC to 40 MC, can be shifted to a higher or lower frequency range as required. —**PCA Electronics Inc., 6368 De Longpre Avenue, Hollywood 28, Calif.**—TELE-TECH

Antenna Filter

(*Continued from page* 120)

and VHF sections. When considering operation in the UHF range, the filters labeled 195 and 69 MC in the circuit diagram capacitative short circuits that permit the flow of UHF energy from the antenna feed points through the filter to the transmission line. At UHF, filters labeled 680 MC are high series impedances isolating UHF energy picked up on the VHF receiving elements from reaching the transmission line. In the VHF range, filters labeled 69 and 195 MC effectively isolate energy picked up by the UHF V from reaching

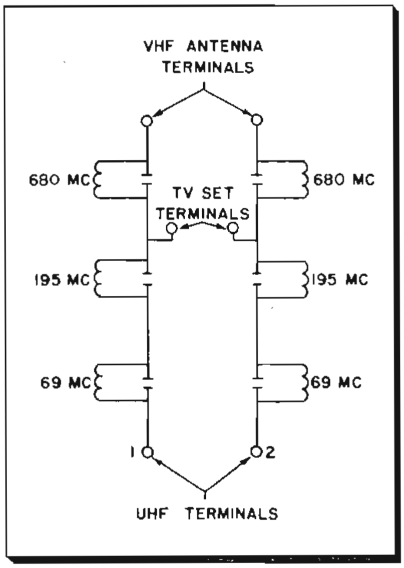


Fig. 2: Six-section filter attenuates UHF signals between VHF antenna and transmission line, and eliminates VHF from the UHF section

the transmission line. The 680 MC filters "look" like extensions of the transmission line and do not attenuate passage of VHF signals.

Both the integral antenna filters (195 MC) and the multisection coupling unit are manufactured by a photo-etched process. This process, in essence, consists of exposing a photo sensitive copper-clad phenolic sheet to a high intensity light source through a master negative of the desired circuit configuration. This is done under high vacuum to insure perfect duplication of all pieces. The sheet is then immersed in an acid bath to remove the undesired portions of the copper sheet. Secondary operations include the individual filter sections, and automatic eyeletting of the filter join points and lug connections. The whole filter is then solder dipped at low temperature to make positive connection. Testing of the total unit before incorporation in end equipment is simplified by a three-frequency resonance indicator with end limits of 2%. The impending use of higher frequencies for TV and commercial purposes, and the ever present need for miniaturization has created a demand for high accuracy mass produced components.

PERSONAL

Dr. Thomas T. Goldsmith has been elected president of Du Mont Television & Electronics, Ltd., new Canadian subsidiary of Allen B. Du Mont Laboratories, Inc. Dr. Goldsmith is director of research and a member of the Board of directors of the parent U. S. company. Offices for the Canadian subsidiary have been established at 901 Victoria Square in Montreal, Canada.

Goldsmith

Caruthers

Robert S. Caruthers has joined the Lenkurt Electric Co., San Carlos, Calif. manufacturers of telephone and telegraph carrier equipment, as chief systems engineer. In this capacity he will be responsible for working out design objectives for new carrier systems to meet future requirements of the communications industry.

Frederick G. Suffield has been appointed engineering manager of Transco Products, Inc. with headquarters at the company's Los Angeles plant.

Suffield

Moncton

Howard S. Moncton has been named administrative engineer of the Radio and Television Division of Sylvania Electric Products Inc., in Buffalo, N. Y.

Robert R. Williamson, formerly of Stevens Institute of Technology, has joined the staff of Librascope, Inc., Glendale, California. In this new post, he will direct an advanced digital computer program.

Louis V. Feldman has been appointed technical director of the Division Lead Co., 836 W. Kinaie St., Chicago, Ill.

Clifton N. Jacobs has been elected vice president in charge of research and engineering of the Taylor Fibre Co., Norristown, Pa. and LaVerne, Calif.

NEC Program

(*Continued from page 94*)

W. E. Michel, T. R. O'Meara, and H. D. Webb, University of Illinois, Urbana, Ill.

XI—Circuits: I

"AN ALTERNATIVE APPROACH TO OPTIMUM FILTERING" by E. W. Pike, Raytheon Manufacturing Co., Waltham, Mass.

"SYNTHESIS OF A DYNAMICALLY-VARIABLE ELECTRONIC FILTER" by J. G. Truxal and J. N. Warfield, Purdue University, Lafayette, Ind.

"A RELATION BETWEEN SUSCEPTANCE SLOPE AND SELECTIVITY FOR OSCILLATOR DESIGN" by W. A. Edson, Georgia Institute of Technology, Atlanta, Georgia, and R. D. Teasdale, Radio Corporation of America, Camden, N. J.

"THE APPROXIMATION OF ARC TANGENT (ω) WITH A LINEAR ELECTRICAL NETWORK BY USE OF A CONTINUED FRACTION EXPANSION" by D. L. Finn, Purdue University, Lafayette, Ind.

"A METHOD OF EVALUATION OF THE QUASI-STATIONARY DISTORTION OF FM SIGNALS IN TUNED INTERSTAGES" by J. J. Hupert, A. R. F. Products, Inc., River Forest, Ill.

XII—Components, Assembly & Measurements

"USE OF FERROMAGNETIC MATERIALS IN ELECTRONIC TUNING OF RADIO FREQUENCY COMPONENTS" by S. Stiber, Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

"LIQUID DIELECTRIC R-F COAXIAL CABLES" by R. M. Soria, C. C. Camillo, and J. G. Krisilas, American Phenolic Corporation, Chicago, Ill.

"MINIATURE WIRING FOR ELECTRONIC APPLICATIONS" by J. M. Caller, Raytheon Manufacturing Co., Waltham, Mass.

"PRINTED CIRCUITS AND THE AUTOMATIC FACTORY" by R. Gerhold, Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

"MEASUREMENTS ON AN AMPLITUDE-MODULATED CRYSTAL-CONTROLLED MAGNETRON TRANSMITTER" by L. L. Koros, Radio Corporation of America, Camden, N. J.

XIII—Semiconductors

"SEMICONDUCTING FILMS" by W. M. Becker and K. Lark-Horovitz, Purdue University, Lafayette, Ind.

"MICROWAVE MEASUREMENTS ON GERMANIUM SEMICONDUCTORS" by F. A. D'Altroy and H. Y. Fan, Purdue University, Lafayette, Ind.

"THE DETERMINATION OF THE RESISTANCE-TEMPERATURE CHARACTERISTICS OF BULK SEMICONDUCTORS BY THE PULSE HEATING METHOD" by R. B. McQuistan, Purdue University, Lafayette, Ind.

"CADMIUM SULFIDE AS A CRYSTAL RECTIFIER" by G. Strull, Northwestern University, Evanston, Illinois.

XIV—Memory Tubes & Tube Reliability

"DEVELOPMENT OF AN IMPROVED GRAPHECON STORAGE TUBE" by W. T. Dyall, G. R. Fadner, and M. D. Harsh, Radio Corporation of America, Lancaster, Pa.

"PERFORMANCE CHARACTERISTICS OF THE RAYTHEON RECORDING TUBE" by R. C. Hergenrother and A. S. Luftman, Raytheon Manufacturing Co., Waltham, Mass.

"RELIABILITY OF FILAMENTARY SUBMINIATURE TUBES" by R. Wood, Raytheon Manufacturing Co., Newton, Mass.

"CATHODE INTERFACE IMPEDANCE AND ITS MEASUREMENT" by H. M. Wagner, Signal Corps Engineering Laboratories, Belmar, N. J.

"IMPROVING GAS TUBE GRID CIRCUIT RELIABILITY" by J. H. Burnett, Electrons, Incorporated, Newark 4, N. J.

XV—Circuits: II

"FREQUENCY FEEDBACK" by H. E. Hollmann, U. S. Naval Air Missile Test Center, Point Mugu, Calif.

"THE DUAL-INPUT PARALLEL-T NETWORK" by C. F. White and K. A. Morgan, Naval Research Laboratory, Washington, D. C.

"HARMONIC INSENSITIVE RECTIFIERS

(*Continued on page 188*)

NEC TECHNICAL PAPERS PROGRAM

(*Continued from page 187*)

FOR A-C MEASUREMENTS" by R. L. Frank, Sperry Gyroscope Co., Great Neck, L. I., N. Y.

"A METER FOR MEASURING THE COEFFICIENT OF COUPLING OF IF TRANSFORMERS" by E. A. Saunders, U. S. Military Academy, West Point, New York, and G. R. Cooper, Purdue University, Lafayette, Ind.

"A SIMPLE METHOD OF COUPLING TOROIDAL COILS" by R. R. Darden, Jr., Raytheon Manufacturing Co., Point Mugu, Calif.

WEDNESDAY, OCTOBER 1

XVI—Computers

"FUNDAMENTAL CHARACTERISTICS OF DIGITAL AND ANALOG UNITS" by J. M. Salzer, Hughes Aircraft Co., Culver City, Calif.

"A DIFFERENT APPROACH TO ANALOG COMPUTATION" by C. R. Bonnell, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

"INTERCONVERSION OF ANALOG AND DIGITAL DATA IN SYSTEMS FOR MEASUREMENT AND CONTROL" by B. Lippel, Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

"A FIVE-CHANNEL ELECTRONIC ANALOG CORRELATOR" by M. J. Levin and J. F. Reintjes, Massachusetts Institute of Technology, Cambridge, Mass.

"AN ELECTRONIC STATISTICAL TABULATOR" by R. M. Stewart, Jr., and A. R. Kassander, Jr., Iowa State College, Ames, Iowa.

XVII—Antennas

"GROUND REFLECTION PHASE ERROR CHARACTERISTICS OF A VERTICAL ANTENNA" by H. Greenberg and D. Meierdierks, Sylvania Electric Products Inc., Bayside, N. Y.

"INPUT IMPEDANCE OF FOLDED DIPOLE ANTENNAS" by R. E. Beam and P. Andris, Northwestern University, Evanston, Ill.

"YAW MEASUREMENTS ON ROTATING PROJECTILES BY R-F LINK" by S. J. Raff, U. S. Naval Ordnance Laboratory, Silver Spring, Md.

"AIRCRAFT CORONA INTERFERENCE VARIATION WITH ALTITUDE" by M. M. Newman and J. D. Robb, Lightning and Transients Research Institute, Minneapolis, Minn.

XVIII—Electronic Instrumentation

"AUTOMATIC EJECTION IN BETATRONS AND SYNCHROTRONS" by L. W. Von Tersch and R. L. Doty, Iowa State College, Ames, Iowa.

"A STABILIZED ELECTRONIC MULTIPLIER" by C. D. Morrill and R. V. Baum, Goodyear Aircraft Corporation, Akron, Ohio.

"AN ELECTRONIC WATTMETER" by W. B. Boast, Iowa State College, Ames, Iowa.

"A THERMOCOUPLE AUDIO-FREQUENCY WATTMETER" by J. D. Ryder and M. S. McVay, University of Illinois, Urbana, Ill.

"STABLE FREQUENCY DIVIDERS USING THYRITE ELEMENTS" by W. L. Hughes, Iowa State College, Ames, Iowa.

XIX—Engineering Management

Program prepared in cooperation with IRE Professional Group on Engineering Management.

Gen. T. C. Rives, General Electric Co.
H. A. Leedy, Armour Research Foundation.
J. F. Byrne, Motorola, Inc., Chicago, Ill.
G. L. Haller, Pennsylvania State College.

XX—Coding & Recording Techniques

"A SYSTEM FOR CODING AND DETERMINING TIME RELATIONSHIPS OF EIGHT RANDOM REPETITIVE EVENTS" by D. R. Church, U. S. Naval Ordnance Laboratory, Silver Spring, Md.

"PULSE GROUP CODING AND DECODING BY PASSIVE NETWORKS" by R. F. Blake, Naval Research Laboratory, Washington, D. C.

"AN OPTICAL POSITION ENCODER AND DATA RECORDER" by J. N. Shive, R. E. Yaeger, and H. G. Follingstad, Bell Telephone Laboratories.

"AN ACOUSTIC DEPTH RECORDER FOR USE IN LIQUIDS, OPERATING IN THE FRACTIONAL MEGACYCLE FREQUENCY RANGE" by C. E. Goodell, U. S. Naval Ordnance Laboratory, Silver Spring, Md.

"AN AUTOMATICALLY CALIBRATED FREQUENCY RECORDER OF THE ELECTRONIC TYPE" by W. E. Phillips, Leeds & Northrup Co., Philadelphia, Pa.

XXI—Delay Lines & H.F. Test Equipment

"HIGH CHARACTERISTIC IMPEDANCE DELAY LINES FOR FRACTIONAL MICROSECOND PULSES" by W. S. Carley and E. F. Seymour, U. S. Naval Ordnance Laboratory, Silver Spring, Md.

"VITREOUS SILICA FOR ULTRASONIC DELAY LINE APPLICATIONS" by E. S. Pennell, Bell Telephone Laboratories.

"A WIDE-RANGE PULSE GENERATOR FOR LABORATORY APPLICATIONS" by R. W. Frank, General Radio Co., Cambridge, Mass.

"AN S-BAND SWEEP GENERATOR AND TEST SET" by J. H. Kluck and R. E. Larson, Naval Research Laboratory, Washington, D. C.

"WIDE-RANGE CRYSTAL-CONTROLLED FREQUENCY CALIBRATOR" by J. F. Sterner, Radio Corporation of America, Camden, N. J.

Checking Analogue Computer Solutions

In the article, "Checking Analogue Computer Solutions," August 1952 TELE-TECH, on p. 46 our printer inadvertently omitted a dot over the first x on the left of Eqs. 4 and 5, over the x in the line under Eq. 5, and over the y of Eq. 12. On p. 86, Eq. 14 should read,

$$\eta = \sqrt{2}\sigma \sqrt{1 + A^2/4},$$

and Eq. 17,

$$\eta = \sigma \sqrt{1 + A^2B^2 \cos Bx.}$$

In Fig. 4,

$$\lambda_2 = -4.126.$$

COMPUTING SERVO POTENTIOMETERS

(*Continued from page* 97)

Preloading: Where the source voltage scale factor cannot be increased it is possible to use a potentiometer which is "preloaded" by an external resistance (or several resistances) to compensate for the error. Again a specific case will best serve to illustrate. Fig. 7 indicates the input-output voltage relationship of curve (2) of Fig. 4.

It may be observed that, to a first approximation, if the potentiometer resistance curve approximated curve (A) which is vertically displaced as far above the theoretical curve as is the loaded output voltage curve is below the theoretical curve, the output voltage would be the theoretical linear function of shaft rotation. There are commercially available non-linear potentiometers (Helipot Corp.) which approximate this function under given load conditions.

It is possible to approximate this curve rather well with a single padding resistor tapped into the potentiometer as shown in Fig. 7b. For the excitation of Fig. 3 it is necessary to use two padding resistors as indicated in Fig. 8b.

In two specific cases for the loading of Fig. 7b, the following percentage of full scale deviations from linearity are obtained:

(1) a=10, tap at 0.75, b=2.88
max. normal deviation=1.47%
max. preloaded deviation=0.2%

(2) a=100, tap at 0.8, b=20
max. normal deviation=0.15%
max. preloaded deviation=0.03%

Case (1) is calculated, case (2) measured (including test equipment error).

Specific results for the configuration of Fig. 8 have not been calculated but approximately the same degree of improvement can be expected.

Feedback Amplifier Approach: For some applications none of the preceding methods are sufficient. For example, the case of a servo-driven potentiometer loaded by a second servo-driven potentiometer or a functional potentiometer presents a rather difficult problem, or it may be that in a large computing installation there are enough spare feedback amplifiers during a given problem to permit the luxury of unloading with feedback amplifiers. Very excellent results can be so obtained.

As a preliminary step, consider a high-gain phase-inverting amplifier with feedback as shown in Fig. 9. This basic block diagram may be easily modified to be applicable to any analog computing loop. From the diagram the following should be observed:

(1) The e_g voltage is essentially zero (neglecting drift considerations in the case of a dc amplifier)
(2) The input impedance is z_{in}
(3) The output impedance is essentially zero (actually a

(*Continued on page* 190)

Fig. 11: Zero source impedance division circuit has low output impedance and internal loading

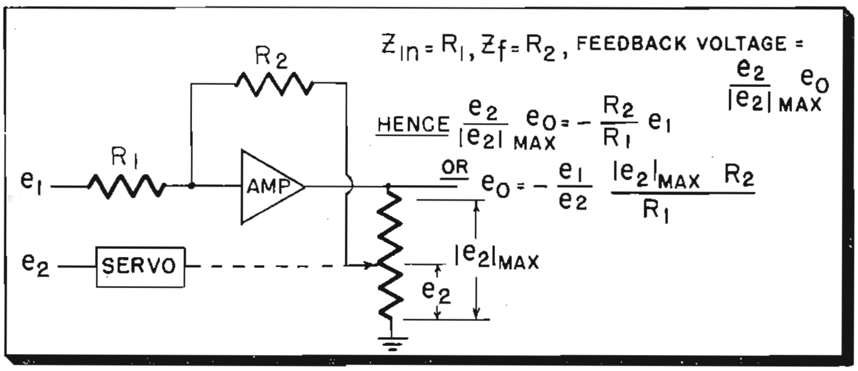
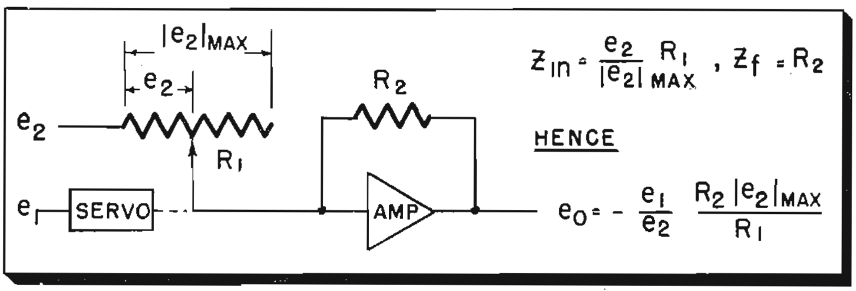


Fig. 12: Alternate zero source impedance division circuit is free from internal loading effects



Measuring Transmission Line Attenuation

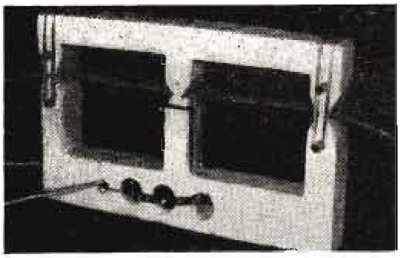
R. C. Powell of the National Bureau of Standards has developed a new method for measuring the attenuation of balanced, unshielded transmission lines, such as those used in TV and FM receivers. The new procedure, simple and rapid, requires easily obtainable laboratory equipment. By using a grid-dip meter and a microammeter, for example, results reproducible to better than 10% can be obtained. With more elaborate apparatus, reproducibilities of better than 0.1% and attenuation values to an estimated accuracy of 1% are possible for uniform sections of line.

In determining attenuation at frequencies between 30 and 300 MC external effects arising from the test apparatus, connectors, terminations, and bends often cause variations. A suitable measuring method must account for these inconsistencies by either reducing the external effects or by evaluating them and including the information in extensive calculations.

The NBS method for measuring unshielded lines is based on the fact that if a section of line a number of half-wavelengths long is resonated when both ends are shorted, the standing wave ratio at the receiving end will be greater than at the input end. Furthermore, the change in SWR is due only to the attenuation in the line. This fact makes it possible to determine the attenuation merely as a function of the standing wave ratio, that is, the ratio of the maximum to the minimum current in the line.

To avoid errors introduced by improper terminations, the test transmission line is rigidly fastened and held in tension by clamps made of low-resistance materials that also act as good short circuits to the electric field. A coupling loop built into the input-end terminal loosely couples the output of a conventional power source to the line. A similar loop is part of the receiving-end termination, and its output is connected to a crystal rectifier and filter circuit. The minimum and maximum currents (the standing waves) are detected by a sliding probe made of polystyrene foam or a similar material. The probe is designed to hold a small pick-up loop at a constant distance from the line. In this way, irregularities in the line are compensated and, at the same time, the loop interferes as little as possible with the fields of the line. An additional rectifier and filter circuit is also built into the probe.

The dc leads from the probe and the receiving-end terminal networks are connected to a switching arrangement that controls a shunt on a sensitive galvanometer. The shunt is designed to permit maximum deflection for both maximum and minimum readings, to give critical damping to the galvanometer, and to provide a constant-output resistance for the filter networks.



Sliding probe, for measuring attenuation of balanced transmission lines, is made of polystyrene foam. Rectifier and filter circuit is composed of 500 ohm resistors and 500 $\mu\mu$f capacitors.

In making a measurement, the galvanometer is first connected to the receiving-end terminal, and the generator frequency is adjusted to the resonant frequency of the line, as indicated by a maximum deflection on the meter. (If the measurement is to be made at a particular frequency, the line may be cut to a length equal to some multiple of the wavelength). The power source is then adjusted so that the amplitude of the detected radiation is at some convenient level, and the value of the galvanometer deflection is noted. The galvanometer is then switched to the probe circuit through a shunt, and the probe is moved along the line, near the input terminals, until a maximum current is indicated by the galvanometer. The generator frequency and the output power are readjusted to the original resonance and current values to compensate for the probe movement. The deflection of the galvanometer and position along the line of the probe at the point of maximum current are then noted. The same procedure is repeated for the minimum current position. The standing wave ratio is obtained from the values of the minimum and maximum currents. Attenuation is derived from the SWR.

In order to accurately obtain the standing wave ratio, the probe-filter circuits-galvanometer system must be calibrated at the operating frequency. The probe is set at a convenient position near the input end of the transmission line—a point of maximum current. The input signal is then varied by known amounts of power, voltage, or current so as to effectively reproduce the standing wave conditions normally experienced by the probe as it is moved along the line. The input signal is measured by conventional laboratory apparatus (calibrated attenuator or voltmeter), and the resulting galvanometer deflections are then calibrated in terms of the standing wave ratio introduced into the system. The attenuation of the line is approximately equal to the arc hyperbolic cotangent of the standing wave ratio, a value that is obtainable directly from most handbooks of mathematical tables.

Although galvanometers and extensive generating equipment are used for these measurements by the National Bureau of Standards, very acceptable results can still be obtained by using a low-power generator, such as a grid-dip meter, as the signal source to be coupled into the line. Standing waves along the line, can be measured by a sensitive microammeter.

COMPUTING SERVO POTENTIOMETERS

(Continued from page 189)

small fraction of an ohm) within the amplifier operating range i.e., independent of load current.

In any accurate closed analog computing loop there are accurate computing components associated with a high-gain amplifier (or servo). The whole function of the high-gain element is to maintain a virtual ground so that accurate computation may be performed by the passive elements with no feed-through between signal sources (such as is obtained when a group of inputs are summed across a resistor).

The multiplying circuit, shown in Fig. 10, depends on the virtual ground which the amplifier maintains at its input. In this case a current, $i=e_1/R_1$, is thereby established and flows in that part of the potentiometer which is in the circuit, resulting in a voltage at the arm which is a linear function of potentiometer position. The amplifier supplies the load current independent of the current flowing in the feedback resistor. The multiplying circuit is completely unloaded for any load current which the output stage of the amplifier is capable of supplying.

A circuit for the division of variables is indicated in Fig. 11. It will be observed that this circuit has a similarly low output impedance, but that there is an internal loading problem by virtue of the fact that R_2 loads the dividing potentiometer. The resultant error can be minimized by making R_2 large, or eliminated by loading the servo follow-up potentiometer with a resistance equal to R_2.

Another possibility, which suggests itself because an operation in the feedback loop has the inverse effect of the same operation in the forward loop, is to move the servo-driven potentiometer of Fig. 10 to the forward loop (see Fig. 12). This circuit has the advantage of freedom from internal loading effects. However the input impedance to the e_1 source is $e_2R_2/|e_2|$ max. For small values of e_2 this impedance becomes too small to be practical.

MILITARY CONTRACT AWARDS

Manufacturers who have received contract awards for producing of radio-radar-electronic equipment for the Armed Services are listed below by name, city and equipment. Subcontractors interested in bidding on performance of any part of each contract should sell their services to these prime contractors. This list, which is current up to our press time, covers the period from July 2 to August 1.

Dynometers: Clayton Mfg. Co., El Monte, Calif. $113,626.70

Electron tubes: Chatham Electronics Corp., Newark, N. J.; Electronic Industrial Sales, Washington; General Electric Co., Electronics Park, Syracuse, N. Y.; Credda, Inc., 19 W. 26th St., N. Y. C.; Hytron Radio & Electronics Co., Div. CBS. Salem, Mass.; RCA, Harrison, N. J.; Sylvania Elec. Prods., 1740 Broadway, N. Y. C.

Electron tubes: Credda, 19 W. 26 St., New York City; Electronic Industrial Sales, Washington, D. C.; General Elec. Co., Electronic Dept., Schenectady, N. Y.; Hytron Radio & Electronics Co., Div. CBS; Kann-Ellert Electronics, Balto., Md.; Life Electronic Sales, New York City; Radio Corp. of Am., Harrison, N. J.; Sylvania Elec. Prods., New York City; Tung Sol Elec., Newark, N. J.; Western Elec. Co., New York City; Westinghouse Elec. Corp., Electronic Tube Div., Bloomfield, N. J.

Power transformers: Westinghouse Electric Corporation, Portland, Ore. $350,722

Radio sets: A B C Supply Co., Washington, D. C.; Precision Hearing Aids, Chicago; Radio Corp. of Am., RCA Victor Div., Camden, N. J.; Southern Wholesalers, Washington, D. C.; Stromberg-Carlson Co.; Television Engineering Co.

Recorder equipment: Daystrom Electric Corp., Poughkeepsie, N. Y.

Resistors, capacitors, etc.: Aerovox Corp., N. Bedford, Mass.; American Radio Hardware Co., Mt. Vernon, N. Y.; Allen Bradley Co., 136 W. Greenfield Ave., Milwaukee; Hugh H. Eby, 4700 Stenton Ave., Phila.; General Radio Co., 275 Mass. Ave., Cambridge, Mass.; Heminway & Bartlett Mfg. Co., 500 5th Ave., N. Y. C.; Herbach & Rademan, 1204 Arch St., Phila.; Insuline Corp. of Am., L. I. City, N. Y.; Kann-Ellert Electronics, 9 S. Howard St., Balto.; Kenyon Radio Supply Co., 2020 14th St. N. W., Washington, D. C.; Life Electronics Sales, 345 Broadway, N. Y. C.; Micro Switch Div., Minneapolis Honeywell Regulator Co., Freeport, Ill.; Radio Elec. Service Co., 5 N. Howard St., Balto.

Tape recorders and accessories: Sand, Inc., 221 E. Cullerton, Chicago

Terminal lugs: Eastrex Corp., 612 W. 144 St., N. Y. C.; Electronic Industrial Sales, 2345 Sherman Ave., N. W., Washington; Herbach & Rademan, Philadelphia, Pa.; Howard B. Jones, Div. Cinch Mfg. Corp., Chicago; Peerless Radio Distr., Jamaica, N. Y.; Pioneer Radio Supply Co., Cleveland, Ohio; Radio Elec. Service Co., Baltimore; Winchester Electronics, Glenbrook, Conn.

IRC's European Licensees Expanding Production

After a six-week European tour of International Resistance Co. licensees, v-p Jesse Marsten reports an intensive expansion program to increase production and initiate the manufacture of a new line of products, including IRC's BT composition resistors, boron and deposited carbon resistors, FS fuse resistors, Microstak selenium diodes, Kel F terminals and molded capacitors. Facilities in London, England, as well as Turin, Italy, and Copenhagen, Denmark, were visited. An educational program, to be held in IRC's Philadelphia plant, will train licensees' representatives in the manufacturing processes involved.

SPEECH INPUT SYSTEMS

(*Continued from page 63*)

of positions of the output line keys, both amplifiers and lines are always terminated in 600 ohms by the output network.

Audition Channel: Audition key provides a means of feeding the output of either main program channel to a separate local amplifier system external to the 250A Speech Input Equipment for audition circuits or sound reinforcement in large audience studios.

Monitor Channel: The monitor key permits the output of either main program channel to be fed through a balanced volume control to the monitor amplifier input. The monitor amplifier output is normally connected to the loudspeakers in the control room, Studio A and Studio B, except under the following conditions:

(1) When the talkback keys are operated to Studio A or B, cutting off the control room loudspeakers, or

(2) When any microphone key is operated to Studio A or B, cutting off Studio A or B loudspeakers.

Operation of these circuits is further discussed below in connection with the talkback facilities.

Talkback: Talkback to either of the two studios is provided through the use of one of the seven preamplifiers (preamplifier associated with mic. mix 1) and the monitor amplifier. Transmission from the studio to the control room is through normal monitoring means. As already described, the operation of the microphone key on the console to connect the studio microphone, disconnects the studio loudspeaker.

Talkback Key

In talking back to the studio from the control room, the talkback key is operated from its normal position to the Studio A or Studio B position. In either position, operation of the talkback key opens the circuit to studio microphone #1, connects the control room talkback microphone to the preamplifier input and connects the preamplifier output to the monitor amplifier input through the monitor gain control. The talkback key has, in addition, contacts supplying operating voltage to console relays K1 and K2, for muting Studio A or Studio B microphones, and contacts removing relay operating voltage from the relay control contacts of the microphone keys for Studio A or B (depending upon the position to which the talkback key is thrown), thus removing the operating voltage from the P-523A relays K2 or K3. This reconnects the studio loudspeaker to the output of the monitor amplifier. At the same time, operation of the talkback key to either Studio A or B position, operates P-523A relay K1 cutting off the control room loudspeaker to prevent feedback.

Cue Circuits: Line cue programs can be fed to the studio and control room loudspeakers by turning the mixer control associated with the line to the extreme counter-clockwise position, and the monitor key on normal.

Air cue is fed to the monitor loudspeakers with the cue key to "air cue," with the monitor key on normal and also to the incoming lines if the mixer controls are operated to the "cue" position.

VU Circuits: Two volume indicator meters are provided, one connected across each program output. A range key for each meter is provided, whereby the sensitivity can be decreased or increased by 5 db. Normally with the 10 db pad in, the meter reads "0" VU when +8 VU is being delivered to the output line. Cutoff keys are also provided for each meter.

Signal and Light Control Circuits: The signal and control circuits provided in the 250A console consist of two keys controlling Studio A and Studio B lights; and two additional keys mechanically coupled to the output line keys, signal lamps, associated terminals and a 12 volt dc source to operate lamps and external relays.

These circuits may be used for signaling between control room and master control, for operating relays or energizing signal indicators at master control, and for operating light signals in studios. Signal facilities are provided for dispatch of two simultaneous programs.

Typical intermodulation distortion curves for the 250A Console with A-428B and A-429B amplifiers are shown in Fig. 4.

Model 230B Console

The Altec Lansing Model 230B Console is designed for small station and single studio operation in large studios that may be master controlled. Being an entirely self-contained ac operated unit, weighing 80 pounds, it can also be used for portable pickup when facilities required are beyond the capacity of the conventional remote units. See Fig. 6.

For compactness and economical reasons, the amplifiers, consisting of four single-stage preamplifiers, two single-stage booster amplifiers, a line amplifier and monitor amplifier, are mounted on a hinged sub-assembly. The mechanical layout of this sub-assembly is such that all of the amplifiers are positioned adjacent to their respective controls so that the inter-connecting leads are held to minimum lengths. Input transformers for the preamplifiers are easily accessible for changes in strapping for the desired input impedance. All interior parts are made accessible by lifting the front panel which is hinged and locked up in service position.

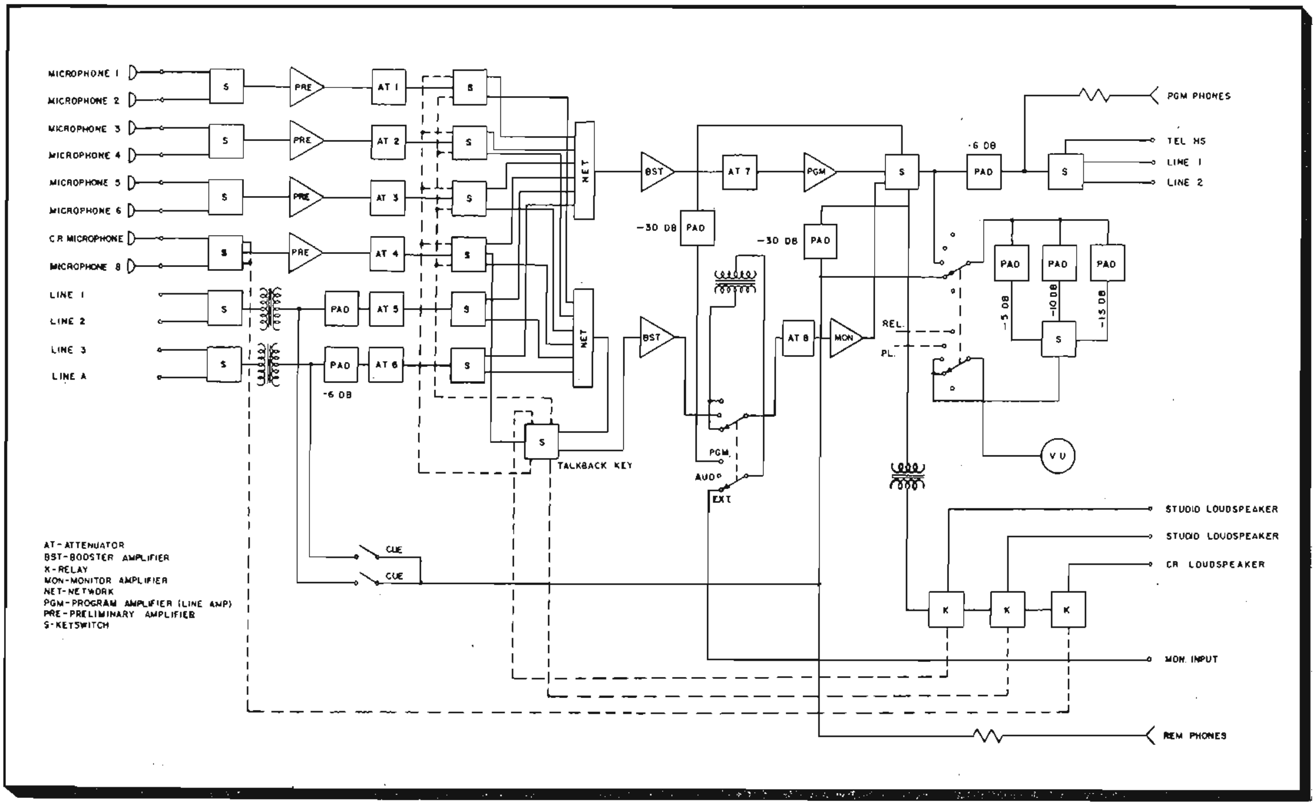
The main amplifier power supply and the relay unit and its power supply are of the plug-in type, the same as used in the larger 250A Console. They are mounted on the floor of the console.

The console has four separate low level controls and two high level controls. Either of two low level inputs may be connected by means of a key to each of the four preamplifiers so that a total of eight microphone inputs are available. The out-

(*Continued on page* 194)

put of each single stage preamplifier is terminated in a high impedance potentiometer. This parallel mixer combination is followed by a single-stage booster, a master volume control and a line amplifier. This sequence of amplifiers and controls permits the maximum signal-to-noise ratio and meets the conditions

Fig. 5: Model 230B Console has four separate low level controls and two high level controls. Good S/N ratio meets TV requirements



of TV operation which as a rule requires higher overall gain due to more distant pickup.

Any two of four high level inputs may be selected by means of keys ahead of the two high level line mixer potentiometers. Each of the high level mixer controls has a cue position when the control is in the "Off" position. This connects the output of the monitor amplifier to any desired remote line through a bridging pad. See Fig. 5. All control knobs and keys are color coded for ease of recognition.

Space for Line Isolation

Space is provided for line isolation coils in those cases where the telephone company does not supply them.

A switch is provided so that the 8 watt monitor amplifier can serve four other functions:

1. As an audition amplifier. In this case it is driven by a second single stage booster.
2. As an emergency line amplifier through the audition circuit.
3. As a cue amplifier.
4. With an external input.

Two phone jacks are provided for program or remote line monitoring. The VU meter is used in conjunction with a switch to measure program level, remote lines, as well as low and high voltage power supplies. A talkback key is provided for use with an external microphone through preamplifier #4.

The overall gain of the 230B Console is approximately 100 db from microphone to line.

The response is ±1 db from 20 to 20,000 CPS. The noise level is 74 db below rated output with 70 db net gain and +24 dbm maximum output. Overall harmonic distortion between microphone and line is less

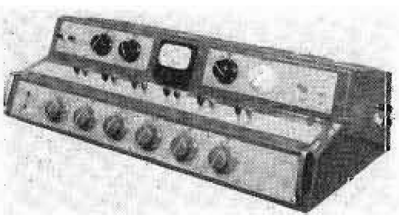


Fig. 6: Model 230B Console for small stations

than 0.5% from 30 to 15,000 CPS at +20 dbm line output. Overall harmonic distortion of the monitor amplifier is less than 1% in the range 50 to 15,000 CPS at +39 dbm.

The equipment meets the FCC standards for broadcasting. The console will be found useful for recording studios and public address installations.

New Test Set-Up Speeds Crystal Production

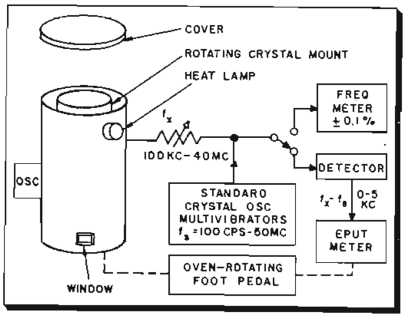
A simple yet effective set-up for checking the frequency of quartz crystals in the final stage of production test permits an unskilled worker to do the job which formerly required a skilled person. In addition, the new method saves two to three minutes per frequency check over older methods.

Temperature Range

Using the test set-up shown in the diagram, crystals can be checked from -50°C to 90°C to determine frequency variation over this range. Military specifications usually permit about 0.001%. The 50 crystals inserted in an oven with rotatable inner section are monitored through the small window. Dry ice and heat lamp are used to obtain the required temperature range. The crystals, approximately of the same frequency, are switched on by wiper contacts from an oscillator mounted on the side of the oven. The unknown crystal frequency, f_x, combines with the output of a secondary standard, f_s. This standard employs a stabilized crystal oscillator driving three cascaded multivibrators producing odd and even harmonics up to 50 MC.

The difference frequency, $f_x - f_s$, is read directly on the heterodyne frequency meter to an accuracy of ±0.1%, and is then switched to the detector where the beat signals are mixed. The difference output from the detector, several volts in amplitude and below 5 KC, is fed to an EPUT (Events-Per Unit-Time) meter such as the Berkely Scientific Model 554, which is a combination electronic counter and time base producing instrument. The EPUT meter reads the difference frequency directly.

As the foot pedal which rotates the oven is depressed, with the EPUT meter in "External Start" position, the reset line is broken and the meter reset. This method, used in a plant in the San Francisco area which manufacturers crystals for the military, makes frequency checks as rapidly as once every two or three seconds.



Crystals' output is mixed with standard. EPUT meter rapidly measures difference frequency

New Amperex Plant Completed and Operating

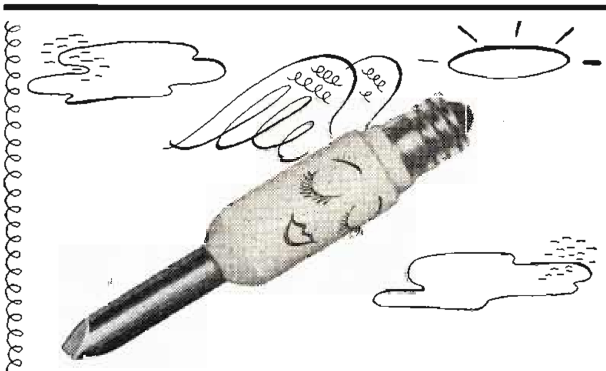
Mr. S. E. Norris, president of Amperex Electronic Corp., has announced that the newly constructed Hicksville plant is in full operation.

This modern structure not only houses executive and clerical departments, but contains elaborate research, engineering, and production facilities for the design and manufacture of electronic tubes exclusively; transmitting tubes, special purpose tubes, industrial type, communication tubes, electromedical and x-ray tubes, ultra high frequency tubes, fixed vacuum condensers, hydrogen thyratrons, magnetrons and Geiger-Muller (radiation) counter tubes.

This latest Amperex facility is part of an extensive and long range expansion program.

New Plant for Beckman

Dr. A. O. Beckman, president of Beckman Instruments, Inc., South Pasadena, California has announced that the engineering and architectural firm of Donald R. Warren Co., Los Angeles, has been retained to design the new main plant and offices which will be erected for the company on a recently acquired 45-acre site in the La Habra-Fullerton area. Plans call for an expandable design with an initial floor space of 200,000 sq. ft. Helipot Corp., a wholly owned subsidiary, will also move to the new plant.



LETTERS . . .

West Coast Electronics Industry: THEN AND NOW

Editors· TELE-TECH:

I am interested to learn that Sept. TELE-TECH will be devoted to the growth of west coast Electronic Industries. I would like to bring to your attention some significant "firsts." The more important of these are as follows:

1. The first large scale use of cw in radio at substantial power was a development of Federal Telegraph Company of Palo Alto, Calif. (now Newark, New Jersey). Federal Telegraph Company was organized in 1909 to exploit the possibilities of the Poulsen Arc. This development was climaxed by the 600 KW arc built for the government during W.W. 1 and installed in the Lafayette Station at Bordeaux, France. This was a lot of power in 1918, and it is still a lot of power today.
2. Lee deForest's invention of the oscillating vacuum tube was made in Palo Alto, California in 1912 while he was employed by the Federal Telegraph Company.
3. The first reduction to practice of a successful all electronic TV system was carried out by Philo Farnsworth in San Francisco about 1928. At the same time Farnsworth demonstrated his all electronic system, RCA and Bell Labs. were giving public demonstrations of mechanical scanning systems.
4. The klystron tube was invented at Stanford University shortly before the first world war by Russell Varian in collaboration with the late Professor W. W. Hansen.
5. The largest power that has ever been obtained from a single vacuum tube is that produced by the high power klystron tube developed at Stanford to drive the Stanford Linear Electron Accelerator, now under construction. These tubes under actual test have developed an output of 25,000 KW peak output power at a wavelength of 10 cm, with an input to the anode of 100,000 KW.
6. The midget radio receiver, which put a radio in every room in the American home, was developed in 1930 by a group of small manufacturers working under the sponsorship of the Gilfillan Company in Los Angeles.
7. The cyclotron.

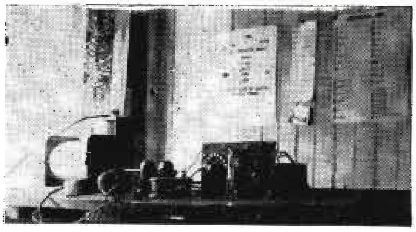
F. E. Terman
Dean, Stanford University
Stanford, California

Editors, TELE-TECH:

In San Francisco the first evidence of the radio industry easily remembered was the store of Haller-Cunningham. This was followed by Leo J. Meyberg's store on Market St. and later by "Staf" Warner's store in Oakland. These oases dispensed "wireless" sup-

(*Continued on page* 198)

plies, usually imported from the East but occasionally manufactured in small quantities by local firms taking a busman's holiday from more substantial operations like marine installation, of which Ets, Hokin and Galvin were an example.



Illustrative of radio in 1921 on West Coast is Lubcke's first vacuum tube receiver in Alameda. (l to r) Antenna lead-in, vertical loading coil, loose coupler, and detector control panel. 23-plate variable condenser was used

Perhaps the first formal manufacturer was the Colin B. Kennedy Co. of Palo Alto. This organization was known for tap-switch tuned long-wave receivers, two stage audio amplifiers and other apparatus, well constructed on bakelite panels and housed in hardwood cases.

Radio broadcasting in California started with the radiotelephone transmissions of Dr. Lee deForest from the California Theatre in San Francisco. With crystal detector receivers we picked up music and opera and were just about able to win over the skeptics to the belief that there was something to wireless after all. Your visitors shared the headphones and sat quietly to avoid jarring the crystal detector. This was about 1921.

Before long the Remler Co. started quantity manufacture of radio parts in San Francisco, being known for their molded bakelite work. There was the Federal Telegraph Co., too, long manufacturers of ship and shore wireless equipment in Palo Alto. By 1928 they had a broadcast receiver research laboratory in full operation with about a dozen engineers.

Research in television started in the West with the activities of Philo T. Farnsworth at 202 Green St., San Francisco, after an apartment house beginning in Los Angeles. Your writer became Assistant Director of Research there, starting in January 1929. What was perhaps the first all-electronic system of television was developed. Relatively great strides were made in that laboratory.

Television broadcasting started in Los Angeles in August 1931. The late Mr. Don Lee himself financed the enterprise as a part of what later became the Don Lee Broadcasting System. Formal programming started on December 23, 1931. Transmissions were on the ultra-high frequency of 44.5 mc. In those days anything over 30 mc was classified as ultra-high by the then Federal Radio Commission.

The transmitter was likely the first grid modulated one for television. With an rf power output of 45 watts into a dipole antenna, images were transmitted to our all-electronic receiver in an airplane for the first time in the world in early 1932. During some of these early days the film pickup was a cathode-ray flying spot, just now coming into favor.

Space does not permit tracing the development of Heintz and Kaufman, Inc., Eitel-McCullough, Inc., the start of Hewlett-Packard in a garage, to mention the San Francisco peninsula, as well as Edgecomb's Wireless Shop, Gilfillan Bros., Packard-Bell and others in Los Angeles. Finally has come the multi-pronged expansion in research and manufacturing of Hughes Aircraft, Northrup, North American, Lockheed, Douglas, Convair and Boeing, the miracle of Tektronix in isolated Oregon, and Bendix, Consolidated Engineering and a host of smaller organizations that are found congregated around each major industrial center.

There have been omissions. This recitation has been brief. I ask your indulgence.

Harry R. Lubcke
Consulting Television Engr.
2443 Creston Way
Hollywood 28, Calif.

Dr. DeForest's "Firsts" in Early California Days

The possibilities for stereophonic reception by using now-duplicating AM and FM channels, as outlined on page 34 of your July issue, are extremely

(*Continued on page* 200)

Endless-Loop Magazine Speeds Tape Handling

Engineers of Salesmaster Corp., 5117 West 54 St., Los Angeles 43, Calif. have developed a simple, fool-proof spiral endless-loop magazine which promises to solve the problem of tape handling in all manner of applications from precision computer memory devices to home tape phonographs.

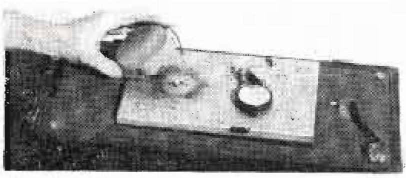


Fig. 1: Endless-loop unit with T-100-5 mechanism. Tape life unaffected after 30,000 plays

The endless-loop principle has been used previously. Several versions were utilized for running an endless loop of movie film. However, attempts to use the same devices for the thinner and more flexible magnetic tape have not been too successful. Basically, the problem is one of supplying a needed measure of mechanical power to the spiral of tape. Several hundred turns of tape, each turning inside the next outer turn, present a large total sliding area, and require a definite amount of power to maintain the endless action. The original endless magazines relied on the film or tape transmitting this power into the spiral by the direct outward pull of the film. The new principle involves furnishing the power by a separate mechanical means that does not put any work requirement on the tape itself.

Tape-Life Expectancy

Several hundred units of an endless-loop continuous-announcing advertising machine have been in the field for over a year. This machine, shown in Fig. 1, uses the T-100-5 mechanism. Tests have shown that no shortening of tape life-expectancy has resulted from the endless operation. As many as 30,000 plays have been counted.

The present production magazine holds up to 200 ft. of tape which represents a playing time of slightly over 10 minutes at 3.75-in./sec. A simple threading operation is required when changing magazines in order to pass the tape around the driving capstan and past the reproducing head. It will be obvious, however, that it is possible to arrange a magazine so that the pulling

(*Continued on page* 212)

Network TV for Denver

The first TV station to be connected with the Bell System's transcontinental microwave relay since the lifting of the FCC freeze—KFEL-TV—has been announced by AT & T Long Lines Dept. The Denver station, an NBC affiliate thus becomes the 108th station to be connected to Bell's intercity TV network extending service to 66 cities.

interesting. Wherever a station employs both A M and F M, transmitting simultaneously the same music program, the arrangement assuredly makes possible some genuine stereophonic effects in large rooms where it is possible to separate suitably the two audio outlets. An ideal arrangement would be to have the F M and A M receivers in one control cabinet, so that both could be tuned simultaneously.

Tele-Tech, as usual, performs a useful and forward-looking service in describing and advocating this stereophonic music, now made practical for the first time by using both radio frequency bands.

In your forthcoming West Coast issue, as a historical background, you might mention that the first electronic amplifier was created by myself at the Federal Telegraph Company's laboratory in Palo Alto in 1912.

Also that the first factory for making transmitter tubes was established by myself in San Francisco in the spring of 1920.

The first use of the Audion Amplifier was by the Federal Telegraph Company in 1912, in receiving wireless messages from Honolulu. High-speed messages were then received on telegraphone wire and reproduced at a slower speed for copying.

LEE DEFOREST
United Engineering Laboratories
1027 North Highland Ave.,
Los Angeles 38, Calif.

Radio Fall Meeting Agenda at Syracuse

Sessions of the 1952 Radio Fall Meeting will be held Oct. 20-21, at the Hotel Syracuse, Syracuse, N. Y. under the sponsorship of the RTMA's Engineering Dept.

Technical program, as announced by Virgil M. Graham, chairman of the Fall Meeting Committee, follows:

MONDAY, OCTOBER 20

UHF Session

Study of Noise Reduction by Feedback in Ultra-High Frequency Amplifiers
Alvin B. Glenn, General Electric Co.
Connection of UHF and Color Adaptors to VHF Receivers
Leonard H. Horn, Underwriters' Laboratories, Inc.
A UHF Grid Dip Meter
A. E. Hylas and Walter Tyminski, Allen B. DuMont Labs., Inc.
UHF Tuning Devices
Norman Altman and Fred Barr, General Instrument Corp.

Electron Tube Quality Control Session

Performance Evaluation of Special Red Tubes
H. J. Prager, Radio Corp. of America
Development of Inspection Manual for Reliable Tubes
Edgar K. Wimpy, Hytron Radio and Electronics Co.
Adaptation of Industry Proposals to Subminiature Tube Evaluation
A. J. Heitner, Sylvania Electric Products Inc.
Latest Developments in Airinc Reliability Program
R. E. Moe, General Electric Co.

TUESDAY, OCTOBER 21

Symposium on NTSC Color TV Receiver Development

General Considerations in the Design of a Color Television Receiver
B. D. Loughlin and C. J. Hirsch, Hazeltine Electronics Corp.
IF and Video Design Considerations as Applied to the Color Signal
Bernard S. Parmet, Motorola, Inc.
Color Synchronization
William E. Good, General Electric Co.
Color Signal Demodulators
D. H. Pritchard and R. N. Rhodes, Radio Corp. of America
Color Phase Alternation
Solomon J. Klapman, Admiral Corp.
General Discussion of preceding papers.

Color Television Session

Principles of Colorimetry as Applied to Television
F. J. Bingley, Philco Corp.
Colorimetric Analysis of Gamma Corrected Color Television Systems
Donald C. Livingston, Sylvania Electric Products Inc.
Instrumentation for Color Television Development
Kenneth E. Farr, Westinghouse Electric Co.

WEDNESDAY, OCTOBER 22

Electronic Devices Session

Future Trends in Tube Design
R. R. Law, Radio Corp. of America
Mechanisms in Transistor Electronics
R. M. Ryder, Bell Telephone Laboratories, Inc.
Properties of PNP Diffused Junction Transistors
John S. Saby, General Electric Co.

General Television Session

Problems of Television Interference
W. B. Smith, Canadian Department of Transport
AFC Circuit Design for Television
George D. Doland, Philco Corp.
Ninety-Degree Cathode-Ray Sweep System Consuming less than "Fifty-Degree" Power
C. E. Torch, General Electric Co.
Design Considerations for Series Heater Strings in Television Receivers
M. B. Knight, Radio Corp. of America

Electronic Devices Session (Cont.)

Operational Aspects of the "Sleeping Sickness" Irving Levy and F. M. Dukat, Raytheon Manufacturing Co.
The Application of RCA Point-Contact Transistors
R. M. Cohen, Radio Corp. of America

News of MANUFACTURERS' REPS

Adams Engineering Ltd. has been formed with offices at 1500 St. Catherine Street W, Montreal, Que., Canada. This new firm will act as representatives for certain Electronic, Electrical and Aircraft component manufacturers. A complete technical and commercial service will be rendered all manufacturing and distributing accounts, as well as Government offices. Clyde B. Adams, president, was formerly associated with Canadian Marconi Co. and J. R. Longstaffe Ltd. in various sales capacities.

Charles J. Merchant has become a staff member of Walter J. Brauer and Associates, Cleveland, Ohio. He was formerly sales engineer for P. R. Mallory Co.

Tom Marchiano has joined the Newhope Corp., 6 E. 39th St., New York 16, N. Y., as an associate. The Newhope Corporation, manufacturers representatives, concentrate in Metropolitan New York City and Northern New Jersey. The company represents American Television & Radio Company, St. Paul, Cambridge Company, Chicago, Duotone Co. Inc., Keyport, N.J., Thomas Electronics, Passaic, N. J. and Vidaire Electronics Mfg. Co., Lynbrook, N.Y.

Eugene D. Cahn, formerly with Burlingame Associates, has recently formed The Industron Co., 250 W. 40., New York 18, N.Y. covering the Northeastern United States and is handling the following lines: Photron Instrument Co.; Reiner Electronics Co.; Waveforms, Inc.; Scientific Electric Co.; North Hills Electric Co.

Kinney Manufacturing Co., Boston, Mass., subsidiary of The New York Air Brake Co. and manufacturer of high vacuum pumps and rotary liquid pumps has announced the appointment of William A. DaLee, Inc., Detroit, Mich., as exclusive sales representative in Michigan.

Vidaire Electronics Manufacturing Co., Lynbrook, N. Y., manufacturer of TV color equipment and phono and TV amplifiers has appointed Edward Braddock, Browning lane, Haddonfield, N. J., representative for Washington, Baltimore, Philadelphia, Trenton and Camden. The Leroy J, Smith Co., 3270 Stoner Ave., Los Angeles 34, Calif. was appointed for the southern California and Arizona territory.

Drake Manufacturing Co., 1713 West Hubbard St., Chicago, manufacturer of socket and jewel light assemblies, has announced the appointment of: Henry W. Burwell Co., Atlanta, Ga., in the Southeastern States territory; Max Heidenreich, Dallas, Texas, in the Texas, Okla., Arkansas, La. territory; The Lawton Co., Philadelphia, Pa., in the Eastern Pennsylvania territory; Tanner & Covert, Pittsburgh, Pa., in the Western Pennsylvania territory; and Young & Myers Co., Kansas City, Mo., in the Kansas & Missouri territory.

TELEVISION SWEEPS

(*Continued from page* 133)

We require 14 kv for the anode voltage. Due to the very tight coupling available from ferrites, the oscillations in primary and secondary windings are primarily those of the effective coupled inductance and stray capacity. Some oscillations do occur in the primary coil alone due to leakage inductance. These are small and do not affect high voltage, although they are the cause of ringing (bright bars) on the left side of the raster. Since we have a 3500 v. negative pulse at point (3) of the transformer (see Fig. 9), we need an additional 14,000 − 3500 = 10,500 v. positive pulse at the HV point.

$$\frac{N_1+N_3}{N_2+N_4} = \frac{10,500}{3,500} = 3;\ N_3 = 725 \text{ Turns}$$

The complete transformer design is shown in Fig. 9. The effective oscillatory inductance of the yoke coupled to the top of the transformer primary is $[(725 + 828)/289]^2 \times 10.3 = 297$ mh. The parallel inductance of the transformer is four times this value, giving an equivalent value of 238 mh. For 70 kc, C = 21.6 μμf. To minimize C, it is common practice to wind the step-up winding with a narrow cam.

The 1 megohm resistor is required for filtering and to keep from adding excess capacity at point (3).

It may be desirable from size and cost considerations to reduce the total number of turns. This will, of course, also decrease the efficiency. It is only necessary to reduce all turns in the same ratio.

The required air gap may readily be found experimentally. In the above design a total air gap of 0.016 in. was computed. The actual gap utilized two pieces of 0.005 in. tape plus the inherent gap between core pieces. Too small a gap will cause excessive heating with resultant sweep loss due to the changes in ferromagnetic properties.

Sufficient Vertical Sweep

When using tubes with 70° deflection angles it has been found rather difficult to obtain sufficient vertical sweep with low voltage power supplies. The presence of an appreciably higher dc voltage due to the boost action of the horizontal sweep had led to the use of this voltage as a power supply source for the vertical output stage. In such a case the additional current drawn from the boost supply forces a reduction in the number of turns on N_4 (Fig. 8) until the total average currents through the driver tube and vertical output tube are equal to that through the damper. This, of course, reduces the effective efficiency of the horizontal sweep circuit.

Although the coefficient of coupling is extremely high, the leakage reactance associated with N_1 in Fig. 8 causes some undesirable oscillations. These appear as vertical bars on the left side of the raster on the picture tube. In addition, on negative swings it is possible for the driver tube plate to go negative with respect to ground. This permits undesirable r-f oscillations of the Barkhausen-Kurz type. These oscillations show up as dark narrow, hashed-up bars located somewhere between the left side and center of the raster. (Similar bars on the right side of the raster are due to dynatron effects in the driver tube and can be removed in practice by slight screen or grid voltage changes—or changing driver tubes).

It is possible to reduce these effects by using primary damping in place of the secondary damping shown in

Fig. 8. Fig. 9 illustrates this and the turns are labeled in exactly the same manner as in Fig. 8.

It is possible to reduce the losses even with conventional sponge iron cores if the flux densities are kept very low. This, however, requires appreciably more turns in each winding with a correspondingly higher cost. Also, the very large number of turns required for the HV winding make voltage doubling mandatory to keep the physical size to a practical value.

The introductory photograph shows a transformer design for 70° deflection utilizing the circuit of Fig. 10. Turns used are:

$N_1 = 650$ T	$N_2 + N_4 = 350$ T
$N_2 = 200$ T	$N_3 = 1000$ T

1. Schade, O.H.—"Magnetic-Deflection Circuit for Cathode Ray Tubes"—**RCA Review**, vol. VIII, No. 3, September 1947—pp. 506-538.
2. Friend, A. W.—"Molded Iron Dust Cores for use in Horizontal Deflection Circuits"—**RCA Review**, vol. VIII, no. 1, March 1947.

West Coast Radio

·(*Continued from page* 142)

to find receptive markets. Substantial global distribution of transmitting tubes and test instruments made on the West Coast has also made itself evident.

To meet the growing export trade, a World Trade Center has been planned. Postwar problems have delayed construction, but now a site at the foot of Market St. in San Francisco has been secured and construction of the first building unit will start during the coming year. The Center, shown in the accompanying artist's sketch, will house product exhibits of foreign and U. S. manufacturers, consular representatives, and the numerous finance, transportation and communication interests involved in the promotion of world trade.

Radio and Electronic Exports from U.S. During 1951 to All Countries*

Audio Amplifying Apparatus	$ 1,733,235.00
Capacitors	$ 5,834,459.00
Inductors and Receiver Transformers	$ 2,077,147.00
Loudspeakers, Radio	$ 2,581,469.00
Radio Phonograph Combinations	$ 1,729,851.00
Radio Receiver Accessories	$ 4,266,806.00
Radio Receivers, Automobile	$ 2,542,054.00
Radio Receivers, Home	$ 7,849,477.00
Radio Receivers, Including TV	$16,921,536.00
Radio Transmitting, Trans-Rec parts and accessories, not including tubes	$18,673,710.00
Resistors	$ 2,235,743.00
Testing Apparatus, Electrical, not specified	$ 6,604,287.00
Tubes, Receiving	$14,596,766.00
Tubes, Transmitting	$ 4,480,945.00

*Source: Compiled from Report No. FT 410 of U. S. Exports of Domestic and Foreign Merchandise Commodity By Country Of Destination—Calendar Year 1951.

BULLETINS

Metallized Paper Capacitors

Astron Corp., 255 Grant Ave., E. Newark, N. J., manufacturers of Metalite metallized paper capacitors, have announced the availability of new catalog sheets, complete with engineering performance and test specifications, on its new Astron Type AQ subminiature paper capacitors.

Decade Inductor Units

A bulletin describing the Hycor decade inductor units (Series 700) has been published by the Hycor Co., Inc., 114 23 Vanowen St., N. Hollywood, Calif. Four units are available in ranges from 10 x 0.001 henry to 10 x 1.0 henry. When all four units are connected in series, 11,110 steps from 0.001 henry to 11.11 henries are obtained.

Microphones

American Microphone Co., 370 South Fair Oaks Ave., Pasadena 1, Calif., has released a new booklet describing the American line of "fullvision" microphones. Crystal cartridges, pickup arms, floor stands and other microphone accessories are included.

TV Replacement Guide

Featuring replacement items for 77 different makes of radios and televisions, Catalog TV-52, Television Replacement Guide has just been released by Triad Transformer Mfg. Co. The catalog contains a complete and separate listing of all replacement transformers together with specifications and prices. Copies may be had by writing Triad Transformer Manufacturing Co., P. O. Box 17813, Los Angeles 34, Calif.

Plugs and Connectors

The audio connector serries of plugs, receptacles and accessories are included in a new brochure recently released by Cannon Electric Co., 3209 Humbolt St., Los Angeles 31, Calif.

Resistors

A handy bulletin describing fixed composition resistors designed for JAN-R-11 uses is now available on request from the Stackpole Carbon Co., St. Marys, Pa. JAN types covered include RC10, RC20, RC21, RC30, RC31, RC41 and RC42. The bulletin is designed as a convenient guide and includes prices on the various fixed composition resistor types.

Calculator

Ivan Sorvall, Inc., 210 Fifth Ave., New York 10, N. Y. has published a brochure describing and illustrating the "Original-Odhner," an economical yet practical machine equipped for complete computations. The unit is said to be particularly useful in problems involving percentages, proportions, substitutions of digits in formulae, etc.

FM Communication Unit

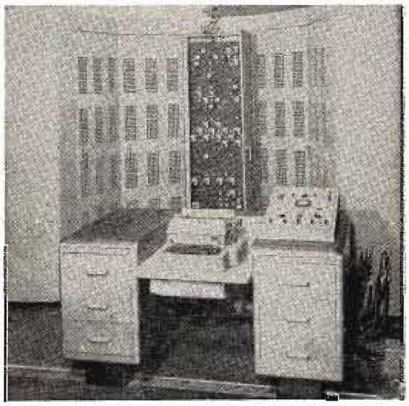
"Packmaster," a dependable portable FM communication unit, is the subject of a bulletin being made available by the Radio Specialty Manufacturing Co., 2023 S. E. Sixth Ave., Portland 14, Ore. Equipped with battery power supply, it is an easy-to-carry, lightweight unit. Carrying straps with "D" rings are provided to convert it to a "backpack."

Admittance Meter

General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass., has published a bulletin describing the 1602-A admittance meter. It will measure admittance, impedance, reflection coefficient, standing-wave ratio, and impedance magnitude.

Low Cost Computer Being Mass Produced

A new general purpose digital computer for factories and research centers has been announced by Electronic Computer Corp., 160 Ave. of the Americas, New York 13, N. Y. A slightly modified version of the Elecom 100, the Elecom 110, is going into mass production and will be offered for $62,500 outright sale, or alternative lease. Delivery time is estimated at 120 days. The 1500-lb unit has 240 tubes and requires 3 kw supply. Magnetic drum memory has 512 word capacity, and magnetic tape unit can hold 102,400 "words" of nine decimal digits each. Basic pulse rate is 115 KC; average



time for internal operations is 46 milliseconds; tape instructions are inserted at the rate of one block in 1.25 seconds. Typing out operation on the input and output typewriter is done at the rate of 7.5 characters per second, the accent being on handling many computational operations rapidly instead of having a high speed input and output. Main computer is 6 x 10 x 2 ft.; drum unit is 2 ft. square; and control desk is 34 x 60 in.

Frequency Meter

(*Continued from page 73*)

quency oscillator need be accurate to only 0.1% for an instrument accuracy of ±0.005%. For a frequency above 40 MC, the dial readings are simply multiplied by the order of the harmonic being used. For example, to generate 88 MC, the 4th harmonic would be used, which means that the instrument would read 22 MC.

There are several deficiencies in the FM-1. While it is theoretically possible to attain better accuracy than ±0.005%, it is not practical in the FM-1 in its present state for three reasons:

(1) The major cause for this is drift of the transfer oscillator. For example, in measuring an unknown signal the transfer oscillator is first matched to this signal and then its frequency measured by the difference frequency from the balanced modulator. If the transfer oscillator should drift in the time interval between these two operations, the measured frequency will be in error by the amount that the transfer oscillator drifted.

(2) Also, due to the necessarily close proximity of the tuned harmonic multiplier tuning capacitor to the high frequency oscillator tuning capacitor, the high frequency transfer oscillator tends to lock into the crystal harmonics when it is tuned close to an integral MC point.

(3) One other deficiency in the FM-1 is a falling off of the desired signal response when matching the transfer oscillator frequency to the difference frequency from the balanced modulator at points between any two adjacent crystal harmonics. This is due to the lack of a perfect selectivity curve in the tuned circuit of the crystal harmonic multiplier.

Advantages of Model FM-3

To overcome these deficiencies, the Model FM-3 was developed. The first deficiency, drift of the transfer oscillator, was eliminated completely by the process of locking the transfer oscillator to the difference frequency from the balanced modulator. Several other immediate advantages occur from this arrangement:

(1) The instrument now has the stability of the difference frequency from the balanced modulator when it is generating a signal. In practice this stability has proved to be approximately ±0.001% short term.

(2) The FM-3 has an exceptional resetability. This has proved to be approximately ±0.0005% or almost

(*Continued on page 206*)

as close as the low frequency oscillator dial can be read.

The tendency to lock in to crystal harmonics and the falling off of desired signal response was eliminated by using a separately tuned crystal harmonic multiplier physically removed from the high frequency transfer oscillator. Since it is physically removed, there is very little coupling between the two circuits, and since it is separately tuned, the desired signal response does not fall off because once the harmonic is selected, no further tuning is done.

Other Improvements

Other improvements in the Model FM-3 over the FM-1 are:

(1) An improved low frequency oscillator having better stability.

(2) A diode type harmonic multiplier used in conjunction with the high frequency transfer oscillator to produce greater output at very high frequencies. This enables the FM-3 to be used up to and possibly beyond 640 MC.

(3) More audio gain. The FM-3 has approximately 30 db more gain than the Model FM-1.

(4) Better gear trains and capacitors. The gear trains in the FM-3 are all precision built with instrument bearings, axially loaded shafts and spring-loaded anti-backlash gears. The low frequency capacitor in the FM-3 is a precision 264° straight line frequency variable, linear to better than 0.1%, made of special materials so that it has a negative temperature coefficient. This results in a very low overall temperature coefficient of the entire low frequency oscillator.

With reference to the block diagram, Fig. 2, V_1 is the high frequency transfer oscillator which we now term the search oscillator, which covers again from 20 to 40 MC. V_2 is a 1 MC crystal oscillator, and V_3 is the tuned crystal harmonic multiplier. V_4 is the low frequency oscillator which again covers from 1 to 2 MC. Balanced modulator Y_1 through Y_4 is the same as in the FM-1. The difference frequency output from the balanced modulator is now fed to a buffer, V_5. The buffer has for its plate circuit the tank circuit of the search oscillator. Therefore, the difference frequency from the balanced modulator appears in amplified form in the tank circuit of the search oscillator and serves to lock it. Y_5 is the high frequency detector serving the same function as it does in the FM-1. V_6 and V_7 are the audio amplifiers and Y_6 is the calibration detector which is used solely for the purpose of calibrating the low frequency oscillator against the 1 MC crystal.

The operation of the FM-3 is slightly different from the operation of the FM-1. To measure an unknown frequency, for example 22.5 MC again, the procedure is as follows:

(1) With all circuits inactive except the search oscillator, high frequency detector, and audio amplifier, the search oscillator is tuned to match the unknown frequency;

(2) All other circuits with the exception of the calibration detector are then activated. The proper crystal harmonic is selected by the tuned crystal harmonic multiplier by tuning until its dial reads the next lowest MC of the reading of the search oscillator dial, which in this case would be 22. When the dial reads 22, the 24th crystal harmonic is selected and is fed to the balanced modulator. The low frequency oscillator is then tuned throughout its range until the difference frequency from the balanced modulator approaches the frequency of the search oscillator. As it approaches, the search oscillator will be pulled away from the unknown frequency resulting in a rising beat note in the phones. Tuning of the low frequency oscillator is continued, and eventually the high frequency oscillator will lock to the difference frequency from the balanced modulator. This will be noticed by a definite squawk in the phones and also only one beat note will be heard. Tuning is now continued on the low frequency oscillator until the search oscillator, which is now locked to the difference frequency from the balanced modulator, again matches the unknown frequency. The frequency is now read from the dials. Notice that since the frequency being used to *measure* the unknown frequency comes from the balanced modulator, the search oscillator does not enter into the accuracy consideration at all. It serves merely to locate the unknown signal so that the proper crystal harmonic can be selected, and to amplify, when it is locked, the difference frequency from the balanced modulator.

Generating a Signal

To generate a signal, the procedure is again reversed. To generate 22.5 MC, the procedure is as follows: The low frequency oscillator is tuned to 1.5 MC so that its dial reads .500 and the proper crystal harmonic, 24 MC, selected by tuning its dial to 22. The search oscillator would then be tuned between 22 and 23 MC until it locked to the difference frequency

(*Continued on page* 212)

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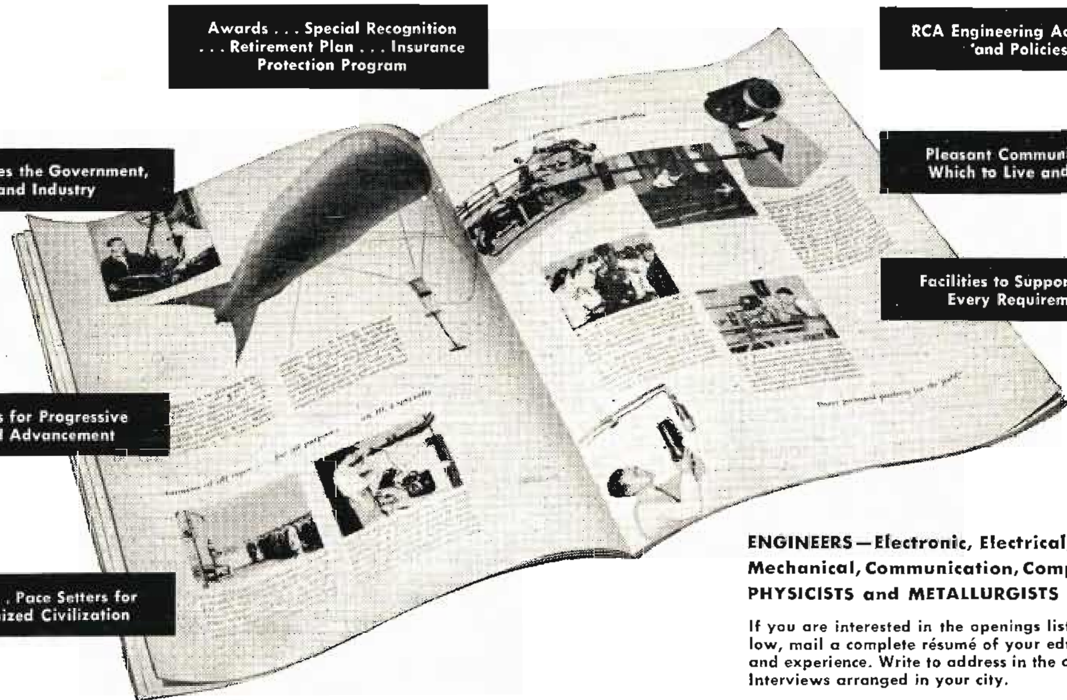

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TELE-TECH — *Advertisers — September, 1952*

from the balanced modulator. This is accomplished by listening in the phones for the oscillators to lock. The desired frequency, 22.5 MC, is now available at the output jack of the instrument.

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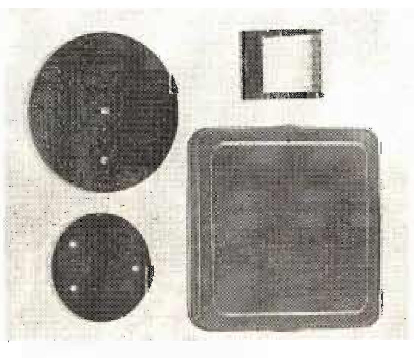
Special Loop Magazine

(*Continued from page* 199)

capstan and the reproducing head perform their functions through small slots in the magazine's edge surface. This has been accomplished in preliminary engineering models, several of which are shown in Fig 2. In these the tape never gets outside the container.

The endless-loop principle may be destined to provide the phonograph record of the future. By doing away with the necessity for manual handling of the tape, it offers a convenient and practical means for utilizing the tremendous improvement in reproduction available in magnetic tape. By using very thin and narrow tape, a complete popular musical selection can be contained in a plastic cartridge not much larger than a silver dollar. This can be manufactured at approximately the same cost as a present-day record. Players and changers will be actually simpler than those used for disc records today.

Fig. 2: Preliminary engineering model has a simplified slot design to permit easy threading



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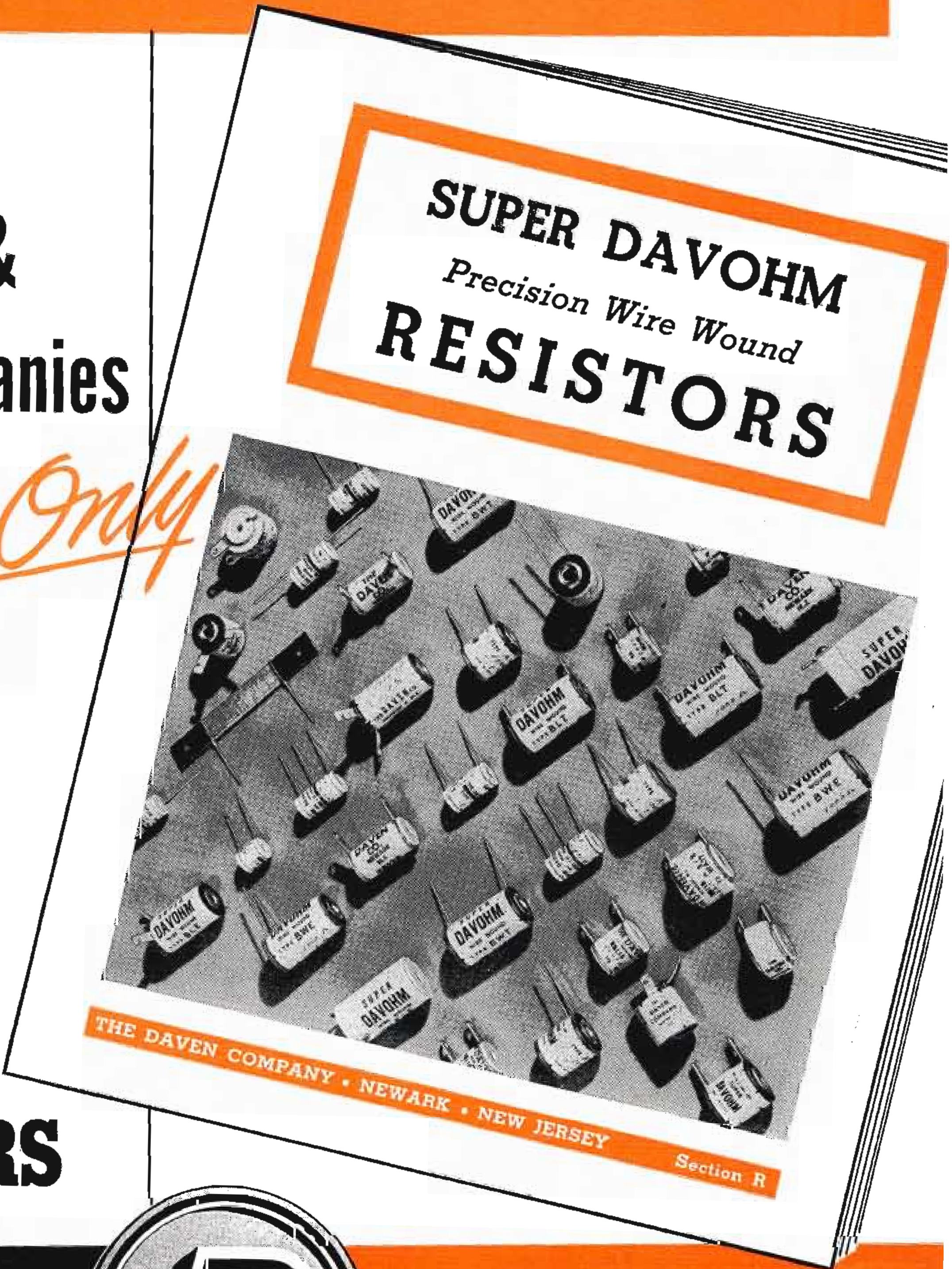

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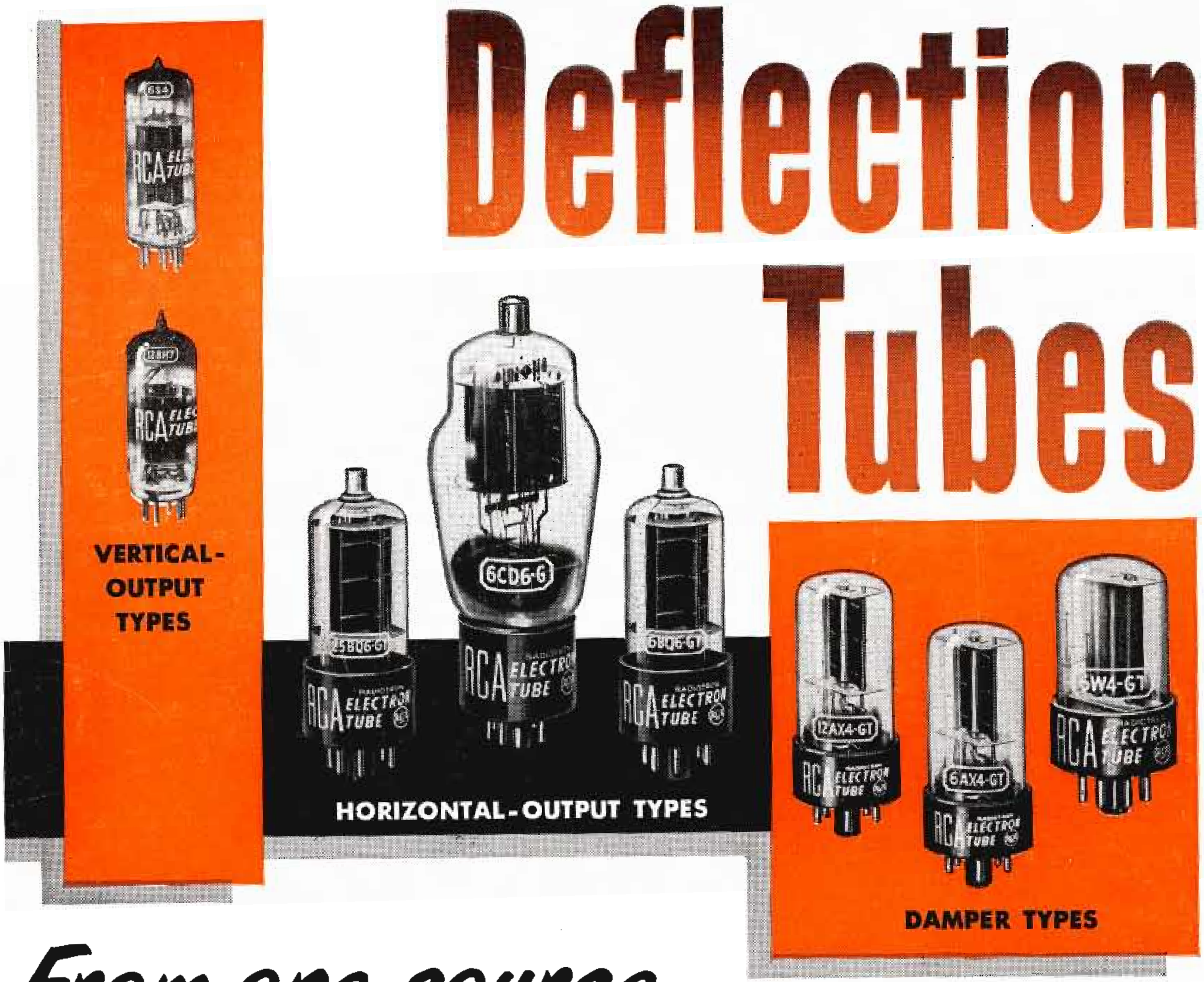

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Vertical-Output Tubes: The RCA-6S4 is a miniature medium-mu triode for circuits operating from the boosted B-voltage supply and is capable of supplying ample deflection for kinescopes having diagonal-deflection angles up to 70 degrees and operating at voltages up to 18 kilovolts. The RCA-12BH7 is a miniature twin triode used in similar circuits having more modest deflection-voltage requirements and permits the economy of using one triode unit as the vertical oscillator.

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Application Notes: Application Notes covering "Design Considerations for Minimizing Ripple and Interference Effects in Horizontal-Deflection Circuits," and "Horizontal-Deflection-Output and High-Voltage Transformer RCA-230T1 for 18-Kilovolt Kinescope Operation" are yours for the asking. For your copies —and data on these RCA tubes for deflection systems—write RCA, Commercial Engineering, Section IR57, Harrison, N.J.

For additional information on using these RCA tubes in your circuits contact the nearest RCA Field Office.

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