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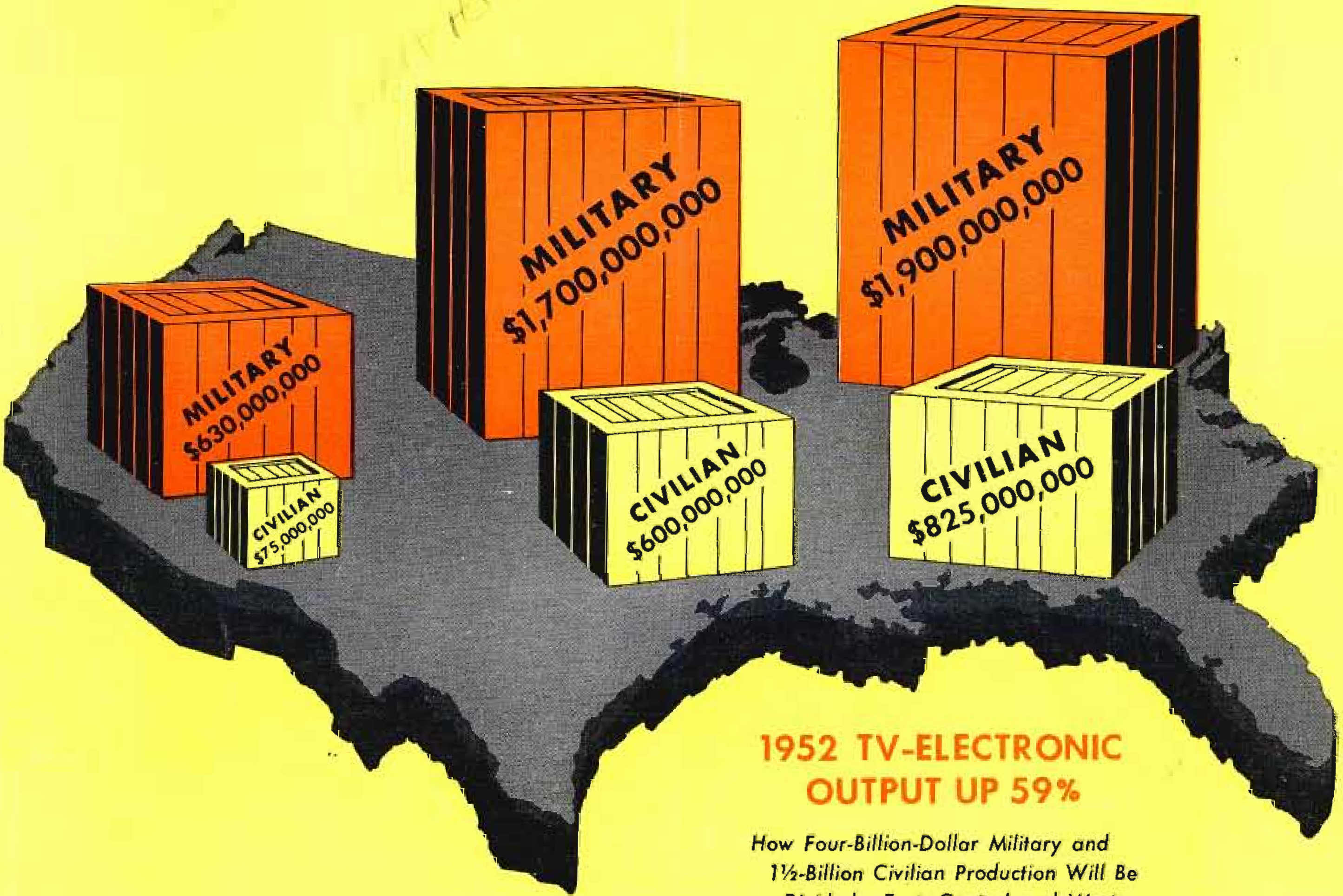
TELE-TECH

RADIO-TELEVISION-ELECTRONIC INDUSTRIES



1952 TV-ELECTRONIC OUTPUT UP 59%

How Four-Billion-Dollar Military and 1½-Billion Civilian Production Will Be Divided,—East, Central and West

ANNUAL STATISTICAL ISSUE

Electrolytic Capacitors at Low Temperatures

Cold-Cathode Tubes for Aircraft

January • 1952

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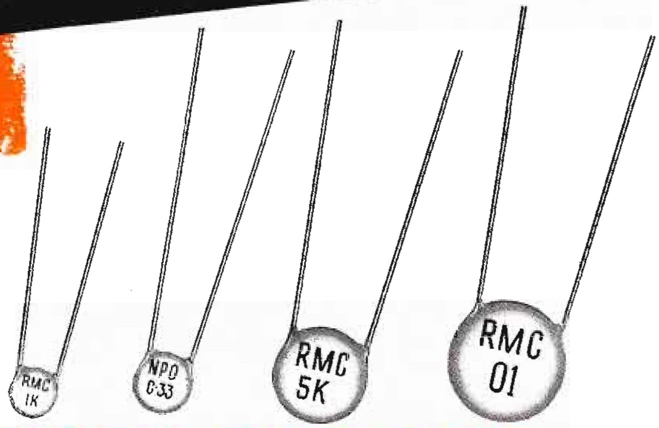
RMC CERAMIC DISCAPS

. . . THE MONEY-SAVING REPLACEMENT FOR MICA AND CERAMIC TUBULAR CONDENSERS



RMC DISCAPS are approved and used by leading manufacturers of TV sets and tuners, radio receivers and high frequency electronic equipment. In addition to their lower cost, they offer the advantages of small size, low self inductance, low power factor, high working voltage, greater mechanical strength and faster production line handling.

TYPE B DISCAPS

GMV By-Pass Series

Type B DISCAPS are the finest high frequency by-pass capacitors available and are engineered to exceed guaranteed minimum capacity at 85° C with 250 applied V.D.C. Capacity change between room temperature and 65° C is only +18%,—0%. Available in all standard capacities from .001 MFD to .02 MFD and in a number of dual capacity types.

SPECIFICATIONS

POWER FACTOR . . . . . . 1.5% at 1 KC
WORKING VOLTAGE . . . . 600 V.D.C.
TEST VOLTAGE . . . . 1200 V.D.C.
INSULATION . Durez Phenolic—Vacuum Waxed
RESISTANCE . . . . . . Initial 7500 Megohms
After Humidity 1000 Megohms
LEADS . . . #22 Tinned Copper (.026 DIA.)
CAPACITY TOLERANCE . . . . GMV

TYPE C DISCAPS

NPO and TC

Type C DISCAPS are ideally suited to coupling and tuned circuit applications. Their capacity will not change under voltage. Available in a wide range of capacities and temperature coefficients conforming to the RMA specifications for Class I ceramic condensers.

SPECIFICATIONS

POWER FACTOR . . . .
Less than .1% at 1 Megacycle
WORKING VOLTAGE . . . . 600 V.D.C.
TEST VOLTAGE . . . . 1200 V.D.C.
INSULATION . . . .
Durez Phenolic—Vacuum Waxed
RESISTANCE . . . . Initial 7500 Megohms
After Humidity 1000 Megohms
LEADS #22 Tinned Copper (.026 DIA.)
CAPACITY TOLERANCE . . . .
±5%, ±10%, ±20%

TYPE D DISCAPS

STABLE CAPACITY

Specify Type D DISCAPS when a more stable capacity is required for coupling and by-passing filter networks. Available in a capacity range between 150 MMF and 5000 MMF. They feature a very small capacity change between +25° C and +85° C.

SPECIFICATIONS

POWER FACTOR . . . . 1% at 1 KC
WORKING VOLTAGE . . . . 600 V.D.C.
TEST VOLTAGE . . . . 1200 V.D.C.
INSULATION . . . .
Durez Phenolic—Vacuum Waxed
RESISTANCE . . . . . Initial 7500 Megohms
After Humidity 1000 Megohms
LEADS . . . #22 Tinned Copper (.026 DIA.)
CAPACITY TOLERANCE . . . .
±20% at +25° C

NEW! RMC DEPENDABLE HI-VOLTAGE DISCAPS

ACTUAL SIZE

SPECIFICATIONS

CAPACITY . . . . 500 MMF + 50% – 20%
WORKING VOLTAGE . . . . 20,000 V.D.C.
TEST VOLTAGE . . . . 30,000 V.D.C.
POWER FACTOR . . . . 1% Max. at 1 KC
LEAKAGE RESISTANCE . . . . . . Initial 7500 Megohms
After Humidity . . . . 1000 Megohms
INSULATION . . . . Moulded Plaskon

SEND FOR SAMPLES AND TECHNICAL DATA

DISCAP CERAMIC CONDENSERS

RMC

RADIO MATERIALS CORPORATION

GENERAL OFFICE: 3325 North California Avenue, Chicago 18, Illinois

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Two RMC Plants Devoted Exclusively to Ceramic Condensers

TELE-TECH

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Edited for the 18,000 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 development are sought by the leaders in the many engineering fields listed below.

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LONG & SHORT WAVE RADIO
AUDIO AMPLIFYING EQUIPMENT
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AUDIO ACCESSORIES

MOBILE • MARINE • COMMERCIAL
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AMATEUR COMMUNICATION
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Research, design and production of special types
TUBES, AMPLIFIERS, OSCILLATORS, RECTIFIERS, TIMERS, COUNTERS, ETC. FOR
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Installation, operation and maintenance of telecommunications equipment in the fields of

BROADCASTING • RECORDING
AUDIO & SOUND • MUNICIPAL
MOBILE • AVIATION
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JANUARY, 1952

FRONT COVER: 1952 TV-ELECTRONIC OUTPUT UP 59%—How the four-billion-dollar military production schedule and the one-and-one-half billion-dollar civilian radio-TV program will be divided, during the coming year, between East, Central and West. The Atlantic Coast centers still lead the procession for both military and civilian outputs, with the Central and Middle-West states a close second. But most rapid growth, military-wise, has been that of the Far West, with tremendously accelerated military output, largely attributable to the huge airplane production of the Pacific Coast region.

★ ELECTRONIC INDUSTRIES for DEFENSE . . . See articles marked with asterisks

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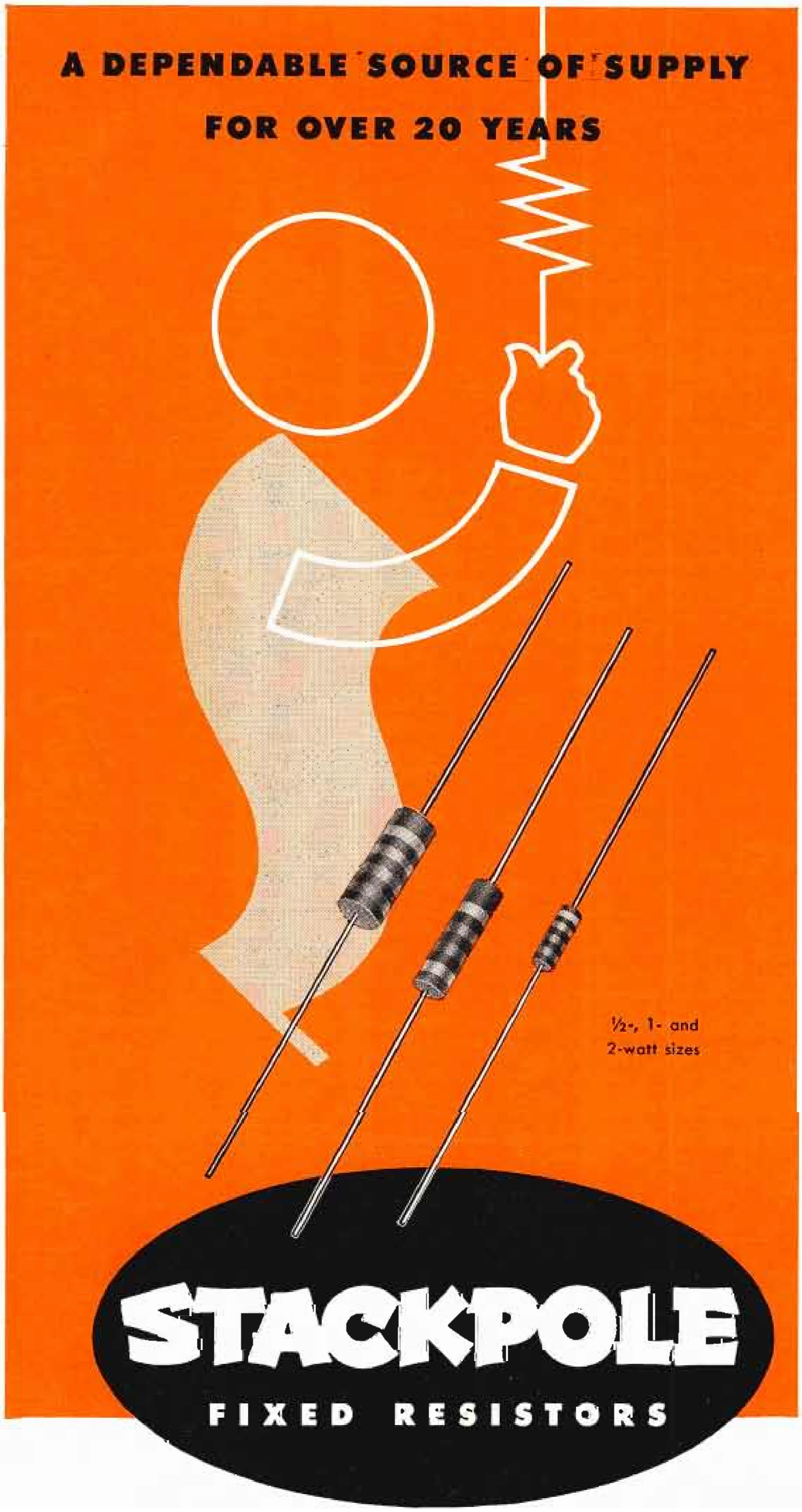

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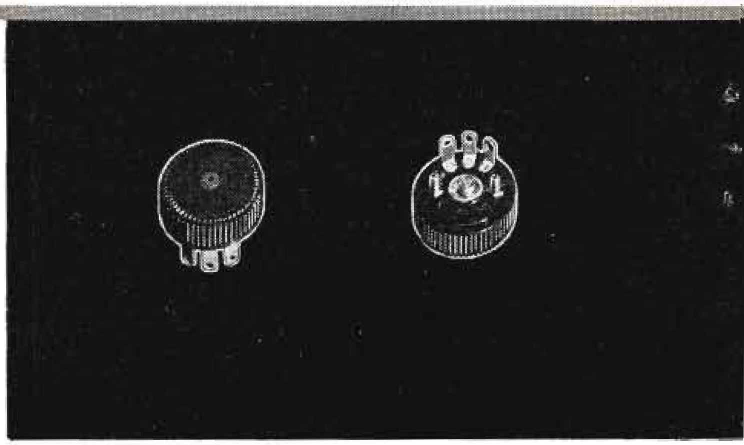
CENTRALAB PARTS CUT DOWN

OF TV-AM-FM AND

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

MINIATURE CONTROLS

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



Model 1 variable resistor — a truly miniature unit . . . no bigger than a dime! Available in standard or new Hi-Torque types . . . Also available with slot — front or rear — for screw-driver adjustment. New high torque units will hold settings under conditions of vibration or shock. Check No. 42-158 on coupon.

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

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

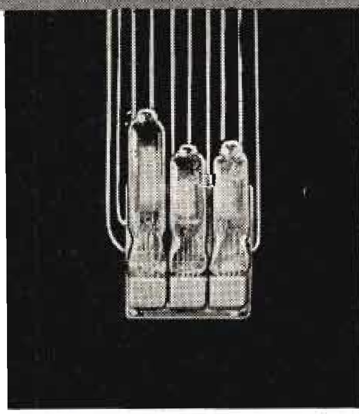
Also available with dual switches operated independently with dual concentric shafts.

MINIATURE CAPACITORS

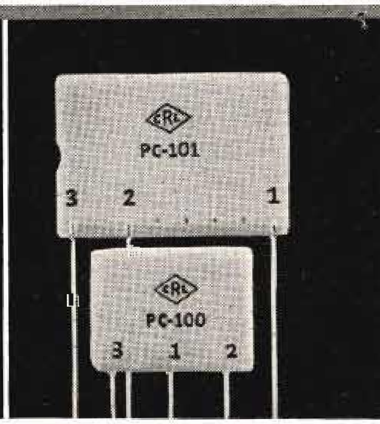
Centralab ceramic capacitors make possible tremendous savings in space; many of them are 1/7th the size of ordinary capacitors. This is particularly important where new design requirements call for less bulk. What's more, they provide a permanence never before achieved with old-fashioned paper or mica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

PRINTED ELECTRONIC CIRCUITS

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



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



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

SIZE-SPACE-WEIGHT- AND COST

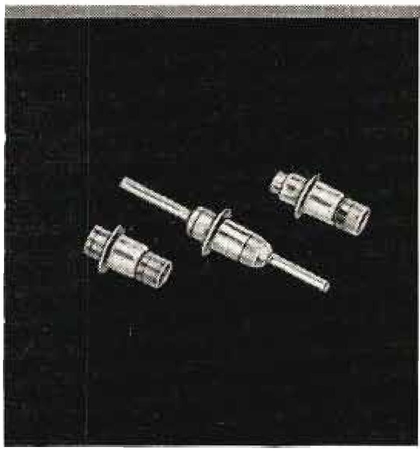
MILITARY ELECTRONIC GEAR

MINIATURE SWITCHES

Centralab's new miniature Series 20 and Series 30 switches have been specifically designed to meet the modern trend toward greatly reduced size for high-frequency, low-current applications. Extremely compact design and small size, plus availability of separate sections and index assemblies, provide an adaptability that is invaluable to design engineers and manufacturers. For complete information on the new Centralab Miniature Series 20 and Series 30 Switch line . . . multi-pole, multi-position, multi-section models or combinations with attached line switches and variable resistors, mail the coupon today. *Manufacturer's samples promptly.* Bulletins 42-156 and 42-157.

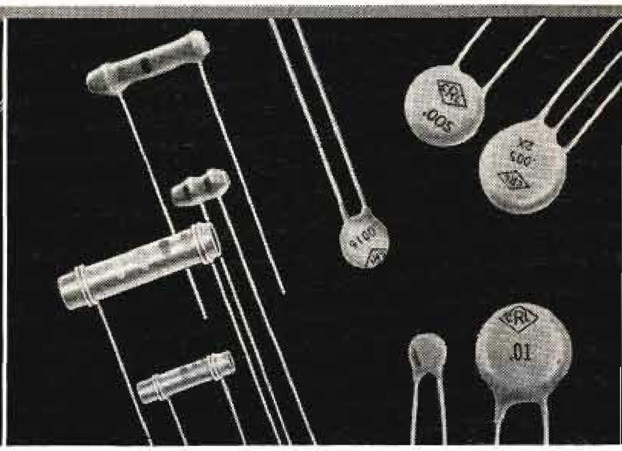
New Centralab Series 20 miniature switch, single steatite section. Available in 2 to 11 positions with stops, or 12 position continuous rotation—and with multiple sections.

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

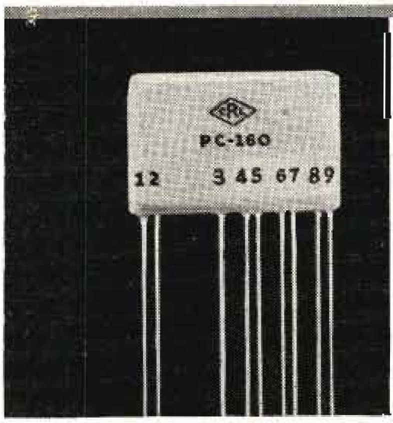


NEW Eyelet-Mounted Feed-through Ceramic Capacitors are exceptionally small. Capacities range from 25 to 3000 mmf., Voltage rating. 500 V. D. C. W. Check No. EP-15 in coupon.

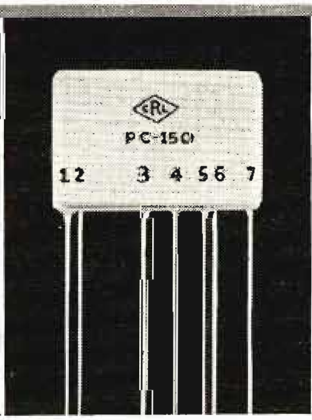
Centralab's Type 850 high voltage ceramic capacitors are especially designed for high voltage, high frequency circuits. Centralab's Type 950 high accuracy ceramic capacitors are especially developed for exacting electronic applications. Bulletins: 42-102 and 42-123.



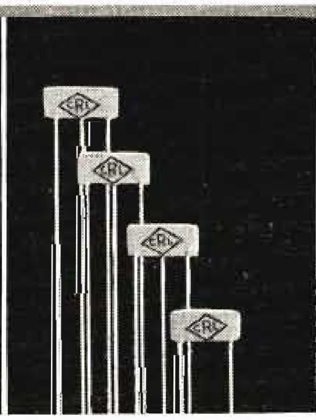
Ceramic Disc Hi-Kap Capacitors have very high capacity in extremely small size. Bulletin No. 42-4R. TC Tubulars (Temperature Compensating)—TCZ units show no capacity change over wide range of temperature; TCN's vary capacitance according to temperature. See Bulletin No. 42-18. BC (By-pass Coupling) Tubulars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



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



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



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

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☐ 42-24	☐ 42-129	☐ 42-157	

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TELE-TIPS

FIELD-EMISSION microscope has been constructed at the University of Chicago with a magnification of a million diameters. This exceeds the electron microscope with a 200,000 magnification, and far outruns the optical microscope with only a few thousand. Though less versatile than the electron microscope, the new device intended for basic metal studies, is similar to a television tube but uses no lenses or magnets.

HEARING-AID RECEIVER units in the past were manufactured along the lines of conventional headphones, and because of their smaller size, their impedances ranged between 50-120 ohms. Recent achievements have permitted the attainment of 400-ohm impedances in units about the diameter of a nickel. Current development is directed toward a 9000-ohm impedance in a unit smaller than a dime. No. 42 wire is being used experimentally.

RECORD for long-distance transmission of TV signals was set during the recent Japanese Treaty Conference in San Francisco. Pictures flashed across the continent to the New York terminal of the microwave relay. There, the signal was fed into the coaxial network which backtracked it to Omaha, Neb. WOW-TV, approximately 1800 miles from San Francisco, broadcast conference scenes to Omaha televiewers that travelled via 4300 miles of cable and relay.

TV FOR EVERYONE—Several years from now when the last UHF-TV channel has been allocated, there will be many isolated towns all over the U. S. which will not be able to enjoy TV. Mountainous terrain surrounding these areas will block incoming TV signals. In many instances, the number of people in these no-television zones will not be large enough to warrant the erection of a local outlet. Commissioner George Sterling of the FCC said recently that he hopes programs of national importance can be made available to these people. His suggestions include tapping nearby coaxial cables, establishing low-power satellite stations, installing hill-top antennas, and developing theatre-TV facilities.

(Continued on page 77)

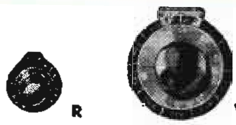
In this panel are illustrated standard models of HELIPOT multi-turn and single-turn precision potentiometers—available in a wide range of resistances and accuracies to fulfill the needs of nearly any potentiometer application. The Beckman DUODIAL is furnished in two designs and four turns-ratios, to add to the usefulness of the HELIPOT by permitting easy and rapid reading or adjustment.

MODELS A, B, & C HELIPOTS
A—10 turns, 46" coil, 1-13/16" dia., 5 watts—resistances from 10 to 300,000 ohms.
B—15 turns, 140" coil, 3-5/16" dia., 10 watts—resistances from 50 to 500,000 ohms.
C—3 turns, 13-1/2" coil, 1-13/16" dia., 3 watts—resistances from 5 to 50,000 ohms.

MODELS D AND E HELIPOTS
Provide extreme accuracy of control and adjustment, with 9,000 and 14,400 degrees of shaft rotation.
D—25 turns, 234" coil, 3-5/16" dia., 15 watts—resistances from 100 to 750,000 ohms.
E—40 turns, 373" coil, 3-5/16" dia., 20 watts—resistances from 200 ohms to one megohm.

MODELS F, G AND J PRECISION SINGLE-TURN POTENTIOMETERS
Feature both continuous and limited mechanical rotation, with maximum effective electrical rotation. Versatility of designs permit a wide variety of special features.
F—3-5/16" dia., 5 watts, electrical rotation 359°—resistances 10 to 100,000 ohms.
G—1-5/16" dia., 2 watts, electrical rotation 356°—resistances 5 to 20,000 ohms.
J—2" dia., 5 watts, electrical rotation 357°—resistances 50 to 50,000 ohms.

LABORATORY MODEL HELIPOT
The ideal resistance unit for use in laboratory and experimental applications. Also helpful in calibrating and checking test equipment. Combines high accuracy and wide range of 10-turn HELIPOT with precision adjustability of DUODIAL. Available in eight stock resistance values from 100 to 100,000 ohms, and other values on special order.



MODELS R AND W DUODIALS
Each model available in standard turns-ratios of 10, 15, 25 and 40 to 1. Inner scale indicates angular position of HELIPOT sliding contact, and outer scale the helical turn on which it is located. Can be driven from knob or shaft end.
R—2" diameter, exclusive of index.
W—4-3/4" diameter, exclusive of index. Features finger hole in knob to speed rotation.

FOR PRECISION POTENTIOMETERS come to Helipot

...world's largest manufacturer of such equipment!

For many years The HELIPOT Corporation has been a leader in the development of advanced types of potentiometers. It pioneered the *helical* potentiometer—the potentiometer now so widely used in computer circuits, radar equipment, aviation devices and other military and industrial applications. It pioneered the DUODIAL*—the turns-indicating dial that greatly simplifies the control of multiple-turn potentiometers and other similar devices. And it has also pioneered in the development of many other unique potentiometric advancements where highest skill coupled with ability to mass-produce to close tolerances have been imperative.

In order to meet rigid government specifications on these developments—and at the same time produce them economically—HELIPOT* has perfected unique manufacturing facilities, including high speed machines capable of winding extreme lengths of resistance elements employing wire even less than .001" diameter. These winding machines are further supplemented by special testing facilities and potentiometer "know-how" unsurpassed in the industry.

So if you have a problem requiring precision potentiometers your best bet is to bring it to The HELIPOT Corporation, world's largest manufacturer of such equipment. A call or letter outlining your problem will receive immediate attention!

**Trade Marks Registered*

The versatility of the potentiometer designs illustrated above permit a wide variety of modifications and features, including double shaft extensions, ganged assemblies, the addition of a multiplicity of taps, variation of both electrical and mechanical rotation, special shafts and mounting bushings, high and low temperature operation, and close tolerances on both resistance and linearity. Examples of potentiometers modified for unusual applications are pictured at right.

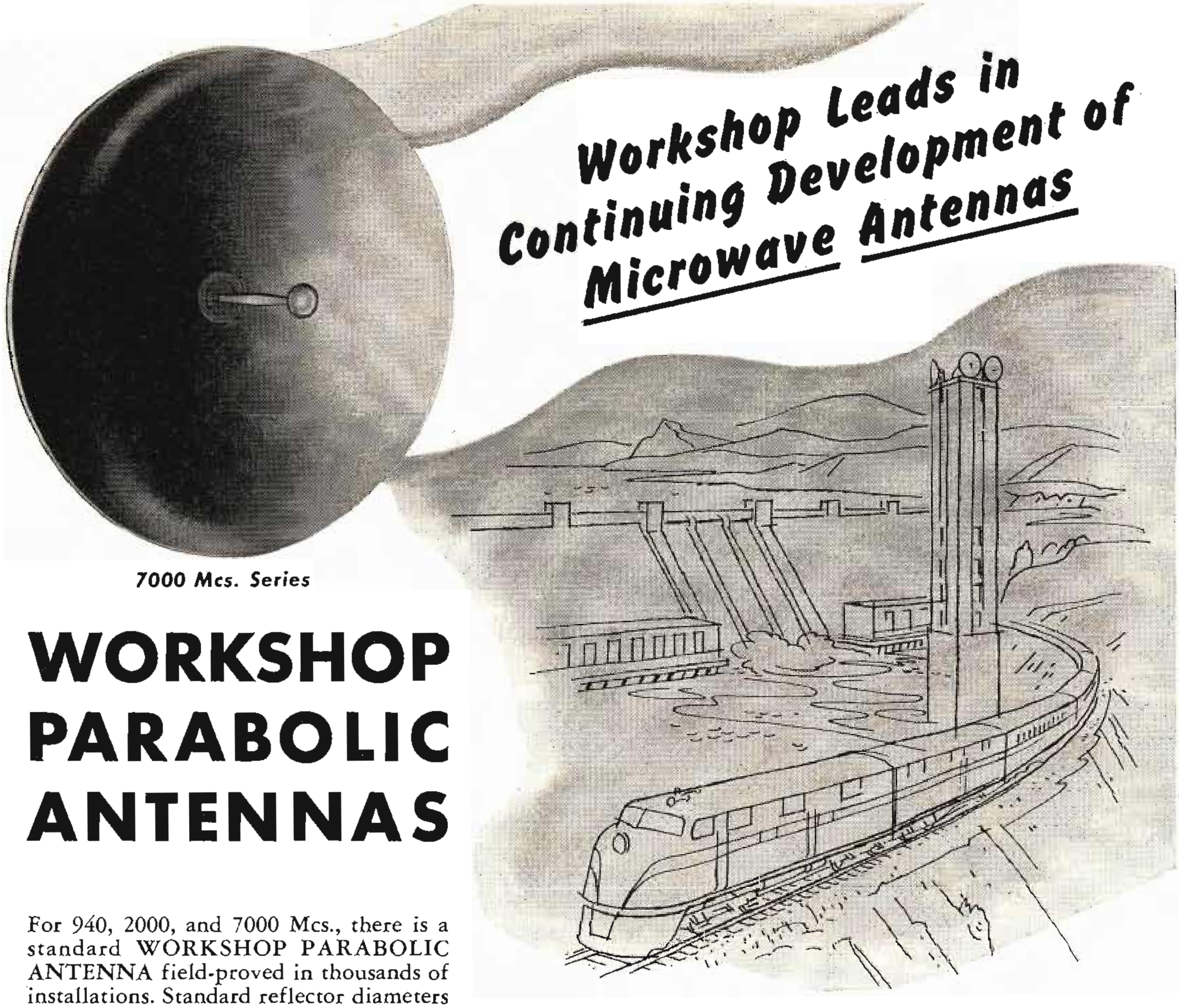
3-GANGED MODEL A HELIPOT AND DOUBLE SHAFT MODEL C HELIPOT
All HELIPOTS, and the Model F Potentiometer, can be furnished with shaft extensions and mounting bushings at each end to facilitate coupling to other equipment.
The Model F, and the A, B, and C HELIPOTS are available in multiple assemblies, ganged at the factory on common shafts, for the control of associated circuits.

MULTITAPPED MODEL B HELIPOT AND 6-GANGED TAPPED MODEL F
This Model B Helipot contains 40 taps, placed as required at specified points on coil. The Six-Gang Model F Potentiometer contains 19 additional taps on the middle two sections. Such taps permit use of padding resistors to create desired non-linear potentiometer functions, with advantage of flexibility, in that curves can be altered as required.

THE Helipot CORPORATION, SOUTH PASADENA 3, CALIFORNIA

Field Offices: Boston, New York, Philadelphia, Rochester, Cleveland, Detroit, Chicago, St. Louis, Los Angeles and Fort Myers, Florida. Export Agents: Fratham Co., New York 18, N.Y.

Workshop Leads in Continuing Development of Microwave Antennas



7000 Mcs. Series

WORKSHOP PARABOLIC ANTENNAS

For 940, 2000, and 7000 Mcs., there is a standard WORKSHOP PARABOLIC ANTENNA field-proved in thousands of installations. Standard reflector diameters are 48″, 72″ and 96″. Special diameters and frequencies on request.

PARABOLAS — Precision-designed aluminum reflectors. Can be supplied separately, if desired.

MOUNTINGS—Various types of heavy-duty reinforced mountings can be supplied for all antennas.

R.F. COMPONENTS—Precision-machined and heavily silverplated. Critical elements are completely weatherproofed.

FEEDS—Each feed is labeled with measured V.S.W.R. at three frequencies.

POLARIZATION—Either vertical or horizontal polarization can be obtained easily by a simple adjustment at the rear of the reflector.

Write for catalog and complete specifications.

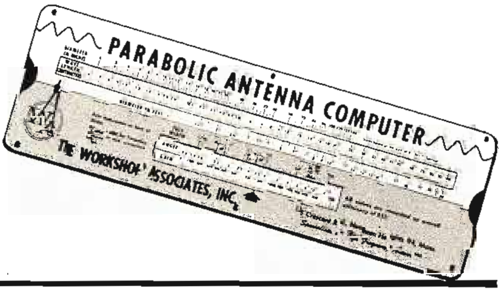
WORKSHOP Parabolic Antennas consistently cut transmission costs by improved design and added efficiency.

Operators of railroads, television stations, public utilities and all other users of microwave find WORKSHOP'S antennas ruggedly constructed and precisely engineered to meet every need. First with a complete parabolic antenna line, WORKSHOP maintains its leadership with continuing development.

The WORKSHOP laboratory—outstanding in the industry—can help you solve special communication problems. WORKSHOP also offers high-gain mobile transmitting antennas and point-to-point antennas for all types of high frequency communication.

WORKSHOP invites your inquiries. Write, or phone Needham 3-0005. No obligation.

WORKSHOP PARABOLIC ANTENNA COMPUTER . . . Pocket size slide rule that quickly computes diameter, wave length, angle and gain for parabolic antennas. Available to you without charge. . . . Write for your computer today.

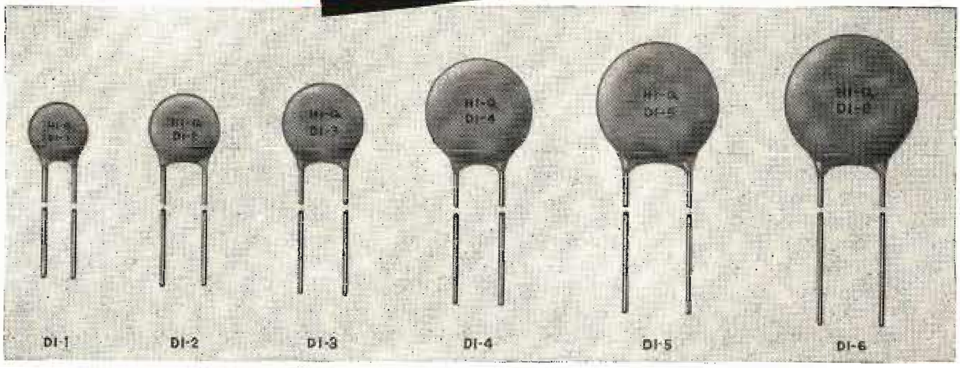


The WORKSHOP ASSOCIATES

Division of the Gabriel Company

135 Crescent Road, Needham Heights 94, Massachusetts

NEW from HI-Q*



Illustrations approximately actual size.

Temperature Compensating DISK Capacitors

Capacity range from 475 mmf on the DI-6 N1400 material down to .3 mmf on the DI-1 size with tolerances of ± 5% or greater. Conservatively rated for working voltage at 500 volts DC and flash tested at 1500 volts DC. Insulation resistance at 100 volts is well over 10,000 megohms. Electrodes are fired directly to the low loss dielectric and are coated with a non-hydroscopic phenolic for protection against moisture and high humidities. Conform to RTMA Class 1 ceramic capacitors.

Extended Temperature Compensating DISK Capacitors

Produced from a recently developed group of extended coefficient ceramics, this type of **HI-Q** Disk permits a much wider temperature compensating range than was possible on the formerly available normal linear temperature coefficient ceramics. Specifically developed for applications requiring a very large gradient of capacity versus temperature. These new **HI-Q** Disks exhibit relatively higher dielectric constants permitting capacities in the range intermediate between the high K and linear or normal group of ceramics. The Q (a minimum of 250 at 1 megacycle) is somewbat lower than the Class 1 ceramics. It has, therefore, not been classified by RTMA as Class 1. However, characteristics are superior to by-pass Class 2 ceramics.

ALL HI-Q DISK CAPACITORS COME IN THESE SIX SIZES

Type	Diameter	Lead Width	Thickness
DI-1	5/16″ Max.	3/16″ ± 1/16″	5/32″ Max.
DI-2	3/8″ Max.	1/4″ ± 1/16″	5/32″ Max.
DI-3	7/16″ Max.	1/4″ +1/8″ −0″	5/32″ Max.
DI-4	19/32″ Max.	1/4″ +1/8″ −0″	5/32″ Max.
DI-5	11/16″ Max.	3/8″ ± 1/8″	5/32″ Max.
DI-6	3/4″ Max.	3/8″ ± 1/8″	5/32″ Max.

Companion Lines to the Popular HI-Q By-pass DISK Capacitors

The widely used **HI-Q** By-pass Disks are fixed ceramic dielectric capacitors which meet RTMA Class 2 specifications. They are available in the complete capacity range of from .3 mmf to 30,000 mmf. Standard tolerances of 5% thru 20% where applicable can be furnished.

Write for Engineering Bulletin Giving Details of all HI-Q DISK Capacitors

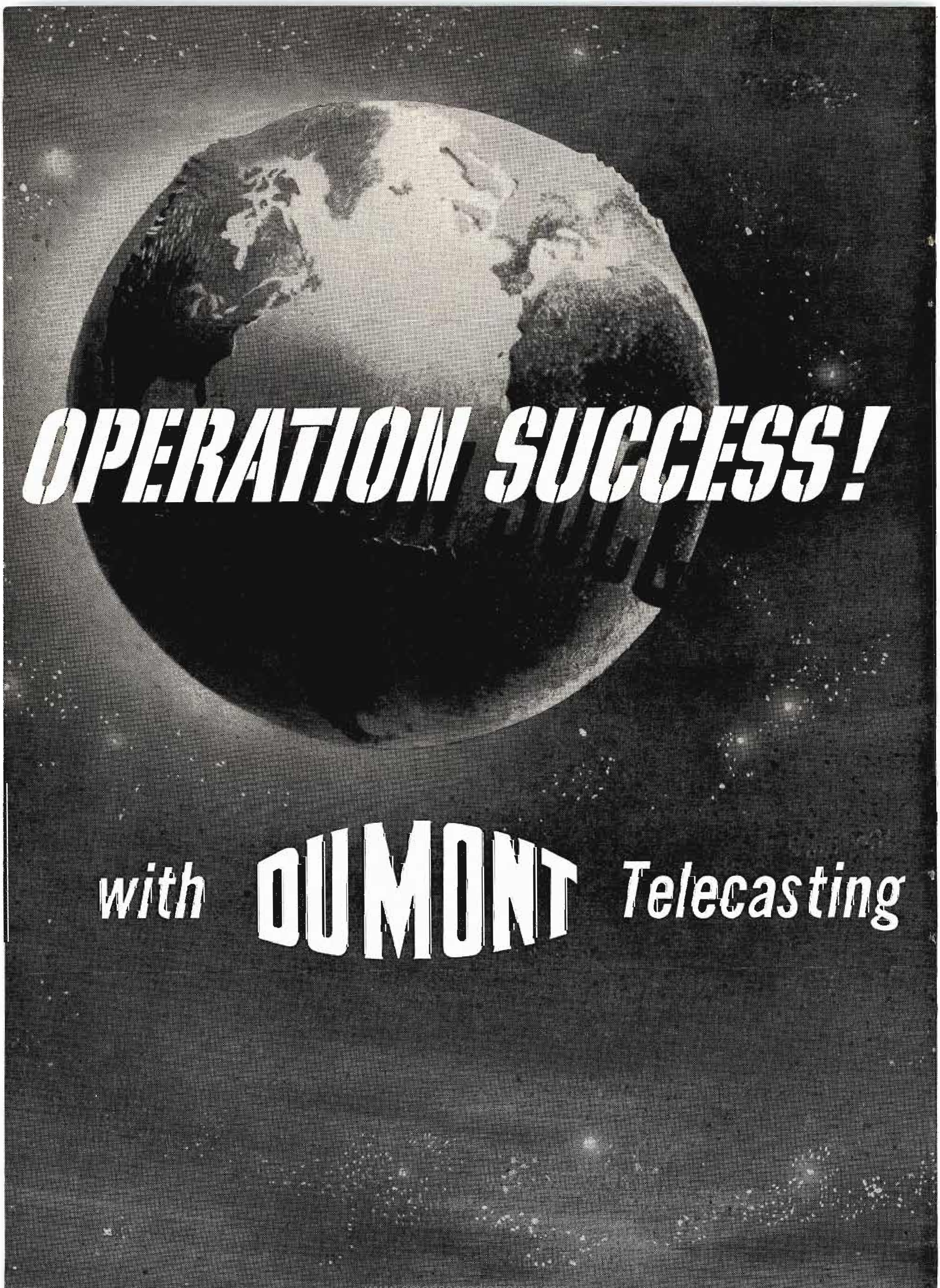
HI-Q*

*Trade Mark Registered, U. S. Patent Office

Electrical Reactance Corp.
OLEAN, N. Y.

SALES OFFICES: New York, Philadelphia, Detroit, Chicago, Los Angeles

PLANTS: Olean, N. Y., Franklinville, N. Y. Jessup, Pa., Myrtle Beach, S. C.


OPERATION SUCCESS!
with DUMONT Telecasting

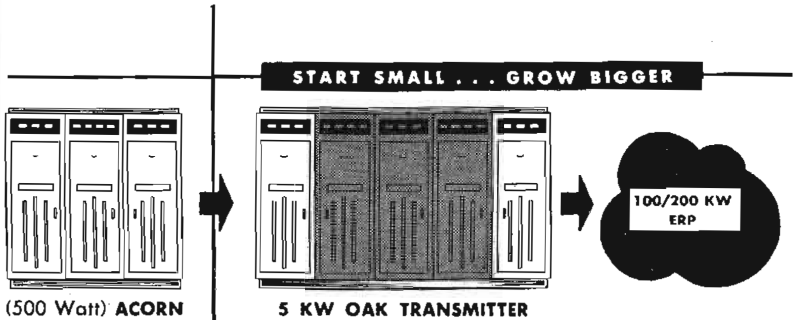
Equipment

The rich heritage of over 12 years experience in the design, manufacture and use of telecasting equipment is reflected in every piece of Du Mont equipment today. This experience results in equipment without peer for performance, dependability and operating economies.

Du Mont-equipped stations were among the first to "break into the black" a few years ago. Today a roster of the most successful stations in the television world shows an impressive percentage of partial or 100% Du Mont-equipped operations.

It was Du Mont who first advocated the "Grow As You Earn" basis of station equipment. This has paid dividends to the many stations who recently increased their transmitting power through the Acorn-to-Oak Series Transmitters. Such power increases were achieved with no loss of "time on the air" or loss of former equipment.

Truly, a Du Mont-equipped TV station exemplifies OPERATION SUCCESS!

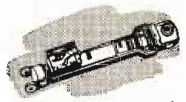


TELEVISION TRANSMITTER DIVISION,
ALLEN B. DU MONT LABORATORIES, INC.
Clifton, New Jersey

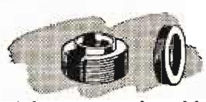
Connector Problem?

...We'll take it from HERE

Good ideas for electronic circuitry sometimes run afoul of connector problems. Maybe existing connector units won't hold air pressure gradients, won't stand the heat, aren't rugged enough for the job. Or maybe it's a question of altitude, or under-water application. But if you can sketch the circuit, we'll take it from there. We've engineered so many special connectors, solved so many "impossible" problems, that whatever the requirements are, we can usually provide the answer.

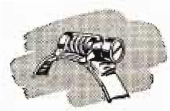


Lightweight actuators for any requirement.



Job engineered, welded-diaphragm bellows.

Flexible conduit and ignition assemblies.



Aero-Seal vibration-proof hose clamps.

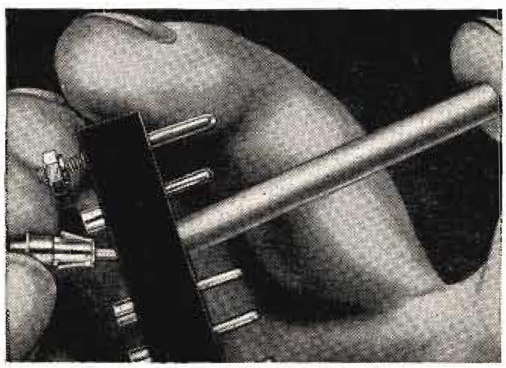
WRITE TODAY for specific information, or send us your sketches. We'll forward recommendations promptly.

BREEZE

Special CONNECTORS

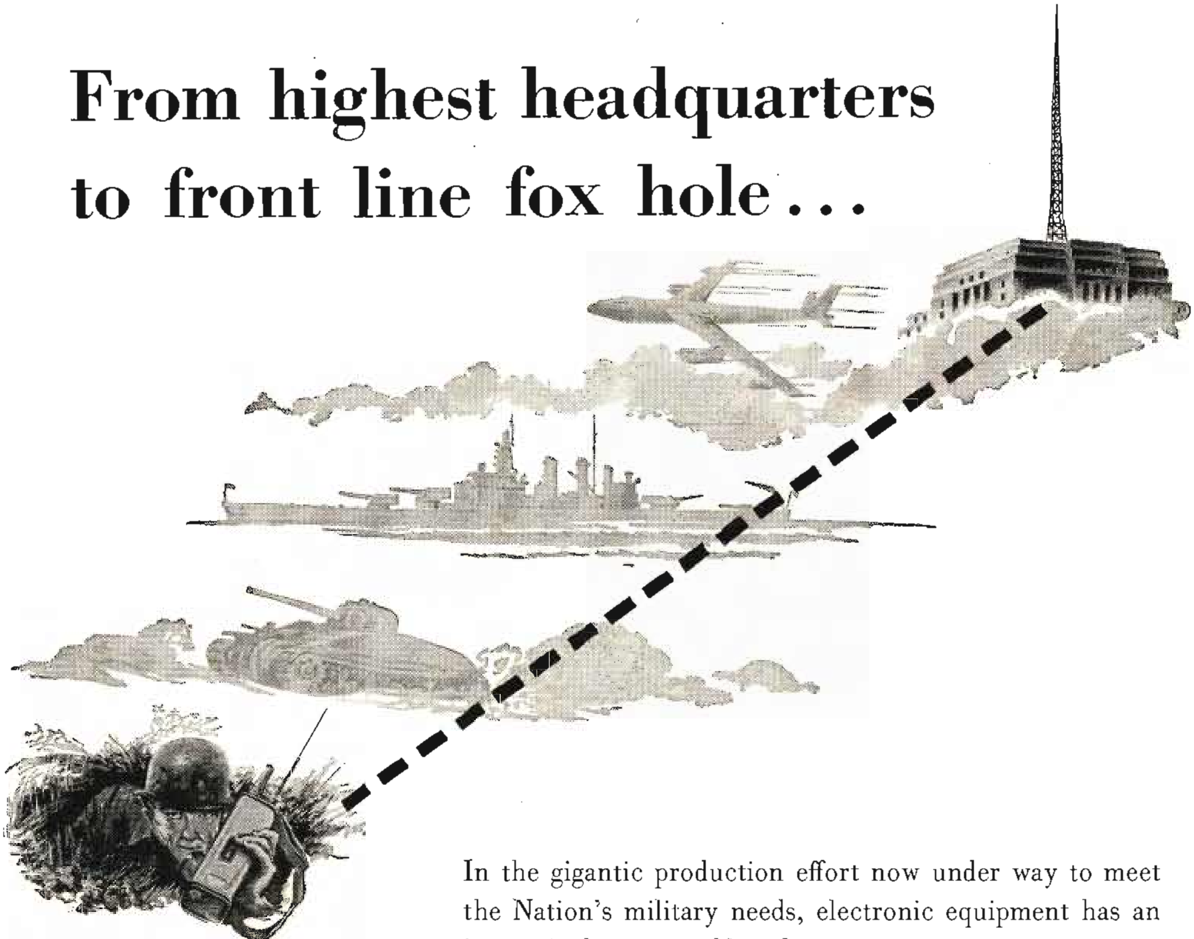
BREEZE CORPORATIONS, INC.

41 South Sixth Street Newark, New Jersey



Removable pins in Breeze connectors speed soldering, save time, trouble. Pins snap back into block.

From highest headquarters to front line fox hole...



In the gigantic production effort now under way to meet the Nation's military needs, electronic equipment has an increasingly responsible role.

At every level, from highest headquarters to front line fox hole, military personnel and equipment depend on electronic devices. And no electronic equipment can operate without capacitors.

To assure dependable performance of their equipment, many manufacturers rely on Mallory capacitors.

They know Mallory produced the first high voltage dry electrolytic capacitor . . . pioneered electrolytic capacitor miniaturization . . . developed designs providing long shelf life and wide temperature range characteristics. They know Mallory offers unique facilities, personnel and products.

It will pay you to use Mallory capacitors in your electronic equipment . . . to consult Mallory on any problem involving the application of standard capacitors, the development of special types, or the simplification of related circuits.

Key to Subminiaturization

Timely example of Mallory capacitor know-how is the new Tantalum capacitor, developed by Mallory for the Armed Forces subminiaturization program. It is remarkably efficient from −60°C. to +200°C.

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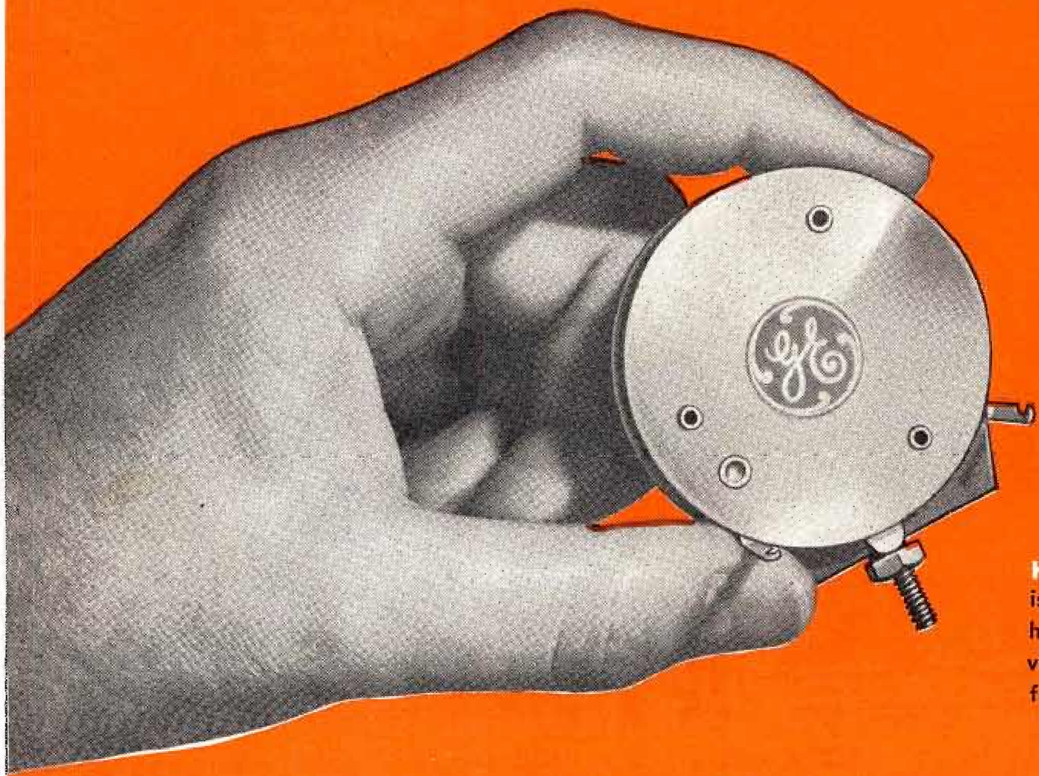
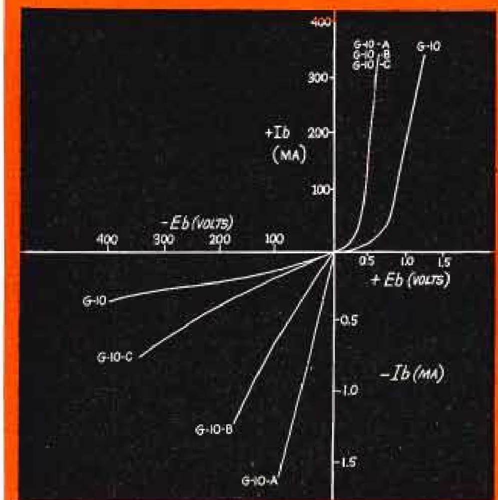
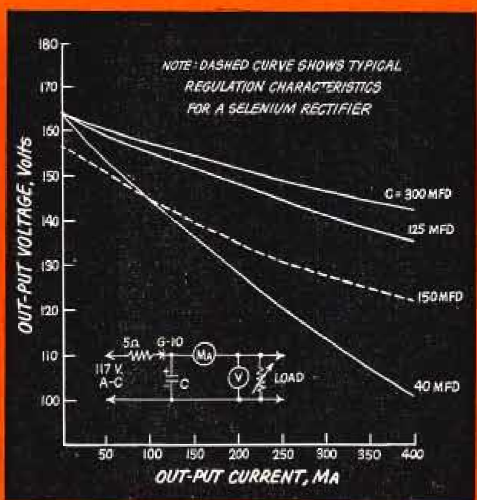
Announcing a GERMANIUM

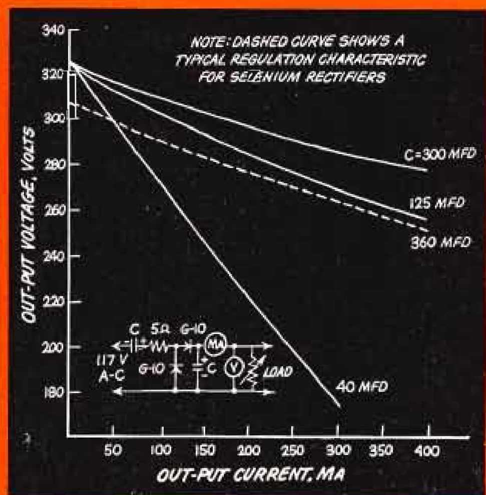


Heart of the G-10 Rectifier is this minute sealed button, shown here actual size in front and side views (G-10A). This unit is available for lower voltage applications.



Typical Current-Voltage Characteristics





Regulation Characteristics

Revolutionary NEW POWER RECTIFIER!

G-E Research Advances New Principle of Area Rectification . . . Usage with Large Currents and Exceptionally Low Losses Now Possible

Can You Use These Outstanding Features?

- **Higher Output Voltage**—15 volts more B+ in typical TV power supply due to rectification efficiency up to 98%
- **Longer Life**—Moisture and fume resistant...gasket-sealed units
- **Lower Forward Resistance**—Approx. 3.5 ohms forward resistance at 350 ma
- **Higher Current Capacity**—400 ma average dc current
- **Higher Peak Inverse Voltage**—400 volts
- **Higher Back Resistance**—approx. 1 megohm at 350v
- **Smaller Size**—smaller than comparably rated dry rectifiers of other types

Specifications

Description and Maximum Ratings
Type G-10

Ambient Temperature	**40°C**	**55°C**	**65°C**
RMS Input Voltage (Max.)	130	130	130 Volts
RMS Current (Max.)	1.2	1.2	.2 Amps
D-C Output Current (Max.)	400	350	50 Ma
D-C Surge Current (Max.)	25	20	2.5 Amps
Peak Forward Current (Max.)	3	3	.5 Amps
Peak Inverse Voltage (Max.)	400	400	400 Volts
Full Load Voltage Drop (Max.)	1.5	1.4	1.3 Volts
Operating Frequency (Max.)	50	50	50 Kc

Single Rectifier Types		**G-10A**	**G-10B**	**G-10C**
RMS Input Voltage (Max.)	25°C	32	50	65 Volts
	40°C	32	50	65 Volts
RMS Current (Max.)	25°C	.6	.6	.6 Amps
	40°C	.5	.5	.5 Amps
D-C Output Current (Max.)	25°C	200	200	200 Ma
	40°C	150	150	150 Ma
D-C Surge Current (Max.)	25°C	10	10	10 Amps
	40°C	8	8	8 Amps
Peak Forward Current (Max.)	25°C	1.5	1.5	1.5 Amps
	40°C	1.2	1.2	1.2 Amps
Peak Inverse Voltage (Max.)	25°C	100	150	200 Volts
	40°C	100	150	200 Volts
Full Load Voltage Drop (Max.)	25°C	.8	.8	.8 Volts
	40°C	.7	.7	.7 Volts
Operating Frequency (Max.)	25°C	50	50	50 Kc
	40°C	50	50	50 Kc

● These rectifiers are now in pilot production. To purchase sample quantities, call the G-E Electronics Division Tube Dept. office near you or wire us: *Commercial and Government Equipment Dept., Electronics Park, Syracuse, N. Y.*

● *A newly printed bulletin on the G-10 Germanium Power Rectifier will be sent to you on request.* General Electric Company, Section 4812, Electronics Park, Syracuse, New York.

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GENERAL ELECTRIC

Q: Are all brands of Resistors similar in Quality, Specifications and Performance?

A: Naturally, no! That's why DAVEN has earned the right to add a superlative in naming its line

SUPER DAVOHM

PRECISION WIRE WOUND

RESISTORS

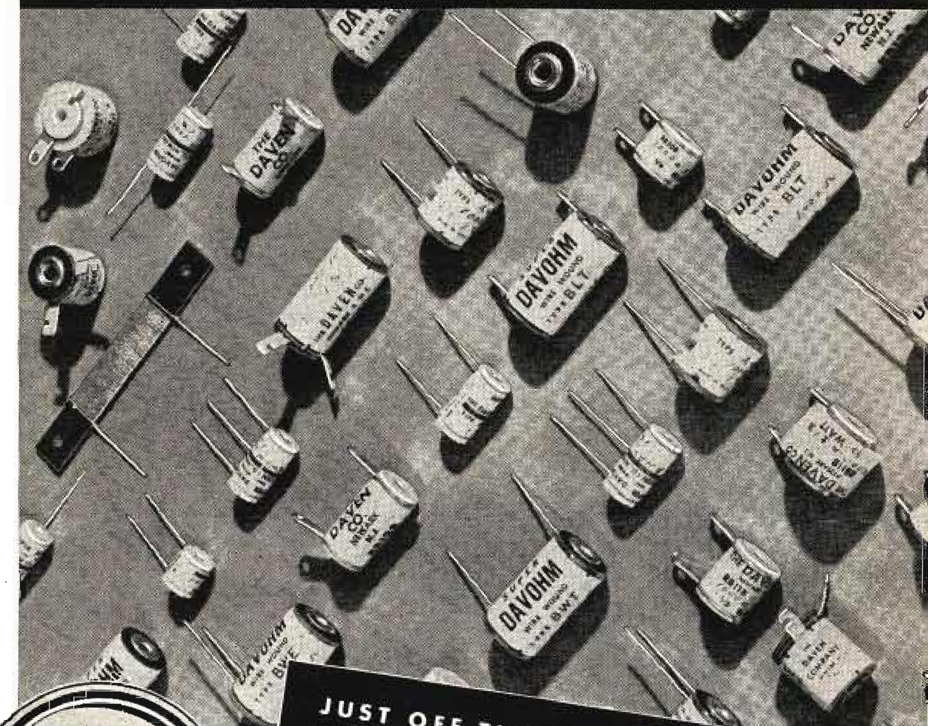
● Brands of Resistors vary as widely in the completeness of a line and in performance, as do brands of any other product.

DAVEN originated the first pie-type, wire wound Resistor more than a generation ago. Since that time, DAVEN has designed and manufactured Precision Wire Wound Resistors of every conceivable type to meet the increasing demands of the electronics industry.

SUPER DAVOHM RESISTORS are noted for their high stability and accuracy under extreme temperature and humidity conditions. DAVEN Resistors are made in accordance with JAN-R-93 specifications and are in use in all types of Army, Navy and Air Force electronic equipment.

DAVEN has developed special small precision Resistors for use in miniaturized assemblies. All types of mountings, sizes, tolerances and temperature coefficients are available from a large variety of standard types. That's why DAVEN can fill your precision Resistor needs.

Take advantage of DAVEN's advanced engineering and manufacturing techniques to help with any Resistor problem confronting you.



THE DAVEN CO.
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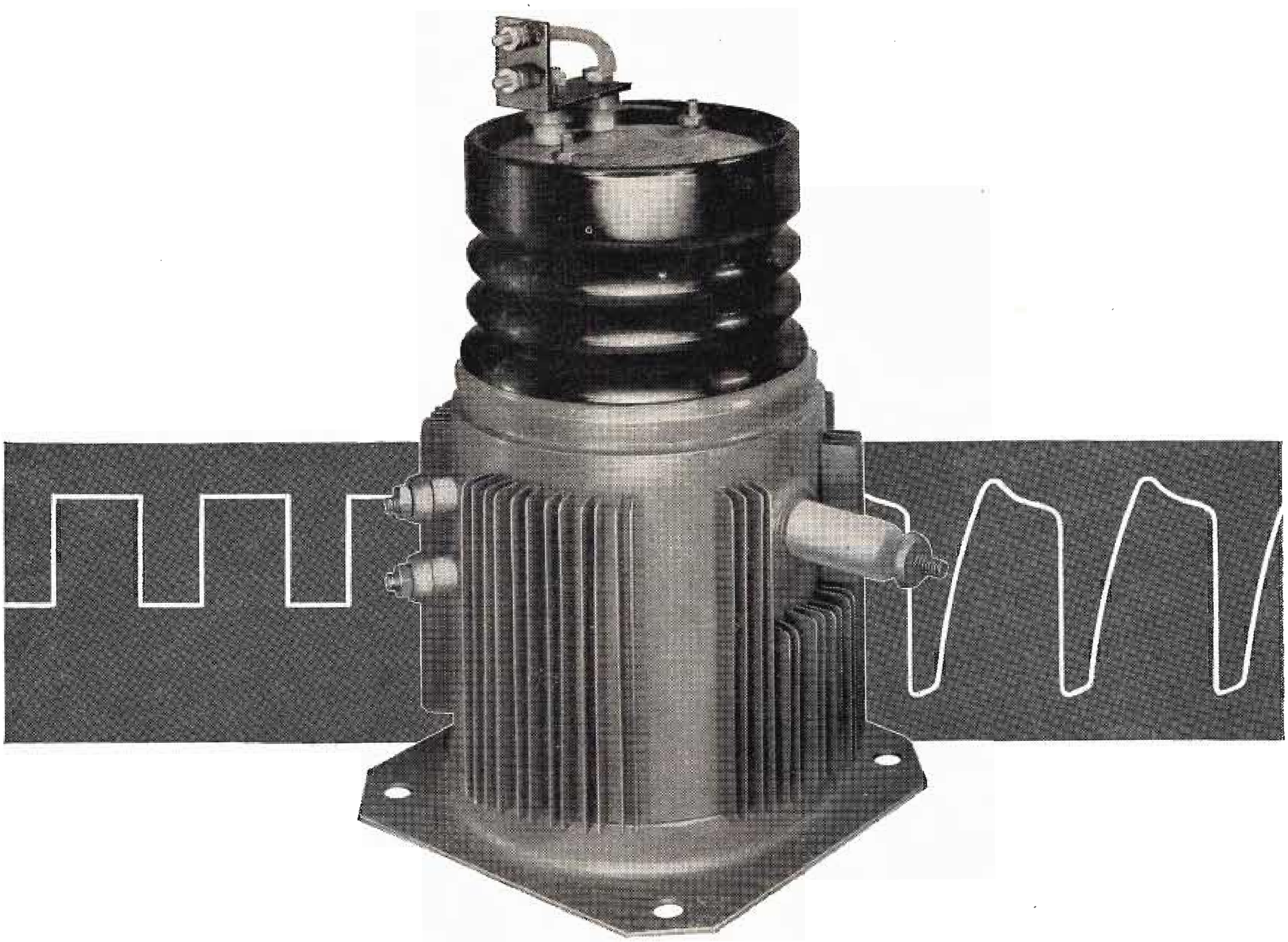
JUST OFF THE PRESS IS DAVEN'S IMPORTANT NEW BULLETIN ON RESISTORS.

Write for your copy today and prove to yourself, from the information supplied, that when you order Resistors you should specify only . . .

SUPER DAVOHM Precision Wire Wound RESISTORS



To tailor a wave more accurately...

It's a recognized principle that the smaller, more compact the pulse transformer, the more acceptable will be the shape of the output wave. That's where Westinghouse transformer engineering can offer greater advantages to the designer of electronic circuits.

In pulse transformers like the one above, for example, Westinghouse is able to produce a smaller, lighter, better performing transformer by using a two-piece HIPERSIL® type C core wound from one mil thick material. Insulation applied depends upon actual requirements . . . for instance, Fosterite® insulation on open-type transformers for adverse atmospheric conditions; silicone oil for high-temperature applications. But with an initial advantage on core size, and corresponding reduction in coils, the compactness of Westinghouse Pulse Transformers assures better wave shape, plus saving in both size and weight.

If size, weight, performance or quantity production have any bearing on your transformer problem call your Westinghouse representative. For many applications, standardized designs are available at substantial savings. Westinghouse Electric Corporation, Specialty Transformer Department, Sharon, Pa. J-70611

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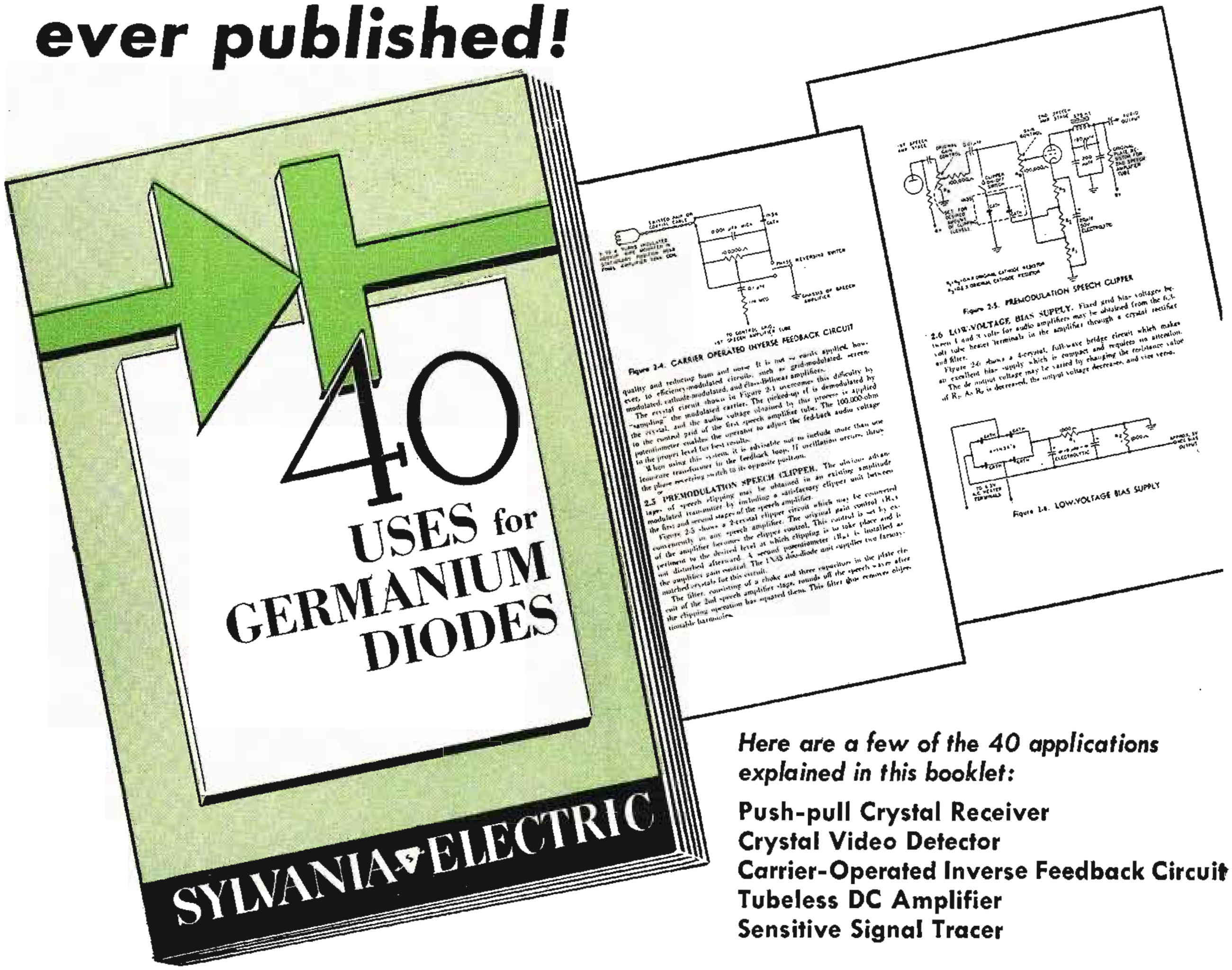

Here are a few of the 40 applications explained in this booklet:

Push-pull Crystal Receiver
Crystal Video Detector
Carrier-Operated Inverse Feedback Circuit
Tubeless DC Amplifier
Sensitive Signal Tracer

Sylvania's handy-sized book, "40 Uses for Germanium Diodes," presents for the first time all the most important applications of germanium diodes. In it, the engineer and technician will find time-saving devices and simplified circuits. Hams, hobbyists and experimenters will find plans for a host of interesting instruments and gadgets, from crystal receivers to voltage and frequency multipliers.

Simple, clear explanations, plus more than 40 separate diagrams, describe germanium diode applications in receiver and transmitter circuits, instrument construction and electronic devices.

This book is full of new circuit ideas. It will save you time and money. It costs only 25 cents. Mail the coupon today with your quarter and your copy will be sent you at once.

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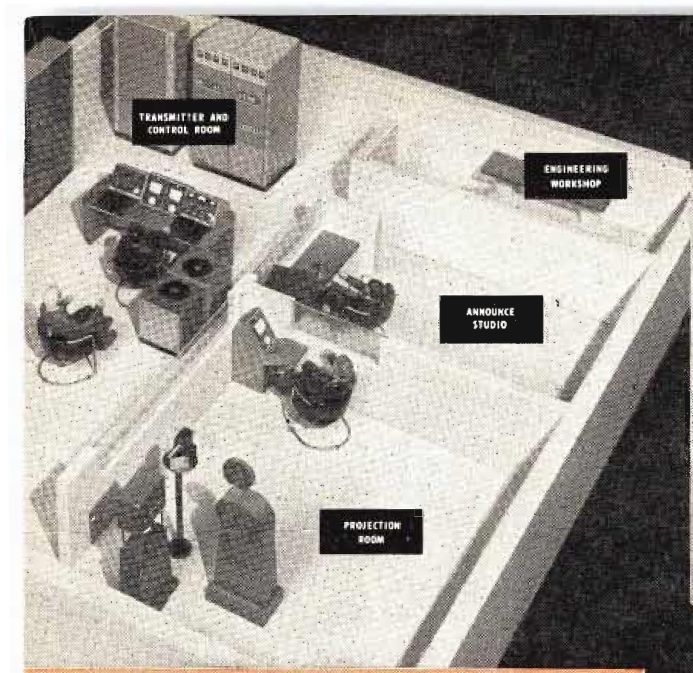
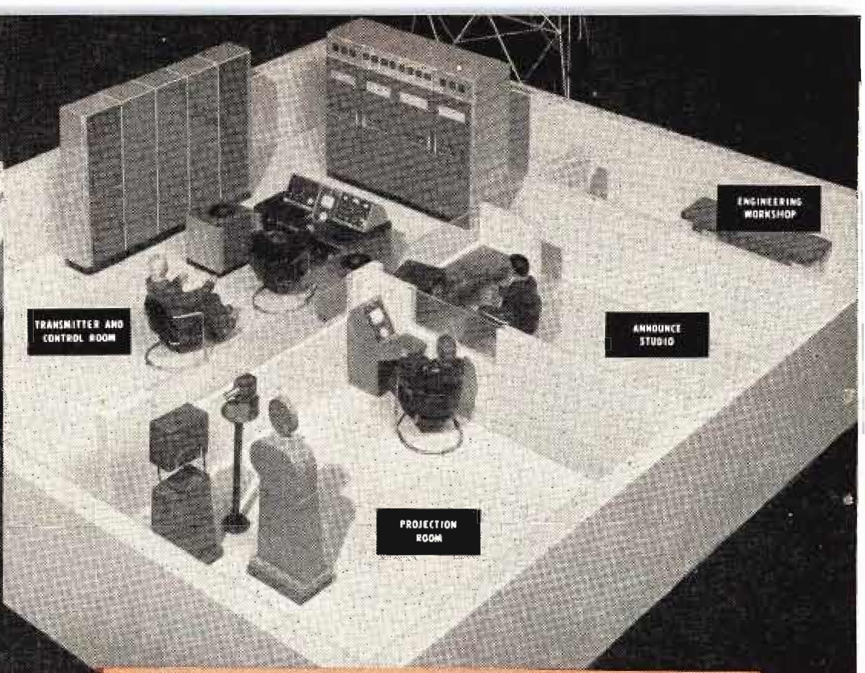


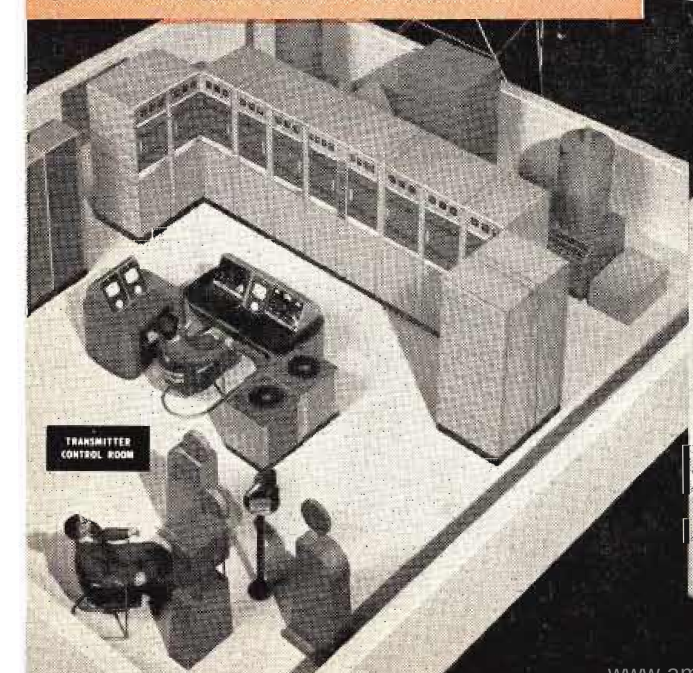
500 watts VHF (ERP range, ½ to 2 kw) This is a control-room set-up—complete with an RCA 500-watt transmitter, announce booth, and film facilities. The arrangement, and an RCA 5-bay Super Turnstile Antenna, provides up to 2 kw ERP*—gets you on the air for minimum outlay.



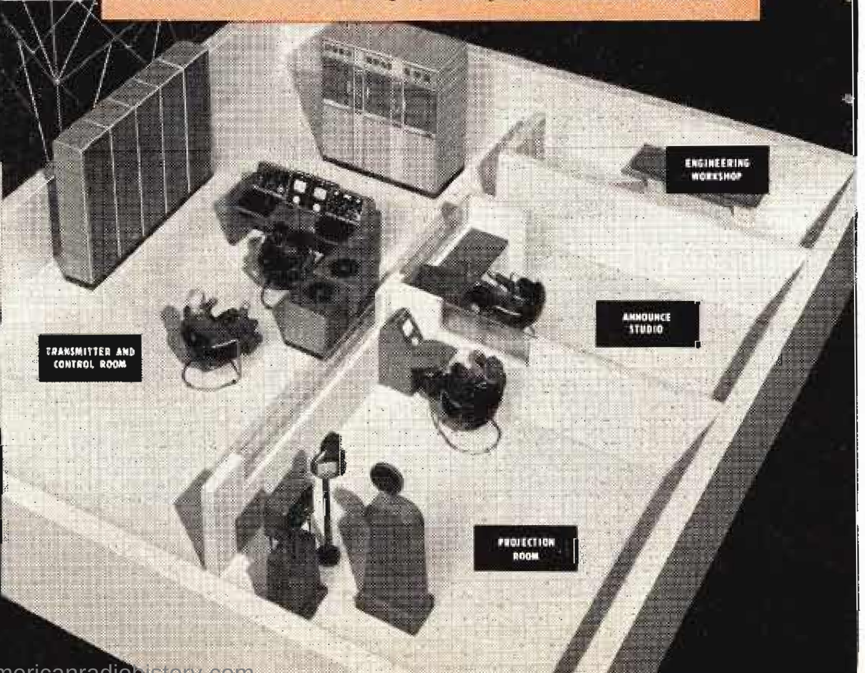
2 kw VHF (ERP range, 2 to 20 kw) Similar to 500-watt plant, but uses an RCA 2-kw transmitter. The ideal set-up for getting up to 20 kw (ERP) for a small investment. "In line" racks at left of control console are: monitoring, audio, and video equipments, sync generator, and power supplies.

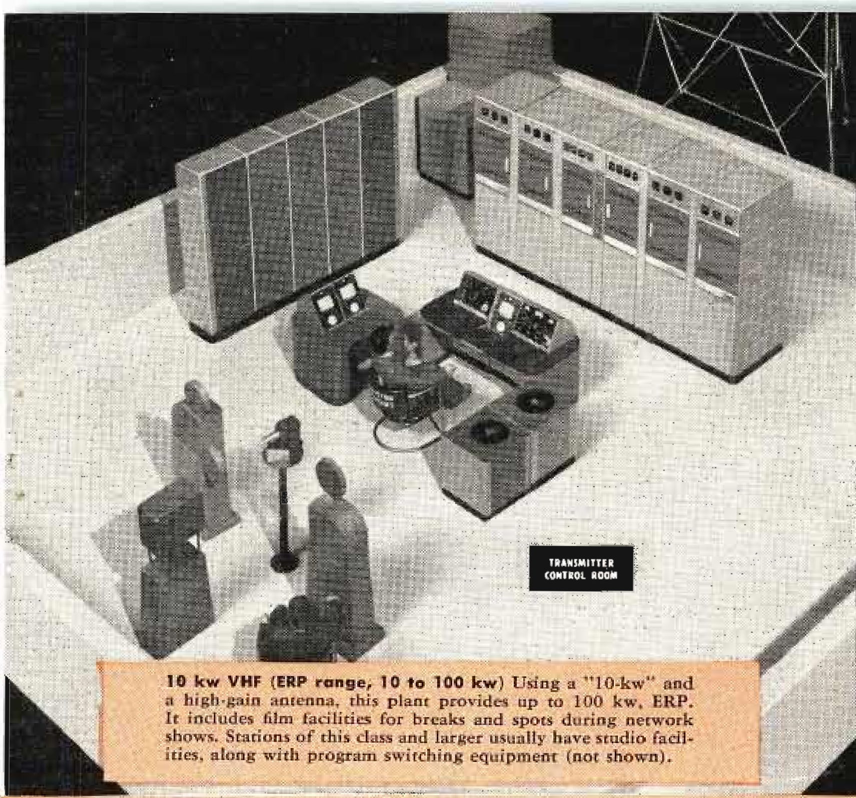
"Tailored" transmitter plants

50 kw VHF (ERP range, 50 to 200 kw) Block "U" set-up for RCA's "50-kw." This arrangement is well suited for local building situations—or where physical limitations call for an antenna of medium gain and high ERP. Note film camera control and preview monitor next to operator for his convenience.



1 kw UHF (ERP range, 1 to 20 kw) For areas where UHF channels will be assigned, the "1 kw" and UHF antenna make it practical to start with a minimum investment. It offers interesting possibilities for areas up to 150,000 people—could prove popular in communities up to 1 million. Note network, film projection spots, station break facilities.





10 kw VHF (ERP range, 10 to 100 kw) Using a "10-kw" and a high-gain antenna, this plant provides up to 100 kw, ERP. It includes film facilities for breaks and spots during network shows. Stations of this class and larger usually have studio facilities, along with program switching equipment (not shown).

20 kw VHF (ERP range, 20 to 200 kw) For the new TV station that wants to start right in with maximum power, using a "20-kw" and an RCA 12-section Super Turnstile antenna. The transmitter, arranged "in line," can also be set up in a block "U" arrangement like the "50 kw" shown below.

...for any TV power up to 200 KW*!

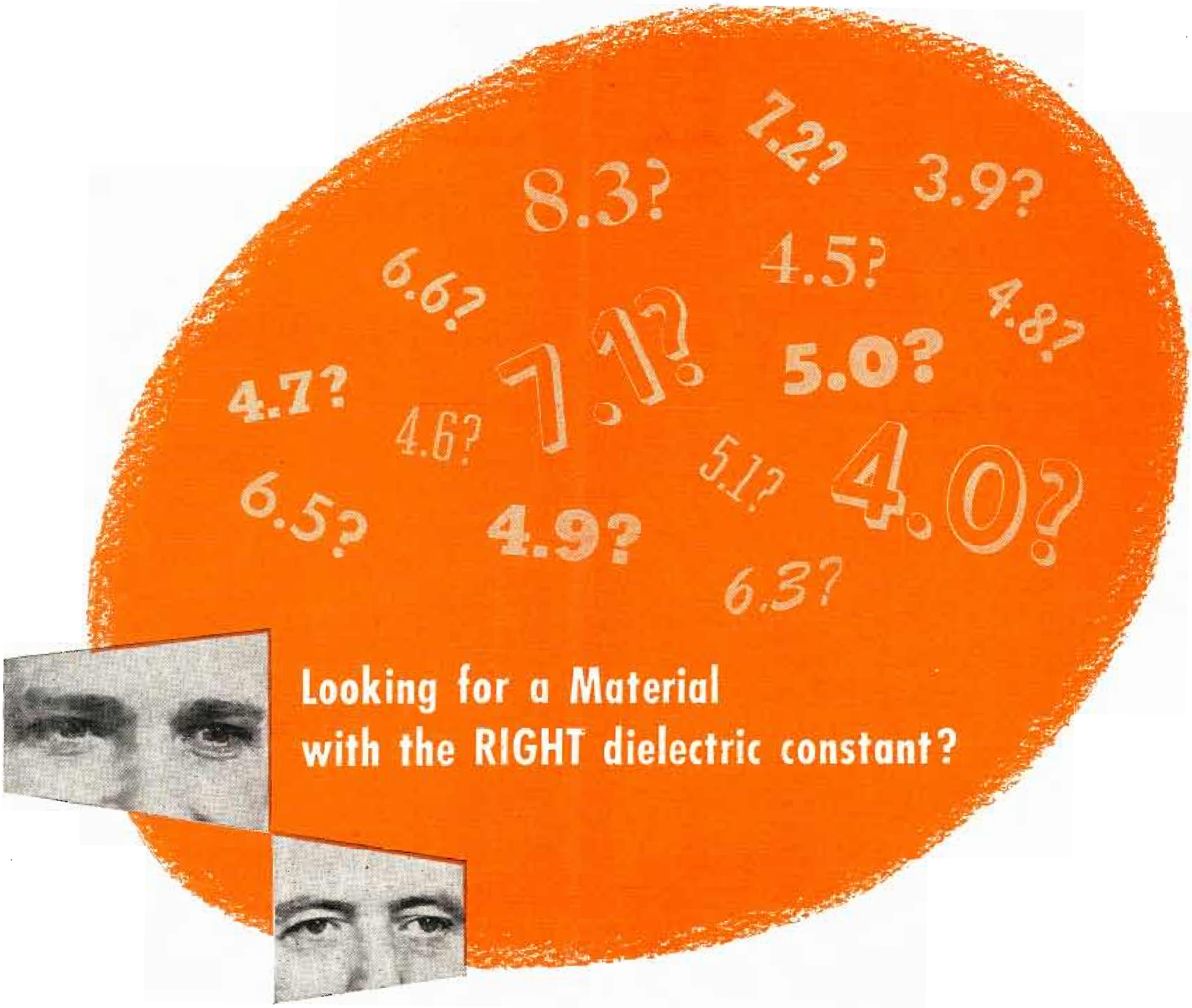
10-kw UHF (ERP range, 10 to 200 kw) Using an RCA "10-kw UHF" type TTU-10A and a TFU-24B high-gain antenna, this set-up offers the next logical step above the "1-kw" range. Or, you can start with 1 kw now—and increase power later simply by adding RCA matching amplifiers and associated equipment.

These models represent seven typical TV transmitter room arrangements for various power classes—from 500 watts to 200 kw, ERP*. They include the film equipment required for spot, station breaks, and network operation. They show the basic or minimum facilities you need to go "on the air" for a given power. The set-ups are worked out in accordance with tried-and-proved operating procedure and provide a handy means for estimating your space requirements. There is ample leeway to meet the particular needs of every station.

Your RCA Broadcast Sales Representative is ready to give you planning help like this—throughout your station! By all means, call him.

*Effective radiated power

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



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Accurately controlled dielectric constant is just one of the properties Corning can build into your electronic glass components. Whether you need low loss and power factors, controlled transparency, proper sealing characteristics, or corrosion resistance, glass by Corning may well be your answer.

Our research and engineering staffs are ready to help you solve your problems. Just let us know what you have in mind, or write for Bulletin B-88—Glass In The Design Of Electrical Products—Corning Glass Works, Dept. T-1, Corning, N. Y.

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ELECTRONIC SALES DEPARTMENT — ELECTRICAL PRODUCTS DIVISION

Corning means research in Glass

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New CBS-HYTRON 12B4

New 9-pin miniature; high-perveance, low-mu triode with 6/12-volt heater for parallel or series connection. 12B4 is designed specifically for vertical amplifiers with limited primary B supply voltages. Delivers adequate vertical sweep power in proper circuit to sweep any 70° rectangular picture tube.

Characteristics of 12B4 are similar to those of 6W6GT, but 12B4 . . . for same input . . . supplies substantially more sweep power. 12B4, because of special design and processing, is also virtually free from grid emission.

New CBS-HYTRON 12BY7

New 9-pin miniature; very-high-transconductance pentode amplifier. As video amplifier in high-quality receivers, gives extended gray scale. In low-cost receivers, 12BY7 provides adequate voltage amplification for wide-band video amplifiers with primary B voltages as low as 135 volts.

Within its power capabilities, 12BY7 gives gains equal to those of 6AG7. High ratio of transconductance to interelectrode capacitances makes 12BY7 useful as video i-f or pulse amplifier for radar. High grid-to-screen transconductance suits 12BY7 (within its power handling capabilities) for class C harmonic oscillators.

Which of these CBS-HYTRON ORIGINALS can you use?

New CBS-HYTRON 5Y3WGT

New "ruggedized," full-wave filamentary-type rectifier with electrical characteristics equivalent to those of 5Y3GT . . . but 5Y3WGT is specially designed for equipment subject to high impact and shock.

New CBS-HYTRON 12A4

New high-perveance, medium-mu, 9-pin miniature triode for use as vertical amplifier, class C oscillator, or low-distortion audio output amplifier in push pull.

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A DIVISION OF COLUMBIA BROADCASTING SYSTEM, INC.

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HYTRON RADIO & ELECTRONICS CO.
Salem, Massachusetts

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12B4............ 12BY7............ 5Y3WGT............

12A4............ 12BZ7............

Name ....
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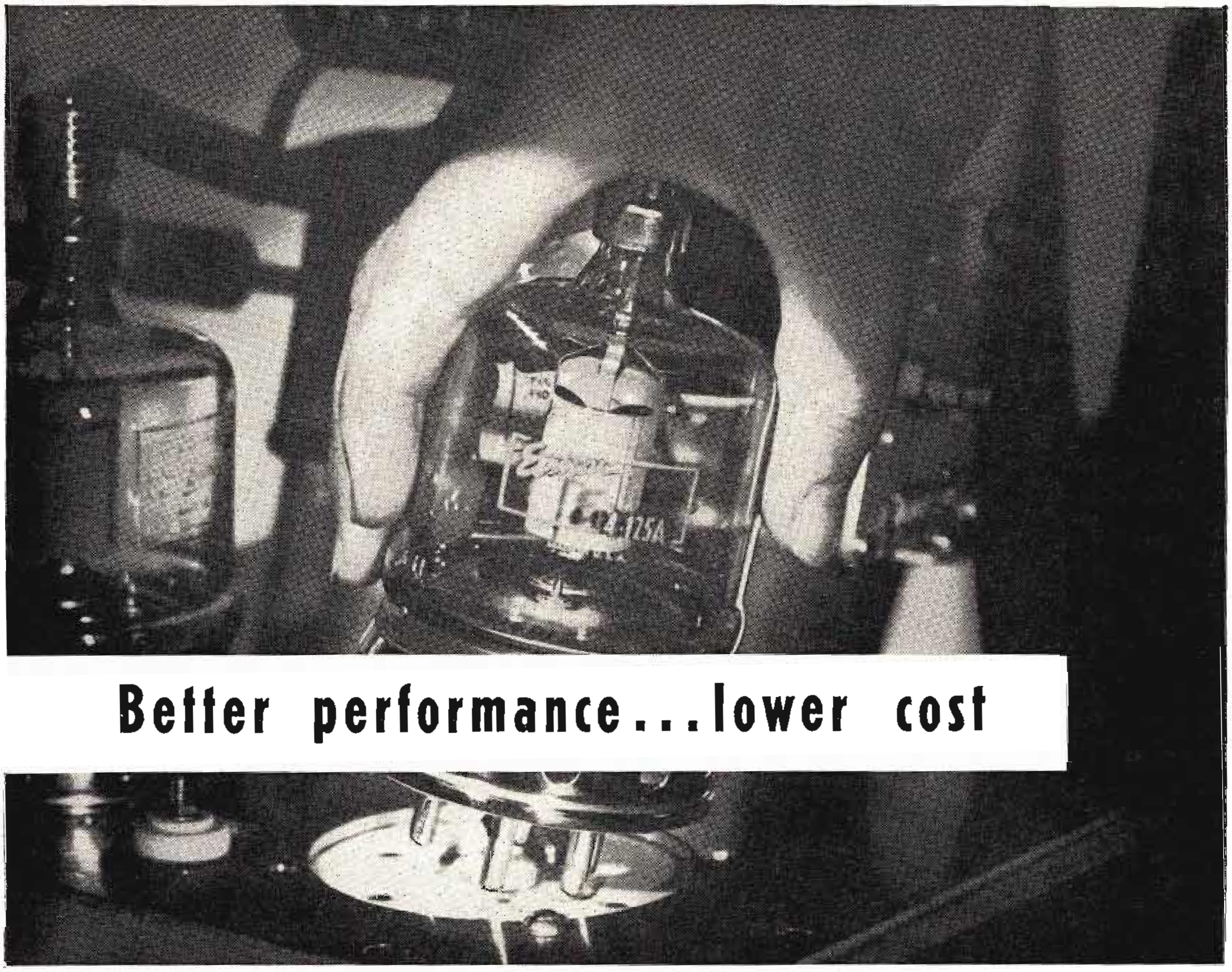

Better performance...lower cost

Transmitter performance goes up—costs go down . . . the inevitable result of specifying Eimac tetrodes to fill key sockets. Costs will stay down because the service life of these time-proved tubes is long, replacement costs are low, and the circuit simplicity they allow keeps power bills down.

Eimac tetrodes are made for a wide range of power from 65 watts plate dissipation to 20,000 watts dissipation. They are unexcelled for amplifier, oscillator, and modulator service. All are backed by the experience and know-how of America's foremost transmitting tube manufacturer.

Take the advice of countless users and equipment manufacturers who consistently not only recommend but rely on . . . Eimac tetrodes for unvarying performance, exceptional service life, and compatibility to modern circuit techniques.

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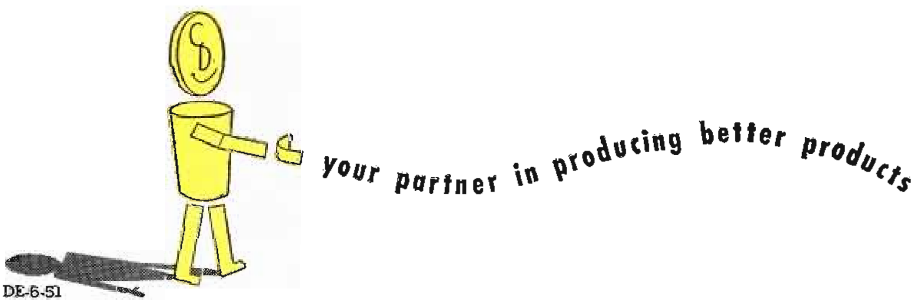

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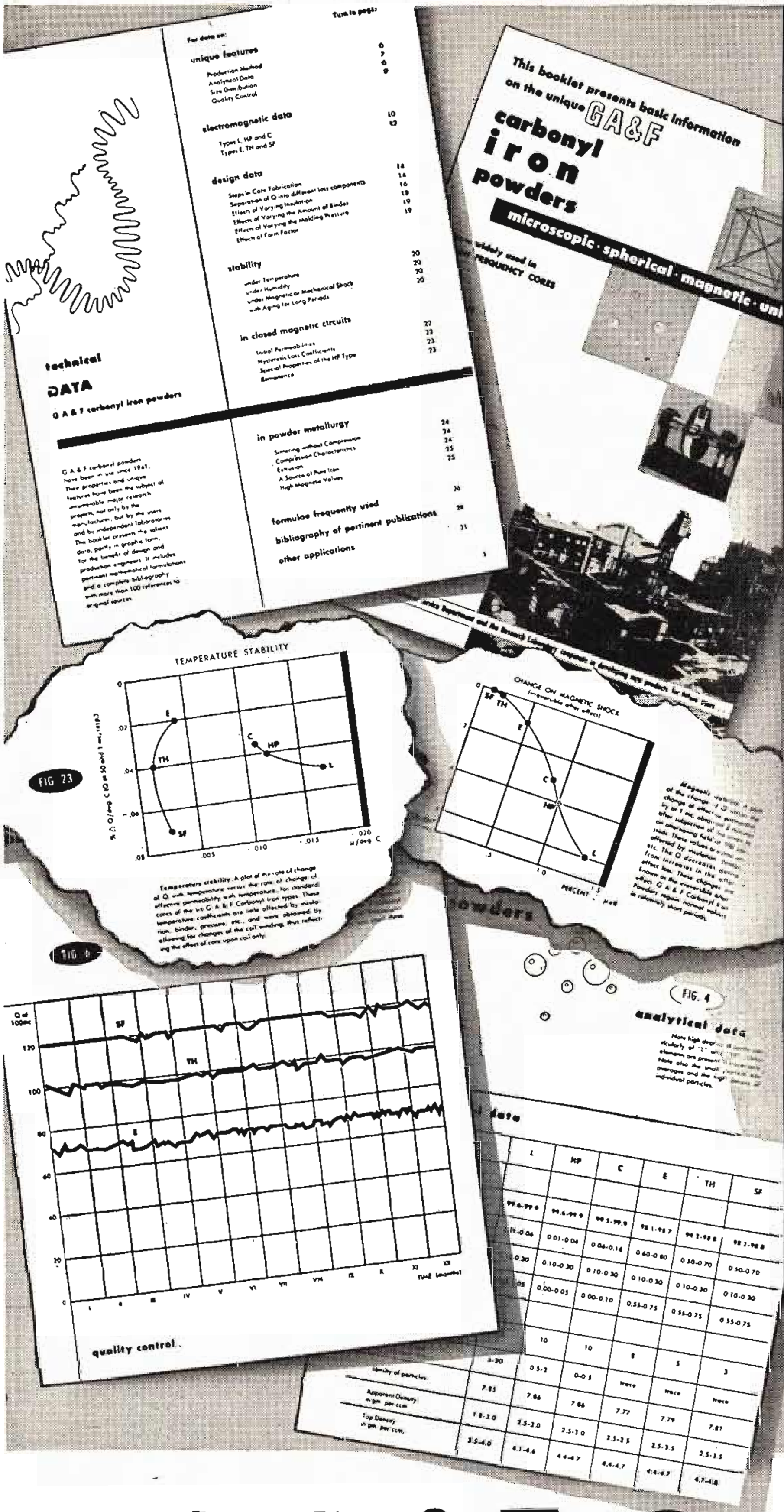

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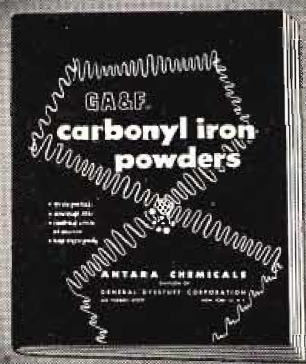

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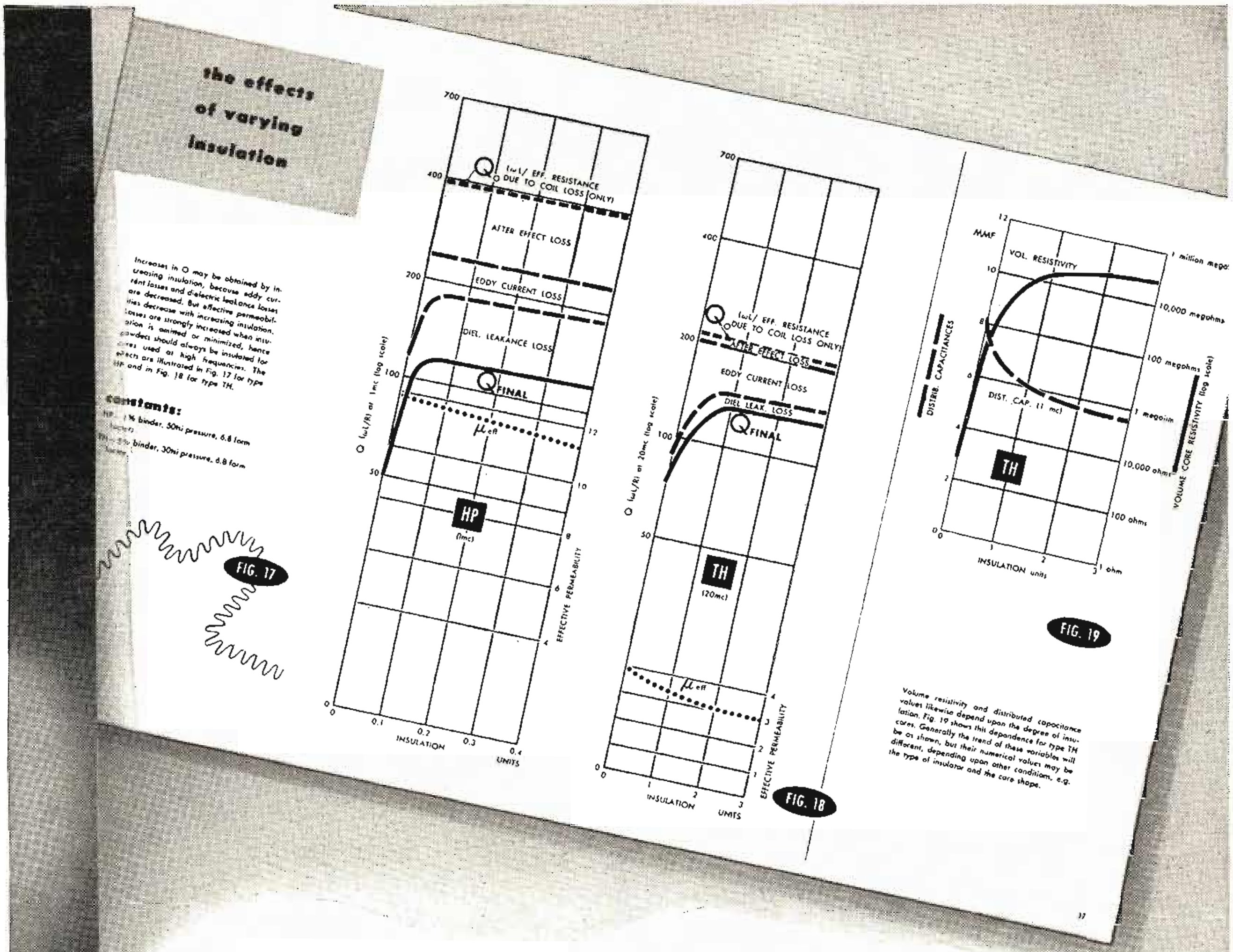

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GENERAL DYESTUFF CORPORATION

435 HUDSON STREET • NEW YORK 14, N. Y.

Iron Powders . . .

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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.

WHAT'S AHEAD FOR '52?

PRODUCTION

WHILE MILITARY radio-electronic production is expected to double, going from $2 billions in 1951 to $4 billions in 1952, civilian radio-TV output will show a reduction for the coming year, forced by shortages of materials and manpower. Estimated TV production in 1952 is 4½ million sets; radio 11 million sets, including home (AM and FM), portable and automobile receivers. The new year opens with 15¾ million TV sets in use, and should close with 20 million.

MATERIALS

METALS—In 1952 aluminum, steel and copper will be tight. Latest figures reveal that supplies of all three will fill only about 65% of original requests for first quarter of 1952. Tightest will be copper, with aluminum being used as a replacement for copper, wherever possible. Expanded uses for aluminum include drawing it for wire. Copper has already sold for as high as 60 cents a pound, whereas today's normal (what's normal?) price is near 25 cents a pound. Our steel supply will improve by 15 to 20%. Informed sources outside the government but well-placed in the steel industry state that they do not expect further NPA slashes of any size. Nickel supply will improve somewhat throughout 1952 because of new Canadian sources opening up.

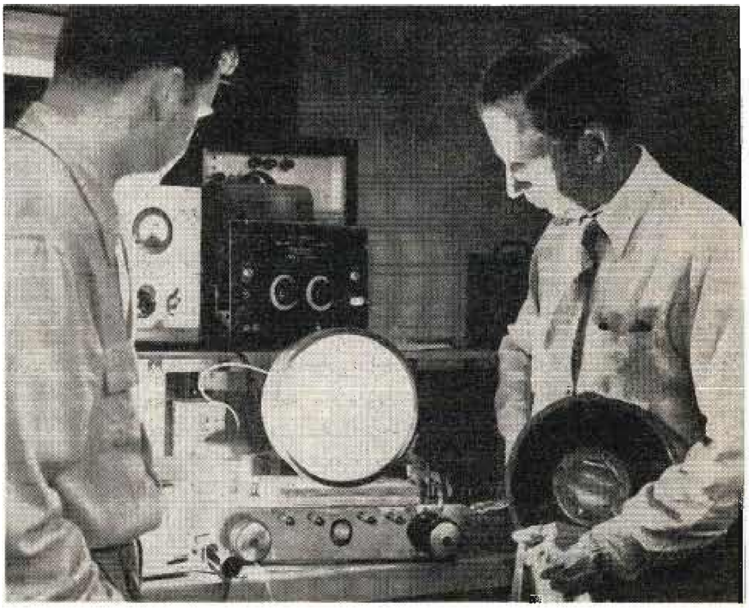
RELIABILITY

WITH 1,500 TUBES in a B-36 bomber and 10,000 tubes in an aircraft carrier, failure of any one of these can result in the failure of the mission. This points up the reason for the current attention to tube reliability programs. Add to the above figures, two tubes as spares for every tube in use and eight tubes in the supply lines, and it becomes evident that the number of tubes required by the military reach staggering proportions. Tube manufacturers insist that they can make reliable tubes but that the costs would be from three to four times greater. Meanwhile tests have shown an increase of ten times in reliability when these tubes are employed, so from a purchasing standpoint these tube types will be the ones used in military gear. It may be that because of the added costs involved in making these tubes (added inspectors at more points on the line) those sent into the civilian replacement market may also become more expensive in the near future.

TRANSISTORS

POINT-CONTACT transistors will be on a mass-production basis during 1952 and already these units display uniformity and reliability comparable to the vacuum tube. The new "junction transistor" with its advantages of high gain per stage, low noise, and extremely small power consumption (one-millionth watt) is still held back by limitations in the higher frequencies and in pulse circuits, so that considerable experimental work lies ahead. In general, however, transistors' simple construction, sturdiness, long life, low power drain, and resistance to shock and vibration make them attractive for military uses.

RECORDING TV ON TAPE



W. B. Johnson and J. T. Mullin have developed process for recording continuous television signal on magnetic tape. Present laboratory reproduction is said to be "hazy" but convincing, and commercial apparatus by Ampex, Redwood City, Cal., is promised for mid-1952. Such TV tape recording is declared to be one-tenth as costly as photographic film, and needs no processing. Tape can be erased and reused. The sound track parallels the video recording on the same tape

CALDWELL-CLEMENTS'

ANNUAL STATISTICS of the TV-

ANNUAL BILL OF U. S. FOR RADIO-TV

Sale of Time by broadcasters, 1951	$ 565,000,000
Talent Costs	150,000,000
Electricity, batteries, etc. to operate 119,000,000 radio and TV receivers	400,000,000
13,500,000 radio receivers at retail value	675,000,000
5,600,000 television receivers at retail value	2,100,000,000
Phono records 186,000,000 at retail value	200,000,000
Radio-TV servicing and installation	
84 million replacement receiving tubes	141,000,000
750,000 replacement TV picture tubes	37,500,000
Radio-TV component parts, antennas, accessories	300,000,000
Labor	350,000,000
TOTAL	$4,918,500,000

RADIO AND TV SETS IN U. S.; WORLD

January 1, 1952

United States homes with radio*	45,850,000
Secondary sets in above homes	30,400,000
Sets in business places, institutions, etc.	6,000,000
Automobile radios	21,000,000
TV Sets	15,750,000
TOTAL sets in United States	119,000,000
Total radio sets in rest of world: North America, 8,000,000; South America, 8,000,000; Europe, 64,000-000; Asia, 13,000,000; Australia, 3,500,000; Africa, 2,500,000.	99,000,000
TOTAL sets in world	218,000,000

PRODUCTION OF CIVILIAN RADIO SETS — 1922 TO 1951

	Total Civilian Radio Sets Manufactured		Total Receiving Tubes* Manufactured		Automobile Sets Manufactured		Total Radio Reception Equipment	Auto Sets in Use	Homes with Radio Sets	Total Radio Sets in Use in U. S.	At Close of
	Number	Retail Value	Number	Retail Value	Number	Retail Value	Value	Number	Number	Number	
1922	100,000	$ 5,000,000	1,000,000	$ 6,000,000	......	......	$ 60,000,000	......	260,000	400,000	1922
1923	550,000	30,000,000	4,500,000	12,000,000	......	......	151,000,000	......	1,000,000	1,100,000	1923
1924	1,500,000	100,000,000	12,000,000	36,000,000	......	......	358,000,000	......	2,500,000	3,000,000	1924
1925	2,000,000	165,000,000	20,000,000	48,000,000	......	......	430,000,000	......	3,500,000	4,000,000	1925
1926	1,750,000	200,000,000	30,000,000	58,000,000	......	......	506,000,000	......	5,000,000	5,700,000	1926
1927	1,350,000	168,000,000	41,200,000	67,300,000	......	......	425,600,000	......	6,500,000	7,000,000	1927
1928	3,281,000	400,000,000	50,200,000	110,250,000	......	......	690,550,000	......	7,500,000	8,500,000	1928
1929	4,428,000	600,000,000	69,000,000	172,500,000	......	......	842,548,000	......	9,000,000	10,500,000	1929
1930	3,827,800	300,000,000	52,000,000	119,600,000	34,000	$ 3,000,000	496,432,000	......	12,048,762	13,000,000	1930
1931	3,420,000	225,000,000	53,000,000	69,550,000	108,000	5,940,000	300,000,000	100,000	14,000,000	15,000,000	1931
1932	3,000,000	140,000,000	44,300,000	48,730,000	143,000	7,150,000	200,000,000	250,000	16,809,562	18,000,000	1932
1933	3,806,000	180,500,000	59,000,000	49,000,000	724,000	28,598,000	300,000,000	500,000	20,402,369	22,000,000	1933
1934	4,084,000	214,500,000	58,000,000	36,600,000	780,000	28,000,000	350,000,000	1,250,000	21,456,000	26,000,000	1934
1935	6,026,800	330,192,480	71,000,000	50,000,000	1,125,000	54,562,500	370,000,000	2,000,000	22,869,000	30,500,000	1935
1936	8,248,000	450,000,000	98,000,000	69,000,000	1,412,000	69,188,000	500,000,000	3,500,000	24,600,000	33,000,000	1936
1937	8,064,780	450,000,000	91,000,000	85,000,000	1,750,000	87,500,000	537,000,000	5,000,000	26,666,500	37,600,000	1937
1938	6,000,000	210,000,000	75,000,000	93,000,000	800,000	32,000,000	350,000,000	6,000,000	28,000,000	40,800,000	1938
1939	10,500,000	354,000,000	91,000,000	114,000,000	1,200,000	48,000,000	375,000,000	6,500,000	28,700,000	45,300,000	1939
1940	11,800,000	450,000,000	115,000,000	115,000,000	1,700,000	60,000,000	584,000,000	7,500,000	29,200,000	51,000,000	1940
1941	13,000,000	460,000,000	130,000,000	143,000,000	2,000,000	70,000,000	610,000,000	8,750,000	29,700,000	56,000,000	1941
1942	4,400,000	154,000,000	87,700,000	94,000,000	350,000	12,250,000	360,000,000	9,000,000	30,800,000	59,340,000	1942
1943	......	......	17,000,000	19,000,000	......	......	75,000,000	8,000,000	32,000,000	58,000,000	1943
1944	......	......	22,000,000	25,000,000	......	......	85,000,000	7,000,000	33,000,000	57,000,000	1944
1945	500,000	20,000,000	30,000,000	35,000,000	......	......	105,000,000	6,000,000	34,000,000	56,000,000	1945
1946	14,000,000	700,000,000	190,000,000	200,000,000	1,200,000	72,000,000	900,000,000	7,000,000	35,000,000	60,000,000	1946
1947	17,000,000	800,000,000	220,000,000	260,000,000	2,500,000	150,000,000	1,100,000,000	9,000,000	37,000,000	66,000,000	1947
1948	16,000,000	700,000,000	200,000,000	230,000,000	2,800,000	200,000,000	950,000,000	11,000,000	40,000,000	74,000,000	1948
1949	10,000,000	500,000,000	200,000,000	350,000,000	3,500,000	240,000,000	1,500,000,000	14,000,000	42,000,000	81,000,000	1949
1950	14,600,000	721,000,000	383,000,000	644,000,000	4,760,000	248,000,000	2,800,000,000	17,000,000	45,000,000	90,000,000	1950
1951	13,500,000	675,000,000	400,000,000	640,000,000	4,450,000	236,000,000	3,000,000,000	20,000,000	45,850,000	103,250,000	1951

*Total tubes include those used in TV. Replacements accounted for about 25% in 1951.

1951 PRODUCTION OF RADIO, RECORDS, RECORDERS, PHONOGRAPHS, TUBES, BATTERIES

RADIO BATTERIES

Total Units 19,000,000 Retail Value $ 50,000,000

HOME RECORDERS

(Wire, Tape, Disc)

Total Units 175,000 Retail Value $ 31,500,000

PHONOGRAPHS

(Players; Combinations)

Total Units 4,000,000

RECEIVING TUBES

Total Units 400,000,000 Retail Value $640,000,000

PHONOGRAPH RECORDS

Total Units 186,000,000 Retail Value $200,000,000

TV CATHODE RAY TUBES

Total Units 6,000,000 Retail Value $300,000,000

*Note: Caldwell-Clements' figure on "homes" includes every dwelling unit, whether individual or family, and includes permanent residents in hotels, apartment-hotels, and apartment houses.

RADIO-ELECTRONIC INDUSTRIES

PRODUCTION OF TELEVISION SETS 1946-1951

	Total TV Sets Manufactured		Receiving Tubes Used in New TV Sets and for Replacement		Total TV Picture Tubes Manufactured		Total Receiving Sets Manufactured AM—FM—TV	TV Stations on Air	Homes With TV Sets	Total TV Sets in Use in U.S.	At Close of
	Number	Retail Value	Number	Retail Value	Number	Retail Value					
1946	10,000	$ 5,000,000	350,000	$ 588,000	20,000	$ 100,000	14,010,000	5	8,000	8,000	1946
1947	250,000	100,000,000	8,500,000	15,000,000	300,000	150,000	17,250,000	20	250,000	250,000	1947
1948	1,000,000	350,000,000	32,200,000	53,000,000	1,500,000	75,000,000	17,000,000	44	1,000,000	1,000,000	1948
1949	3,000,000	950,000,000	87,000,000	146,000,000	3,500,000	210,000,000	13,000,000	100	4,000,000	4,000,000	1949
1950	7,500,000	2,700,000,000	225,000,000	378,000,000	8,000,000	400,000,000	22,100,000	107	10,400,000	10,500,000	1950
1951	5,600,000	2,100,000,000	161,000,000	270,000,000	6,000,000	300,000,000	19,100,000	108	15,500,000	15,750,000	1951

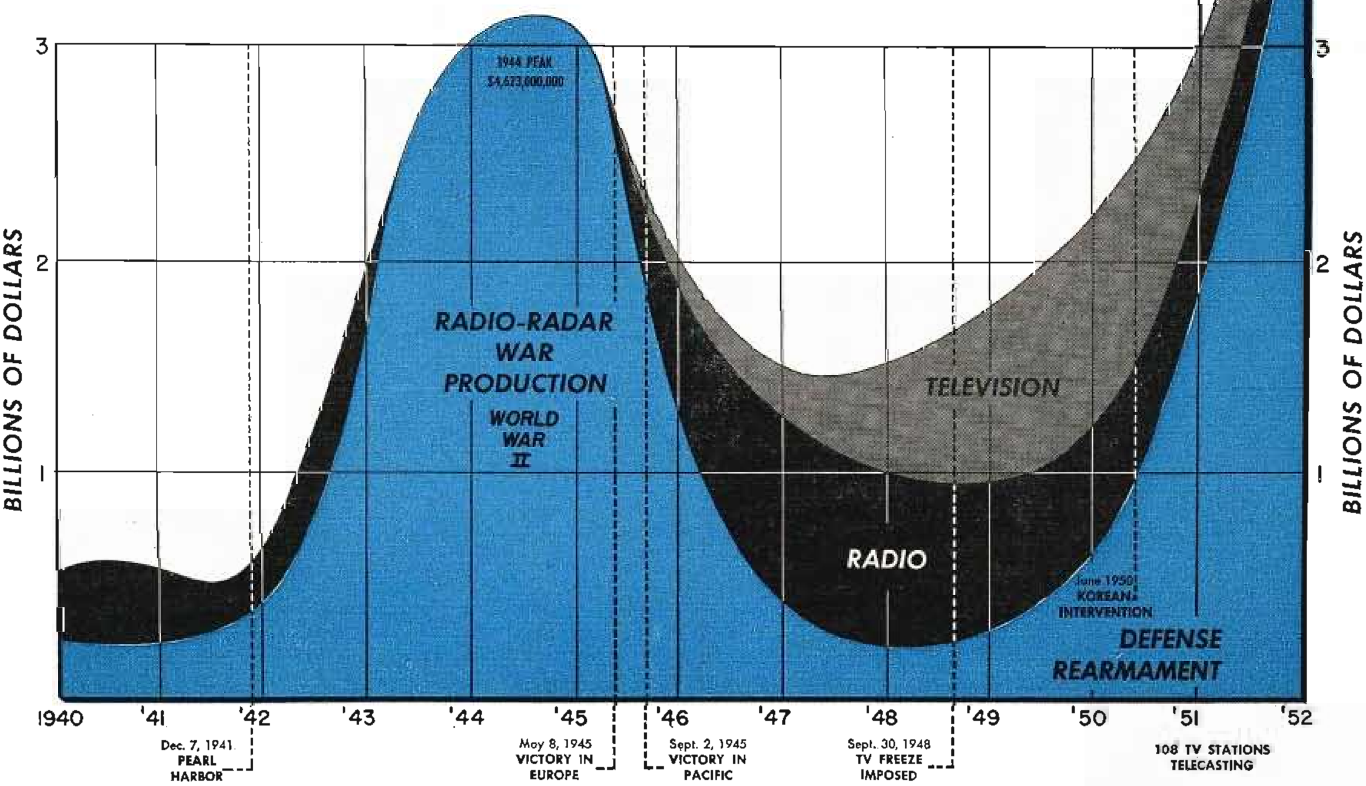
THE RADIO-TELEVISION-ELECTRONIC INDUSTRY

Data Covers Year Ended December 31, 1951	Total Investment	Annual Gross Revenue	Number of Employees	Annual Payroll
Radio and TV manufacturers (1600)	$ 200,000,000	$3,000,000,000	275,000	$ 550,000,000
Radio and TV distributors, dealers, etc.	500,000,000	3,000,000,000	200,000	650,000,000
Broadcasting stations (3100), including talent costs	175,000,000	615,000,000	*40,000	275,000,000
Commercial communication stations	100,000,000	....	20,000	75,000,000
Listeners' radio and TV sets in use (119,000,000) ...	10,000,000,000	....	......	†1,250,000,000

* Regular staff — not including part-time employes, artists, etc., who number at least 40,000 more.
† Annual operating expense for listeners' sets, for tube replacements, electricity, servicing, etc.

1952 RADIO INDUSTRY OUTPUT WILL FAR EXCEED WORLD WAR II PEAK

These curves show (1) pre-war scale of home radio production, (2) tremendous rise of military production during war years—with erasure of civilian radio, (3) sudden cutback of military radio after V-J day with resumption of civilian radio, (4) rising volume of TV output with contraction of radio, (5) recent and future increases in military and defense production. In 1944-45, output of industry was 4.6 billion dollars. That figure, however, includes production from plants not normally engaged in radio manufacture. The 1952 peak will reach $5½ billions,—made up of $4 billion military, and $1½ billions civilian output.



U. S. CONSUMPTION OF CRITICAL RAW MATERIALS

Material	1946		1947		1948		1949		1950		1951	
	Quantity (tons)	Est. Dollar Value	Quantity (tons)	Est. Dollar Value	Quantity (tons)	Est. Dollar Value	Quantity (tons)	Est. Dollar Value	Quantity (tons)	Est. Dollar Value	Est. Quantity (tons)	Est. Dollar Value
METALS												
Aluminum	409,630	115,812*	571,750	161,626*	623,456	180,755*	603,462	181,000*	718,622	238,200*	842,000	331,013*
Cobalt	2,053	6,780*	2,083	6,880*	2,525	8,660*	2,301	8,100*	4,142	14,105*	4,785	21,533*
Copper	1,797*	604,600*	1,789*	762,400*	1,719*	767,700*	1,825*	593,900*	1,108*	437,155*	1,066*	525,350*
Iron	70,843*	215,006*	93,092*	320,805*	101,004*	394,461*	84,938*	332,000*	120,000*	491,155*	126,000*	531,720*
Lead	956,476	7,750*	1,172*	17,200*	1,134*	20,400*	1,087*	17,400*	829,752	21,961*	800,156	31,206*
Nickel	80,015	53,400*	80,757*	56,500*	93,558	69,200*	94,022	70,320*	99,022	95,479*	156,700	148,700*
Tungsten	3,229	81,000	3,906	91,009	4,427	110,000	2,479	62,000	3,050	76,200	2,262	98,000
PLASTICS												
Cellulose	41,500	41,500*	29,500	29,500*	24,500	24,500*	28,000	28,000*	40,920	41,000*	53,500	53,500
Phenolic	70,000	28,000*	69,500	28,000*	85,000	34,000*	66,000*	26,000*	91,500	45,750*	176,500	87,250
Polyethylene									30,850	31,000*	36,614	40,000
Polystyrene	33,500	23,400*	47,500	40,200*	73,500	51,500*	91,500	64,200*	135,000	115,000*	131,500	126,550
Vinyl	30,500	33,300*	36,500	33,200*	37,000	40,700*	40,500	44,500*	57,000	62,000*	65,400	73,000

* Multiply figure by 1000 (Tons shown are short tons)

PRODUCTION OF PRINCIPAL COMPONENTS USED IN RADIO-TV RECEIVERS

Year	Coils, Transformers (Iron-Core)	Coils, Transformers (Air-Core)	Capacitors, (Electrolytic)	Capacitors, (Mica-Fixed)	Capacitors, (Ceramic-Fixed)	Capacitors, (Tubular)	Resistors, (Composition)	Resistors, (Wire Wound)	Loudspeakers	Year
1946	28	126	28	57	170	155	477	29	14	1946
1947	44	163	35	70	209	196	608	37	17	1947
1948	22	169	36	71	214	212	654	42	17	1948
1949	24	165	32	61	186	218	670	50	13	1949
1950	43	280	58	88	280	351	1090	70	22	1950
1951	37	234	50	75	236	284	862	59	19	1951

Figures shown are in millions of units

Television Receivers in Use, by Market Areas as of January 1, 1952

These figures are based on the population living within the 0.1 millivolt contour, which has been revised and expanded in accordance with the recent increoses in Effective Radiated Power granted a number of the TV stations.

City	Families	Sets Installed	% Saturation	Number of Stations
Ames, Iowa	212,000	71,600	34%	1
Atlanta	337,500	145,100	43%	3
Baltimore	461,000	365,000	79%	3
Binghamton, N. Y.	912,000	48,600	53%	1
Birmingham	274,000	81,500	30%	2
Bloomington, Ind.	49,300	19,100	39%	1
Boston	1,084,000	870,000	80%	2
Buffalo	309,400	252,000	81%	1
Charlotte, N. C.	330,800	105,300	32%	1
Chicago	1,809,000	1,100,000	61%	4
Cincinnati	468,000	310,000	66%	3
Cleveland	872,000	570,000	65%	3
Columbus	354,300	189,900	54%	3
Davenport, Iowa	222,200	80,300	36%	2
Dayton	275,500	164,900	60%	2
Detroit	983,500	605,000	62%	3
Erie, Pa.	92,000	59,900	65%	1
Grand Rapids, Mich.	194,500	85,650	44%	1
Greensboro, N. C.	162,100	81,400	50%	1
Huntington, W. Va.	203,500	64,400	32%	1
Indianapolis	423,000	184,100	44%	1
Jacksonville	113,800	45,550	40%	1
Johnstown, Pa.	336,200	130,100	39%	1
Kalamazoo, Mich.	166,600	59,700	36%	1
Kansas City, Mo.	471,900	170,000	36%	1
Lancaster, Pa.	234,000	126,900	54%	1
Lansing	206,900	72,600	35%	1
Los Angeles	1,666,000	1,130,000	68%	7
Louisville	278,000	120,300	43%	2
Memphis	269,900	112,800	42%	1
Milwaukee	373,600	300,000	80%	1
Minneapolis	452,900	300,000	66%	2
Nashville	222,000	47,000	21%	1
New Haven	515,400	201,000	39%	1
New York	4,219,000	2,840,000	67%	7
Norfolk	204,200	94,400	46%	1
Omaha	236,000	104,800	44%	2
Philadelphia	1,458,000	1,010,000	69%	3
Pittsburgh	729,200	366,000	50%	1
Providence	406,100	184,000	45%	1
Richmond	145,000	100,000	69%	1
Rochester, N. Y.	235,000	100,900	43%	1
Salt Lake City	83,700	64,200	77%	2
San Diego	197,700	117,100	59%	1
San Francisco	1,055,000	290,300	28%	3
Schenectady	322,500	196,000	61%	1
St. Louis	567,700	352,000	62%	1
Syracuse	222,200	155,000	70%	2
Toledo	300,100	136,000	45%	1
Utica	134,900	61,000	45%	1
Washington, D. C.	450,600	325,000	72%	4
Wilmington, Del.	147,000	91,200	62%	1

NON-INTERCONNECTED CITIES

City	Families	Sets Installed	% Saturation	Number of Stations
Albuquerque	133,100	12,100	9%	1
Dallas, Ft. Worth	400,000	153,000	38%	3
Houston	307,500	107,000	35%	1
Miami	167,800	84,600	50%	1
New Orleans	257,700	73,450	28%	1
Oklahoma City	259,500	100,000	39%	1
Phoenix	89,600	42,100	47%	1
San Antonio	157,000	60,450	38%	2
Seattle	425,400	165,000	67%	1
Tulsa	152,500	84,000	55%	1
Brownsville, Texas (Matamoros, Mexico)	20,000	10,700	5%	

Total Stations	108	Total TV Sets	15,750,000
Total Families	28,000,000	Average Saturation	56%

STATISTICS of the U.S., WORLD

SOUND RECORDING

In 1951 Radio & TV used:

800 million feet magnetic tape — Appr. cost $2,250,000

4 million transcription discs (all types) — Appr. cost $10,400,000

In 1950 Radio & TV used:

400 million feet magnetic tape — Appr. cost $1,200,000

3.5 million transcription discs (all types) — Appr. cost $8,750,000

In 1950 TV used:

300 million feet of 16 mm film — Appr. cost $12,000,000

3 million feet of 35 mm film — Appr. cost $200,000

All TV broadcast stations used 16 mm projectors

Appr. 30 TV stations used 35 mm projectors

MOTION PICTURE FILM

In 1951 TV used:

400 million feet of 16 mm film — Appr. cost $20,000,000

4 million feet of 35 mm film — Appr. cost $300,000

All TV broadcast stations use 16 mm projectors

Appr. 35 TV stations use 35 mm projectors

LICENSED TELEVISION and RADIO STATIONS

Total Television Stations Operating 108

Population Served by TV Programs.................. 95 million people

Total FM Stations Operating 631

Total AM Broadcast Stations Operating........ 2,290

Total special service stations: marine, aeronautic, railroad, industrial, public safety, mobile, etc. 400,000

Radio Operators Licensed.................... 760,000

Amateur Stations 99,000

FOREIGN TELEVISION BROADCASTING

LOCATION	CALL LETTERS	STATUS	OWNER/LICENSEE	CHANNEL	ERP (KW)	STANDARDS Lines Frames
ARGENTINA (Est. recvrs.—12,000)						
Buenos Aires	LR3	on air	Radio Belgrano	7	45	625-25
Buenos Aires	—	pending	—	3	5*	625-25
Buenos Aires	LR1	pending	Radio El Mundo	5	5*	625-25
AUSTRALIA						
Sydney	—	pending	bandwidth 7.5 mc. 181.5-204 mc.	—	5*	625-25
BRAZIL[1] (Est. recvrs.—16,000)						
Sao Paulo	PRF-3TV	on air	Emissoras Associadas	3	15	525-30
Sao Paulo	—	on air	Radio Televista Paulista	5	15	525-30
Sao Paulo	—	purchased	Radio Sao Paulo	—	5*	525-30
Rio de Janeiro	PRG-3TV	on air	Radio Tupi Emissoras Associadas	6	21	625-25
Rio de Janeiro	—	pending	Radio Taboio	10	5*	625-25
Rio de Janeiro	—	purchased	Radio Rio	10	5*	625-25
Belo Horizonte	—	purchased	Emissoras Associadas	—	5*	625-25
Porte Allegre	—	pending	Emissoras Associadas	—	—	625-25
CUBA (Est. recvrs.—30,000)						
Havana	CMUR-TV	on air	Union Radio, S.A.	4	15	525-30
Havana	CMQ-TV	on air	Circuito CMQ	6	15	525-30
Havana	—	purchased		2	5*	525-30
Santa Clara	—	purchased	Circuito CMQ	5	5*	525-30
Santa Clara	—	pending	Telenews/ Sr. Manuel Alonso	—	—	525-30
Santiago	—	purchased	Circuito CMQ	2	5*	525-30
Santiago	—	purchased	Cadena Oriental de Radio-Sr. Serra	7	5*	525-30
Camaguey	—	purchased	Circuito CMQ	6	.5*	525-30
Holguin	—	pending	Circuito CMQ	5	5*	525-30
Mantanzas	—	purchased	Circuito CMQ	9	.5*	525-30
Pinar Del Rio	—	pending		—	.5*	525-30
MEXICO[2] (Est. recvrs.—5,500)						
Mexico City	XHTV	on air	Television de Mexico, S.A.	4	15	525-30
Mexico City	XEW-TV	on air	Cadena Radiodiffusora Mexicana	2	15	525-30
Mexico City	XEQ-TV	purchased	Radio Panamericana	9	—	525-30
Mexico City	XHGC	purchased	Sr. Camarena	5	.5	525-30
Matamoros	XELD	on air	Compania Mexicana de Television	7	2.8	525-30
Mexicali	XEAZ-TV	purchased	F. Sanchez Mayans	6	5*	525-30
Mexicali	XED-TV	pending		4	—	525-30
CANADA[3] (Est. recvrs.—75,000)						
Montreal	—	purchased	Canadian Broadcasting Co.	6	5*	525-30
Montreal	—	purchased	Canadian Broadcasting Co.	2	—	525-30
Toronto	—	purchased	Canadian Broadcasting Co.	9	26	525-30
CZECHOSLOVAKIA	—	exper.			1*	625-25
DENMARK						
Copenhagen	—	exper.	62.5-67.5 mc.	—	.5*	625-25
FRANCE (Est. recvrs.—35,000)						
Paris	—	exper.	Radiodifusion Francaise	(A)	30*	441-25
Paris	—	on air	Radiodifusion Francaise	(B)	3	819-25
Lille	—	on air	Radiodifusion Francaise	(B)	.3*	819-25
Bordeaux	—	pending	Radiodifusion Francaise	(C)	30*	819-25
Marseilles	—	pending	Radiodifusion Francaise	(D)	30*	819-25
Nice	—	pending	Radiodifusion Francaise	(C)	30*	819-25
Toulouse	—	pending	Radiodifusion Francaise	(D)	30*	819-25
Lyons	—	purchased	Radiodifusion Francaise	(C)	30*	819-25
Strasbourg	—	purchased	Radiodifusion Francaise	(D)	30*	819-25

(Continued on page 108)

USSR Moscow, Leningrad, Kharkov, exper. stations. Also plan installations later in Kiev, Stalingrad, Sverdlovski, and other cities.

Note 1—Brazil also contemplates stations for Roseria, Cordoba, and Mendoza.

Note 2—Mexico has applications in addition for Guadalajara, Guanajunto, Monterery (Ch. 2), Tampico, Tiajuana and Vera Cruz.

Note 3—Additional planned stations in Toronto, Montreal, Windsor, Ottowa, Canada, and New Westminster, B.C.

Frequency, in mc:

(A) 42-46	(D) 54.5-59	(G) 174-216	(J) 48.25-51.75	(M) 62.25-67.75	(P) 51-56
(B) 174.1-185.25	(E) 63-66	(H) 48.25-53.75	(K) 53.25-56.75	(N) 42-47	(Q) 107
(C) 63-68	(F) 189-184	(I) 41.5-45	(L) 58.25-61.75	(O) 60-65	

* Power output transmitter.

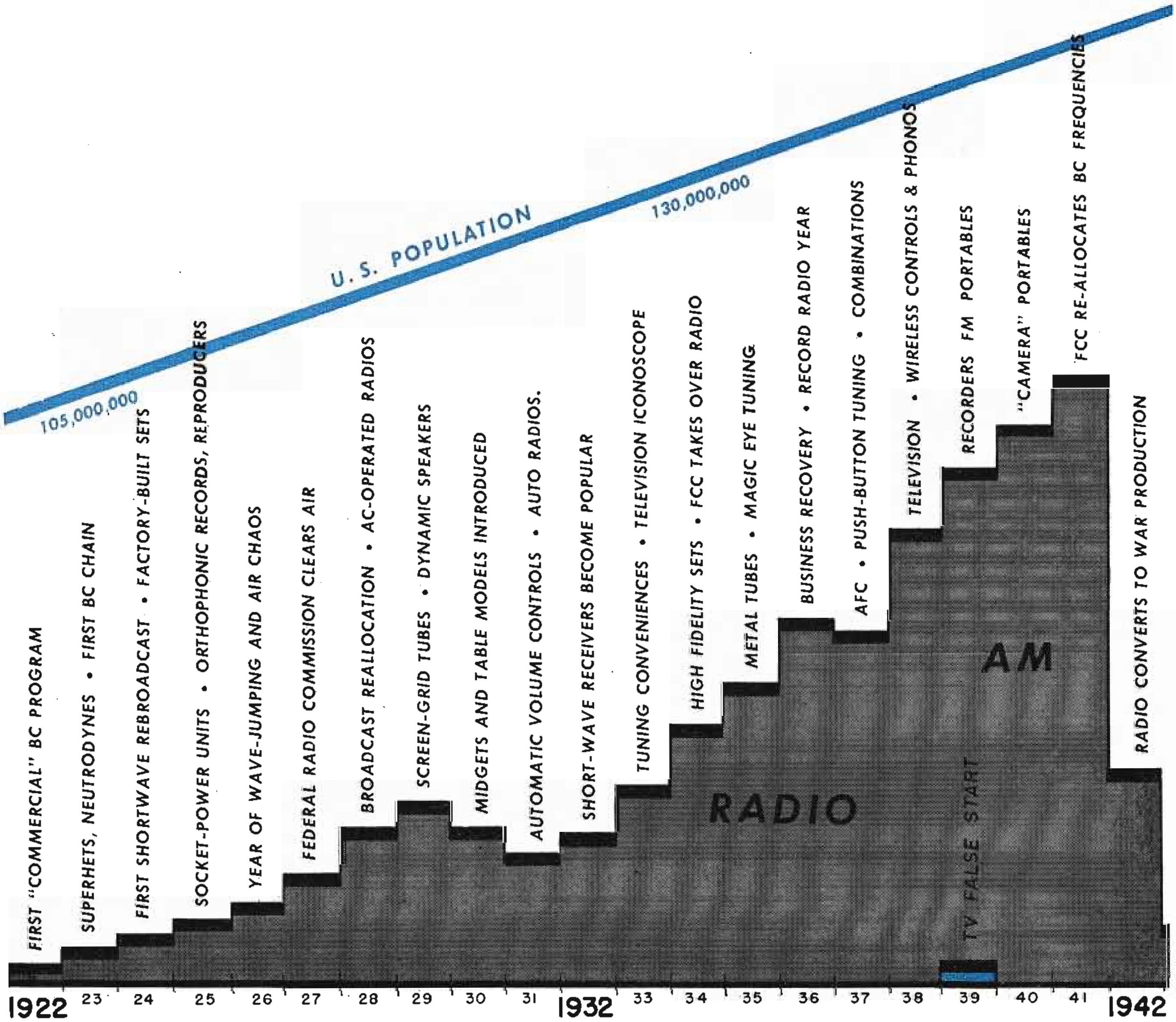
Milestones of 30 Years of Radio-

And Some Conjectures on What May Happen

SOME 30-YEAR TOTALS FOR RADIO-TV

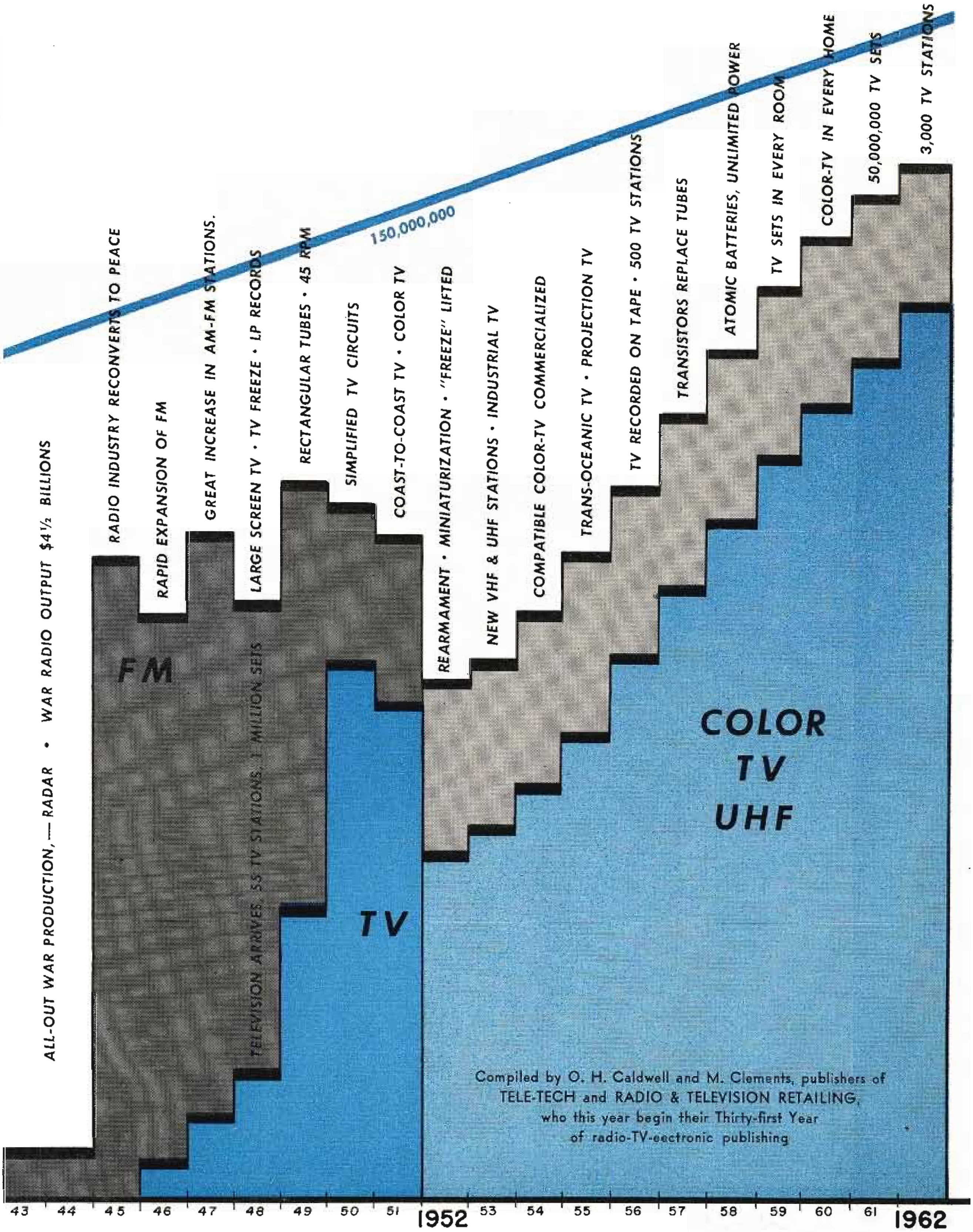
Radio Sets Built 1922-1951, inclusive	190,000,000 sets
Total Value at Retail	$12,000,000,000
Television Sets Built to date	16,500,000 sets
Total Value at Retail	$ 4,000,000,000
Tubes Made to date	3,000,000,000
Total Value at Retail	$4,500,000,000
Total Civilian Output of Radio-TV Industry, 1922-1951, inclusive	$20,000,000,000

Note: In chart below, height of column for each year is proportional to the total dollar value of the civilian radio and/or television production for that year



TV Development—1922-1951

in the Coming Decade, 1952-1962



Cold-Cathode Tubes and their Application to

Absence of heater-power and warm-up requirements; reduction in heat dissipation; tion. Ability to install tubes in remote locations reduces auxiliary equipment

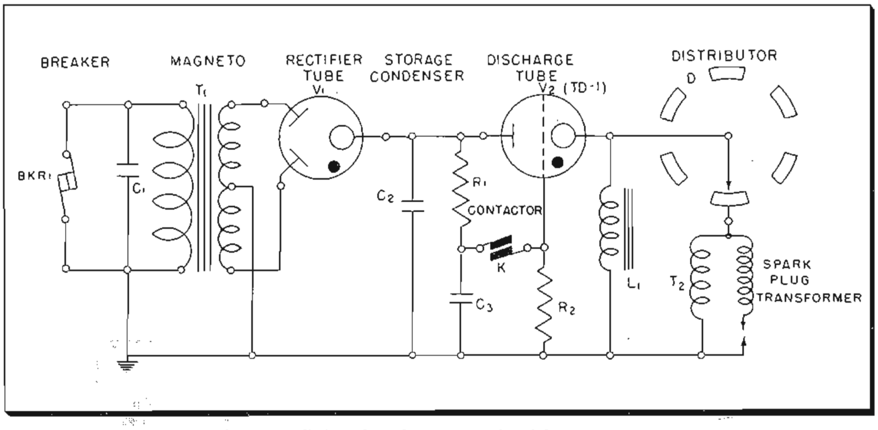


Fig. 1: Scintilla electronic ignition system

Fig. 2: Cross-sectional view and physical appearance of TD-1 discharge tube

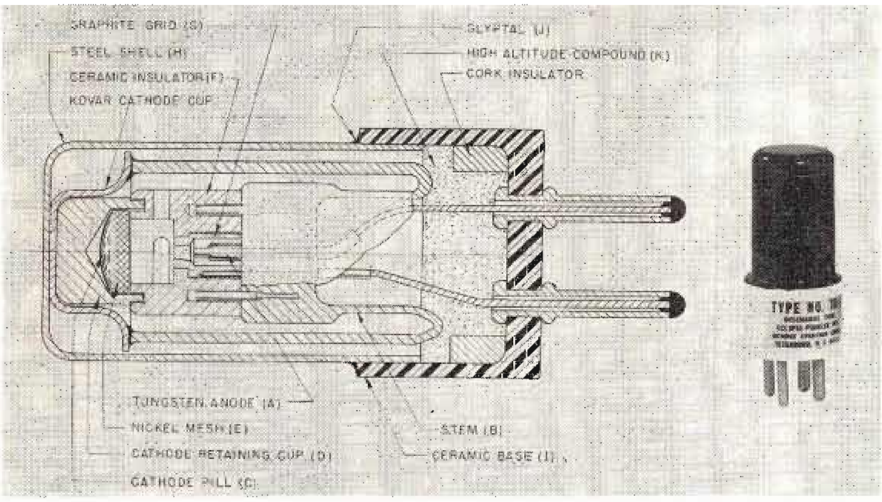
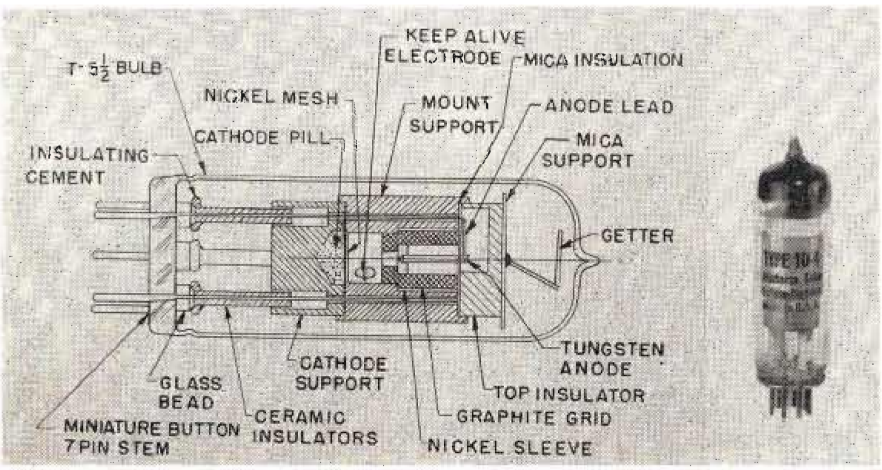


Fig. 3: Cross sectional view and appearance of TD-4 and TD-5 miniature types



By MAYNARD A. BABB
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Eclipse Pioneer Division
Bendix Aviation Corp., Teterboro, N. J.

THE special, exacting requirements of airborne electronic equipment, and their dependence on tubes, caused the Eclipse-Pioneer Div. of Bendix Aviation Corp. to develop and manufacture cold cathode gas tubes as one of the means of solving some of the problems so intimately familiar to aircraft instrument and accessory manufacturers.

Cold cathode gas tubes have inherent characteristics which make them particularly desirable for airborne equipment. These features include:

1. No heater power required.
2. No warm-up time required.
3. Tube heat dissipation reduced.
4. More rugged designs possible.
5. Adaptable to miniaturization.

The fact that cold cathode tubes require no heater power eliminates the necessity of generating the power normally consumed by the heater. In turn, this often eliminates the weight and volume of filament transformers, and eliminates the filament lead wires, thus making the tube more adaptable for remote mounting. In practice, they have even been mounted directly on an aircraft engine.

Freedom from warm-up time is important in airborne applications where electronic apparatus must be ready at all times for instantaneous operation. With hot cathode type tubes, this can be met only by supplying stand-by power to keep the filament hot. Cold cathode tubes start instantly without this obvious waste of power and power generating capacity.

The amount of heat which must be dissipated in equipment is also greatly reduced where cold cathode tubes are used. Airborne equipment must be small, compact, and sometimes potted or hermetically sealed and consequently this reduction is very important. With hot cathode

Airborne Electronic Equipment

permit rugged designs more adaptable to miniaturiza-requirements and simplifies internal wiring of aircraft

tubes about 70% of the heat generated is caused by the heater.

The ruggedness and reliability of design are inherent in the structure of cold cathode tubes. Heater burnouts, heater-cathode shorts, long brittle filaments, or chipped emission coatings are eliminated. The grids are usually simple rugged structures, as contrasted to the conventional flimsy wound wire types. The simple internal structure, and the lack of heater leads simplifying the stem structure, makes the tubes readily adaptable for miniaturization.

An example of the application of cold cathode tubes in aircraft may be found in the Scintilla Magneto Division's development of a high frequency electronic ignition system. This system will fire spark plugs even when their points have become shunted with a relatively low resistance such as occurs when plugs become fouled, loaded, or carbonized. This shunting can also be caused by leakage due to moisture, acids or oxides, or to the lowered flash-over resistance at high altitudes. The system utilizes the extremely short, high frequency discharge of a condenser to provide the ignition current. It has been found capable of firing plugs that have twenty times the leakage that could normally be tolerated in a conventional system.

TABLE I

RATINGS

Heater Voltage	None
Max. Plate Voltage	2000 volts
Max. Average Current	90 ma.
Max. Peak Current	100 amps.
Tube Voltage Drop	100 volts (Approx.)
Max. Frequency	500 p.p.s.
Min. Trigger Voltage	150 volts

PHYSICAL CHARACTERISTICS

Base	4-pin ceramic
Envelope	Mt-8
Max. Overall Length	2.917 in.
Max. Seated Height	2.281 in.
Max. Diameter	1 3/16 in.
Mounting Position	any
Ambient Temperature	67° to + 165°F
Max. Altitude	65,000 ft.

TABLE II

	A	B	C
Anode Voltage, Maximum Volts	300	1000	1000
Peak Anode Current, Amperes	10	10	10
Average Current, Max. Milliamperes	12	50	12
Repetition Rate, Max.	1000	1000	1000
Duty, Max.	0.0012	0.0024	0.0012
Pulse Width, Max. Microseconds	6	6	6
Time Jitter, Max. Microseconds	0.01	0.01	0.01
Life Hours, Min.	10	50	500
Trigger Voltage, Max. Volts	250	250	250
Ambient Temperature, Minus 40°C to Plus 90°C			
Bulb and Base, Miniature—7 Pin			

Rectified Output

Instead of coupling the magneto output directly to a spark plug, it is first rectified by cold cathode rectifier tube V_1 (Fig. 1). The rectified output is then stored in condenser C_2. The TD-1 cold cathode gaseous discharge tube serves as a switch. It first permits the storage condenser C_1 to storage fully. At the proper moment in the engine timing sequence, it discharges the condenser, furnishing the high frequency components that are stepped up by a transformer mounted directly in the spark plug. The discharge of the TD-1 is triggered by the positive charge on C_3, applied to the grid of the tube by contactor K, which is operated mechanically by the magneto. This discharges the condenser through the tube and fires the spark plug.

The type TD-1 tube developed to meet this application is shown in Fig. 2 together with a cross-section drawing showing its internal construction. This tube, with the magneto and associated circuitry, was mounted directly on the engine of the plane, thus comprising an independent power unit.

This mounting requirement virtually eliminated the possibility of a heater cathode type tube, since heater power was not available from the magneto output due to its poor regulation and its inability to furnish "stand-by" power. Further, to run filament leads from elsewhere in the aircraft would have prevented the aircraft engine from being a completely integral unit. Since in this application, the tube is required to

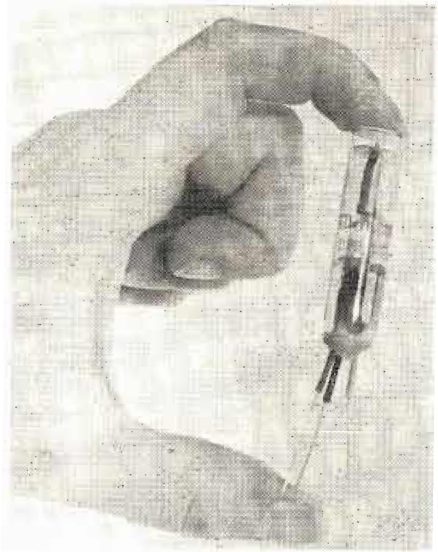

Fig. 4: Type TD-7 cold cathode gaseous triode glow discharge tube

instantaneously discharge the storage condenser, it was found necessary for the cathode to be capable of furnishing a peak current of approximately 90 amperes. The caesium chloride aluminum mixture, which comprises the cathode, liberates free caesium under the action of the cathode spot. Due to the low work function of caesium, sufficient thermionic emission can be obtained at a relatively low temperature to sustain an arc without damage to the cathode. It is interesting to note that a hot cathode tube capable of delivering this peak current requires a heater power of over 30 watts.

The location of the TD-1, directly on the aircraft engine, required that it withstand extreme shock and vibration in all planes. As now designed, the tube will withstand shocks in excess of 500 g's and continuous vibration at 30 cps, 0.04 inch amplitude. Consideration of the structure of the tube as shown in Fig. 2 indicates the features incorporated in its design which contributes to this ruggedness.

Three Electrodes

The tube consists of three electrodes — anode, cathode, and grid. Filling the tube with Helium, makes its performance independent of temperature variation. The Tungsten anode (A) is integral with the glass press type stem (B) and thus derives its support therefrom. The cathode pill (C) is pressed into the cathode retaining cup (D) beneath nickel mesh (E). The ceramic insulator (F) serves as the central support member of the tube, acting not only as electrical insulation between the tube elements, but also giving rigidity to the structure and establishing the spacing between the elements.

The ceramic insulator is suported vertically between the stem and the cathode retaining cup, and is supported laterally by the stem leads at its base and by the cathode retaining cup at its upper end. The graphite grid (G) is similarly supported in all directions by the ceramic insulator and the stem.

Surrounding the tube envelope is a steel shell (H), affording extra protection, and terminating in a four pin Steatite base (I). This base prevents electrical leakage between the pins due to moisture absorption common to conventional phenolic bases. Glyptal (J) is applied to the junction of the base and the steel shell, to prevent the entrance of moisture within the base, and finally a plastic insulating compound (K) fills the internal volume of the base, surrounding the leads to prevent corona discharges from occurring between the leads at the low atmospheric pressure of high altitudes.

While the TD-1 was initially developed for use in association with aircraft piston-driven engines, it has subsequently been found applicable to jet ignition systems. It is presently being used in the Scintilla TEN jet ignition system now in production. In conjunction with a totally enclosed spark gap, the TG-2 and associated circuits, it produces the high frequency, high voltage impulse across the ignition gap required to assure breakdown. In this case, after breakdown of the ignition gap, the long hot spark is furnished by the discharge of a condenser charged to 600 volts.

The electrical and physical characteristics of the TD-1 are shown in Table I. This rugged, stable tube, capable of passing high peak currents at high repetition rates should find many applications in pulsing and control circuits. The success of the TD-1 led to attempting the development of a miniature tube having similar electrical characteristics for the Army Signal Corps. This tube was to be suitable for use in airborne pulsed modulator applications, and was to be contained in a T-5½ miniature 7-pin envelope with no topcap connection.

Electrical Requirements

The electrical requirements were rather stringent, the time jitter requirement being particularly severe. Time jitter is the term designating the variation in the interval between grid and anode breakdown. A summary of the objectives of this development appears in Table II. To attain these objectives, two tubes were developed; the TD-4, operating at 300 anode volts and conforming to requirements "A", and the TD-5 operating at 1000 anode volts and conforming to requirements "B" and "C". Physically, the tubes are essentially the same and appear as indicated in Fig. 3.

These tubes were to be triggered by the approximately 5 microsecond pulse normally available from a multivibrator or blocking oscillator circuit. Cold cathode tubes of this type cannot readily be fired with pulse widths of this short duration. Thus it was found necessary to include a keep-alive electrode in the tube to provide a source of ions sufficient to permit breakdown with the trigger pulse available. Since the keep-alive draws only several microamperes at about 250 volts, d.c., this may readily be tapped off the anode voltage supply.

Another tube now being produced is designated as the TD-7. This is a small cold cathode gas triode glow discharge tube that conforms fully to the requirements of JAN-1A-395A, as well as meeting special leakage and matching requirements. Fig. 4 shows a photograph of this tube. As can be seen from Table III, this tube has a low grid firing voltage and low transfer current, making it particularly suitable for aircraft installations requiring a sensitive electrical relay that may be easily triggered by a small signal. Other features of this tube include the fact that its flexible tinned leads permit it to be soldered directly into a circuit, furnishing a secure mounting and further, the tube is designed and tested to withstand an acceleration of 1000 g's. Applications are to be found in voltage regulators, relaxation oscillators, relays, and in control and switching circuits.

TABLE III

PHYSICAL CHARACTERISTICS

Base	Three color-coded, insulated leads which permit soldering of the tube directly into the circuit
Bulb Diameter	0.500 in. (max.)
Bulb Length	1.875 in. (max.)
Lead Length	1.375 in. (max.)
Lead Colors—	
Cathode	Yellow
Anode	Black
Grid	Red
Mechanical shock will withstand A1000G acceleration	
Mounting Position	Any

RATINGS

Heater Voltage	None
Grid Breakdown Voltage	75 Volts D-C Nom.
Grid Stability	±2 Volts (no ionization for 24 hours, and immediately after ionization)
Grid Voltage Drop	70 Volts D-C (Max.)
Peak Cathode Current	35 MA.
Average Cathode Current Max. Averaging-Time 1 Sec.	13 MA.
Transfer Current (Anode at 130 Volts)	3 Microamps. (Nom.)
Insulation	2800 Megohms Min.
Ambient Temperature Limits	—40° to +60°C.
Tube Illumination	5 to 150 Lumens/Sq.Ft.

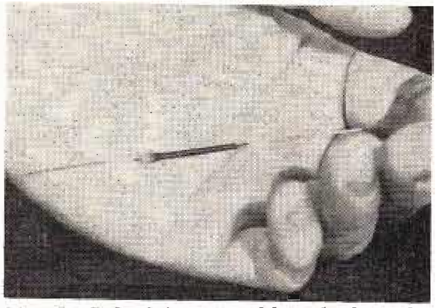

Fig. 5: Subminiature cold cathode voltage regulator tube now in development

The type TD-8, high-voltage, Cold-Cathode, half-wave rectifier tube, now under development, should also find considerable application in the aircraft industry. This tube is to have a peak inverse voltage in excess of 3000 volts and a forward voltage of 500 volts. The forward current is to be about 10 milliamperes d-c. The tube is to be in a T-5½ envelope and will have tinned, flexible leads to permit soldering directly into the circuit. This tube will be particularly suited to small, high voltage, low current supplies as, for example, a battery-operated unit in which a mechanical vibrator is used to generate the high alternating voltage which is then rectified by the TD-8. In applications in which extremely high voltages are used, a number of these tubes may readily be connected in series.

Development has begun on a subminiature voltage regulator tube. A photograph of the prototype of this tube appears in Fig. 5. This tube is to serve as a voltage regulator at 140V d-c, drawing a maximum current of 400 microamperes.

As can be seen from this photograph, the tinned electrode leads emerge from opposite ends of the ⅛ in. O.D. by 1¼ in. long metal envelope. The size and shape of the tube combined with the lead arrangement permit the tube to be soldered directly to a terminal board in the same manner conventionally used for small condensers and resistors.

Rating Communication Systems by db Method

A proposed method of assigning power response ratings to circuit components in decibels so that they may be added to give over-all response in discrete terms

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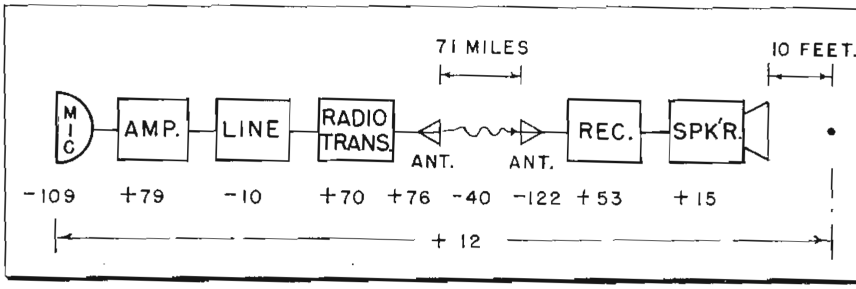

Typical circuit component line-up showing db ratings for individual units

IT is often desirable to evaluate the approximate over-all response of a complete communication system. Romanow and Hawley have proposed a method of rating microphones and loudspeakers,[1] and the same method can be extended to other system components, including antennas. In a well designed system the impedance of the various units of equipment and circuits are matched for maximum power transfer, and the available power concept is significant. By giving each component a power-response rating in decibels, all the ratings may be added algebraically to give the over-all response. An example of this proposed method of rating a communication circuit is shown in Fig. 1.

Assume that it is desired to evaluate the over-all performance of a circuit at a medium audio frequency of 1,000 cps. This is a standard testing frequency[2] and in the example a reference sound pressure of 1 microbar (that is 1 dyne per square centimeter) is assumed to exist at the point where the microphone is to be placed. This corresponds to a sound level[3] of 74 db, when measured with a standard sound level meter.[2] The circuit consists of a dynamic microphone feeding an amplifier, which is adjusted to supply 1 milliwatt to a transmission line, and this in turn connects to a radio transmitter operating on a frequency of 5 MC and feeding a quarter-wave antenna. At this point the signal has been raised to a level of 1 kw. A similar type receiving antenna, located about 71 miles away over a sea-water path, is connected to a receiver adjusted to deliver .5 watt into a typical loudspeaker. The problem is to determine the sound level about 10 ft. away on the axis of the loudspeaker and to relate this to the input sound level, thereby determining the over-all system response at this point of frequency. Examples are given to illustrate the method proposed, with "system ratings" specified to the nearest decibel and *underscored.*

The microphone-system rating[1] in decibels is equal to 10 log available output watts/microbars squared. The available output power is $E^2/4R$ watts, where E is the open circuit output voltage and R is resistive component of the output impedance at 1,000 cps. This is the maximum power that a source can deliver into a matched conjugate load impedance. The free-field voltage response of the microphone is —90 dbv per microbar, (—90 dbv equals 90 decibels below 1 volt, or 3.16 x 10^{-5} volts on open circuit) and the output impedance is 20 ohms resistive. Performing the indicated calculations gives the microphone output as 1.25 x 10^{-11} watts and the microphone-system rating of —109 db. This means the microphone output is 109 db below a reference response of 1 watt per microbar squared.

Amplifier Rating

The amplifier rating is 10 log watts output/watts input, and since the amplifier is adjusted to deliver 1 milliwatt into the line, the system rating is 10 log $10^{-3}/1.25 \times 10^{-11}$ equals + 79 db. The line loss of 10 decibels is merely 10 log watts output/watts input or 10 log $10^{-4}/10^{-3}$ equals —10 db for the system rating. The radio transmitter raises the signal level to 1 kilowatt, and the system rating is 10 log watts output/watts input, 10 log $10^3/10^{-4}$ equals + 70 db. This power is fed into a quarter-wave vertical antenna having an input impedance of 36.6 ohms resistive at the operating frequency of 5 MC (i.e. a wavelength of 60 meters). A quarter-wave vertical antenna radiating 1 kw over a perfectly-conducting earth delivers an unattenuated field at 1 mile of approximately 194 millivolts per meter.[4] The antenna-system rating is usually specified at 1 mile and is 10 log E^2/watts input, where E is the microvolts per meter at 1 mile. The rating is therefore 10 log $(1.94 \times 10^5)^2/10^3$ equals + 76 db. (Note: This includes the 1 mile path loss and the antenna directivity in decibels and the rating means the output is 76 decibels above the reference of 1 microvolt per meter squared per watt).

From transmission data for sea-water paths at 5 MC, it is known that the field about 71 miles away from a quarter-wave vertical antenna, when 1 kilowatt is radiated, is approximately 1.94 millivolts per meter (i.e. 66 dbs. above 1 microvolt per meter). The loss of the radio path between the 1 mile point (where the transmitting antenna was rated) and the receiving antenna 70 miles further is 20 log E_2/E_1, where E_1 is the volts per meter at point 1 and E_2 the volts per meter received at point 2. This is 20 log $1.94 \times 10^{-3}/1.94 \times 10^{-1}$ equals —40 db.

The system rating of the receiving antenna is 10 log available watts/e^2, where e means the received field intensity in microvolts per meter. The received field of 1.94 millivolts per meter corresponds to a power flow of 10^{-8} watts per square meter at the receiving antenna location. Multiplying this by the effective area of the receiving antenna[4] gives a received available power of 2.35 x 10^{-6} watts.

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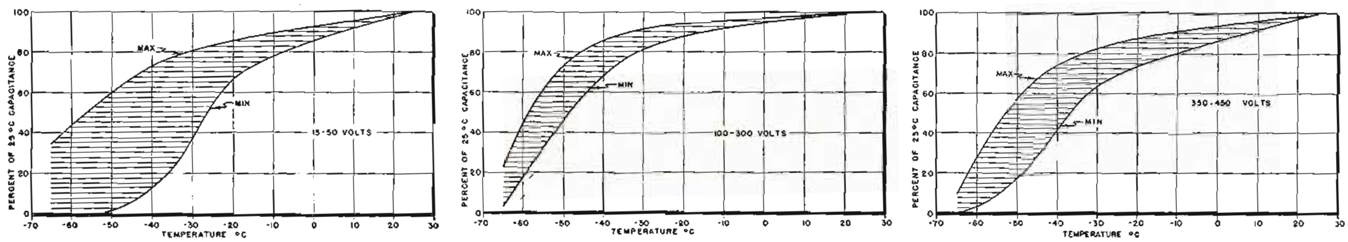

Figs. 1-3: (l to r) Performance variation of etched foil types from four manufacturers in three voltage ranges of operation

Electrolytic Capacitors

Results of test conducted on four manufacturers' products indicate permit superior stability; extended operation at —55°C does not

By C. D. CRATER,
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THE necessity for global operation by military service has made it mandatory that Signal Corps equipment function satisfactorily under all possible combinations of environmental factors likely to be encountered. This became particularly apparent early during World War II, when many failures under extreme environmental conditions were reported from the field.

Consequently a project was set up to develop equipment which would qualify for service under these extreme conditions. From 1943 to the end of the war major stress was naturally focussed on conditions prevailing in tropical locations. Since the war emphasis has been placed upon the need for proper performance of apparatus under conditions likely to be encountered in arctic and other low temperature zones. Obviously, satisfactory operation of an equipment cannot be obtained unless the components and materials employed in its construction are individually capable of performance under the specified conditions. As an essential part of an overall environmental program it was planned to compile information about the low temperature performance of all major components and materials.

Published information on the characteristics of electrolytic capacitors clearly indicates that difficulty may be encountered in the operation of this component at low temperatures. Due to the inherent limitations of electrolytic capacitors, their use in military equipment has always constituted a major component problem.

In order to carry out a suitable investigation, test samples representing typical etched foil construction of various voltage ratings were purchased from four of the larger manufacturers of electrolytic capacitors. These samples were of a type which would normally be submitted as meeting characteristic "C" of Specification JAN-C-62. These units would ordinarily be expected to operate, although at reduced efficiency, at —40° C. Measurements of capacitance, impedance, and equivalent series resistance at 130 cps and leakage current at rated voltage were made at 25° C, and at each 15° C interval down to —65° C. Six units were measured and the results averaged.

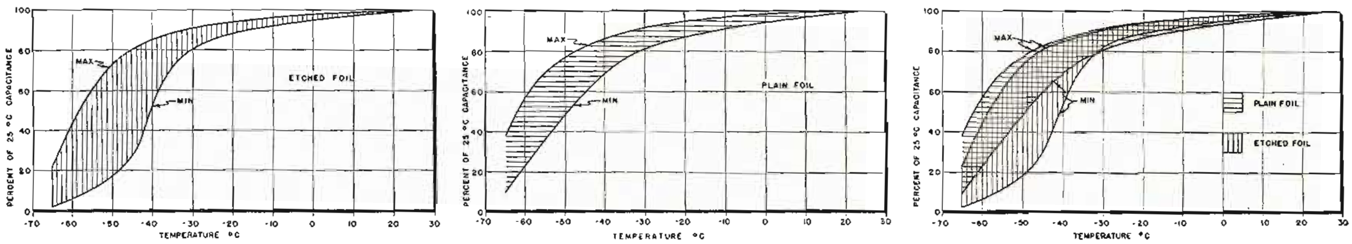
Effective Capacity Varies

Analysis of the test results revealed considerable variation in effective capacity at low temperature among units of different manufacturers, among different voltage ratings, and even among different manufacturing lots of the same manufacturer. It was, therefore, obvious that no single curve could be constructed to represent the performance of even one manufacturer's product.

A study of industry practices provides a reason for this situation. In the manufacture of electrolytic capacitors, the operating electrolyte is chosen on the basis of the required conductivity, ability to withstand rated working voltage, and ability to maintain a suitable dielectric film on the anode. Undoubtedly, the ionic conductivity of the operating electrolytic affects the low temperature performance to a great extent. Since the electrolyte is effectively in series with the capacity, and since the conductivity of practically all operating electrolytes vary with a change in temperature, it can be seen that the proper choice of an electrolyte is very important. The best electrolyte for a specific voltage rating would not be suitable for the next higher voltage. Therefore, optimum performance over a wide temperature range would require a separate type electrolyte for each voltage rating.

In practice, this is found to be impracticable since it does not readily lend itself to mass production. An electrolyte is generally chosen which will operate over a range of voltages, although at some slight sacrifice in performance for voltage ratings below the maximum for that range. The performance of capacitors of a specific voltage rating may be still further modified by the type and number of spacers employed, particularly in the higher ranges, these ranges requiring both more spacers and electrolytes of lower conductivity. The most favorable conditions of electrolyte conductivity, number of spacers and current density per microfarad usually occur in the voltage ratings between approximately 100 and 300 volts.

In order to arrive at a suitable method of presenting the large amount of data accumulated, all voltage ratings tested were divided into three general groups, Group I, 15-50 volts; Group II, 100-300 volts



Figs. 4-6: (l to r) Capacitance vs temperature for etched and plain foil types. Fig. 6 shows the two curves superimposed

at Low Temperatures

severe operational degradation at low temperatures; plain foil types produce significant permanent changes in operating characteristics

and Group III, 350-450 volts. While this particular division may not hold true for individual manufacturers, a similar grouping is almost always used.

It was noted that in a particular group using the same electrolyte and number of spacers, the highest voltage rating of the group had the best low temperature performance. This is apparently due to the fact that the lower voltage ratings have a thinner dielectric film, greater capacitance per unit area, and less cross sectional area of electrolyte, resulting in greater current density in the electrolyte. As indicated previously, considerably better performance was obtained from those capacitors in the voltage group between 100 and 300, with the low voltage group 15-50 generally giving poorest performance.

Etched Foil Types

Figs. 1, 2 and 3 show the variation in performance of etched foil types of the four manufacturers' products in each of the three voltage groups previously mentioned. While these curves do not represent the absolute maximum or minimum possible values, since only four manufacturers are included, they do show in a general way what may be expected and in all probability any deviations from these values by other manufacturers would be insignificant.

Examination of the data obtained from the plain foil units indicates that all voltage ratings of this type performed better than the etched foil, the greatest improvement being noted in the 400 volt and least in the 250 volt ratings. Fig. 4 shows the variation in performance among all voltage ratings of etched foil types of a typical manufacturer. Fig. 5 gives a similar representation of the same voltage ratings of the same manufacturer's plain foil units. Fig. 6 shows the two curves superimposed for ease in comparison.

While electrically the plain foil types are much more stable, in making a comparison of this kind the question of relative size must be considered. Fig. 7 shows how the two types compare on the basis of capacitance per cubic inch. As can readily be seen, the plain foil types appear unfavorably, there being a ratio in volume for equivalent capacitance of approximately 3 to 1 for the 15 and 100 volt ratings and approximately 2 to 1 for the 250 and 400 volt ratings. Therefore, the ultimate capacitance per unit of volume at any temperature down to at least —40° C will be greater for the etched foil, although the change may be much greater.

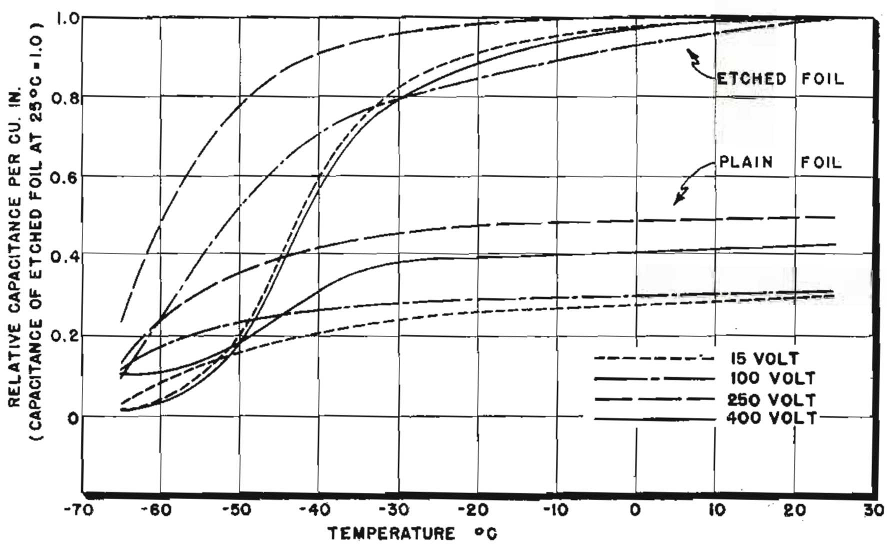
Leakage Current

It was found that values of leakage current were originally below the normally accepted maximums, and were greatly reduced with a reduction in temperature. No significant difference was observed between the etched and plain foil types in this respect.

The previous discussion has been concerned primarily with the temporary change in electrical characteristics under operation at certain abnormal temperatures. It is of in-

(Continued on page 72)

Fig. 7: Comparison of etched and plain foil on basis of capacitance per cubic inch



Design for a Current-Regulated

Contrary to the usual voltage-regulated supply, this output impedance. Ripple suppression is measured

By R. O. MAZE

Test Equipment Design Dept., Bendix Radio Div., Bendix Aviation Corp., Baltimore 4, Md.

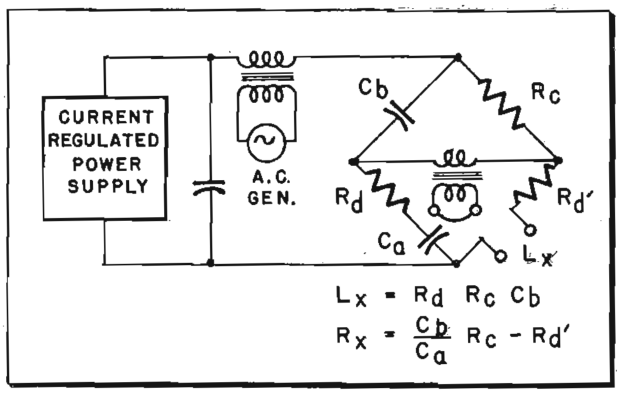


Fig. 1: Schematic of current regulated power supply for use with an Owen type bridge for measuring incremental inductance of various inductors

THE usual regulated power supply is regulated in output voltage and intended to have a very low internal impedance. In the case of measurements where the current is to be held constant it is very convenient to have a power supply in which the current is regulated. In this type of supply the dynamic output impedance is very high. It is interesting that the ripple suppression must now be measured in terms of the ripple remaining in the current at the output of the regulator rather than the ripple component of voltage.

A regulated supply of this type has been constructed for use with an Owen Bridge for measuring the incremental inductance of various inductors. The circuit arrangement is shown in Fig. 1. In balancing the bridge for measuring the effective resistance of the inductor, the value of R_d' is varied. Using an ordinary regulated supply makes this difficult because changes in R_d' make changes in the current through the inductor, and therefore require readjustment of the power supply voltage. The *current* regulated supply eliminates this difficulty, and permits the operator to be concerned only with the bridge controls.

A number of usable circuits have been devised for the regulation of current. These circuits differ in the current sensing element used and in the method of control. Some of these schemes are diagrammed in Fig. 2. The method shown in 2a has the advantage of providing effective control of the current at frequencies up to well above the audio range, whereas, the other schemes shown do not provide regulation against fast changes in current. This arrangement is best suited for laboratory supplies for currents up to about 200 milliamperes.

The regulation of higher currents by the method of Fig. 2a is not practical because of the excessive number of vacuum tubes required. The method shown in 2b is suitable for regulation of higher currents. The method of 2c is simple, but does not allow regulation to zero output voltage, and therefore does not provide overload protection. In the circuit arrangements of Fig. 2a

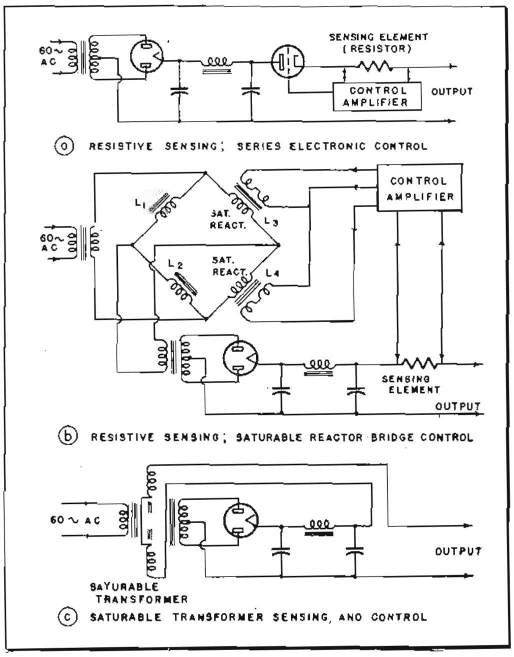
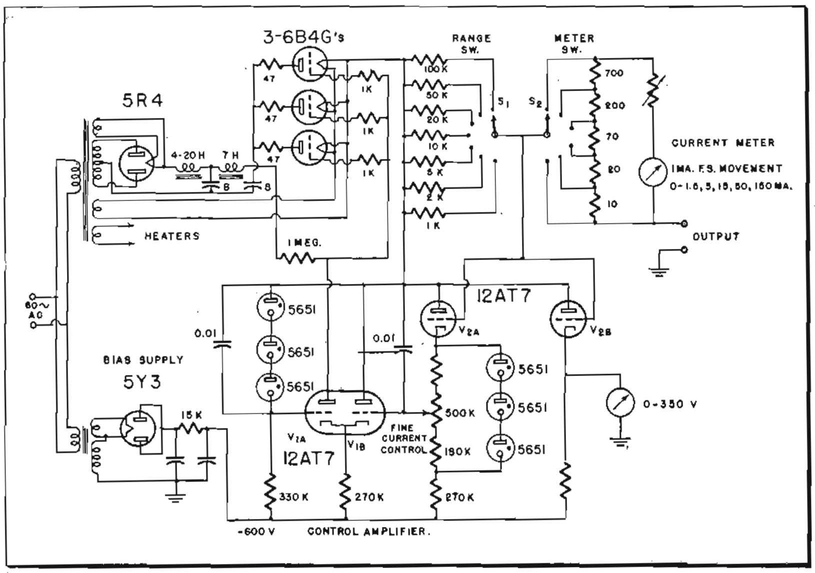


Fig. 2: (Left) Various methods of regulating current

Fig. 3: (Below) Schematic of current regulated power supply



Power Supply

equipment provides a high dynamic

as remaining ripple current in output

and 2b, shorting the output terminals does not result in an appreciable increase in the output current, and overload protection is provided.

In the circuit of Fig. 2b, the reactors L_1 and L_2 are fixed reactors. The control current is applied differentially to the saturable reactors so that the reactance of L_3 is a maximum when the reactance of L_4 is a minimum and vice versa. At one extreme of the operating range, the bridge reaches a balance with $L_1 x L_4 = L_2 x L_3$. The output voltage is then zero. At the other extreme, the bridge is far out of balance, and the output voltage is a maximum.

Circuit Modifications

The circuit of Fig. 2a has been constructed in a practical form by modifying a voltage regulated supply. The schematic is shown in Fig. 3. The positive supply is a conventional supply with a swinging choke input. The series regulators are three 6B4G's. The 47 ohm resistors in the plate leads and the 1000 ohm resistors in the grid leads are to prevent parasitic oscillations. The bias supply employs a half wave rectifier to provide approximately 400 volts negative. This large negative voltage is required to provide a high resistance negative source for the control amplifier. The current drain on the negative supply is only about 10 milliamperes.

The control amplifier consists of two twin triodes, V1 and V2. The sections of V2 are cathode followers which allow a voltage to be obtained from the output without drawing current. Any current load drawn from the supply beyond the sensing resistor would impair the performance particularly at low output current levels. The section V2a supplies the voltage information to the comparison circuit. The section V2B supplies voltage to the output voltmeter.

The comparison circuit is composed of V1, the six voltage reference tubes (5651's) and their associated components. This circuit compares the drop across the sensing resistor with a voltage derived from the voltage reference tubes. The

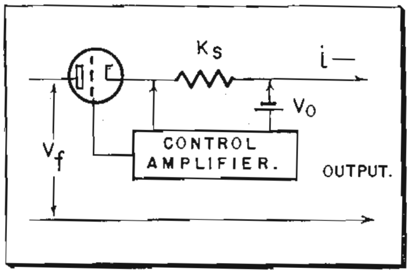


Fig. 4: Equivalent circuit diagram for the derivation of load current

cathode of V2A is at approximately the output voltage. The voltage applied to the grid of V1B is the output voltage minus the portion of the drop of the voltage reference tubes corresponding to the setting of the "Fine Current Control".

The voltage difference between the cathode of V2A and the grid of V1B may be adjusted to any value from 55 to 207 volts. The voltage at the grid of V1A is held at 262 volts below the voltage at the high side of the sensing resistor. The action of the comparison tube is to adjust the bias on the series regulator until the voltage on the grids of V1A and V1B are equal. Therefore the drop across the sensing resistor is caused to become 262 minus 55 or 207 volts at one end of the "Fine Current Control" setting and 262 minus 207 or 55 volts at the other extreme of the control setting. The output current may thus be adjusted by choosing the proper range resistor, and then adjusting the "Fine Current Control" for the voltage drop desired.

The equation for the load current may be derived by reference to the equivalent circuit of Fig. 4.

A = gain of control amplifier
μ_s = amplification factor of series regulator
V_o = preset reference voltage

Solving for i:

$$i = \frac{V_f - A\mu_s V_o}{Z_L - R_s (A\mu_s - 1)}$$

In the above equation, as A and μ_s are increased, the output current approaches the value, $\frac{V_o}{R_s}$, and becomes independent of Z_L. In a practical circuit such as that of Fig. 3, the values obtained for A and μ_s are such that a change of output voltage from zero to the maximum capacity of the supply might result in a change of about 1% in the output current.

RTMA Charts Equipment Reliability

The RTMA Engineering Department has prepared a 14-point chart on the subject of electronic equipment reliability. The chart, which is printed in colors, is suitable for use on the walls or at the desks of equipment designers.

RTMA prepared the chart at the suggestion and with the assistance of the Directors of the Armed Services Electro Standards Agency.

Following are the 14 points for designers:

Study the Equipment Requirements

1. Before selecting the components, determine all circuit requirements and conditions, noting environmental and operational hazards—such as temperature, vibration, dust, fumes, and the electrical hazards—such as over-and-under voltage of the power sources and frequency variations of the power system.
2. Determine the required characteristics of each component, including all limiting factors established by RTMA Standards or by that component's manufacturers.
3. Select components that qualify under accepted standards, or with known capibilities wherever possible.
4. Specify parts whose characteristics fulfill all circuit requirements, noting their limitations.
5. Check with an approved source of supply, or with the manufacturer, for each specific part before final decision if any doubt exists as to its performance capabillties with anticipated operating conditions.

Operate All Components Within Their Capabilities

6. Use the regular derating factors listed in RTMA Standards or in JAN-MIL SPECIFICATIONS for temperature effects, currents and voltage ratings, especially in case of resistors and capacitors.
7. Compensate for any known limitations in a particular component in the end equipment design.
8. Apply suitable safety factors to compensate for any variable conditions which may be encountered.
9. Protect equipment by fusing, metering, etc., to prevent damage by unexpected operating conditions.

Plan Optimum Layout and Design

10. Position all components so total temperature rise in component and in circuit does not exceed maximum safe operating temperature. Heat radiated from surrounding parts should also be considered.
11. Arrange components so that they are easily accessible for testing and maintenance operations.
12. Provide adequate ventilation. Where necessary add blower to keep components within safe ratings.
13. Add supplementary insulation wherever necessary, especially when unusual operating hazards are found.

Make Complete Tests

14. Check circuit functioning with random selections of tubes. Determine if shifts in tube characteristics or normal aging of other items are likely to affect operation seriously during the desired equipment life.

Poster-size copy of the fourteen points may be obtained by writing to R. R. Batcher, Chief Engineer, RTMA Engineering Dept., 489 Fifth Ave., New York 17, N. Y.

CUES for BROADCASTERS

Practical ways of improving station operation and efficiency

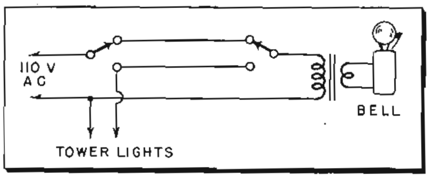
Edited by John H. Battison

Tower Light Indicators

R. S. HOUSTON, 425 Chestnut Lane, Wayne, Pa.

OFTEN a situation arises where the top of the tower is invisible from the transmitter house. If the beacon is a flasher type, its operation can be observed by connecting a neon bulb across the flasher contacts. When the contacts are open, the bulb will light, indicating the beacon light is OK. Should the bulb fail, or the changeover mechanism not operate, the neon lamp would remain dark.

If the beacon is a non-flashing type, a simpler check on all lights may be obtained by connecting an ac



Tower light indicator changeover circuit

ammeter in series with the lighting circuit. Thus any light which burns out on the tower shows up on the meter as less-than-normal drain. One station conserves tower lights and electricity and provides an indication with a simple resistor arrangement. Part of the heater element was connected in series with the tower lighting circuit, and across this was connected a 6-volt pilot lamp. Since the lamp was operated at critical brilliance, any lamp which went out was immediately apparent. To compensate for the loss in brilliance of the tower lights, the next size larger lamp was installed. These lamps lasted for an average of 3 years, and power consumption was decreased by about 6%.

Along this same line is the problem of noting when the lights are illuminated when operated by a clock or photo-electric relay. If the relay or clock contact is of the double-throw variety, a variation of the 3-way lighting switch circuit can be used to operate an audible alarm for notification of the operator. A double-throw toggle switch is wired with its free contacts connected to the similar contacts of the operating switch. The armature of the spare alarm switch is connected to the bell circuit. When the lights go on, the alarm rings, and the operator then throws the switch to the other position, connecting it to the "off" position. When the lights go off, the alarm again rings, and the operator again throws the switch, this time to the "on" position, ready for the next cycle.

$$$ 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.

Simplification of Turntable Operation

SAM W. ENGLE, Engineer, Voice of America, New York City

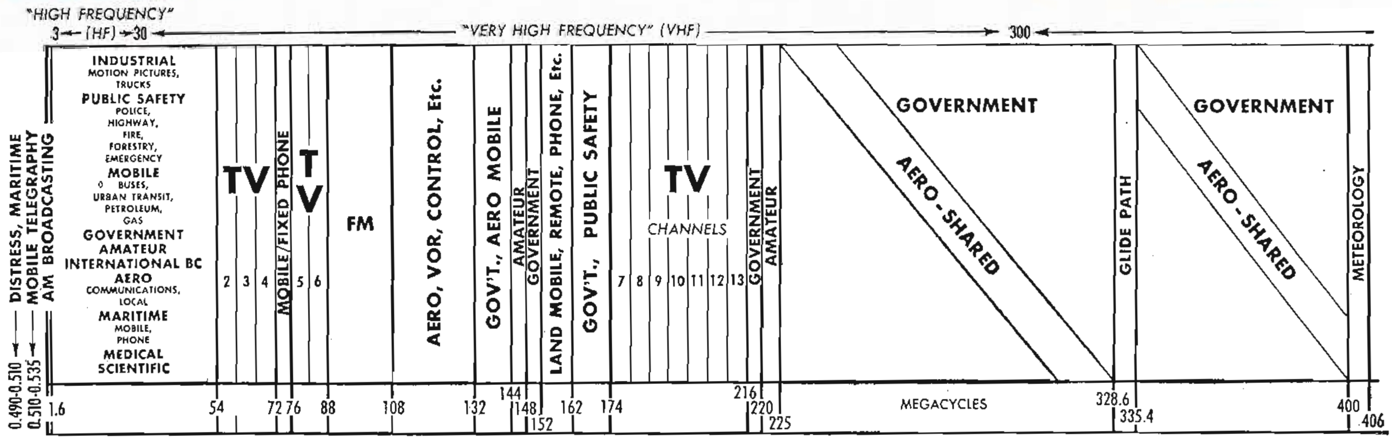
STATIONS are often faced with the problem of efficient operation of turntables. Two simple revisions make the operation of turntables easier for the operator or combination man.

The first is the installation of foot switches to control the turntable motors, thus releasing one of the operator's hands for other operations. The use of regular automobile dimmer switches which can be purchased for about sixty cents solves the expense problem. Only the center leg and one side of the switch are used, providing a switch which is closed on the first operation of the plunger and opened on the second.

The switch is installed in place of the normal on-off unit supplied with commercial turntables. A click filter consisting of a .5 uf 400 v capacitor in series with a 50-ohm 1-watt resistor should be placed across the switch contacts. Installation in control rooms with raised floors is easily accomplished by mounting the switch on a small piece of plywood and then screwing the plywood down to the floor around a slot made to accommodate the switch.

If the control room has a flush floor it is a simple matter to construct a small box with a slanted face to hold the switch. Placement

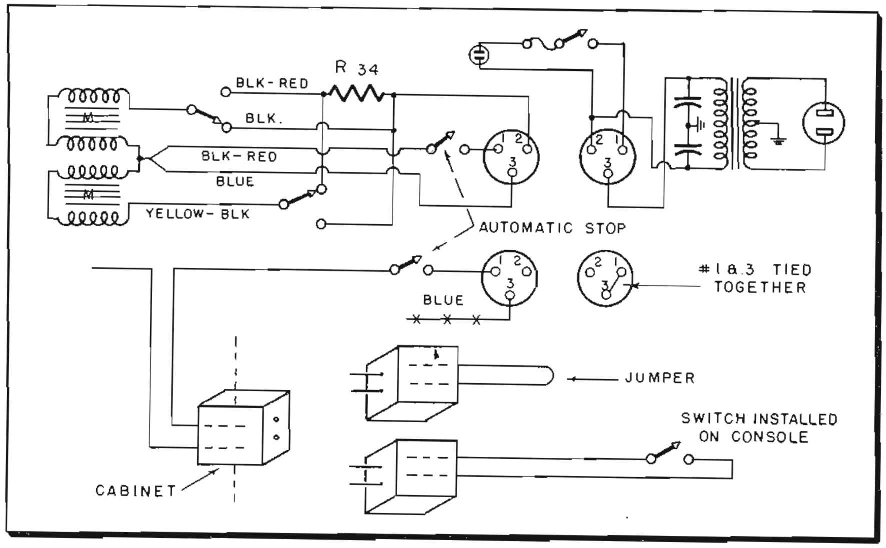
The COMPLETE BROADCASTING SPECTRUM—AM, FM and TV—



of the switch should be carefully determined prior to installation so that it is easily accessible to the operator's feet. Experience has shown that when more than one switch is used (usually the case) they should be spaced widely apart.

The second operating simplification is easily accomplished if the modification is made on RCA series 76 turntables. Removal of the on-off switch from the face of the turntable provides a ready-made location for the turntable attenuator. With the attenuator located on the table and the motor operated by a foot switch, operation of the table is easily accomplished by one hand, leaving the other hand free to handle controls. Also, because the attenuator is on the table next to the platter it is almost impossible to open the fader without first releasing the disc, because one hand controls both operations. Thus, possibility of a whoop is eliminated.

First step in the installation of the attenuator is the removal of the now unused on-off switch. The round metal faceplate of the switch is removed from the switch assembly and used as the mounting plate for the new attenuator. The type of attenuator used will vary but one of the small types is suggested so that it will fit into the available hole. The use of a "cuepot" attenuator is highly recommended as this provides positions on the console. The mixed output of all turntables in use may be combined in a simple resistance matching network and fed into one input position of the console. In the case of a console with a high impedance mixing bus, the combined outputs may be fed into a high quality line to grid transformer located within the console and thus fed straight onto the bus.



Remote control for Webster tape recorder enables it to be used from console

Console Stop-Start Control for Tape Recorder

ED ROBERTS, Chief Engineer, WMAP, Monroe, N. C.

RADIO station WMAP has just purchased a Webster-Chicago, (Webcor) model 210 tape recorder. This machine operates for 2 hours on a single 7 inch roll of tape, making it ideal for recording a full football game. Changes made in the power supply are shown which allow it to be used through a console for broadcasting the recording while the man on the board is able to stop and start the recorder's motors from the board. Upon first examination we found that the automatic stop on the machine shuts the power completely off, allowing the tubes, as well as the motors, to become inoperative. This being undesirable, the following changes were made. The blue wire from the male plug on the motor was removed, and a jumper soldered between #1 and #3 terminals on the female receptacle. With this installed, it will be necessary for the jumper or the switch on the console to be on before the motor will run.

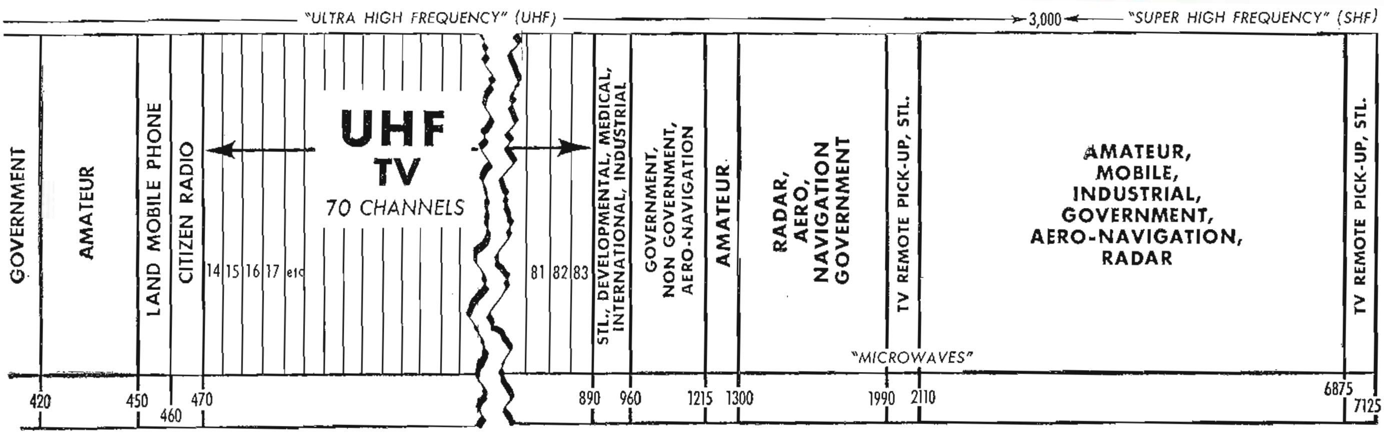
Stabilizer for Disc Recording Head

JOHN M. TIFFANY, Rockville Centre, N. Y.

IN making lateral recordings on discs, one trouble frequently encountered is that of vertical oscillation of the recording head which results in an optical pattern on the finished disc, and also in a low frequency modulation of the program when played back. This modulation is largely due to the variation of the tracking velocity of the playback needle due to the hill-and-dale

(*Continued on page* 78)

SHOWING ALLOCATIONS from 490 KC thru HF, VHF, UHF and SHF



Broad Band Antenna

Newly-developed
because of its

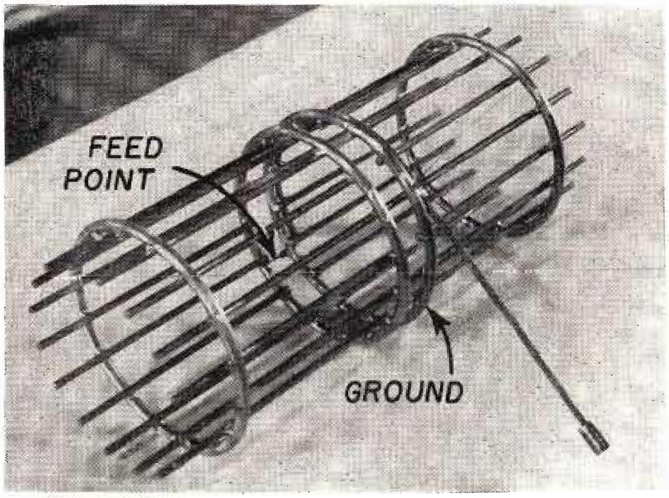


Fig. 1: Unique new structure which may become basic element in broadband systems

By M. W. SCHELDORF
Director of Research, Andrew Corp., 363 East 75th St., Chicago 19, Ill.

MANY antennas in use today consist of a combination of elements, a combination of an element with a reflector or both. When such combinations are arranged for broadband operation, it is often found that the impedance limitation is in the primary radiator or feed. While studying the bandwidth obtained with various enlarged feed elements for a corner-reflector antenna, a new feed structure was developed which may possibly have very general use because of its extended uniform impedance characteristics.

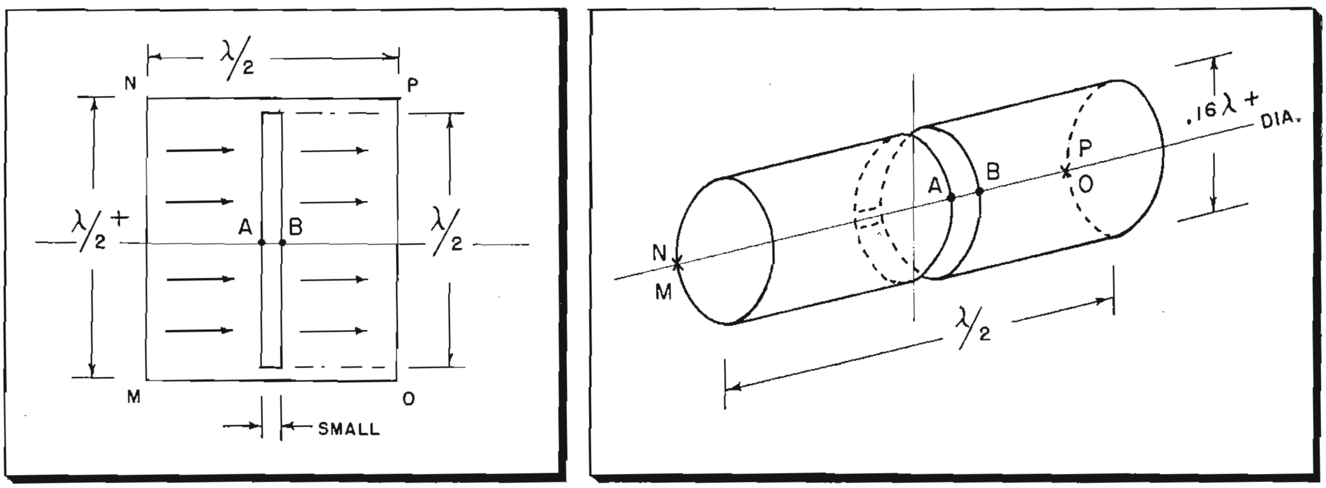
There have been many attempts to utilize antenna elements of large cross-section. It is common experience to find that the large cross-section itself, (a circular cylinder or similar) produces the proper characteristics, but it is difficult to overcome the gap between the end of the feed line and the end of the cylindrical form. An unsatisfactory transformation of impedances and a distortion of the desirable qualities of the cylindrical surface are produced.

Carter has described a double conical structure[1] which overcomes part of the difficulty by avoiding a distinct discontinuity between the conductor size at the transmission line terminal and the large cross-section of the element. This construction has had intermittent interest ever since.[2,3,4,5] Lindenblad developed an antenna for the Empire State Building which included a smooth transition from the coaxial lines to the radiating elements.[6] It had an unusually broad band of operation. Kandoian has described a discone antenna element[7] that is similarly broad but which appears to be difficult to apply. RCA has built a large number of Super-Turnstile antennas for TV transmission, with a unique slot-fed flat-sheet radiator.[8,9] None of these structures seem to be suitable as a feed for flat or curved reflectors and the dimensions are usually too cumbersome for their use as linear radiators.

In the photograph of Fig. 1, a new unique structure which may readily become a basic element in broadband systems is shown. Its development from a known structure can best be shown by reference to Fig. 2. Here we have in the left drawing the equivalent of the Masters[9] slot-driven sheet antenna. It is essentially a half-wavelength slot in a sheet of metal, which is a half-wavelength wide and slightly longer than this, so that the slot has short-circuits at both ends.

A balanced voltage is applied at A and B and the effective currents in the sheet are indicated by the ar-

Fig. 2: Development. At left, Master's slot-fed sheet, and at right, slot-fed cylinder



Element

feed structure may have wide applications extended uniform impedance characteristics

rows. This structure derives its bandwidth from the fact that a large surface is excited with standing waves of current in such a manner that they are cooperative in a high degree. If the straight edges MN and OP are bent into circles and the edge NP is joined to edge MO so as to produce a cylindrical surface instead of a flat sheet, we have established the antenna element that we wish to discuss in detail.

We now have a circular cylinder with a diameter slightly more than .16λ and ½λ long as shown in the lower drawing. This cylinder has an unusually large diameter to length ratio and one would expect to obtain a broad impedance curve, provided

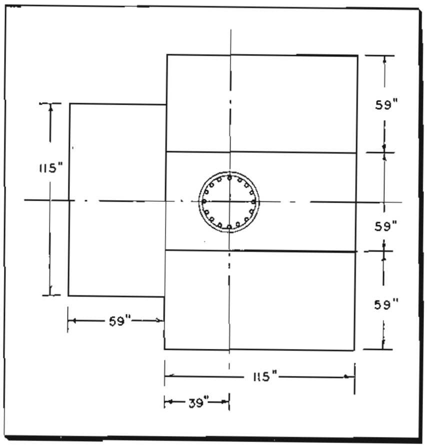


Fig. 3: Ground Plane system employed

the excitation is appropriate. The slot coupling line, as in the sheet antenna provides this correct excitation. Some interesting experimental data has been taken.

We started the study of the new element as a feed for a corner-reflector and subsequently, because of its exceptional bandwidth properties, devoted most of the time to a study of its general properties. This has included measurements of the E-plane and H-plane patterns but the results will be omitted because of the number of curves involved and the length of discussion required.

In the short time that we had to study this new element, we have tried to accumulate the variations that may be considered. The following list indicates the range of conditions possible.

1. Circle diameter, or more appropriately, total slot length.
2. Rod lengths, all alike, and variable along slot (solid sheet is not needed and usually not desired).
3. Impedance of slot edges, as a feed line, uniform and tapered.
4. Type of termination of feed line, open-circuited, short-circuited, resistive, reactive or both.
5. Outward or inward tilt of the rods, to achieve a better match to space.
6. Number of rods used. A critical even spacing, or tapered, possibly logarithmic.
7. Position of ring joining the rods at the outer ends. Constant around slot length or variable.
8. Use of folded elements instead of simple linear rods.
9. Use of a folded slot line.
10. Use of extensions of the slot line, non-radiating. A special case of 4.
11. Position of termination (degree of symmetry).
12. Use of more than one termination.
13. Use of more than one set of input terminals, for larger circle diameters.
14. Change of shape of cylinder to elliptical section, for pattern narrowing or widening.
15. Capacity loading of rod ends.
16. Use of a general capacity hat, as employed with large conical surfaces.

Some of these parameters may seem far-fetched but it must be borne in mind that we are contemplating frequency ranges of more than one octave.

The simplicity of impedance measurements over a wide frequency range with a simple unbalanced feed, dictated a study of the element as a stub radiator over a ground plane. Space and available ground plane facilities prohibited the use of reflecting surfaces as large as ideally desirable but the arrangement was satisfactory for the initial work. The ground plane system used is shown in Fig. 3. We attempted to explore rapidly the range of possible variables, so as to justify extensive

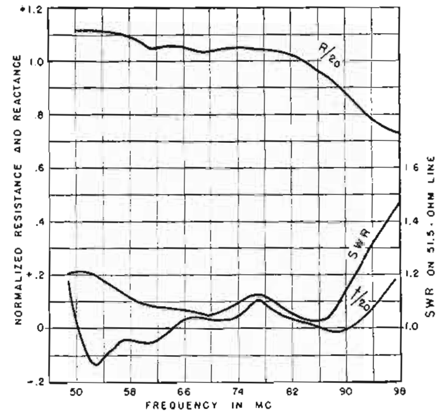


Fig. 4: Curves show impedance relations obtained without matching transformer

studies in the future. Rather than try to make a sketch of the element with which we concluded the first studies, we have tabulated the specifications.

1. Two ring sections, ⅞ in. tube diameter, on circle diameter of 33 in. (circular shape).
2. Rods ⅝ in. diameter, 16 in number, equally spaced, 40 in. long, alike, with upper ring at 30 in. and parallel to the ground plane.
3. Lower ring spaced 2 in. from ground plane at bottom side, constant.
4. Short-circuit termination, 15° away from midpoint.
5. 3 mmf across input terminal.
6. No tilt of rods.
7. No capacity loading of rods or cylinder in general.

The impedance relations obtained, without any matching transformer are shown in Fig. 4. The results are especially gratifying in view of the relatively small dimensions necessary to achieve this performance.

The element developed is essentially a radiator element so that it may be adapted to a multiplicity of applications. In most cases where a simple half-wave dipole antenna is utilized, this structure may be used instead.

Especial credit is due H. M. Anderson for the impedance measurements, which constituted the greater portion of the work.

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Coaxial Tetrode as

A discussion of three circuit efficiency when using this tube

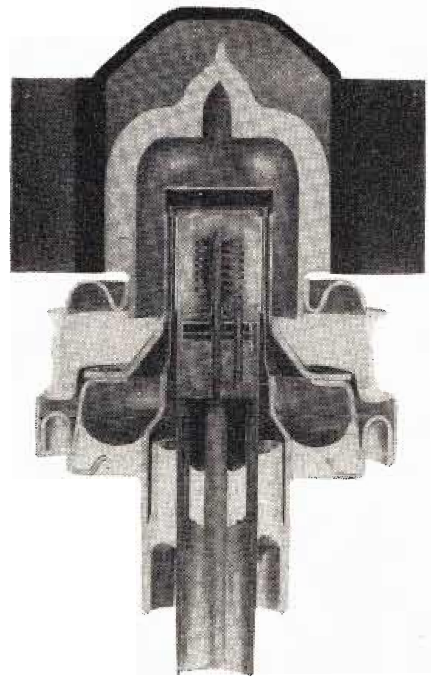


Fig. 1: Cross sectional view of VHF-UHF coaxial tetrode, Eimac type 4X150G

By DONALD H. PREIST
Research Engineer,
Eitel-McCullough, Inc.,
San Bruno, Calif.

BECAUSE of the construction of a coaxial tetrode as can be seen from Fig. 1, the conventional method of connecting the tube to the circuit cannot be used. This is a matter of dimensions in terms of the operating wave length and comes about for the following reasons.

First, in order to obtain the most powerful tube it is desirable to make the active electrode structure as long as possible; about 1/12th wave length in practice.

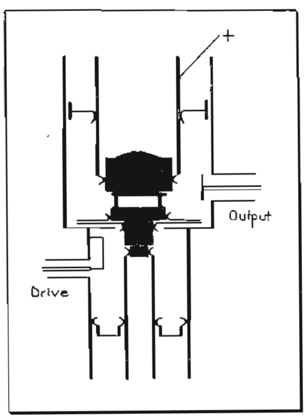
Secondly, some length is involved in bringing out the electrodes through the glass envelope in a mechanically satisfactory manner. In the two tubes, later considered as examples of this technique, effective electrical length of these connections is about 1/10th of a wave length at the highest operating frequency.

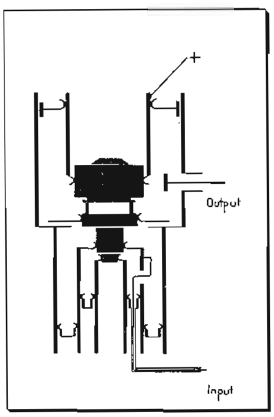
Thus, the total effective length of the tube considered as a transmission line or combination of lines approaches ¼th wave length. If the cathode were returned to the screen grid by means of the conventional bypass arrangement, the amplifier would not operate satisfactorily and some other arrangement has to be devised therefor.

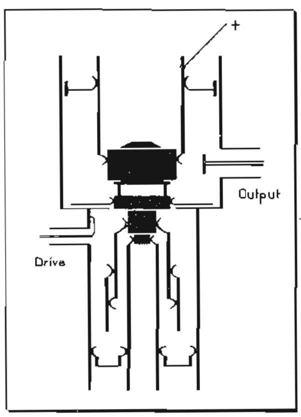
Three alternative arrangements will be considered. The first of these is shown in Fig. 2. Here the control grid and screen grid are maintained at the same r-f potential by means of a bypass capacitor of minimum inductance which is effectively grounded. The amplifier therefor resembles a grounded grid triode amplifier with the exception that the extra grid in the tube makes it possible to accelerate the electrons passing through the control grid by a uniform dc field which is the same at all points in the r-f cycle. In its operation, the circuit is closely analogous to the grounded grid triode and it possesses the same inherent negative feedback due to the passage of the fundamental component of anode current through the input circuit in such a direction to produce a voltage across the latter which is out of phase with the voltage produced by the driving source.

Because the amount of negative feedback is fixed by the tube characteristics and operating conditions, the bandwidth of the circuit on the input side is also fixed and in practice is large. Again, because the gain bandwidth product of the amplifier is primarily set by the tube characteristics, it follows that the power gain obtainable is also fixed and is relatively small because the bandwidth is relatively large. Because of the presence of the screen grid which reduces the voltage swing required between the control grid and the cathode to a smaller amount than would be needed in a triode, however, the amount of negative feedback is somewhat less than in a triode and the power gain correspondingly greater. In practice where a triode may give a power gain of three times, the tetrode may give as much as six times.

Fig. 2: (Left) Diagram of amplifier with both grids of tetrode at same f-f potential
Fig. 3: (Center) Diagram of tetrode amplifier with double input circuits
Fig. 4: (Right) Diagram of tetrode amplifier with folded coaxial line input circuit







Positive or Negative Feedback

The second alternative arrangement is shown in Fig. 3. This is more complicated than the first amplifier but is also a feedback amplifier, because again it is necessary for the fundamental component of anode current to return to the cathode via the input circuit. In this case the feedback may be either positive or negative according to the geometric configuration of the driving loops, assuming that all the feedback current has to flow through this channel and that the capacitance from screen grid to cathode is effectively zero.

The third alternative is shown in Fig. 4. This is the preferred arrangement because it is mechanically simpler than the second alternative, and is easy to adjust and gives relatively easy control of bandwidth and power gain, which makes it superior to alternative 1. The equivalent circuit is shown in Fig. 4a and again it is clearly a feedback amplifier. The sense of feedback depends on the length of the input circuit and in the case to be

a TV Amplifier at VHF and UHF

arrangements for obtaining maximum for high power at high r-f frequencies

considered where the effective length of line attached to the control grid is ½ wavelength, the feedback is positive.

In analyzing these three circuits in more detail, the equivalent circuit in Fig. 5 will be helpful, since it applies to all three.

In the first amplifier, shown in Fig. 2, the reactance between the two grids is substantially zero, and the input and output circuits are resonant and present a resistive impedance at the center frequency of the pass-band. The feedback is therefore clearly negative as in a grounded grid triode amplifier.

In the second amplifier, shown in Fig. 3, there are three resonant circuits tuned to the same frequency and there is a coupling between the grid-to-screen-grid circuit and the grid-to-cathode circuit because of the arrangement of the driving loops, indicated by M on Fig. 5. According to the way the loops are placed, the voltages across these circuits may be either in or out of phase.

The third amplifier, shown in Fig. 4, is identical in its essentials to the second one, although in practice it is a good deal simpler to make and adjust, and it has in certain circumstances a greater inherent bandwidth. However, it is the most difficult circuit to analyze quantitatively in an exact manner. This does not matter in practice if a clear understanding of the comparative magnitudes and phases of the voltages and currents can be arrived at, plus a knowledge of the effect of varying the circuit constants on the performance. This has been done experimentally, and substantiates the rough analysis which follows. A brief summary of the operation of the circuit has already been given elsewhere.[1]

Folded Back Coaxial

Considering the network connecting the screen-grid, control grid, and cathode, it is clear that this is basically a folded back coaxial line, connected between the control-grid and screen-grid at one end and the control-grid and cathode at the other. At the point of folding there is a variable series inductance provided by the stub with its movable short-

(*Continued on page* 80)

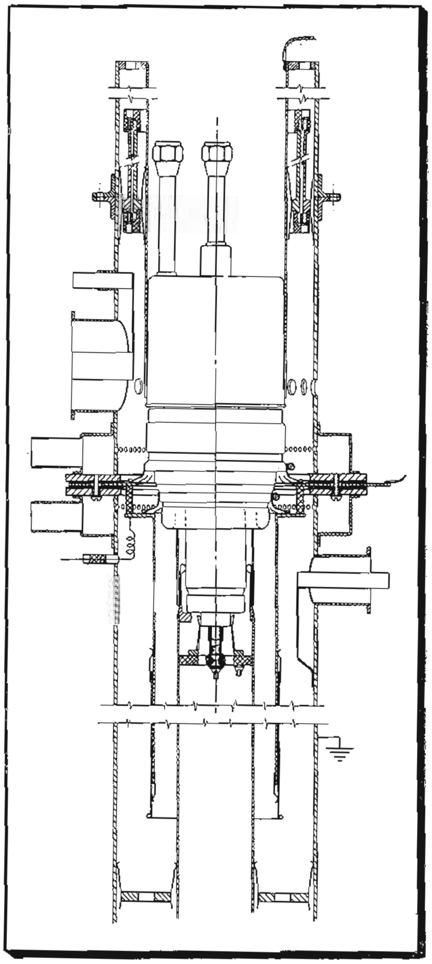
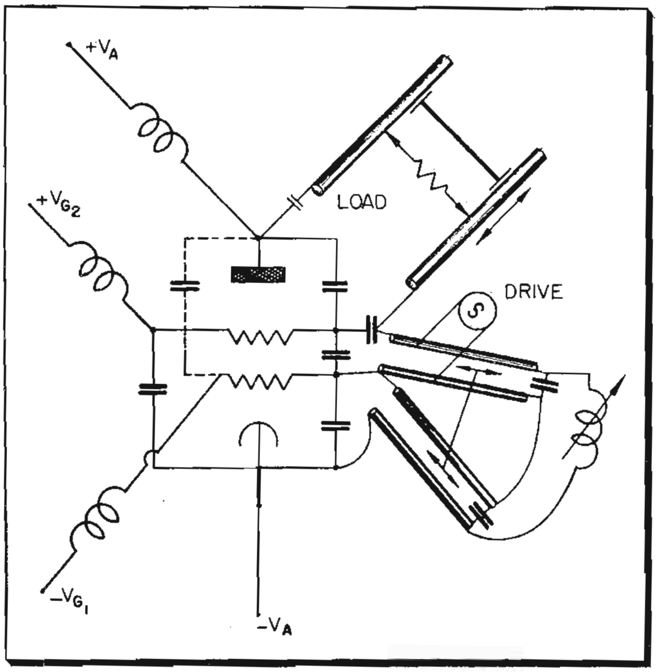
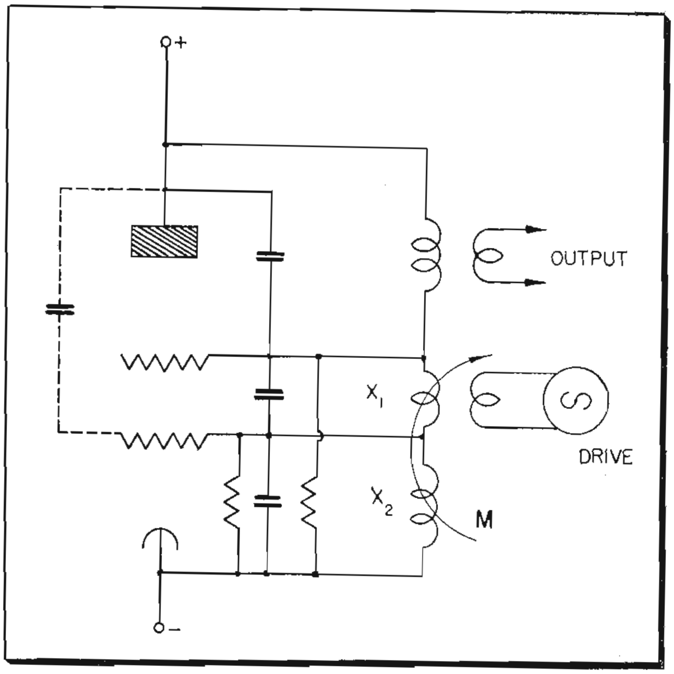


Fig. 7: Eimac 4W20000A in circuit of Fig. 4

Fig. 5: (Left) Equivalent circuit of amplifiers. Fig. 6: Equivalent circuit of amplifier in Fig. 4 using parallel lines





Simplified Approach to

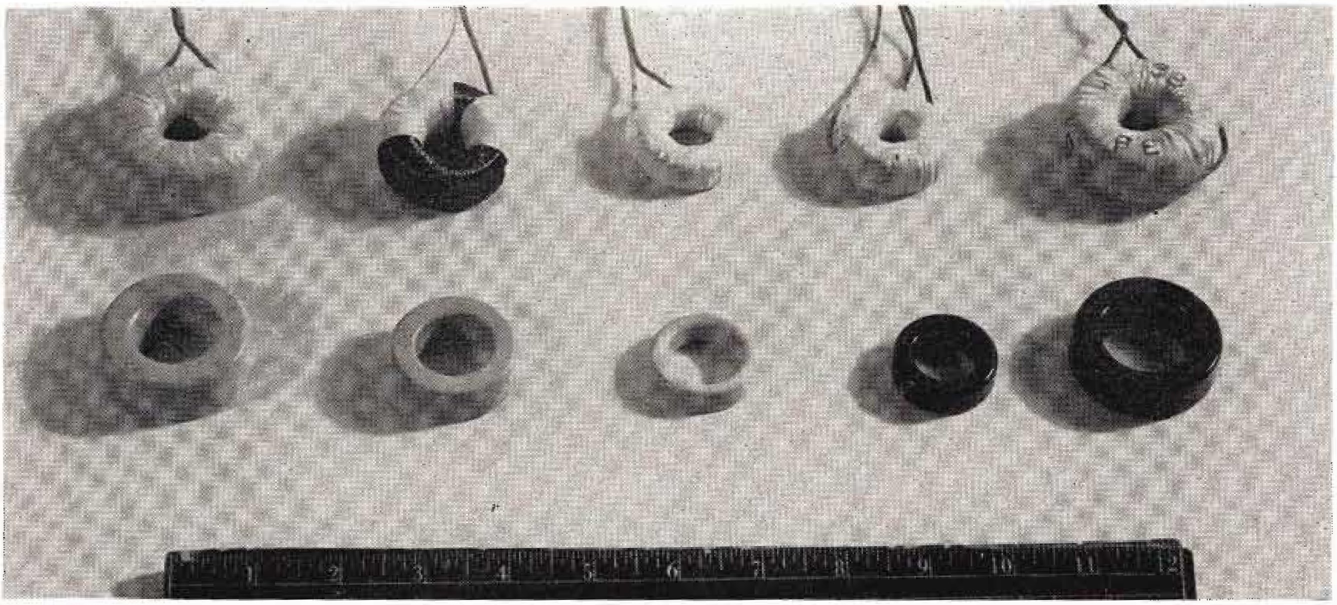


Fig. 1: Various sizes of coils showing core details before and after winding compared with a foot-rule for scaling purposes

By H. E. HARRIS, Apparatus Dept.*
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THE average communications engineer is prone to think that magnetic equipment design involves endless magnetic field plots, laborious calculations, and empirical corrections. To such a person, it may come as a surprise that a simple and effective procedure for the design of coils of optimum Q can be developed using the same type of techniques that would be applied to a problem in electric circuit theory. Such a procedure is the subject of the present paper.

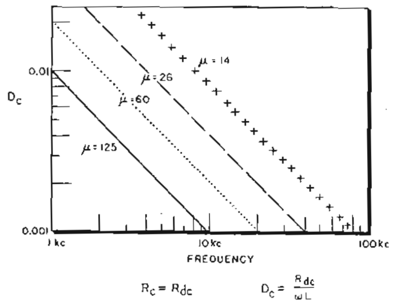
* This paper was prepared while the author was affiliated with the Research Laboratory of Electronics at the Massachusetts Institute of Technology.

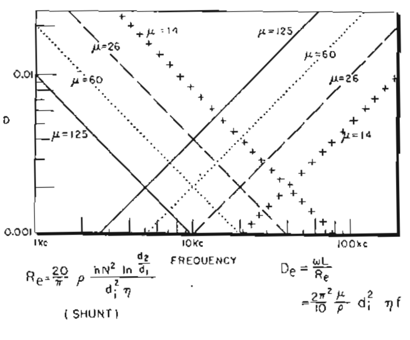
This work used as its point of departure two fundamental principles first advanced respectively by L. B. Arguimbau and R. F. Field.[1, 2] They are:

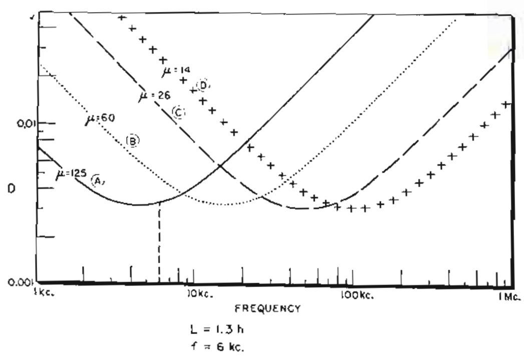
1. The use of the dissipation factor, D, (= 1/Q) in speaking of the coil losses.
2. The use of log-log paper to plot the various dissipation factors.

The use of dissipation factor in dealing with coil losses brings the advantages of superposition to the design of coils. In the usual design methods, an equivalent series resistance is used to represent the loss due to each cause such as hysteresis, eddy currents in the coil, etc. The complexity of the expressions for these series resistances, and the necessity for adding them all up and comparing with the coil reactance before arriving at a quantity which is readily interpreted (in this case the overall coil Q) make it very awkward to determine the effect that variation of any particular design parameter is going to have, or which factor should be changed to improve the design. Using dissipation factors, however, the losses due to each phenomenon can be treated separately, as if it were the only loss in the coil. The effect of every design

Figs. 2, 3, and 4: Design charts for toroidal coils. (left to right) Permeability at various currents; eddy current losses and copper losses.







Toroidal Inductor Design

Toroidal coils offer many advantages over more conventional forms and by using molybdenum permalloy for cores, precise control can be obtained

parameter on that loss is readily apparent and finding the net dissipation factor of the coil is simply a matter of adding up the dissipation factors due to the individual loss phenomena.

Best of all, like most superposition processes, the use of dissipation factor lends itself very well to graphical manipulation. The simplification this affords is especially significant if use is made of the second of the two principles mentioned above—the use of log-log paper to make the plots. The dissipation factor due to each of the loss phenomena of interest in the usual inductor can be expressed as a simple power function of the design variables. Plots of the individual dissipation factors thus become simple straight lines of known slopes. It is merely necessary to establish one point on the plot, either by calculation or measurement, and the whole graph may be drawn in at once.

By the proper use of these two principles, along with a few other simple concepts, it becomes possible to replace the usual tedious algebraic computations almost completely by a simple process of graphical manipulation based on a few initial empirical measurements. The accuracy is still as good; the results are much easier to interpret; and the design is considerably simplified.

In the discussion which follows, this new design approach will be applied to the particular case of coils wound on toroidal cores made from compressed powdered molybdenum permalloy[3]. Samples of such cores, and coils wound upon them are shown in Fig. 1. It should be emphasized, however, that this type of coil is used merely as an example. The same principles can be applied just as well to the design of any type of coil.

Design Procedure

The first thing to be done in applying this general procedure to a new type of coil is to express analytically the inductance and the dissipation factors which are expected to be of importance. For the more common types of coils, this will mean dividing the expression for equivalent series resistance used in the common design procedure by "w" times the formula for inductance. For other types a complete derivation from basic energy principles is necessary. These derivations are straightforward but are rather lengthy (although no more so than that for the usual design procedures), and cannot be included. Suffice it to say that the general method of attack is to set up, by an energy integration, an expression for the total coil power loss due to the particular effect under consideration. This is then converted to an equivalent resistance, either on the series, or parallel basis, by consideration of the terminal conditions, and finally to a dissipation factor by comparing with the reactance. Table 1 gives a summary of the results for the particular case of powdered iron toroids. The notation "series" or "shunt" indicates that it was possible to express that particular loss in terms of an equivalent resistance which is constant with frequency on the series or shunt basis. Some equivalent resistances are not constant on either. The equations shown are all in the unrationalized MKS system of units.

Some thought on the subject of coil design will show that all of the information that is required can be summed up in five main factors:

1. The type and size of the core
2. The number of turns
3. The total outside diameter of the wire

TABLE I

Inductance	$L = 2\mu_r N^2 h \ln\frac{r_2}{r_1} 10^{-7}$ ...(henries)... (1)
DC Copper Loss (series)	$D_c = \frac{R_{dc}}{\omega L} = \frac{1}{\pi^2}\frac{\rho_w}{\mu}\frac{\ell}{N n d_s^2 h \ln\frac{r_2}{r_1}}$ .... (2)
Eddy Current Loss in Copper due to Internal Flux	$D_s = \frac{\pi}{96}\frac{\mu_w^2}{\mu\rho_w}\frac{\rho d_s^2}{n N h \ln\frac{r_2}{r_1}}$ .... (3)
Eddy Current Loss in Copper due to External Flux (shunt)	$D_{ec} = \frac{\pi}{4}\frac{\mu f}{\rho_w} V_w \frac{d_s^2}{\gamma r_m A_c}\frac{B_L^2}{B_{mc}^2} f 10^{-7}$.... (4)
Eddy Current Loss in Iron Core (shunt)	$D_e = \frac{\omega L}{R_e} = \frac{\pi^2}{5}\frac{\mu}{\rho_i} d_i^2 \eta f$ .... (5)
Hysteresis Loss	$D_h = \frac{4}{3\pi}\frac{b}{\mu^2} B_m$ .... (6)
Distributed Capacitance Loss	$D_{cap} = D_0 \frac{f^2}{f_0^2}$ ..... (7)
Residual Loss	D_r = Constant Core of Material (8)

TABLE II

Strand Size for 10% Reduction in Q

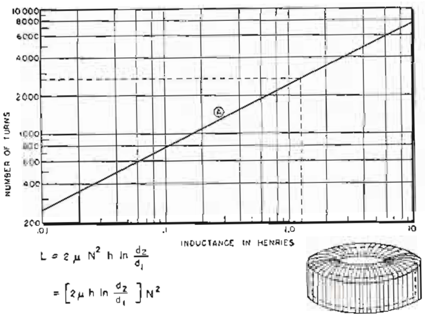
Core A	$\mu = 125$	No. 17
Core B	$\mu = 60$	No. 25
Core C	$\mu = 26$	No. 37
Core D	$\mu = 14$	No. 44

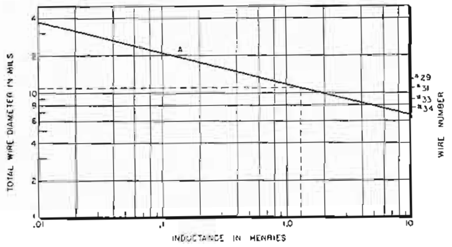
TABLE III

Percentage Reduction in Q with Changing Strand Size

Wire Size	Q-Predicted	Q-Measured
No. 41	0	0*
No. 38	8%	8%
No. 35	24%	20%
No. 32	56%	38%

* Taken as a reference.





Figs. 5 and 6: Mechanical design charts for number of turns and size of wire to use

4. The strand size of the wire, if Litz is desirable
5. Any limitations on the use or applicability of the coil.

Naturally the object of the design procedure will be to adjust these five factors in such a way that the total sum of all the dissipation factors of Table I will be a minimum for the conditions under which the coil is to be operated. Therefore, these factors will be considered in the above order, along with those particular coil losses which govern the selection of each.

To illustrate the application of the general principles, the design of an actual coil will be carried completely through the procedure, as it is explained, and the predicted results will be compared, wherever possible, with measurements made on an actual coil constructed according to the specifications which are derived.

One major assumption will be made at the outset. That is, that the cores will always be wound as full of wire as the winding machine will allow—in other words, the dimensions of every coil wound on a given core will be the same so that different inductances are obtained simply by changing the diameter of the wire and hence getting a greater or lesser number of turns from the same volume of wire. This is a perfectly reasonable assumption where high Q is the major design criterion, for except under the most exceptional circumstances, filling any core full of wire will give the highest Q possible with that particular core.

Resistance Losses

Under requirement 1, consider first the dc copper losses in the coil. It is obvious that this loss can be represented in terms of a resistance constant with frequency on the series basis. Therefore, the dissipation factor will be of the general form. $D_c = R_{dc}/(WL)$

The dissipation factor is thus inversely proportional to frequency. On log-log paper, therefore, the plot of dissipation factor versus frequency will be a straight line sloping downward to the right at an angle of 45° (slope equal to —1), such as the one shown in Fig. 2 for a permeability of 125.

There is one other interesting fact about this dissipation factor apparent from Equation 2, Table I. Under the assumption that has been made that the core will always be wound as full of wire as possible, it will be noted that there is no term of this equation that will change as the inductance is changed. In other words, one line represents the dissipation factor due to dc copper losses for all coils of whatever inductance wound on this particular size and permeability of core. (This is only strictly true if either all coils are wound with Litz or all with solid wire. In changing from one to another, a stranding constant, to be discussed in connection with Requirement 4 above, is necessary to account for the space wastage involved in stranding the wire.)

The dissipation factor will, of course, change for different cores, both with size and permeability. Suppose, for instance, that the permeability of the core were approximately halved from the value of 125 shown in Fig. 2 to, say 60. $D_c = R_{dc}/(WL)$ shows that the dissipation factor is inversely proportional to the permeability, so obviously the dissipation factor will be approximately doubled. Every point on the plot of Fig. 2 will thus be moved upward. But since it is a property of the log-log graph that equal multiples are everywhere represented by equal space increments, every point on the plot will be moved the same amount.

The effect of halving the permeability, therefore, will be merely to shift the original line upward and to the right. Successive halvings, (approximately) of the permeability from 125 to 60, 26, and 14, while

(*Continued on page* 107)

Table of Symbols

- A_c Cross-sectional area of the core
- b Hysteresis constant of core material
- B_L Peak value of leakage flux density of coil
- B_{mc} Peak value of flux density at mean radius within coil
- B_m Maximum value of core flux density
- C_d Distributed capacitance of coil
- d_i Diameter of particles in the iron core
- d_s Diameter of individual wire strand
- d_w Overall diameter of wire bundle
- D_o Dissipation factor of equivalent dielectric of coil
- E_{rms} rms value of coil terminal voltage
- f_o Self-resonant frequency of coil
- h Height of core
- l Mean length of turn
- n Number of strands in wire
- N Total number of turns
- r_1 Inner radius of core ring
- r_2 Outer radius of core ring
- r_m Mean radius of core ring
- V_w Volume of wire in winding including space wanted by stranding
- γ Stranding constant $= \frac{\text{total cross-section of strands}}{\text{total cross-section of wire bundle}}$
- η $\frac{\text{Volume of iron in core}}{\text{Volume of core}}$
- ρ_i Resistivity of core material
- ρ_w Resistivity of wire
- μ Absolute permeability of core
- μ_r Relative permeability of core
- μ_w Absolute permeability of wire

Page from an Engineer's Notebook

Number 13 — Pulse-Power and Duty-Cycle

Chart for determining average power in a pulse modulated system when peak power, pulse duration and repetition are known

By J. F. SODARO

Project Engineer, Electronics Dept., Hughes Aircraft Co., Culver City, Calif.

THE nomogram shown at right can be used to determine the average power for a pulse modulated system when the peak power, pulse duration, and pulse repetition frequency are given. Thus, it solves the equation,

$$P_{AVG} = P_P T f \qquad (1)$$

in which P_P is the peak power, T is the pulse duration, and f is the pulse repetition frequency for a rectangular pulse. Since the product Tf is the duty cycle, the chart also solves for this quantity.

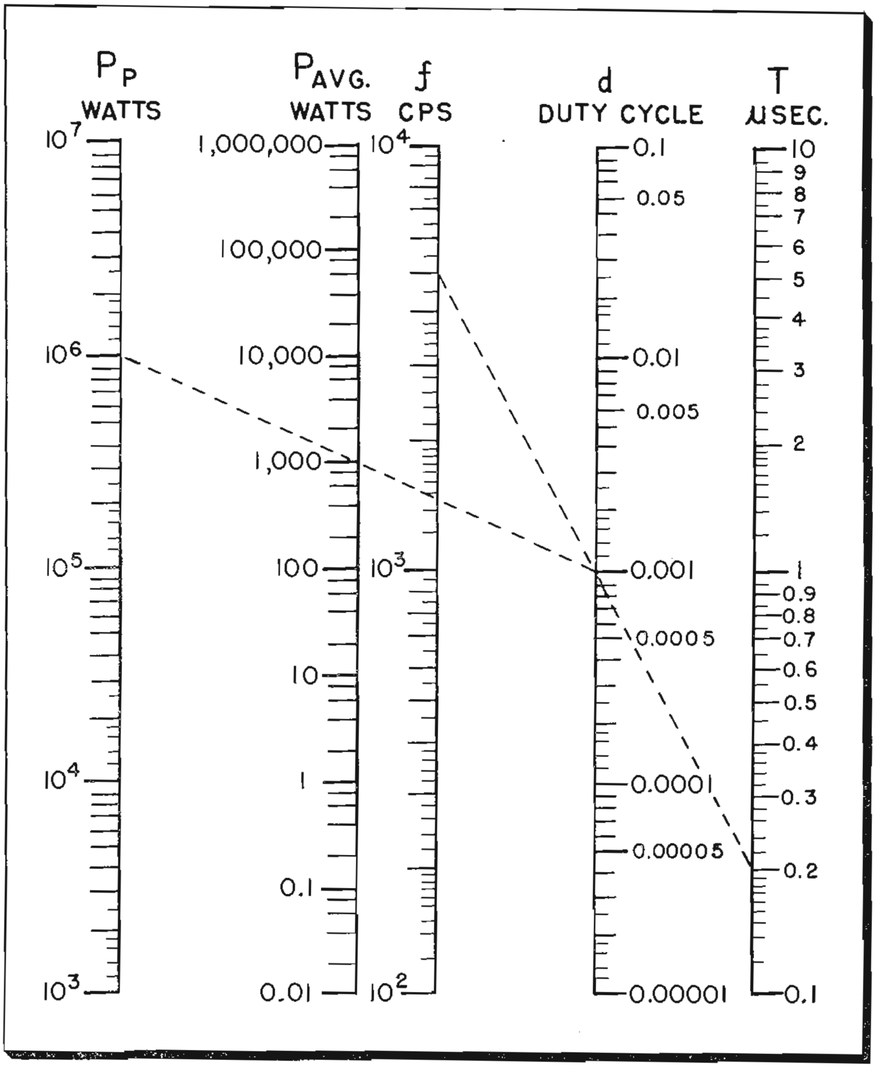
$$d = Tf \qquad (2)$$

On the other hand, if the duty cycle is given the chart can be used to solve the modified equation,

$$P_{AVG} = P_P d \qquad (3)$$

As an example, assume that it is required to determine the average power for a radar transmitter which has a prf of 5000 cycles per second, a 0.2 microsecond pulse, and a peak power of 1,000,000 watts. By joining 0.2 on the T scale and 5000 on the f scale with a straight line, a turning point on the d scale is established. This is a solution of equation (2), also, and gives 0.001 as the duty cycle of the system. Next, join the turning point and 1,000,000 on the P scale by another straight line. The intersection of this line with the P_{AVG} scale gives the average power for the system as being 1000 watts.

If the duty cycle has been given instead of the prf and pulse duration, the chart could have been entered on the d scale and the first construction eliminated. Other possible solutions are the determination of either the pulse duration or prf if one of these quantities and the duty cycle are given. Also, if either the peak power or the duty cycle is given with the average power, the unknown quantity can be determined on the chart.



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A High

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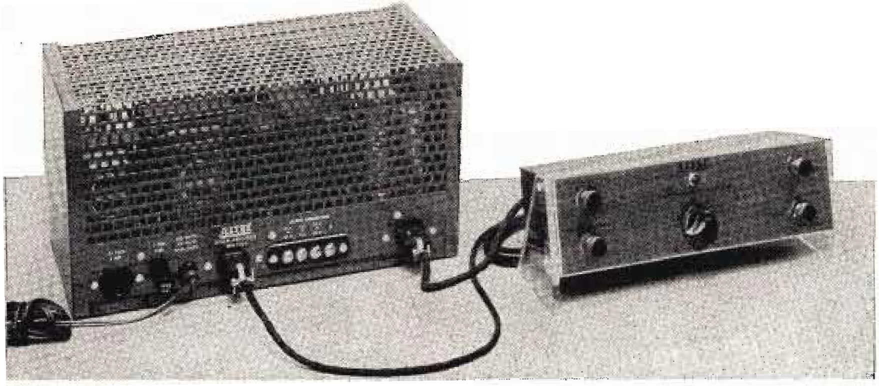


Amplifier and control panel which may be at considerable distance from each other

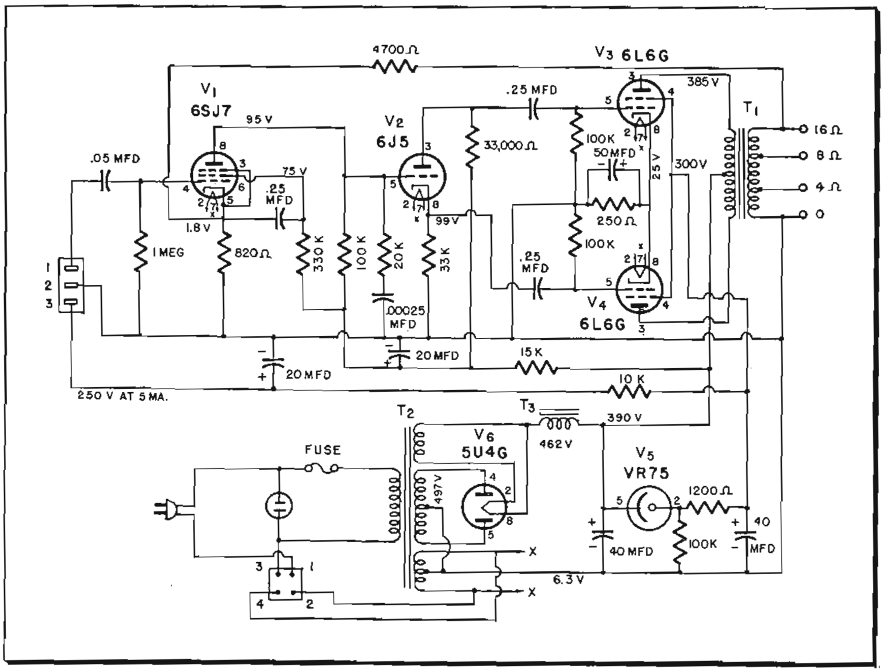
By *JAMES J. NOBLE and JOHN STORK*
Altec Lansing Corp., 9356 Santa Monica Blvd., Beverly Hills, Calif.

THIS article presents a discussion of the electrical and mechanical design of a high quality amplifier system now being manufactured. The components of this system are intended for flexible applications and primarily for phonograph and radio reproduction. Interest in high quality sound reproduction, once confined largely to experimenters in the motion picture and telephone industries, has extended to almost all who own phonograph records. Availability of loudspeakers, amplifiers, record players, radio-tuners and phonograph pickups, each of better quality but in total of lower cost than the assembled and expensively cabineted home console, has done much to expand this interest. We would like to show what is being done in a representative industry to produce amplifiers of excellent quality at reasonable cost.

Preliminary Considerations

In a project of this sort, preliminary considerations, occupying a period of several months, must occur before the designing and assembly of experimental models. The most general steps are a study of competing equipment on the market at the time of investigation, attentive examination of suggestions from men concerned in the manufacture and sale of such equipment, and regard for sales features and production economies which will obtain a wide market at a competitive cost. A final step, based on the considerations above, is a set of minimum electrical specifications for the amplifier.

Fig. 1: Circuit of power amplifier, note 6J5 phase inverter stage and balanced output



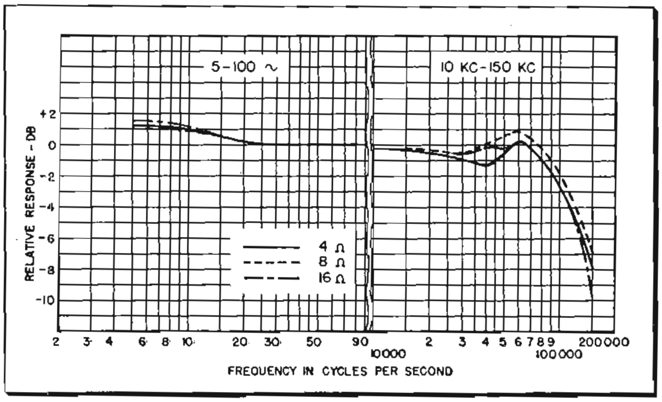
Radio catalogs and advertising literature indicate that amplifiers intended for home music systems are, in the main, divided into two groups—a less expensive set with power output ratings from 8 to 12 watts, and the more expensive group with ratings from 15 to 25 watts. Both fall under the generic title of *high-fidelity* amplifiers as opposed to public-address equipment, although there may often be little difference in performance. Less costly equipment is usually designed for high-level input such as radio-tuner or crystal-pickup signals.

Provisions are often made for the addition of external, non-adjustable pre-amplifiers. Tone controls are simple, providing, in some cases, both boost and droop in the bass and treble, but seldom a selection of crossover frequencies for phonograph equalization. The lower power amplifiers which have the best electrical characteristics use large output tubes, the tubes being operated considerably under their limits, and large output transformers.

More powerful amplifiers generally include pre-amplifiers for variable-reluctance pickup use. Provisions are made to accommodate several inputs of different levels, and in some cases the pre-amplifier, with all operating controls, is offered as a separate, small, remote unit. Tone controls are usually more complicated than in the lower power system, but still, in many cases provide no selection of crossover points. The most elaborate units incorporate such extras as noise suppressors, expanders, and loudness controls compensated for human hearing characteristics. The greatest number of amplifiers in both groups use beam-power pentode output tubes.

Quality Audio Amplifier

audio amplifier provides source of high-level, low-distortion
er components and at lower cost together with remote control



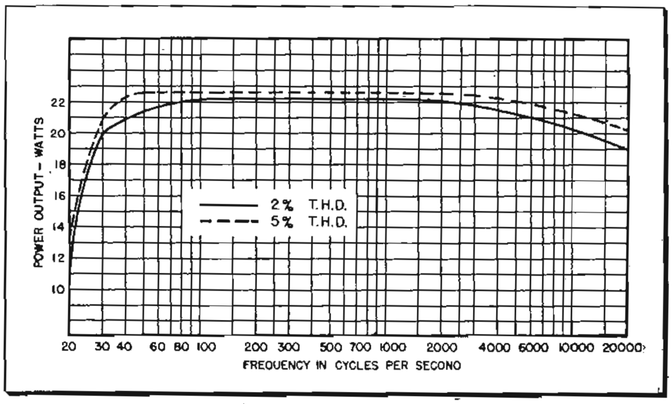


Fig. 2: (left) extended range frequency response characteristic of power amplifier at 0.313 volts (0 db.) across each output impedance
Fig. 3: (right) Harmonic distortion characteristics of power amplifier from 12 to 22 watts across 16 ohm output tap; note low distortion

A survey of advertising literature shows a trend toward the use of separate, remote pre-amplifiers which include all controls for the system, elaborate and complete phonograph equalizer circuits for magnetic pickups, power outputs as high as 50 watts, triode output tubes, loudness controls, noise suppressor circuits, and expanders. This seems to reflect the elaboration of detail and search for perfection exhibited in so many articles on individually built amplifiers appearing in technical magazines since World War II. The most prominent claims are those concerning frequency-response, with variations in tenths of a decibel from the sub-audible to supersonic ranges often stated. Also featured are remarkably low distortion below rated output, and high output damping factor. The frequency-response and distortion claims far exceed those presented by any manufacturer of microphones, loudspeakers and recording equipment.

The many valuable suggestions from individuals concerned with sales of this type of equipment follow the advertising trends. Their ideas on features which should appear in new amplifier design may be summarized briefly: divided interest on the use of triode output tubes; design of system in two units with small, remote pre-amplifier and controls; increased feedback over previous models to obtain extremely low distortion but not necessarily to furnish high damping factor; extensive bass and treble control systems; at least 20 watts output; and a deluxe professional appearance.

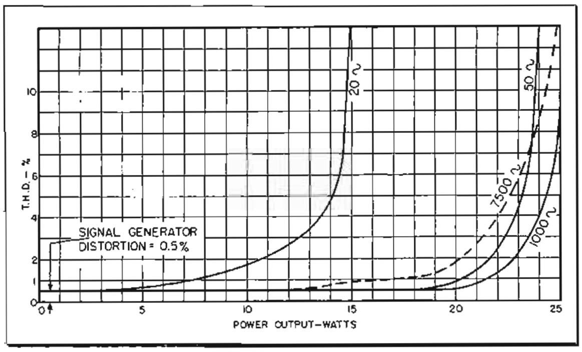
In regard to equalization for phonograph-recording frequency characteristics, it has been suggested that exact compensation be provided, and indicated on control panel markings, for major brands of American and foreign records when played with a magnetic pickup. This is a worthy dream and has even been incorporated in some commercial products. Its impracticality lies in the fact that all recording companies have changed their recording characteristics over the years, and even among records issued in the same period there will be pronounced differences due to variations among cutting heads, and due to temperature effects and the preferences of engineers at the time of recording.

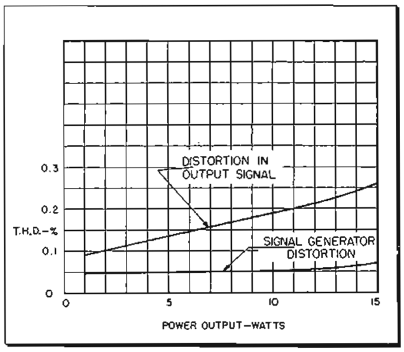
Meeting Established Specifications

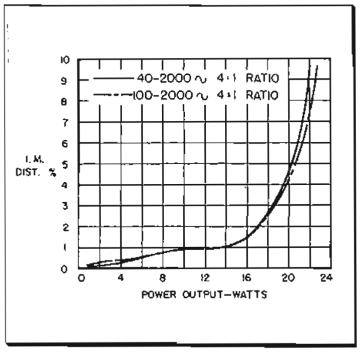
The points mentioned above must all be regarded as valuable sales features. The matter of establishing electrical specifications to be met in design must be guided by the philosophy that the amplifier in this case is a component of a many-link system in which it is desired to re-create as perfectly as possible the original sound of recording music and speech. Therefore, the design must anticipate the need to compensate for all manner of recording and reproducing methods and, to a certain extent, for loudspeaker characteristics and room acoustics. In addition economy, trouble-free service, and ease of repair require simplicity of circuits, use of standard components, and a minimum number of parts. The design objective does not need to be absolute, or laboratory perfection of electrical performance, but rather, quality which is indistinguishable from the ideal under user's conditions.

We do not wish to raise a long discussion of triode versus pentode output tubes here. The probability of the casual experimenter constructing an excellent beam tube amplifier, incorporating transformers of dubious or unknown specification, and lacking in complete laboratory facilities and design experience is small. Generally the reason for preferring triodes, among the amateur builder and designer, is the ease with which a satisfactory amplifier can be fabricated. Aside from this, the amplification factor of a good triode is nearly constant over the usual operating range, although the plate resistance will vary considerably.

Since the optimum load is two to three times the plate resistance, the distortion-producing effect of changing plate resistance will be somewhat smoothed out. At the same time, the impedance reflected to the load will be ½ to ⅓ the value of the load, thus producing effective damping. Pentodes, on the other hand, exhibit a large variation in amplification factor. They require loads which are but a fraction of their







Figs. 4, 5, and 6: Frequency distortion of power amplifier at different levels with 16 ohm output and 0.5% generator distortion, detailed distortion characteristics at 600 cps and 16 ohm tap, and intermodulation characteristics of amplifier with 0.03% generator distortion

plate resistance and consequently will be poorly damped. The varying amplification factor produces principally second order distortion which can be minimized by balanced circuits. Great advantages of beam pentodes are their higher efficiency and large amplification compared to triodes. These tubes may easily be driven to full power from a single driver tube without the use of transformers, a feat not readily achieved with triode tubes. We felt that the requirements of simplicity and small number of components necessitated the use of pentodes. We gain the advantages of greater efficiency and amplification and can control damping and distortion by negative feedback, combined with advanced transformer design.

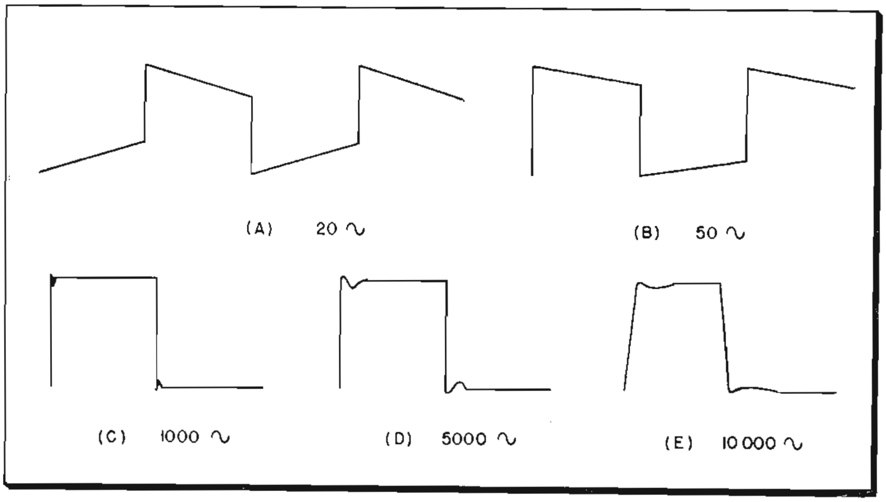
The increasing popularity of chair side cabinets, housing record players and radio tuners, led to the decision to divide the system into two units: the power amplifier, to be without any operating controls and of suitable dimension to fit easily into standard bookshelves or small cabinets; and the remote preamplifier, to be small in size and contain all controls.

Attractive styling of the remote unit for desk or table top use was considered mandatory, along with facilities for mounting in cabinets with panels of varying thickness. The principal factors to be considered were division of gain between the two amplifiers, and choice of small light-weight components and circuitry for the preamplifier.

Minimum Design Requirements

Based on suggestions and observations noted above, the basic specifications for minimum design requirements were as follows: frequency-response ± 1 db from 20 to 20,000 cps; power output greater than 20 watts at 2% total harmonic distortion from 50 to 7,500 cps; power-response at 2% harmonic distortion down not more than 3 db at 20 and 20,000 cps; maximum gain from lowest level input 120 db; 50 db noise to maximum signal ratio from lowest level input at maximum gain and normal phonograph equalization; and a distortion characteristic that drops off rapidly below rated output to a value less than 0.5%.

Fig. 7: 'Scope patterns of power amplifier responses to square wave across 16 ohms



It is possible, using maximum rated voltages, low impedance drive, and with no more than normal power supply regulation, to obtain 35 to 40 watts output with low distortion from two 6L6 tubes in a balanced circuit. With usual output transformer construction, however, it is not likely that the residual distortion at low power output will fall to a remarkably low value. To obtain this result, it is necessary to operate the output tubes under Class A or AB_1 conditions and to provide considerable feedback around the output transformer. Class AB_1 operation was selected for its high efficiency and tolerable distortion. Design objectives dictated sufficient initial gain to allow the use of large amounts of negative feedback and operation of tubes at rated voltage to assure long life. In order that the peak power handling capacity would not be impaired with the screen supply at a lower potential than the plate, some degree of screen regulation was required. A series VR tube was used for this purpose, as shown in Fig. 1. A point of considerable interest is the split-load phase inverter with direct coupling to the preceding stage which admirably satisfies the requirements of simplicity and economy. The power gain of the amplifier, without feedback, is 76 db. A gain and distortion reduction of 21 db is obtained through the use of negative feedback along with appropriate loudspeaker damping.

The large un-bypassed cathode resistor of the first stage might, under some conditions, be a source of considerable hum due to heater-cathode leakage. The fairly low voltage gain of the amplifier and large

(Continued on page 90)

NTSC Color-TV Specifications

Summary of standards to be used in testing all-industry compatible system in principal cities soon

DETAILED technical specifications of the signal to be used in field tests of compatible color television have now been released by NTSC (National Television System Committee). Tests will be conducted by NTSC over television stations in New York, Philadelphia, Chicago, Syracuse and Washington during forthcoming months.

In releasing the information Dr. W. R. G. Baker, NTSC chairman, stated that the specifications were unanimously adopted by the Committee, which consists of technical experts of the industry. The specifications will serve as the basis of tests to investigate field performance of compatible color television.

The purpose of publishing these specifications is to permit all segments of the radio-television industry, manufacturers, consulting engineers, and broadcasters, to participate in the tests.

The test specifications are divided into two groups, the first comprising the FCC standards now authorized for black-and-white television service. The second group consists of supplementary specifications relating to the transmission of color values.

Test Specifications — Group I
Summary of FCC Standards

1. The image is scanned at uniform velocities from left to right and from top to bottom at 525 lines per frame, 60 fields per second, interlaced 2-to-1.

2. Aspect ratio of image is 4 units horizontally; 3 units vertically.

3. The black level is fixed at 75% (±2.5%) of the peak amplitude of the carrier envelope. The maximum white (brightness) level is not more than 15% of the peak carrier amplitude.

4. The horizontal and vertical synchronizing pulses are those specified in Appendix I of the FCC Standards of Good Engineering Practice Concerning Television Broadcasting Stations (for black-and-white transmissions, dated Dec. 19, 1945 as amended Oct. 19, 1950), modified to provide the color synchronizing signal described in Specification 21 (Group II).

5. An increase in initial light intensity corresponds to a decrease in the amplitude of the carrier envelope (negative modulation).

6. The television channel occupies a total width of 6 MC. Vestigial-sideband amplitude-modulation transmission is used for the picture signal in accordance with Appendix II of the FCC Standards of Good Engineering Practice.

7. The sound transmission is by frequency modulation, with maximum deviation ±25 KC, and with pre-emphasis in accordance with a 75-micro-second time constant.

8. The radiated signals are horizontally polarized.

9. The power of the aural-signal transmitter is not less than 50% nor more than 150% of the peak power of the visual-signal transmitter.

Test Specifications — Group II
Supplementary

10. The color signal has the following composition:

$$E_m = E'_Y + \frac{1}{1.14}\left\{\frac{1}{1.78}(E'_B - E'_Y)\sin\omega t + (E'_R - E'_Y)\sin(\omega t \pm 90^\circ)\right\}$$

where

$$E'_Y = 0.59\,E'_G + 0.30\,E'_R + 0.11\,E'_B$$

Notes: In this expression the symbols have the following significance:

E_m is the total video voltage, corresponding to the scanning of a particular picture element, applied to the modulator of the picture transmitter.

E_Y is the gamma-corrected voltage of the monochrome (black-and-white) portion of the color signal, corresponding to the given picture element. This signal carries all of the luminance information.

E_G, E_R, and E_B are the gamma-corrected voltages corresponding to the green, red and blue signals intended for the color picture tube, during the scanning of the given picture element.

ω is 2π times the frequency of the color carrier. The phase reference of this frequency is such that the color synchronizing signal (see specification 21 below) corresponds to an amplitude modulated signal of the form cos ωt. t is the time.

The plus or minus sign (±) near the end of the expression indicates that the phase of this component is alternately advanced and retarded by 90° on successive scanning fields with respect to the stationary color phase alternation axis, (see Specification 20 below).

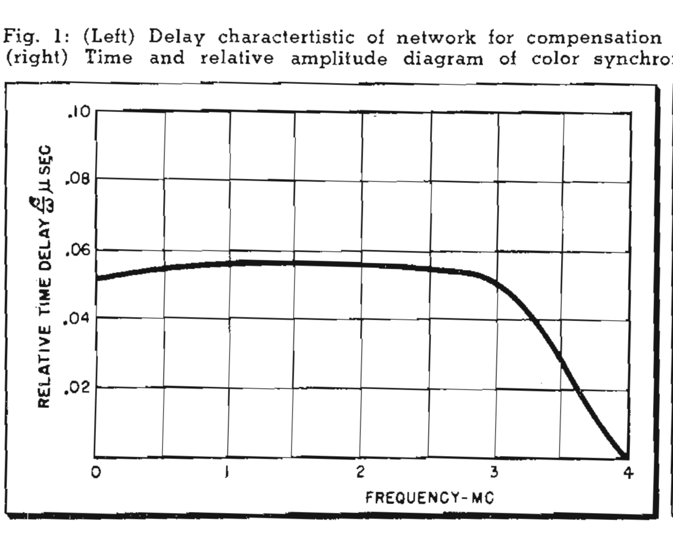
The portion of the expression between brackets represents the color subcarrier signal which carries the chromatic information.

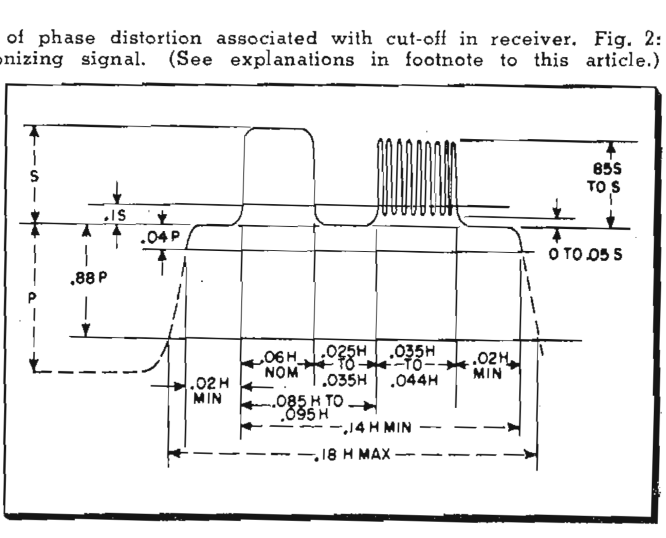
It is recommended that field-test receivers incorporate a reserve of 10 db gain in the chromatic channel over the gain required by the above expression.

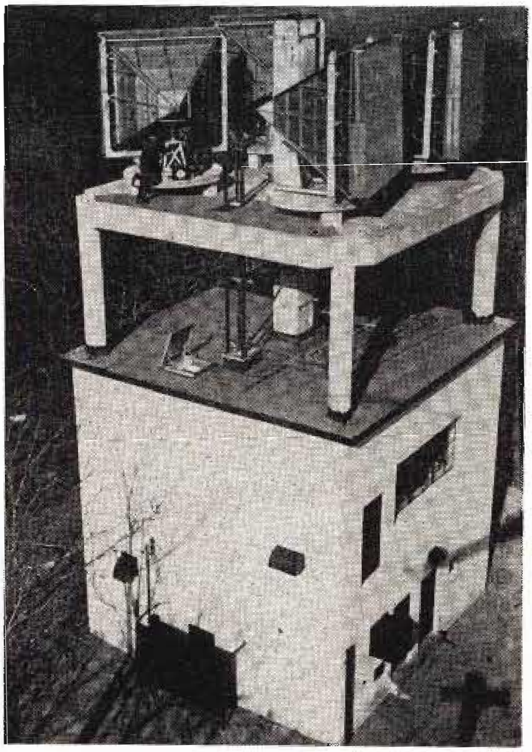
11. The primary colors referred to by E_R, E_G, and E_B have the following

(*Continued on page* 102)

Fig. 1: (Left) Delay charactertistic of network for compensation of phase distortion associated with cut-off in receiver. Fig. 2: (right) Time and relative amplitude diagram of color synchronizing signal. (See explanations in footnote to this article.)







Jackie Jones Mountain relay point near Haverstraw, N. Y. end of first jump; in link between New York City and Boston Mass.

MICROWAVES:

Modern television networking poses development. However, lessons learned

By JOHN H. BATTISON,
Contributing Editor

WHEN radio broadcasting was developed early in the "twenties", its exponents thought merely in terms of *local* coverage. It's true that some powerful stations such as WJZ and WABC provided service to great areas on their exclusive clear channels, but these were exceptions. The governing concept was single station coverage. If a station or sponsor wanted to blanket the nation he had to make individual arrangements with each broadcaster. Then the National Broadcasting Company came into being and laid plans for the *regular continuous* interconnection of many radio stations. Thus network radio was formed.

Since these early days when the telephone line was pressed into broadcasting program service and equalized out to 15 kc, many other branches and facilities of the common carriers have been converted to broadcast operations. For instance, when the first TV remote pickups were made from Madison Square Garden, in New York, two telephone lines were used as a pair to provide a video channel to the studio. It was probably good to 2 MC!

Then the coaxial cable was deemed a suitable medium for carrying signals in the megacycle region, and the A.T.&T. coaxial cables between New York and Washington were used—even for color in 1946. The writer well remembers a CBS color transmission when color TV pictures were sent from New York to Washington and back with no loss of definition after 800 miles of cable passage. And now, today, the microwave relays seem to be only common carrier facility which the telecasters developed first and which later were provided by the Bell Telephone System.

Radio had to blaze the trail; be it single telephone lines for audio or telephone pairs for video, or high frequency remote pick-up links for field events. Television has always found ready-made facilities in every region *except* microwaves. World War II forced the development of microwave equipment and techniques along rapidly. Of course, before the war and immediately preceding it, there were relays from New York to Boston, but these did not use the war-developed techniques.

Today, the major part of all remote television programs travel over microwave relays. A typical route might be a microwave pick-up from football field to studio, or a high reception point, such as the Empire State or RCA Buildings in New York. This link is generally provided by the broadcasting or "telecasting" company. From the receiving point another microwave link also owned by the station or leased from the Bell System may carry the signal to the master control unit. Or it may travel via coaxial cable.

At master control it is carefully combined with a suitable commercial abjuration and again poured into a pipe, or flung into the ether via a microwave "dish" with a gain measured in hundreds of db. The microwave link terminates at the transmitter and the signal broadcast is on a VHF television channel. However, if the program is one of national importance, it may be sent by means of the A.T.&T. relay system across country to the west coast or the midwest.

Network Interconnections

It is the established policy of the FCC to place all relay work in the hands of those best qualified to perform it. Consequently, the Bell Systems and A.T.&T. are invariably the chosen agents. This applies in most cases of straight network, or city to interconnection, but from time to time it becomes necessary to allow private interests to operate their own microwave relay systems. This occurs whenever a remote station with no other user in its vicinity, or relay continuation line, desires television interconnection service. The FCC always inquires whether the A.T.&T. is prepared to give service, and if the answer is "no", or "not yet" a grudging assent to the telecaster's installation is given. In many cases the operation is later taken over by the telephone company in the course of two or three years.

In this insistence on the use of common carrier principles, the FCC is well justified. In fact, its requirements are quite in line with the ideals which prompted the initiation of the common carrier system. After all, an organization which has experience in operating and installing, not to mention maintaining, a microwave circuit, is in a much better position to maintain it. Erection of circuit for the exclusive use of one organization, while not illegal, is less economical than one designed entirely for use by many different people. Thus while the FCC will allow telecasters to install their own microwave links, the requirement is always that it be amortized quickly. This was done so that operation could be abandoned as soon as it is economical for the telephone company to move in and provide service.

Many stations and services were hooked up with privately-owned links in the early days of television; among them were Schenectady and New York, Grand Rapids, Huntingdon, etc. But now, most of these and other links have been taken over by the telephone companies. The na-

Backbone of Network Television

problems much greater than those faced by radio in its early
by pioneer engineers point way to successful operations

tional microwave network operates in the 3500 to 4000 MC region while the equipment used by the telecasters was more often in 7000 MC region.

In connection with the long distance relaying of television sound and vision programs, a point which sometimes arouses interest in the minds of engineers is how the sound and pictures are synchronized when travelling from east to west, or vice-versa. Since video signals travel at the speed of light by microwave and sound travels by telephone line at a much lower rate, a serious desynchronization can occur by the time a few thousand miles have been traversed. One solution would be to put the sound on coaxial cable, but this would be somewhat wasteful of such facilities. Therefore, the sound is carried by a form of carrier transmission system and travelling by coaxial cable it is to all purposes synchronized with the video on reception.

Today, the telecasters' main interest centers around equipment for use in the field in picking up remote happenings. Here he has choice of many including Radio Corporation of America, General Electric, Federal, and Raytheon equipment. The Federal remote pickup equipment includes sub-carrier transmission of the sound portion of the program on the main video carrier. This was the first equipment of this type to offer such facilities and is proving very valuable.

Remote Pickup Equipment

When remote television pickups were in their infancy, telecasters were often put in quite an awkward position by the FCC's ruling that regular radio remote pickup facilities for AM might not be used for television sound. This meant that it was necessary to go to the expense and bother of hiring a telephone line or two from the Bell company to provide facilities for the sound. Fortunately this is changing and together with the new rules, and the Federal remote pickup equipment, such problems are not as common as they once were.

Although frequencies in the 1900, 7000, and 13000 MC bands have been designated for remote pickup television equipment operation by the FCC, it is only comparatively recently that operation in bands other than 7000 MC has commenced to any great extent. The frequencies 6875 to 7125 MC were the first to be actively explored for TV relaying and the famous RCA TTR 1 A is probably the best known of this field. Its spidery tripod parabolic "dish" have become familiar sights in many parts of the country. The fact that the receiver can be split and the i-f fed down a long line from a high receiving point

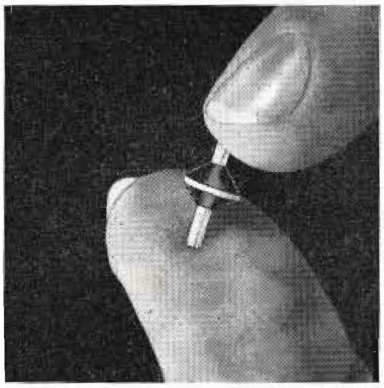
(Continued on page 113)

Terminal (left) of Charlottetown, P.E.I., Canada public telephone link (right) Typical microwave transmitting receiving "dish."


New Equipment and Components

Capacitors

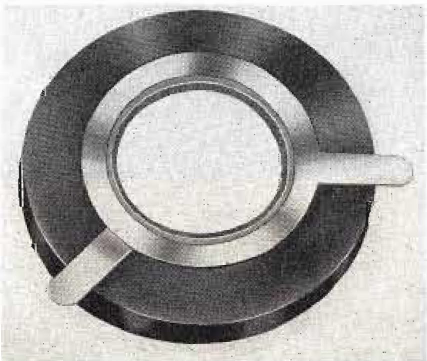
The "shirt-stud" is a new design capacitor for coupling UHF circuits in TV receivers and other electronic equip-



ment. Known as Type 502C, this tiny ¼ in. diameter ceramic unit is fitted with hollow connections to accommodate leads or pins from subminiature tubes. Available capacitance values range up to 22 μμf at 500 v., dc working. Performance characteristics are similar to those of Sprague Cera-Mite disc capacitors. Complete engineering information is available in Bulletin 605, available on letterhead request only.—**Sprague Electric Co., North Adams, Mass.**—TELE-TECH.

Yoke Cover and Centering Device

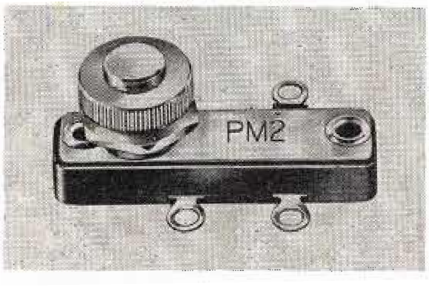
A combination yoke cover and centering device has been developed for electrostatic TV tubes. It provides accurate



centering of the picture on tubes of any size. The unit's uniformity of field assures distortion-free beam and it will not defocus beam. Easy mounting and one-finger centering adjustment are featured. — **Heppner Manufacturing Co., Round Lake, Ill.**—TELE-TECH.

Panel Switch

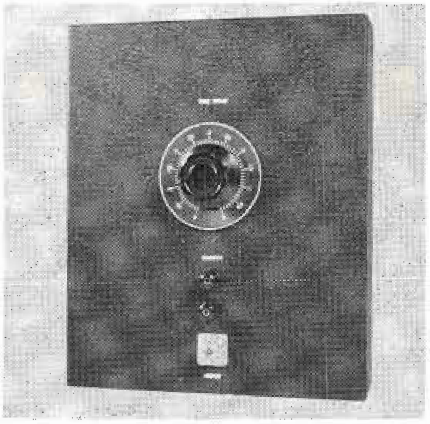
The new model PM Tyniswitch is a miniature panel mount type measuring only 1⅝ x 7/16 x ¾ in. and weighing approximately 17 grams. Compact de-



sign of this unit makes it ideal where available mounting space is limited. It is Underwriters' Laboratory rated at 15 amps. at 125 v. ac and 7½ amps. at 250 v. ac. Movement differential is .010 max. Operating force required is 7 to 11 oz. and release force is 2-3 oz. Unit is manufactured in SPST and SPDT Models.—**The Sessions Clock Co., Tyniswitch Div., Forestville, Conn.**—TELE-TECH.

Continuously Variable Delay Line

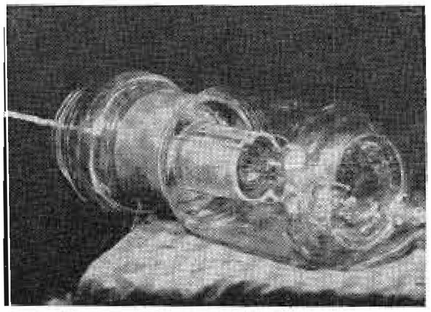
Type 302 is a distributed-parameter line capable of providing continuously variable time delay from zero to 0.6 μ sec. Its transmission characteristics are said to be superior to those of electron-tube delay circuits, ultrasonic lines, or other delay systems. Some of the advantages of this line are complete freedom of time jitter, very fast rise time, no limit on repetition frequency, greater bandwidth, and good transient response. It may be used for accurate distance measurements in radar or loran systems, for establishing coincidence of sweep and input signal in high-speed



oscilloscopes, and for measuring time interval with accuracy better than a small fraction of a microsecond.—**Advance Electronics Co., P.O. Box 394, Passaic, N. J.**—TELE-TECH.

Mercury Thyratron

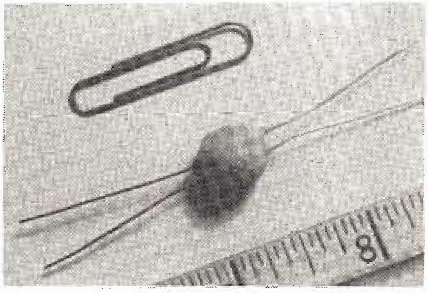
A mercury thyratron tube has been developed which can handle extremely high dc voltages and current. Known



as the MT-1530, it is a grid control tube with a peak anode voltage of 15,000 v. forward or 15,000 v. inverse. It can be built either as a negative or positive control tube. Grid is at the base of the upper half of the tube. It withstands vibrations normally encountered in industrial and commercial applications. Filament voltage is rated at 5.0 v.; filament current is 30 amps. Forward and inverse peak anode voltage is 15,000 v. Peak maximum plate current is 100 amps.; average is rated at 15 amps.—**Sheldon Electric Co., 76-86 Coit St., Irvington, N. J.**—TELE-TECH.

Miniature Pulse Transformers

PCA miniature pulse transformers are the first of a new series of transformers designed for low power application, to be used where space is a premium. Size has been reduced to 7/16 x 7/16 x 3/8 in.,



with weight less than 0.1 oz. These transformers have been built in a range from 0.2 μ sec. to over 5 μ sec. pulse widths, when used as a blocking oscillator. Two, three and four winding units with and without center-taps are obtainable to fit the particular circuitry requirements of your project. Special features are fast rise time, with a minimum decay providing a good wave form for specific pulse techniques. Standard frequency response is from 100 KC to 30 MC, which can be shifted to a higher or lower frequency range as may be required. These transformers may be built of class "H" materials for continuous operation at 200° C.—**PCA Electronics, Inc., 6368 DeLongpre Ave., Hollywood, 28, Calif.**—TELE-TECH.

Calibrator

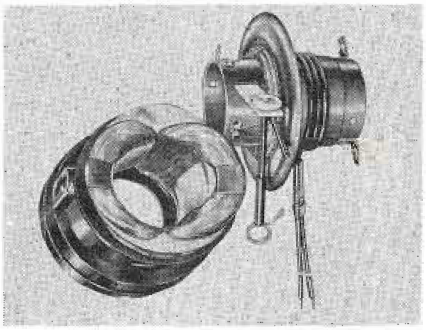
Model D-2 calibrator, an improved version of the model D-1 calibrator, is a device for the accurate generation of

pulse trains. Features include new mechanical design using plug-in type construction, improved ventilation, and an added selection of pulses available from the rotary switches. Seventeen different pulse rates are available. Coincidence circuits are used to render negligible the phase lags between the various outputs. This instrument is valuable for the calibration of synchroscopes and calibration of time delay generators. It may also be used as a secondary frequency standard, as a master timing oscillator for pulse equipment, for the generation of timing signals for oscillographic recording, and the detection of jitter in delayed signals. Simultaneous outputs having the following pulse spacing are available: 10, 100, 1,000, 10,000, and 100,000 μ sec. In addition, a selection of one of the following pulse spacings is provided: 20, 50, 200, 500, 2,000, 5,000, 20,000, 50,000 and 200,000 μ sec. A selection of pulses is also available for calibration purposes. Some of these (designated by "W" after the repetition period) are produced by a single shot multi-vibrator having a pulse width which is a function of the repetition period. They are 10, 100, 100W, 1,000, 1,000W, 10,000, 10,000W, 100,000, and 100,000W μ secs.—**Rutherford Electronics Co., 3707 South Robertson Blvd., Culver City, Calif.**—TELE-TECH.

for Designers and Manufacturers

Deflection Yoke and Flyback Transformer

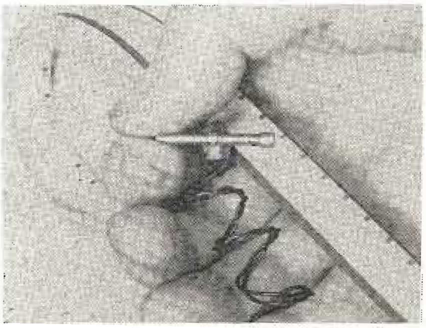
Deflection yoke DY-10 and horizontal output and high voltage transformer A-8131 are companion units used in di-



rect drive TV circuits. The two new components have extensive applications and are exact replacements in thirty-four RCA TV models, thirty Emerson models and seven Capehart models. Sancor DY-10 is an anti-astigmatic yoke with cosine windings and nylon insulation, designed to provide a sharp, well-focused picture over the entire CR tube. Specifications and a complete list of TV models for which these components are exact replacements are contained in Stancor Bulletin 389.—**Standard Transformer Corp., 3580 Elston Ave., Chicago 18, Ill.**—TELE-TECH.

Miniature Recording and Reproducing Head

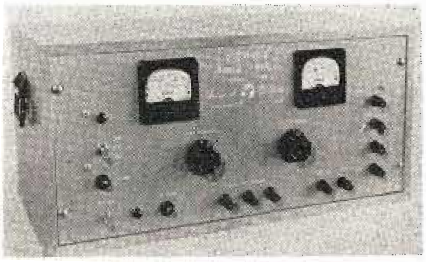
Increasing interest in use of magnetic sound strip motion picture film is responsible for the development of a



miniature recording and reproducing head small enough to mount in existing 16mm projectors. The actual size of the head is 3/8 x 3/16 x 3/8 in. including the triple lamination hum shield. By supplying the basic kit including the head and adjustable mount along with a simple equalization circuit, it is possible to use the photo-electric cell amplifier in most sound projectors for reproduction. Installations have been made on several of the well-known projectors with gratifying results. A second kit will be available which will include a recording amplifier and an erase head to permit recordings to be made directly on the projector.—**Stancil-Hoffman Corp., 1016 N. Highland Ave., Hollywood, Calif.**—TELE-TECH.

Regulated Power Supply

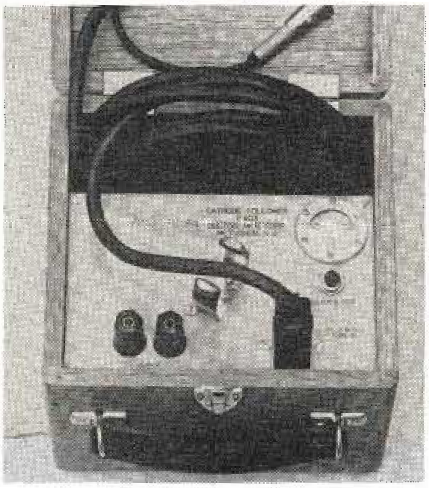
Model 100A5 regulated power supply furnishes continuously variable voltage from 0 to 500 v. dc at 0 to 300 ma. Bias voltage can be varied from 0 to 150 v. with 2 ma. max. Two independent outputs are supplied of low ac voltage that may be used separately or combined to furnish either 6.3 d at 6 amp. or 12.6 v. at 3 amps. Filament, line and load compensation circuitry are featured to se-



cure the supply's strict regulation of less than 0.2 v. variation of the high voltage from no load to full load, 0 to 500 v., or for line fluctuations from 105 to 125 v. Hum voltage is within 2 millivolts rms for any voltage or load within ratings. Internal impedance is less than 1 ohm dc and less than 0.25 ohm from 20 cps to 50 KC.—**Universal Electronics Co., 2012 South Sepulveda Blvd., Los Angeles 25, Calif.**—TELE-TECH.

Cathode Followers

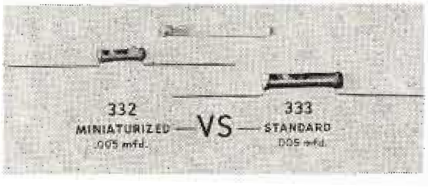
New cathode followers have been designed to terminate piezoelectric pickups and other high impedance devices into



standard electronic equipment. The F403 and F405 are battery powered and the F407 operates on 10 v., 60 cps. These units are completely self-contained in sturdy oak carrying cases, complete with high impedance probe. Battery models include panel meter indicating battery conditions. All three models feature high gain, high input inpedance, low input capacitance, wide frequency response, low noise level, high overload and are designed for utmost operating convenience as well as complete portability.—**Gulton Manufacturing Corp., Metuchen, N. J.**—TELE-TECH.

Miniature Capacitors

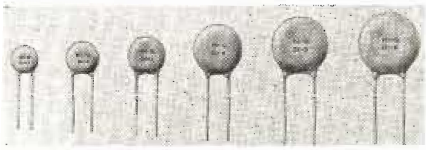
A new line of miniaturized ceramic capacitors has been developed under the trade name GP3 ceramicons. These capacitors employ a high dielectric constant ceramic material especially developed in the manufacturer's engineering laboratories. With this material, capacitance values as high as .002 µf. are available on a basic ⅛ x ⅝ in. long tube, and .005 µf. on a ⅛ x ⅝ in. long



tube. Available on special order since 1949, they are now being made in volume production quantities. Baked enamel, clear lacquer, dipped phenolic insulation or low-loss molded phenolic insulation can be supplied. Miniature GP3 ceramicons are flash tested at 1500 v. dc and are designed to withstand 700 v. dc life test at 85°C for 1000 hours. Standard capacitance tolerance is +80%, −20% and power factor is 2.5% maximum.—**Erie Resistor Corp., Erie, Pa.**—TELE-TECH.

Capacitors

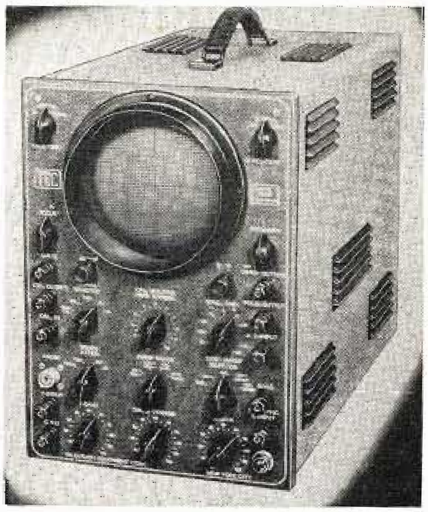
Temperature compensation disc capacitors are now available having a capacity range of 475 $\mu\mu f$ on the D1-6



N1400 material down to .3 $\mu\mu f$ on the D1-1 size with tolerances of ± 5% or greater. Conforming to RTMA Class 1 ceramic capacitors, they are conservatively rated for working voltage at 500 volts dc and flash tested at 1500 v. dc. Extended temperature compensating disc capacitors are being produced from a recently developed group of extended coefficient ceramics. This type of Hi-Q disc permits a much wider temperature compensating range than was possible on former normal linear temperature coefficient ceramics. Developed for applications requiring a very large gradient of capacity versus temperature, these new discs exhibit relatively higher dielectric constants permitting capacities in the range intermediate between the high K and linear or normal group of ceramics.—**Electrical Reactance Corp., Engineering Dept., Olean, New York.**—TELE-TECH.

Oscilloscope

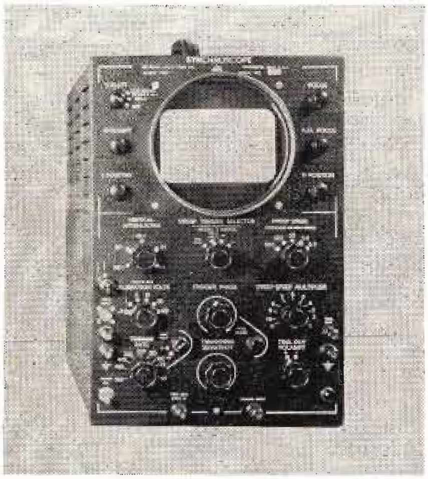
A completely redesigned, reconstructed improvement of the TEC T-601A, the new T-601B 5-in. oscilloscope provides



Y-axis response within 3 db from 2 cps to 12 MC at 10 millivolts r.m.s./in. deflection sensitivity. The sweep generator provides either recurrent sweeps from 10 cps to 100 kc or triggered sweeps from 10^5 µ sec. Phasing is provided for 60 cps sweeps and all sweeps may be synchronized to either positive or negative peaks. New features include front panel availability of sweep sawtooth and retrace pulses for convenience in synchronizing, sweeping or blanking external circuits with the scope. Price: $449.50.—**Television Equipment Corp., 238 William Street, New York 38, N. Y.**—TELE-TECH.

Synchroscope

Model P4-EX synchroscope is designed for those applications requiring a triggered sweep. An internal trigger generator with continuous adjustment from 50 to 5,000 pps enables the scope to be used as a timing source. The triggered sweep is continuously variable and calibrated from 1.0 to 25,000 μ sec. following the start of the sweep. A vertical amplifier with a flat response from 5 cps to 5 MC makes this unit useful for examination of various pulse waveforms. Used with a suitable crystal detector, it is possible to observe the modulation envelope of pulsed r-f sources such as radar modulators. A direct connection to a vertical deflection plate is also provided. Both deflection arrangements make use of a panel-controlled calibration source of 0.3, 1, 3, 10, 30 and 100 v.—**Browning Laboratories, Inc., Winchester, Mass.**—TELE-TECH.

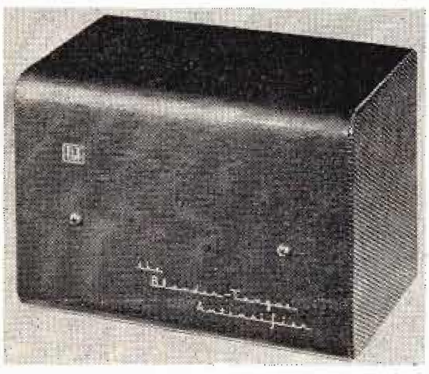


Logarithmic Attenuator

The Kay-Lab logarithmic attenuator or Logaten consists of a network of non-linear circuit elements adjusted to give an output voltage which is proportional to the logarithm of input voltage over a dynamic range of 50 db. Frequency response is from dc to 100 KC and is effective on both halves of a sine wave. All non-linear circuit elements being sensitive, this new Logaten is thermostatically controlled to make it independent of ambient temperature over a range of 32° to 100° F. An individual calibration curve is supplied with each device.—**Kalbfell Laboratories, Inc., 1090 Morena Blvd., P.O. Box 1578, San Diego 10, California.**—TELE-TECH.

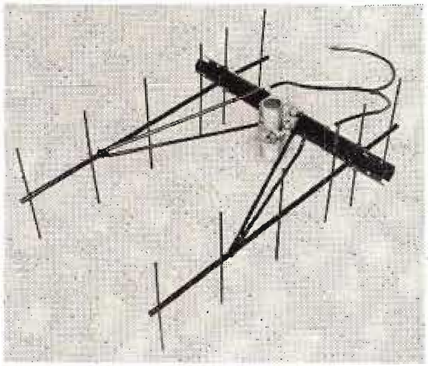
All-Channel Booster

Model HA-2-M is said to be the most powerful, all-channel, fully automatic TV booster on the market. It has no knobs or controls, and goes on and off with TV set operation by means of an automatic, silent thermo-relay power switch. Featuring an improved 4-tube chassis with 4-stage cascaded amplification, and a push-pull circuit, it has an average gain of 16 times (24 db) over all channels. This unusually high gain with the lowest possible noise factor is the result of 2 years of engineering development. Tube complement is 2 6J6s and 1 12AV7.—**Blonder-Tongue Laboratories, 38 North 2nd Ave., Mt. Vernon, N. Y.**—TELE-TECH.



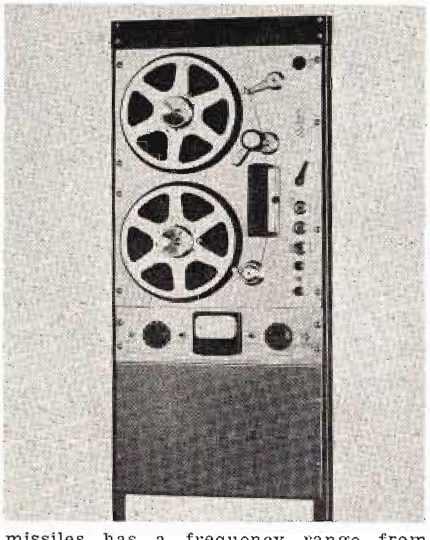
Directional Antennas

High gain and rugged construction are features of two new directional antennas for the 450-470 MC band. Model SPP-161 is a 12-element Yagi with a gain of 11 db. It is vertically polarized for commercial communications (with provision for horizontal polarization where necessary), matches 52 ohms with VSWR of less than 2 to 1, and can handle up to 250 watts of power. Model SPP-172 is a 24 element Yagi of similar construction to the SPP-161, and has a forward gain of 14.5 db. Both units are supplied with matching harnesses.—**Ward Products Corp., Div. of The Gabriel Co., 1523 E. 45th St., Cleveland 3, Ohio**—TELE-TECH.



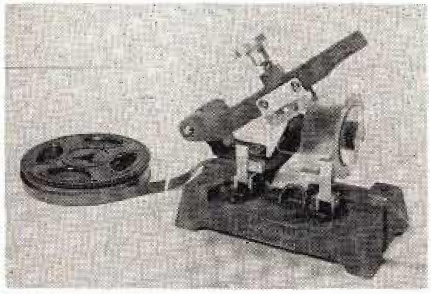
Tape Recorder

A new magnetic tape recorder (model 317) especially designed for recording signals telemetered from aircraft and missiles has a frequency range from 100 to 100,000 cps, thereby permitting the recording of all FM telemetering channels recommended by the Telemetering Panel of Research and Development Board. It is designed for three tape speeds: 60 in./sec. in addition to the usual 30 and 15. The major applications will be in the recording of FM signals which contain measurement data made on aircraft or missiles during flight which must be recorded on the ground. The extended frequency range of this unit makes it useful for recording many types of data which previously could be recorded only by means of a CR oscilloscope and moving film camera.—**Ampex Electric Corp., Redwood City, Calif.**—TELE-TECH.



Tape Splicer

A new non-magnetic splicer has been developed for the editing of tape recordings. Tape is spliced in horizontal grooves. Arm descends over tape and plunger is pressed down, cutting the tape diagonally. Then the tape is edited and splicing strip is placed over the second tape junction. Arm is pressed down again and the splice is completed. Sides are trimmed automatically to insure smooth winding on wheels.—**Alonge Products, 163 West 23rd St., New York, N. Y.**—TELE-TECH.

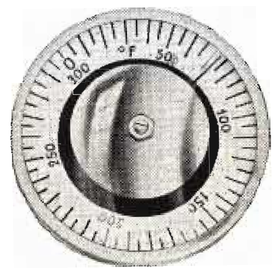


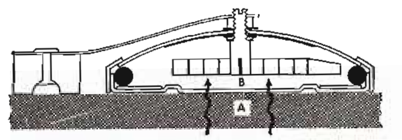
Servo Amplifiers

The 421-A and 423-A are universal, 400 cycle servo amplifiers, designed to drive two-phase servo motors requiring 6 and 9 watts per phase respectively. They feature independent, screw-driver controls on damping, gain and carrier phase, and thus can be stocked for use in all servo loops requiring their respective servo motors. Other characteristics include: maximum gain, 1000; phase adjustable thru 160 degrees; internal pickup below 2 millivolts; damping adjustable over side range. Their plate and filament power can be supplied by any power supply, with no regulation, filtering, or additional bias sources necessary. They will function with any carrier frequency data system, and yield servo loops of broad frequency transmission and low static and velocity errors.—**Industrial Control Co., Wyandanch, L. I., New York.**—TELE-TECH.

Pacific Transducer

A new surface temperature thermometer has been developed for the fast and accurate checking of the outside temperature of pipes, plastic dies, and rubber molds. It may be quickly and easily affixed to any flat surface by applying a small amount of silicone grease, which is supplied with the instrument, and sticking the thermometer in place. This silicone grease does not melt and so holds the instrument throughout all ranges of temperature, providing an excellent thermal coupling between the surface to be measured and the instrument. A small magnetic clamp is furnished which will hold the thermometer securely in place when applying it on steel dies or other ferrous surfaces. The thermometer may be placed on pipes carrying heated or cooled liquid by affixing it in place by either the magnetic clamp or the silicone grease. The range is 0° to 300° F calibrated in 2° increments.—**Pacific Transducer Co., 11927 West Pico Blvd., Los Angeles 64, Calif.**—TELE-TECH.





Cinch
ELECTRONIC COMPONENTS

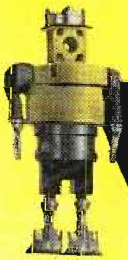
Photographs are one-half size, one fourth area of original terminal boards.

TERMINAL BOARDS

. . . Something of the scope of the Cinch operation in the design and production of electronic components is indicated by these photographs of terminal boards fabricated to meet exacting Armed Forces requirements.

Twenty years ago Cinch Engineers developed an idea . . . that gave the Radio Industry its first terminal strips for practical production. And so established Cinch strips and boards as standard over the years.

In Cinch components the user gets the utmost in quality, of insulation, tooling, fabrication, plating and printing, vacuum waxing, lug types, materials and workmanship. Cinch facilities and engineering experience and ability, assure the satisfactory fulfillment of any assignment for a terminal board or electronic component. *Consult Cinch!*



Cinch
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WASHINGTON

News Letter

Latest Radio and Communications News Developments Summarized by TELE-TECH's Washington Bureau

END OF "FREEZE" (now three years old) is slated to come early in 1952, according to FCC timetable as planned by Chairman Wayne Coy. During the first three months of 1952, FCC will concentrate its attention and efforts on solving the complex and controversial problems of television, Chairman Coy has emphasized. By the end of January or early February the Commission is aiming its efforts and procedure toward the issuance of the new television frequency assignment table on a final and binding basis to provide for more than 2,000 video stations throughout the nation. The new TV-frequency assignment table will include city-by-city allocations of video channels in both VHF and UHF, including technical standards for UHF television.

NO BIG FLOOD—Even though FCC Chairman Wayne Coy has been predicting that as soon as the "freeze" is terminated there will 1,200 to 1,500 new video stations telecasting in a few months, the concensus of expert television observers is that the public service operation of numerous new television stations will not come until 1953, probably the middle of that year, and the real big flood of new television stations in the UHF band will not occur until 1954. In ten years the FCC envisages there will possibly be 2,500 television stations in the United States.

BIG HURDLE—Growth of television, even with the upcoming thawing of the station construction "freeze," faces the most difficult obstacle of the shortages of metals and materials in the present situation of national defense mobilization. But television—demonstrated beyond doubt as the most important medium of mass communication for the public—has gained the ranking by the Defense Production Administration and the National Production Authority, the top defense mobilization agencies in the government, as "most essential" to the public welfare. As a result the industry will receive most favorably treatment feasible in the allocation of critical materials and metals. And when the "big pinch" in shortages lightens, probably by mid-1952, television will be given priority consideration by the defense mobilization authorities. This outlook has been pledged by DPA Administrator Manly Fleischmann, second in national defense mobilization command.

TO MEET SET GOALS—Even with extremely sharp cutbacks in allotments of critical metals for the first quarter of 1952, the radio-television manufacturing industry leaders feel certain the new year will witness the production of nearly 4½ million monochrome television sets and approximately 11 million broadcast receivers. Conservation of materials has been a major aim of the industry ever since the start of the Korean war and this concentration upon careful engineering and use of critical metals by the manufacturers and their research staffs has paid dividends in the continuance of civilian equipment production.

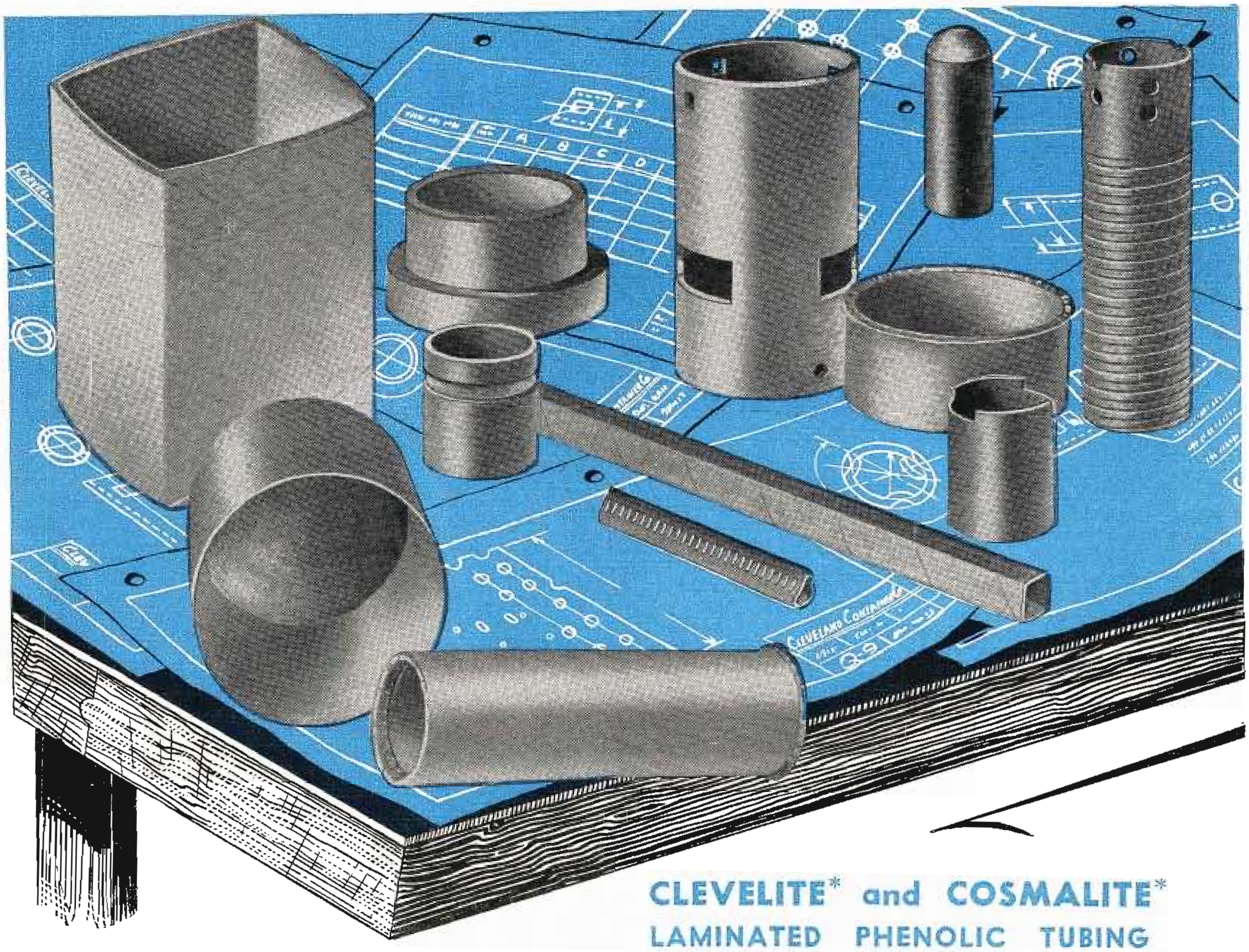
METAL CUTBACKS—But the first quarter of this year will witness drastic cutbacks of the allotments of metals as compared with the base periods of the last half of 1949 and the first half of 1950—copper brass will be only 35% of the base period, copper wire 40%, aluminum 35%, copper foundry products 20%, and carbon, alloy and stainless steel 50%. The defense mobilization authorities are also being urged to allow sufficient materials for television antennas to accompany the 4 million plus video sets to be manufactured this year.

URGE NPA RE-EVALUATION — The National Production Authority has been urged by its Radio and Television Set Manufacturing Industry Advisory Committee to obtain reports on the production of the types of radio broadcast, TV and cobination receivers instead of on the quantity of materials used in the production of these sets to aid the NPA in a re-evaluation of the quotas of critical materials and metals to be allocated to the industry. The set manufacturing advisory committee, composed of the top executives of Emerson, John Meck Industries, Motorola, Philco, Trav-Ler Radio, Radio Corporation of America's RCA-Victor Division, Zenith and Fada, reported to the NPA that suppliers of metals are requiring longer lead-time in meeting the needs of the manufacturers of components and materials.

WHITE HOUSE RADIO-TV SETUP—The President of the United States will have two rooms in the rebuilt White House (which is expected to be completed for occupancy by February) for his radio and television appearances. An elaborate system for the hooking up of cables and fixtures for television lighting has been installed in two rooms of the White House, respectively the diplomatic reception room and the original White House kitchen. When the construction and installation of the receptacles and fixtures and power supply boxes, all concealed behind drapes, are completed, the White House will be the only public building in the country where a mobile TV truck can drive alongside, plug in short cables and start picking up service.

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington, Editor



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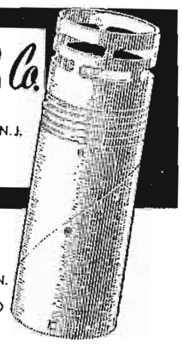

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TELE-TECH's NEWSCAST

NARTB Broadcast Engineering Conference

The sixth annual NARTB Broadcast Engineering Conference will be held in conjunction with the thirtieth annual convention of the National Association of Radio and Television Broadcasters at the Stevens Hotel, Chicago, Illinois the week of March 30th. The exact dates during this week on which the Engineering Conference will be held will be available later.

The Engineering Conference is designed solely for broadcast engineers in AM, FM and Television, and in the past has had a registration of 400 to 500 engineers.

Quality Components Conference

A second government-industry conference aimed at promoting continued improvement in the quality of electronic components, particularly for military equipment, has been scheduled for Washington on May 5-7, according to an announcement by J. G. Reid, Jr., of the National Bureau of Standards, chairman of the Conference Steering Committee. Like the previous session, held in May 1950, the conference is sponsored by the RTMA, the IRE and the AIEE with the active support of the Research and Development Board and other Department of Defense agencies and the National Bureau of Standards. The three-day meeting will carry out the theme "Progress in Quality Electronic Components" and will feature speakers from industry and government.

Murray to Head Future Military Reliability Studies

The Research and Development Board, Department of Defense, Washington, has established a clearinghouse for reliability information which will be responsible for the collection and dissemination of such information to laboratories concerned with government work. Dr. Albert F. Murray, Radio and Television Consultant, Washington, D. C., and Consulting Editor of TELE-TECH, who headed the previous study, and M. Barry Carlton of the RDB secretariat, have been assigned the task of monitoring future research and development programs in this field.

According to RDB officials concerned, improvement in reliability must include all the following links in the chain leading finally to the application of the equipment in the field: military characteristics, experimental models, specifications, manufacturing control procedures, service tests, final inspection, packaging and shipping, storage, installation, operational use and maintenance. Consequently, the combined efforts of the Munitions Board, Joint Chiefs of Staff, and the three Services as well as the Research and Development Board are required. These organizations are represented in the Group.

WCEMA PLANNERS MEET FOR 1952 CONVENTION

New officials make plans for the 1952 Western Electronic Show and Convention, formerly conducted as the Annual Pacific Electronic Exhibit and Western Convention of the IRE. It will be held Aug. 27-29, in the Municipal Auditorium, Long Beach, Calif. 1952 officials are shown above at a recent planning session: (1) Noel E. Porter, Hewlett-Packard Co.; (2) Leon B. Unger, Unger Electric Tool Co.; (3) Joseph H. Landells, Westinghouse Electric Mfg. Co.; (4) Dr. W. D. Hershberger, ULCA; (5) Dr. Leonard J. Black, University of California; (6) Heckert Parker, San Francisco & Los Angeles, Business & Show Manager; (7) Richard G. Leitner, Packard-Bell Co.; (8) Richard G. Huggins, Huggins Laboratories; (9) Barbara Brown, Recording Secretary; (10) Howard G. Grove, West Coast Electronics Co.; (11) Seymour Johnson, Consultant; (12) Norman Neely, Neely Enterprises, Los Angeles, Calif.; (13) Frederick G. Suffield, Radio Corporation of America, Los Angeles, Calif.

Coming Events

January 7-8—AIEE Conference on Electronic Instrumentation in Nucleonics and Medicine, Hotel Statler, New York, N. Y.

January 16—SPE, 8th Annual National Technical Conference

January 21-25—AIEF, Winter General Meeting, Hotel Statler, N. Y., N. Y.

March 3-6—1952 IRE Convention, Waldorf Astoria Hotel and Grand Central Palace, New York, N. Y.

March 10-13—NEMA, Edgewater Beach Hotel, Chicago, Ill.

March 30—NARTB Broadcast Engineering Conference, Hotel Stevens, Chicago, Ill.

April 19—IRE Spring Technical Conference, Cincinnati Section, Cincinnati, Ohio

April 21-25—SMPTE, 71st Convention, Drake Hotel, Chicago, Ill.

April 24-26—AFCA, National Convention, Philadelphia, Pa.

May 8-10—ASA, Semi-Annual Meeting, Hotel Statler, New York City

May 7-9—IRE National Conference on Airborne Electronics, Hotel Biltmore, Dayton, Ohio.

May 16-17—Southwestern IRE Conference and Radio Show, Rice Hotel, Houston, Tex.

May 22-24—ASQC, Sixth Annual Convention, Syracuse, N. Y.

June 23-27—AIEE Summer General Meeting, Hotel Nicolet, Minneapolis, Minn.

AFCA: Armed Forces Communications Assoc.
AIEE: American Institute of Electrical Engineers
ASA: Acoustical Society of America
ASQC: American Society for Quality Control
IRE: Institute of Radio Engineers
NARTB: Nat'l. Assoc. of Radio & Television Broadcasters
NEMA: Nat'l. Electrical Manufacturers Association
SMPTE: Society of Motion Picture & Television Engineers
SPE: Society of Plastics Engineers

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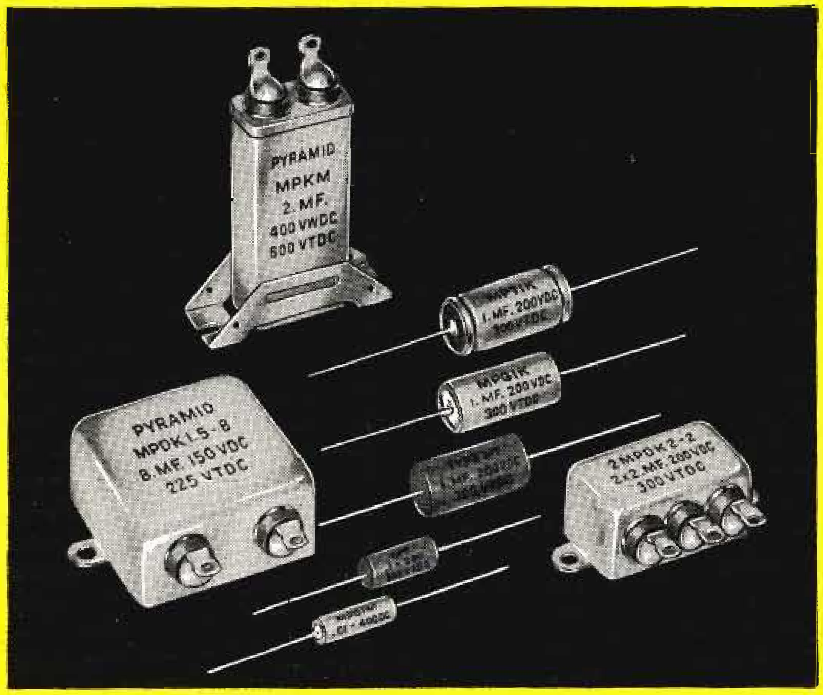

PYRAMID Series M CAPACITORS use a specially-prepared metallized paper, providing all-important savings in size and weight....Pyramid now produces large quantities of these capacitors in a wide variety of cardboard or hermetically sealed metal containers.

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Electrolytic Capacitors

(Continued from page 45)

terest to determine the permanent change in characteristics which might result from extended storage or operation in low temperatures. Also, in electrolytic capacitors the possibility exists that some modification (such as composition or concentration of electrolyte) made to improve low tempertaure performance may adversely affect operation at normal or high temperatures.

Storage and life tests were performed which consisted of storing units of each voltage rating at constant temperatures of 25° C, 65° C and —55° C. Similar units were stored both with and without normal operating voltages. It was found that changes with time under any test condition over a six months' period were of extremely small magnitude and for all practical purposes were considered to be insignificant.

Conclusions

The effective capacity of electrolytic capacitors is materially reduced when operated in an ambient temperature of —20° C and below, the degree of reduction varying over wide ranges, depending on the manufacturer and voltage rating. In general, the best performance is obtained at voltage ratings between 100 and 300, with the low voltage ratings 15-50 volts, giving the poorest performance. These statements apply only to those capacitors especially processed to improve low temperature performance, as capacitors not so processed provide a much lower level of performance at low temperatures than that indicated here.

Plain foil capacitors have a much greater stability under conditions of low temperature compared to etched foil types. This is particularly true at both the low and high voltage extremes. Plain foil types, however, compare unfavorably with respect to the ultimate capacitance per cubic inch at any temperature down to at least —40° C.

Extended storage or operation at temperatures as low as —55° C has a very small permanent effect on capacitor characteristics and apparently does not constitute a major problem. Deforming, chemical deterioration, loss of electrolyte or other physical damage appears to occur at the same or lower rates than that occurring at normal temperatures. Leakage current characteristics are improved by reduction in temperature.

The choice of COLLINS

FOR THEIR 35 KW H-F TRANSMITTERS

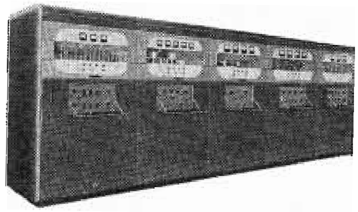
Used in the "Voice of America" Service of the U. S. Department of State—

Federal's

F-8C25

POWER TRIODE

Installation of Federal F-8C25 power triodes in modulator tube compartment of 207B-1 transmitter.



207B-1 35 KW high frequency broadcast transmitter manufactured by Collins Radio Co.

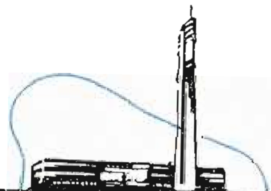
In the operation of the world-wide "Voice of America" service, an important part will be played by the 207B-1, a 35 kilowatt high frequency broadcast transmitter manufactured by Collins Radio Company, of Cedar Rapids, Iowa.

In the view on the right are shown the five similar side-by-side units of the 207B-1, bolted together to form the full AM equipment.

When the time came to select a modulator tube for the 207B-1 the choice of Collins was the Federal F-8C25—a forced air-cooled triode rated at 5 kilowatts anode dissipation. The F-8C25 has a thoriated tungsten filamentary cathode, requiring lower power and providing longer service life.

Federal Telephone and Radio Corporation takes pride in having worked with Collins Radio Company to assure the ruggedness, efficiency and stability required by one of history's most important applications of radio broadcasting.

"Federal Always Has Made Better Tubes"



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Rating by db Method

(Continued from page 43)

(Note: This may also be computed from the antenna's effective length of 9.55 meters, and impedance of 36.6 ohms resistive[4]). Performing the calculation gives the antenna-system rating of 10 log $2.35 \times 10^{-6}/(1.94 \times 10^{3})^{2}$ equals —122 db. This means the antenna output power is 122 db below the reference of 1 watt per microvolt per meter squared.

The receiver-system rating is 10 log watts output/ watts input, and since it is adjusted to deliver .5 watt output, its system rating is 10 log $5 \times 10^{0}/2.35 \times 10^{-6}$ equals +53 db.

The loudspeaker-system rating, is 10 log microbars squared/watts input[1]. The typical loudspeaker in the circuit delivers a sound pressure of 4 microbars per watt input at a distance of 10 ft. on its axis, at a frequency of 1000 cps. This pressure corresponds to a sound level of 86 decibels. This level includes the 10 foot path loss and the directivity index[3] of the loudspeaker at 1000 cycles. The loudspeaker-system rating is therefore 10 log $4^{2}/.5$ equals + 15 db.

The over-all system response rating is 20 log pressure output/pressure input[1]. Therefore 20 log 4/1 equals +12 db. From Fig. 1 this is also the sum of all the component ratings. Obviously this is true since the over-all circuit operates at a 12 db gain to give an output level of 86 db with an input sound level of 74 db. While this example assumed matched impedances and maximum directivities for the microphone, antennas and loudspeaker, the method is not limited to these conditions, as pointed out in the Romanow-Hawley paper.[1]

REFERENCES

1. Proposed Method of Rating Microphones and Loudspeakers for Systems Use, F. F. Romanow and M. S. Hawley, Proceedings, Institute of Radio Engineers, Volume 35, Sept. 1947, pages 953-960.
2. Measurements in Communications, N. B. Fowler, Electrical Engineering, Volume 66, Feb. 1947, pages 135-140.
3. Standards on Electroacoustics: Definitions of Terms, 1951, Proceedings, Institute of Radio Engineers, Volume 39, May 1951, pages 509-532.
4. Vertical Antenna Characteristics, N. B. Fowler, TELE-TECH, Volume 9, Sept. 1950, pages 39-40.

International Rectifier Expands

The purchase of a new factory building, located at 1521 East Grand Ave., El Segundo, Calif., has just been announced by International Rectifier Corp. The plant now occupied at 6809 S. Victoria Ave., Los Angeles, will be maintained for research and development. General sales and administrative offices will be located at the new plant in El Segundo.

LEADING TV MANUFACTURERS REPORT—

G.E.'s ELECTROSTATIC-FOCUS TUBES GIVE THE *Sharpest* FOCUS OF ALL!

17RP4/17HP4
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Comparative tests proved General Electric tubes far superior in needle-sharp distinctness!

FOUR large builders of TV receivers ran their own detailed tests of new G-E zero-focus types against other makes of electrostatic tubes. In every case, General Electric tubes gave pictures with *greater sharpness and definition over the entire viewing area!*

● Improved gun design, precision manufacture, share the credit for this G-E contribution to a TV industry that continues to move ahead despite metal shortages and a heavy defense load.

● Saving precious cobalt, nickel, and copper—needing no receiver focus control, which means simpler TV operation—General Electric's new zero-focus tubes have this third big advantage: they produce outstandingly clear, vivid pictures!

● Five types in popular sizes are listed above. Wire or write for complete facts about the tubes in which you are interested as TV designer or manufacturer! *Electronics Division, General Electric Company, Schenectady 5, New York.*

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The safety factor of a half-filled jug is built into every El-Menco Capacitor. Each unit is factory-tested at *double* its working voltage. You are assured of dependability in every application. El-Menco Capacitors offer peak performance for all specified military capacities and voltages.

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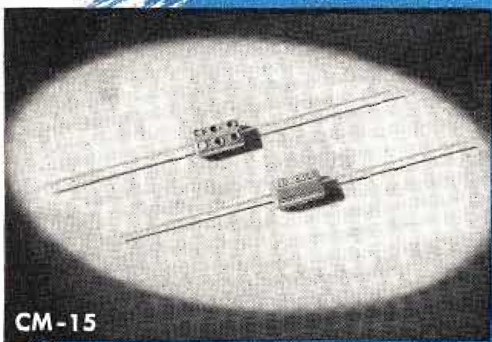
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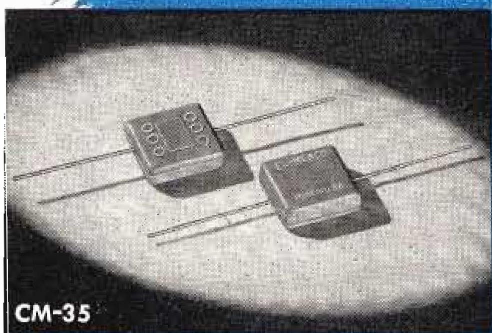
CM-35

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TELE-TIPS

(*Continued from page 8*)

TV IN 1960!—A remarkable 10-year study of the future of the radio-TV industry has been prepared as a thesis by six graduate students of the Harvard School of Business Administration, who did much research among top TV industry executives. The report is written from the interesting idea of a 1960 dateline. Marvin A. Asnes, one of the authors, has let us look over a copy from which we quote some passages:

COLOR-TV IN EVERY HOME—"Today (1960) there are 52,000,000 TV receivers in use. Almost every family in the U. S. owns a color and a black-and-white receiver. . . . Although the market has presently reached a saturation of 130%, sales in coming years promise to exceed 5,000,000 sets per year due to a high level of replacement demand and the expansion of the market with portable, farm, auto and other specialty sets."

TV NETWORKS IN 1960—"The national TV network has grown from four stations in 1946, to 958 stations today. These are organized in five networks (ABC, CBS, DuMont, Mutual and NBC) and one quasi-network (Keystone). The 958 stations reach 135,000,000 people, represent an investment of $519,300,000 and have annual total net time costs of $620,000,000. Their net annual time revenue is $790,000,000, leaving a profit of $170,000,000. The gross bill for telecasting is $1,438,000,000, paid for 33% by local advertisers and 67% by 2,114 national advertisers. This revenue is raised under a rate structure which averages $2.42 per-thousand-set-time for the major networks."

50,000 CHANNEL MILES—"The total networking facilities charge to the industry in 1960 was $29,600,000. Coaxial and microwave relay network consists of 49,500 channel miles connecting 501 cities. The present costs are (1) an average industry line charge of $31 per mile per month for 10 hours of daily consecutive service, plus (2) an industry average of $1,000 per month for the connection charges, the audio line and connections and the local video loop. The decade has seen the number of channel miles increase and a reduction in the relative charges made."

TV ON TAPE—"In 1960, paper magnetic tape is used extensively in recording TV programs. This tape was developed by 1952. Pictures resulting from replaying of a TV tape over a TV station were thus superior to those that would have been obtained if intermediate photographic film had been used. In addition, the tape could be easily edited."

PLUG-IN SUB-ASSEMBLIES—"Major innovation occurring during past ten years (1950-1960) in the service and repair of television sets, was the introduction of plug-in sub-assembly units which considerably simplified the work of repair shops. All the service man had to do was locate the faulty unit, remove it, and replace it with a new one. He charged the customer the difference between the price of the new unit less the factory allowance for the old one which he sent back for salvage and repair. It was first introduced into complicated electronic equipment used by the military forces which had such a tough time training competent servicemen to make detailed repairs to radar, guided missiles, gun controls, and so on, that it welcomed a simplified plug-in sub-assembly type repair which made it no more difficult than the locating and replacement of a faulty tube. The scheme proved so successful in military use that it was gradually introduced into commercial television. A great part of its success was due to the introduction of industry standards for plug-in units similar to that which had been used for tubes."

24-INCH TUBES LEAD—"Picture-tube sizes are standardized on the 16, 20, 24, 30 and 36-in. tubes, with the 24-in. tube being the most popular in the 1960 TV situation."

VIDEOPHONE SERVICE—"While there has been no general audio-visual communication for the public yet (1960), technical developments, lowered equipment costs and experience gained in the use of such equipment for industrial purposes indicate that the public may soon have videophones available, making it possible for a person to see the person he is telephoning. The effects on our society of a videophone system would be numerous. First, it will allow such things as shopping by videophone. Thus, the housewife will need only to call a store, select and have delivered the items she desires to purchase. This could have significant effect on both the location, layout, etc., of department stores. Actually, they would need but warehouses with television sound stages to display merchandise. Second, it would make possible direct rather than airway reception of entertainment programs. This could cause a vast upheaval in the structure of the present broadcasting industry. Lastly, as just one of many, it could bring about the unhappy circumstance of having the gentleman friend call when the lady's hair was up in curlers."

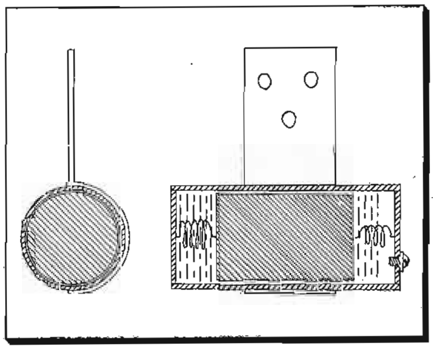
CREDITS—The foregoing are excerpts from "A History of the Television Industry, 1950-1960", submitted as a thesis to General Georges F. Doriot, Harvard Graduate School of Business Administration, Boston, by Marvin A. Asnes, William H. Hurt, Robert J. Irvin, Harold J. Kingsberg, James F. O'Crowley and Kenneth M. Stevenson.

CUES for BROADCASTERS

[*Continued from page* 49]

effect. This trouble is most likely to occur with those recording heads which are suspended by a spring to offset the weight of the head providing a means for adjusting the depth of the cut. The mass of the head combined with the suspension spring forms a mechanically resonant device that must be damped in some way to prevent this resonant condition.

Some manufacturers of recording equipment have developed dashpots with the plunger in an oil-filled container. The oil-filled container is secured to some fixed part of the housing of the recorder, and the plunger is mechanically fastened to the recording head, thereby damping the vertical oscillations. This type of damper is not always convenient when recorders are used for portable work since they usually must be removed from the machine before it can be packed. To overcome this undesirable feature the dashpot shown was made and proved to be very satisfactory in eliminating all apparent vertical oscillation of the head.



Dashpot assembly for sampling recorder

The oil container was made of one-in. inside diameter brass tubing with a bottom disc sweated in place. Inside this tube was a smaller brass tube with clearance between the two of about 1/32 in. This inner tube was filled with lead to add as much weight to it as possible. The relative sizes of the two tubes are shown in the sketch. Lightweight coiled springs of phosphor bronze were wedged in the two ends of the lead-filled tube, and this tube was placed inside the outer one, and the top cover sweated in place. The screw hole in the top cover is intended for filling the device with SAE 20 cylinder oil, nearly to the top. An air space must be left to provide for expansion and contraction due to temperature changes. A brass strap, as shown in the sketch, was sweated to the outer cylinder as a means of attaching it to the recording head. The dashpot is not attached to anything except the recording head.

The action of the device is as follows: When the head tries to oscillate vertically, it must also move the heavy inner plunger. The inertia of the plunger prevents rapid movement. The plunger tries to stay in one place, and, if the head moves, it must force some of the oil from the top side of the plunger to the bottom. Since this requires work, it offers enough mechanical impedance to prevent oscillation. The added weight of the dashpot can be compensated by increasing the suspension spring tension or replacing the spring with a stronger one.

Dimensions of this device are not critical, although it may be desirable to experiment to find the optimum dimensions for individual applications.

Simple Copy Rack

G. J. CASSENS, Chief Engineer, WLDS, Jacksonville, Ill.

A simple copy rack can be made from an old 16-in. aluminum base transcription disc. Place disc in a vise between two pieces of wood. Bend over one third of the disc for a base at an angle of approximately 110 degrees. Holes can be drilled in the base section for mounting on the announcer's table or on top of the control console.

CUES in Book Form

Editors, TELE-TECH:

As a former Broadcast Engineer and Chief Engineer, I find reading your column, "Cues for Broadcasters," an invaluable aid in keeping up with things. Is it possible that one day enough of these "Cues" will be in your files to enable a book to be published under the same title?

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LEON A. WORTMAN
Audio & Video Products Corp., 730 Fifth Ave., New York 19, N. Y.

Ed. Note: Plans to publish "Cues for Broadcasters" in book form have not been finalized as yet, but it is expected that such a volume will be made available in the near future. Meanwhile, a limited number of tearsheets for the back issues of "Cues for Broadcasters" are available and will be forwarded on written request.

Coaxial Tetrode

(*Continued from page* 53)

ing bar, plus two shunt capacitances in the general case, although these are not always required in practice.

Assuming in the first instance, for simplicity, that the series inductance is zero and the shunt capacitances are all zero, including the tube interelectrode capacitances, and also that the line is one wavelength long and therefore resonant, then evidently the voltages across the ends of the line will be equal and in phase. Hence the resultant screen-grid-to-cathode voltage will be zero. Considering now the effect of the anode to cathode current, the fundamental component of which has to pass through the network, it is clear that a field will be excited in the line by the passage of the current, and careful consideration will show that this field is in phase with the field set up by the source of driving power. The feedback is therefore positive or regenerative. Turning now to the equivalent circuit in Fig. 5, it is clear that the behavior of the actual circuit can be completely expressed by the equivalent circuit if we assume that both circuits are resonant, $M = 1$ and the coupling is in such a sense as to give a phase reversal. The resistors in Fig. 5 between cathode and each grid represent the loading due to grid current flow together with circuit losses, and it is evident that unless the circuit losses are large the amplifier will self-oscillate. This is borne out in practice. To make a stable amplifier with a relatively large bandwidth it is therefore necessary to reduce the amount of positive feedback to the correct amount.

This can be done by means of the network of L and the two Cs at the folding point of the line, and by arranging the circuit so that the effective grid-to-cathode circuit is resonant and the effective grid-to-screen grid circuit is off resonance. Remembering that the driving power is applied between control-grid and screen-grid of the tube, in effect, because this gives the simplest mechanical arrangement, the LC network at the folding-point may be considered as a means of adjusting the relative amounts of power flowing into the resonant grid-cathode circuit and into the not necessarily resonant grid-to-screen-grid circuit. If the voltages across these circuits are not equal and in phase, there will be a resultant screen grid-to-cathode voltage which will modify the anode current according to the

(*Continued on page* 82)

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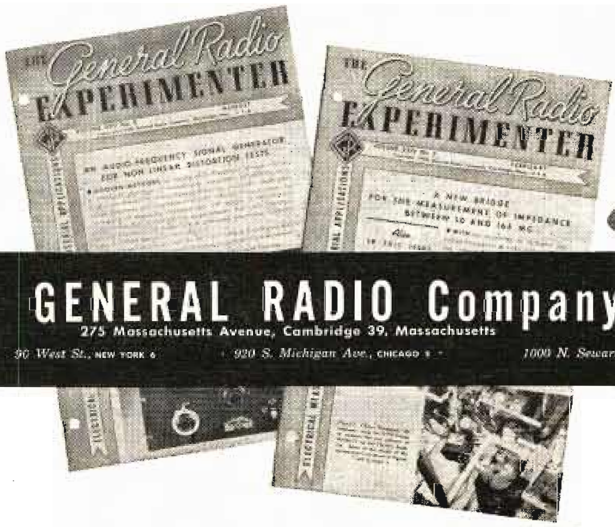

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Your Exact Position ______________________ transconductance of the tube measured between screen grid and anode. If this resultant voltage is out of phase with the control-grid-to-cathode voltage, the gain through the stage will be reduced, the net amount of positive feedback will be reduced, and the bandwidth will be increased. Essentially then we may regard the amplifier as containing a tube with two control grids, (having unequal control over the anode current) the r-f voltages on these grids being so proportioned and phased by the external circuitry that the resulting power gain is brought to the desired amount. Since basically the bandwidth is inversely proportional to the power gain, we may restate this as control of power gain bandwidth ratio by circuit adjustment or again, as control of this ratio by control of feedback. This is in contrast to amplifiers in which the ratio is controlled by adding resistive loading to the input circuit.

The manner in which this is done is very simple. To decrease the power gain the length of the inductive stub is increased by moving the shorting bar (Fig. 4) away from the tube. If this does not have enough effect, capacitance may be introduced between the open end of the grid conductor and the cathode conductor. Alternatively if an increase in positive feedback is required, capacitance may be added between the end of the grid conductor and the outer containing cylinder. In all cases the length of the telescopic grid conductor is adjusted for maximum control grid current at the center frequency of the pass-band.

As an extension of the theory, it may be proved that by making the folded back coaxial line effectively $(2n + 1) \cdot (\lambda/2)$ in overall length, the circuit will possess inherent negative feedback, and will be analogous to the circuit shown in Fig. 2. If the folded line is made $(n + 1)$ λ long, as in the case analyzed above, the inherent feedback will be positive. The arrangement used in a particular amplifier will depend primarily on the circuit and tube losses. At frequencies where these are low it may not be possible to use the positive feedback arrangement because of instability or too low a bandwidth; conversely at UHF where the losses may be large it may be impossible to achieve enough power gain unless positive feedback is used.

An interesting aspect of these feedback amplifiers is that the feedback is provided by the pulsating electron stream; they are therefore

(*Continued on page* 84)

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distinct from feedback amplifiers in which the r-f fields in the input and output circuits are coupled together by some physical element such as a loop, probe, or a common reactance. These latter amplifiers are all subject to the disadvantage that the amount of feedback depends on the loading of both circuits and on the magnitude of the r-f circulating currents. In the amplifiers under discussion however, the feedback is almost independent of the loading, tuning, or L/C ratio of the output circuit especially when a tetrode is used in which the anode current is substantially independent of anode voltage. This makes for relative ease of adjustment.

It is clear that feedback may be introduced into any r-f amplifier by suitable coupling elements between the circuits, and in practice the problem is to do this in a convenient manner which is preferably not too frequency critical. It has been found that a convenient method is the use of a reactance common to the two circuits, and an illustration of this is the application of positive feedback to the amplifier shown in Fig. 2 by the use of a screen grid bypass capacitor which has a critical value of reactance. Subject to the disadvantages mentioned above, this system is of considerable practical value and when the feedback is carried further, produces a satisfactory oscillator. Likewise, the introduction of a critical screen grid bypass capacitance to the circuit of Fig. 4 will introduce positive feedback in addition to that already present due to the electron stream, and this also if carried far enough, results in a satisfactory oscillator as already described elsewhere.[2]

Broad Banding Techniques

It has in the past been considered undesirable to use coaxial line elements in amplifiers for bandwidths of the order of 1 to 10% of the center frequency because of the energy storage properties of such elements, but at frequencies where the tube is effectively a quarter of a wavelength long, it becomes essential to use coaxial line elements and it is therefore necessary to consider how to minimize the effects of the stored energy. The situation has been stated by Harman[3] and Van Weel[4] whose work shows the importance of careful geometrical design of the circuits, particularly when lines longer than ¼ wavelength have to be used, such as in the amplifier described above. In-

(*Continued on page 86*)


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attention to this may result in power gain times bandwidth products of the overall amplifier which will be a small fraction of what can be achieved by correct design. Some practical points are as follows:

1. The shortest possible lines should be used in terms of wavelength.
2. Because the Q of a coaxial line element is always a function of its characteristic impedance and has a maximum at some specific value of the latter, the characteristic impedance used should be chosen to be as far away from this maximum as is practical.
3. All coupling lines and matching arrangements between stages and between an amplifier and its load, should be designed for minimum standing wave ratio and minimum length.
4. In cases where coupling lines between stages are unavoidably long, a considerable improvement may be made by the use of compensating stubs.

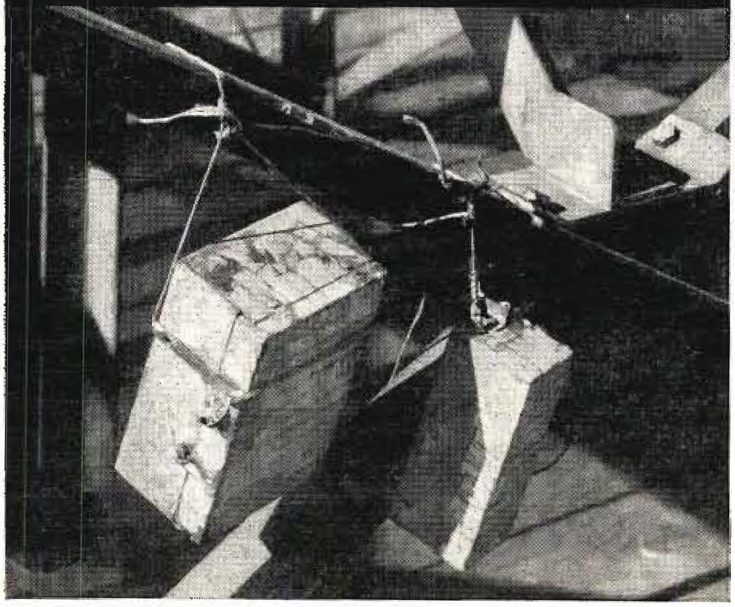
It is clear that an amplifier may be divided into two parts—the output circuit and the input circuit, each with distinct bandwidths, usually different. The output circuit bandwidth is determined entirely by the effective impedance of the tube considered as a generator, by the load impedance and circuit losses, and the effective shunt capacitance of the tube itself and the output circuit. If a bandpass circuit is used the frequency characteristic will be modified accordingly. The input circuit bandwidth, on the other hand, is determined primarily by the losses in the tube control-grid-to-cathode region, by the circuit losses, and by the effective Q of the circuits and by the amount of feedback. From this distinction it follows that the bandwidth of the output circuit, other things being equal, can be increased by overloading the tube at the expense of efficiency, but that increasing the bandwidth of the input circuit can be achieved only by adding losses to the circuit or by decreasing the amount of positive feedback, or increasing negative feedback.

In the amplifier under discussion, these techniques have been applied in the following manner, in the practical example using the Eimac 4X150G tetrode shown in Fig. 4.

The input circuit geometry has been designed so that the characteristic impedances of the lines are low, namely, about 10 ohms; the feedback has been adjusted to the cor-

(*Continued on page* 88)

motorola 2-way radio



Weather Exposure

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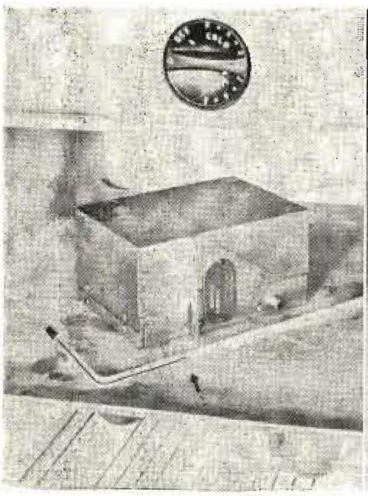
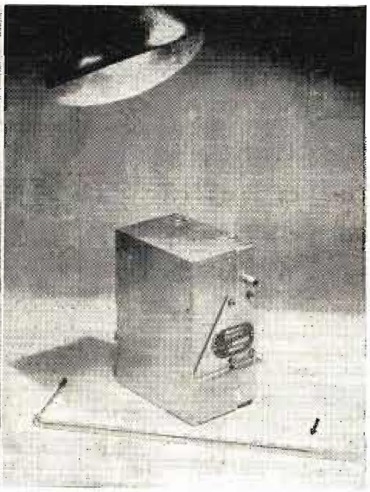


Thermometer reads —30° centigrade as the Permakay selectivity reading remains same as before this extreme cold test was started.



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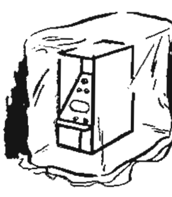
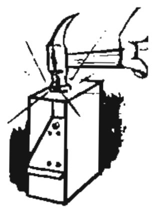


WATER AND COLD-PROOF



TAMPER AND SHOCK-PROOF

motorola 2-way radio

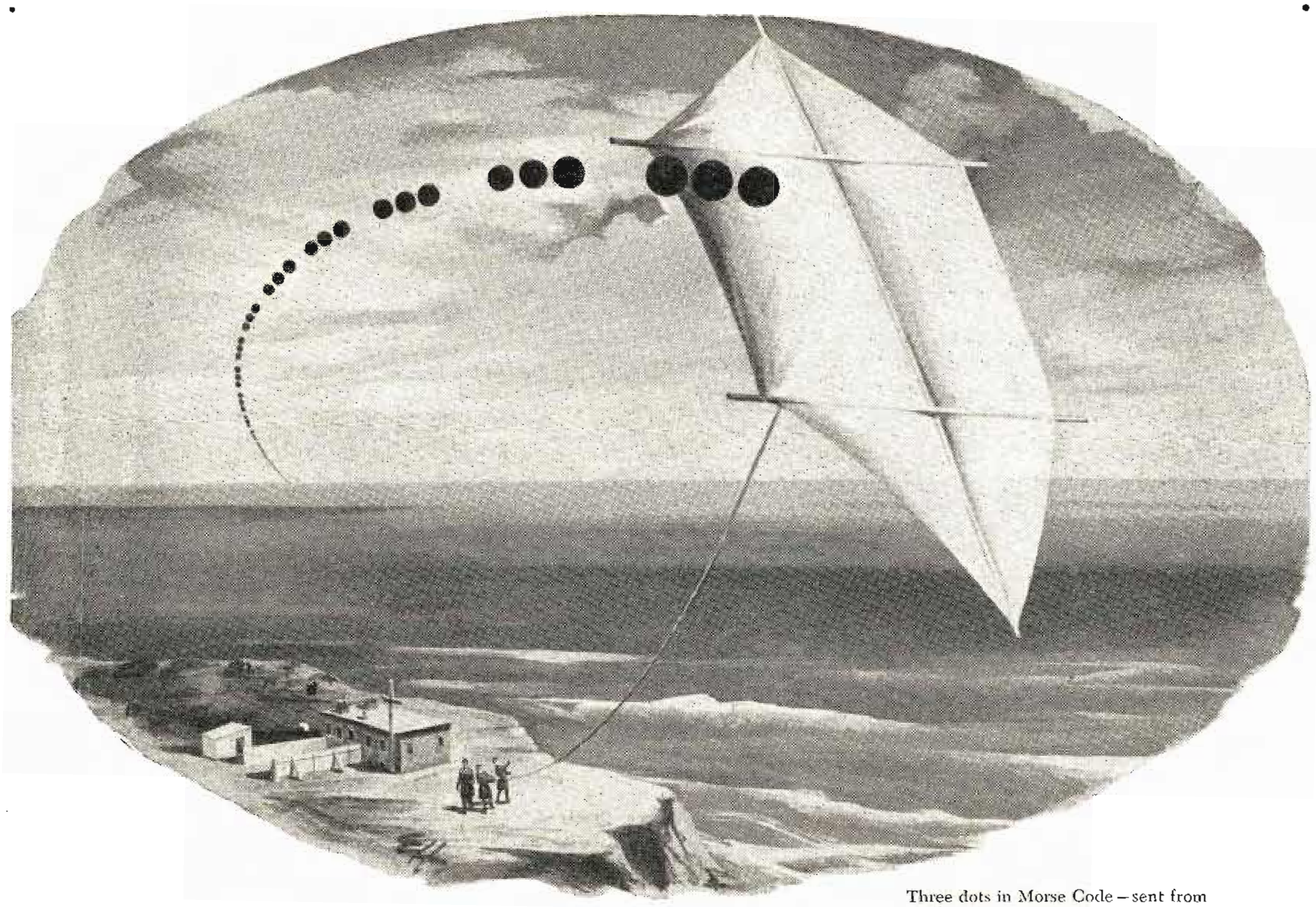
rect amount by adjustment of the length of the stub. It is unnecessary to use added losses in the form of external resistors across the circuit. The output circuit is a conventional two-section bandpass filter (not shown in Fig. 4). The driver is applied via a loop in the control-grid-to-screen-grid cavity space. This is a preferred arrangement at frequencies below 900 MC. This amplifier under Class B linear conditions has given the following performance:

	815 MC	500 MC
Peak Sync Power	107 watts	220 watts
Bandwidth (—3 db)	5 MC	5 MC
Power Gain (times)	8	10
Efficiency at Peak Sync	39%	60%

A cross section through another amplifier of the same kind but using Eimac 4W20000A water cooled anode tetrode having a 20 kW anode dissipation, is shown in Fig. 7.

A final point of some importance concerns the design of the input coupling. This requires care in any feedback amplifier; in particular it must be ensured that the phase relationships do not become reversed at some frequency removed from the working frequency on account of the charateristics of the circuits coupled into the amplifier input. It has been found for example, that if a long mismatched coaxial line with a high SWR is used for coupling to the amplifier in Fig. 4, and if this line is loosely coupled to the previous stage, in certain circumstances the line itself together with the input circuit may have a spurious resonance at a frequency lower than the operating frequency, and this may cause the amplifier to oscillate at the spurious frequency although it is stable at the desired frequency. This may be avoided by improving the matching to the line or by changing its length and by using loop coupling to the input circuit rather than a direct tap. Reference to Fig. 5 will show that the generalized requirement for stability is that the reactance variation with frequency of the control-grid-to-cathode circuit must be in the same direction as that of the total screen-to-control grid circuit including the coupling line and the circuit driving it, over the entire frequency range in which oscillation is possible with the tetrode being used.

[1] "A Pulsed RF Amplifier for the 1,000 Mc. Band."—Tele-Tech, May, 1951, page 48.
[2] "A Tetrode Power Oscillator for UHF".—Tele-Tech, Sept., 1950.
[3] "The Impedance of Resonant Transmission Lines and Waveguides," W. W. Harman, Electronic Research Laboratory, Stanford Univ., Nov., 1948. Published by Navy Research Section, Library of Congress.
[4] "A Comparison of the Bandwidth of Resonant Transmission Lines and Lumped LC Circuits," A. Van Weel, Philips Research Report, August, 1950.
[5] "The Design of Frequency Compensated Matching Sections," V. H. Rumsey, Proc. IRE, Oct., 1950.



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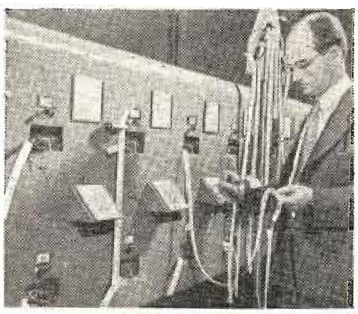

Today RCA Communications sends and receives about 81 million words each year across the Atlantic; the messages are automatically recorded on tape, for error-free transmission.

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Audio Amplifier

(*Continued from page* 60)

amount of feedback eliminate this problem. The maximum value of plate load resistor for the first stage was dictated by allowable phase shift in the extended frequency range (of importance in the design of the negative feedback network). Screen and cathode resistors were selected to establish proper tube operation with the plate potential at a favorable value for direct coupling to the following phase inverter.

Direct coupling of an amplifier stage to a cathode-follower-operated tube affords considerable saving in components. A blocking condenser, grid leak, and cathode bias resistor and by-pass condenser are eliminated. It is sometimes thought that changes in voltage at the amplifier tube plate due to variations in individual tubes and to tube aging would be too great for production application of direct coupling. But since the 6SJ7 screen voltage is determined by the screen current through a high resistance, a change in total space current in the tube will be reflected as a corresponding change in screen potential with regulating effect upon the plate voltage. The screen is, of course, by-passed to signal-frequency voltages.

The split-load phase inverter has not been so widely used in audio amplifiers as its quality and simplicity merit. True, the gain from input to each output terminal is less than unity as compared with many times this obtained from other types of phase inverters. However, these other circuits invariably require two tubes and operate from an unbalance principle, or require exact proportion of tube gain to component value to maintain reasonable inversion balance. The split load phase inverter, on the other hand, when direct coupled to the preceding stage, will combine the same number of tubes and as few or fewer other components with resulting comparable gain.

Furthermore, at frequencies at which shunt capacities are small as compared to circuit impedances, the inversion in terms of phase and amplitude can be perfect, the result depending only upon the ratio of plate and cathode loads, since the same current flows through both. Much loose thinking has been associated with circuit behavior of split load inverters at higher audio and supersonic frequencies. Some is brought about by the realization that the heater-to-cathode capacity of the

(*Continued on page* 92)

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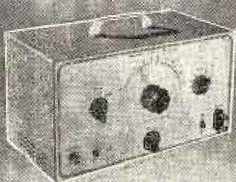

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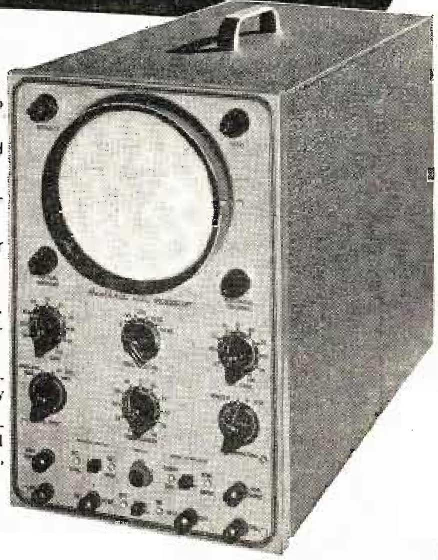

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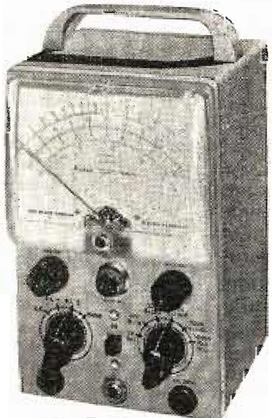

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- Terrific coverage — Reads from ½V to 1000V AC, ½V to 1000V DC, and .1 to over 1 billion ohms resistance.
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- New styling presents attractive and professional appearance.

The 1952 Model Heathkit Vacuum Tube Voltmeter! Newly designed cabinet combines style and beauty with compactness. Greatly reduced size to occupy a minimum of space on your work-bench. Covers a tremendous range of measurements and is easy to use. Uses only quality components including 1% precision resistors in multiplier circuit for greatest accuracy, Simpson 200 microamp meter with easy to read scales for fast and sure readings.

All parts come right with kit, and complete instruction manual makes assembly a cinch.

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SHIPPING WT. 5 LBS.

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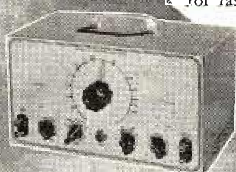
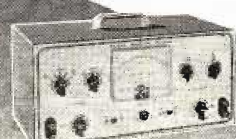
Heathkit A.C. VOLTMETER KIT $29.50



Heathkit SQUARE WAVE GEN. KIT $29.50



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tube is much greater than the plate, or output capacity, thereby making certain a decrease in cathode voltage at the higher frequencies. This concept, however, ignores the effect of negative feedback upon the apparent impedance of cathode and plate circuits. The apparent impedance to signal voltages from cathode to ground is:

$$R = (r_p + R_L)/(\mu + 1)$$

in parallel with R_K, where r_p is the internal plate resistance of the tube, R_L and R_K are the plate and cathode load resistors, respectively, and μ is the amplification factor of the tube. Similarly, the impedance from plate to ground is:

$$R = r_p + (\mu + 1) R_K$$

in parallel with R_L. Application of these equations to the circuit described reveals a ratio of impedances greater that 10 to 1, the cathode being the lesser. This emphasizes the importance of both plate to cathode impedance ratio and plate to cathode capacity ratio in determining extended frequency conditions. In practice, capacitance is sometimes added to the cathode circuit, rather than the plate, to maintain balance at extreme frequencies.

An appreciable percentage of 6L6 tubes produces sufficient ion current to cause changes in bias when grid leak resistors of large magnitude are used. This may result in a decrease of maximum power and is responsible for high tube rejection during critical production tests. Accordingly, 100,000 ohm resistors have been used, reducing the gas current effect to negligible proportions. Blocking condensers of 0.25 mfd. in the output stage grid circuits limit the phase shift to less than 45° at 6 cycles.

The 6L6 tubes are operated close to maximum design-center value voltages of 360 volts plate-to-cathode and 270 volts screen-to-cathode. The combination of choke input filter and VR75 screen-voltage regulator tube furnishes sufficiently good regulation to obtain, with feedback, rated power output with unusually low distortion. A series VR tube is not the most common method of screen supply regulation. It was chosen here because it required but one tube in place of two for the shunt regulator. The success of this application hinges upon the excellent plate supply regulation furnished by the filter input inductance. The small resistor in series with the VR tube, is required in order that a linear element be present in the filter network to dissipate power supply ripple voltage.

(*Continued on page* 94)

For Engineers...

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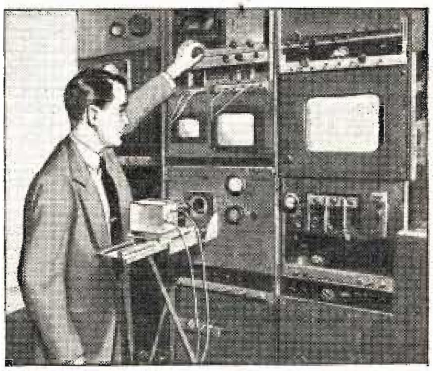
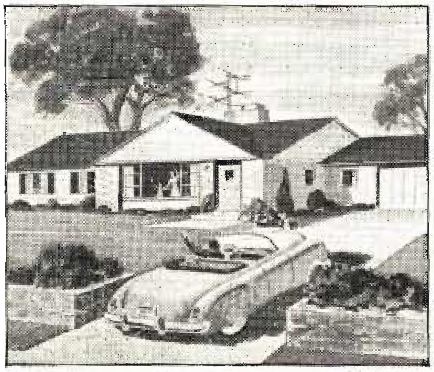


Laboratory Facilities. At RCA, unexcelled laboratory resources and advanced technical apparatus are available. You have unlimited opportunities for the complete expression of your talents in the fields of electronics.

If you qualify for any of the positions listed above, write us for a personal interview—include a complete resumé of your education and experience. Write to:

Mr. Robert E. McQuiston, Specialized Employment Division, Dept. 119-A, Radio Corporation of America, 30 Rockefeller Plaza, New York 20, N. Y.



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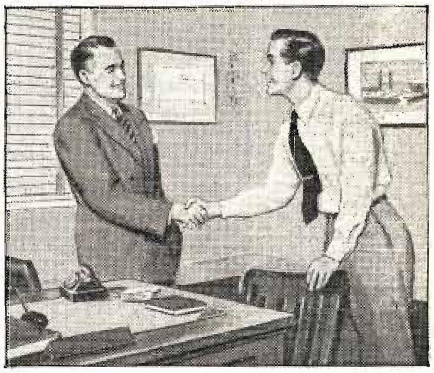
Position Security. These are not temporary positions. Activities are focused not only on the long-range national defense program, but also on a diversified line of products for commercial use. You and your family are protected by Company-paid hospital, surgical, accident, sickness, and life insurance. A modern retirement program helps provide for your future.



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RADIO CORPORATION of AMERICA

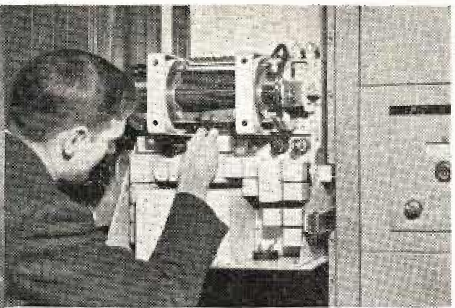
Success or failure in meeting the wide range distortion figures tentatively specified hinged upon the output transformer design, as is usually the case with negative feedback amplifiers. Inclusion of the transformer within the feedback network implies control of the phase shift for several octaves in excess of the useful range. The determination to provide 4, 8 and 16 ohm taps on a terminal strip without the necessity of changing transformer connections introduces transformer complications. The two to one turns ratio required for the four to one impedance range is normally obtained by either a series or a parallel connection of two identical secondary transformer windings.

This is the preferred method because it utilizes all of the copper, occupies the same winding space in the transformer, and gives the same leakage reactance for both impedance connections; its disadvantage being the necessity for reconnecting the transformer for each impedance and, at the same time, changing the feedback resistor if feedback voltage is to be obtained from the loaded winding. A method of internally interconnecting the various secondary windings is used to maintain load current flow through all sections of the secondary winding, even when the load is connected to the lower impedance taps. This system does not maintain an equality of leakage reactance between the various secondary taps when referred to the primary. It does, however, maintain to a closer degree, as compared to a simple tapped winding, the phase angle of load voltage to total secondary voltage, when the load is connected to the lower impedance taps. This improvement is effective only at extremely high frequencies and is of importance in permitting negative feedback voltage to be obtained from the entire secondary winding regardless of the load connection.

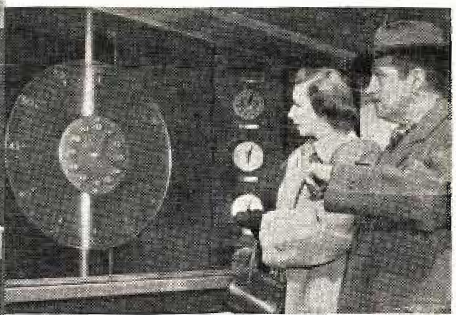
The discussion here will be limited to the general problem, as it applies to this design, rather than a detailed theoretical analysis of negative feedback systems. In loose terms, if the conditions for stability are to be met, the product of $A\beta$, where A is the mid-frequency gain and β the fraction of output voltage return to the input, must be less than unity when the phase of $A\beta$ is shifted $\pm$ 180° from the mid-frequency value.

In the design of practical amplifiers, greater restrictions than this must be placed upon the phase and amplitude of $A\beta$ if trouble-free operation under various load conditions is to be realized. The RC coupled

(*Continued on page* 96)

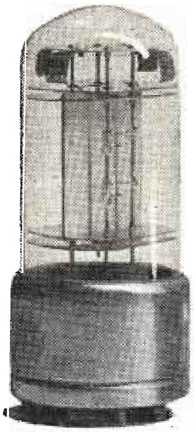


Each crystal is enclosed in a cylindrical oven which holds the crystal temperature to within 1/100 of a degree.



At the A. T. & T. building at 195 Broadway, New York, passersby set watches by the world's most accurate public clock, which is controlled by the master standard.

Front of the new frequency-time standard at Bell Telephone Laboratories. In the rear there are 600 electron tubes and 25,000 soldered connections. Room temperature is maintained within two degrees.



The controlling quartz crystal vibrates in vacuum at 100,000 cycles per second. The standard is powered by storage batteries, with steam turbo-generator standing by, just in case of emergency.

A vibrating crystal keeps master time

Ever since Galileo watched a lamp swinging in the Cathedral of Pisa three centuries ago, steady vibration has provided the practical measure of time. In the 1920s Bell Laboratories physicists proved that the quartz crystal oscillators they had developed to control electrical vibration frequency in your telephone system could pace out time more accurately than ever before.

The Laboratories' latest master standard keeps an electric current vibrating at a frequency that varies only one part in a billion, keeping time to one ten-thousandth second a day.

Through secondary standards, a master oscillator governs the carrier frequencies of the Bell System's ship-to-shore, overseas and mobile radiotelephone services, the coaxial and *Radio-Relay* systems which transmit hundreds of simultaneous conversations, or television. In the northeastern states, it keeps electric clocks on time through check signals supplied to electric light and power companies.

The new standard also provides an independent reference for time measurements made by the U. S. Naval Observatory and the National Bureau of Standards. Thus, world science benefits from a Laboratories development originally aimed at producing more and better telephone service.

BELL TELEPHONE LABORATORIES

Improving telephone service for America provides careers for creative men in scientific and technical fields.

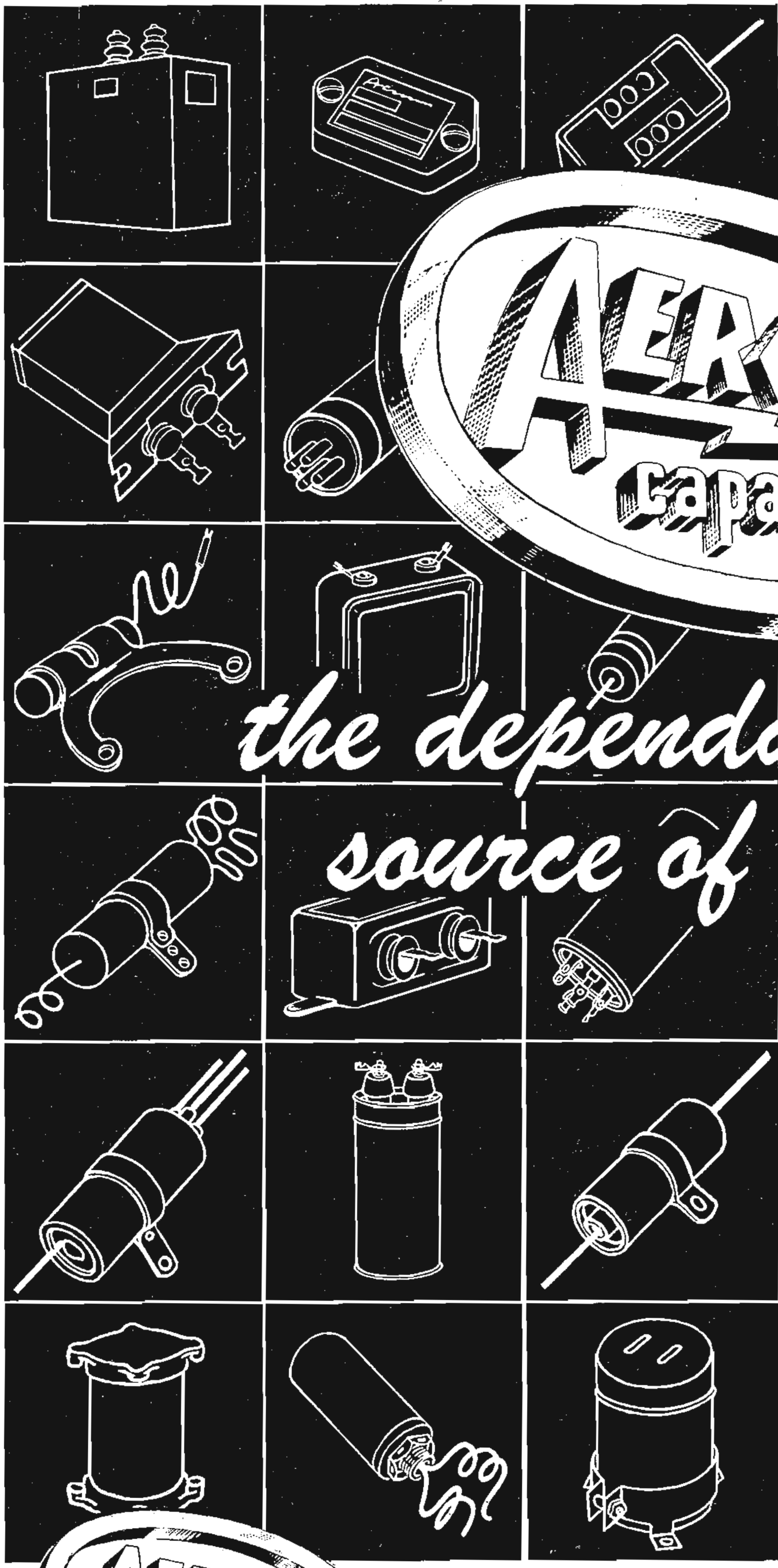
amplifier, in which all of the phase shifts are contributed by parasitic shunt capacities at high frequencies and series capacitive reactances at low frequencies, is a simple case in which the β loop characteristic may be easily controlled. Inclusion of a transformer within this loop, however, introduces other elements, such as the primary to secondary leakage reactance prominent at high frequencies. The presence of both L and C elements in the β loop makes probable extreme attenuation slopes at the cutoff frequency. This is not a desirable condition since the more rapid the attenuation rate, the greater the phase shift.

The ideal Aβ transmission characteristic is uniform throughout the useable range and falls off as rapidly as possible above and below this range. The maximum rate of attenuation, however, is dictated by the maximum phase limitation of 180° and is established by the phase area theorem as the attenuation obtained when the phase shift is constant and is as close to 180° as possible. This ideal transmission is seldom realized in multi-stage amplifiers at high frequencies because of the asymptotic transmission characteristic. This is the ultimate transmission characteristic of the Aβ network at frequencies so high that the parasitic elements take over control.

The slope of the asymptotic characteristic of the multi-stage amplifier, including an output transformer, is normally greater than that permissable in the ideal loop. The excessive phase shift at high frequencies, when the asymptotic characteristic deviates from the ideal, may be negated by incorporating in the transmission characteristic a step of zero attenuation. The length of this step is determined by the ratio of the slope of the ideal characteristic to that of the asymptote. Several important conclusions are reached from the foregoing:

1. If the amplifier is to have a large Aβ product effective over a wide range, the output transformer must be designed to pass a band of frequencies several octaves wider than the useable range. That is to say, the primary inductance to leakage inductance ratio must be large.
2. Since physical limitations and manufacturing economies make it impractical to extend to extreme frequencies the ratio of primary inductance to leakage inductance, the transformer must ultimately control the asymptotic characteristic.

(*Continued on page* 99)



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3. The balance of parasitic transformer capacities to leakage reactance, at the highest frequency at which power is to be delivered from the transformer, should be such as to reflect nearly unity power factor to the tubes. However, in making this adjustment, the electrical configuration of the network must be such that a resonant rise in voltage does not appear across the secondary or feedback winding.
4. Since the transformer is the restricting element in attaining wide band operation, the cutoff frequencies of the interstage networks prior to the insertion of the stepping networks, should be made to extend above and below the asymptotes provided by the transformer. In this way the slope of the asymptotic characteristic is minimized and makes possible the use of a smaller step, or slope, of zero attenuation.
5. When the high-frequency asymptotic slope is steep and not greatly removed from the transmission range, the corrective network providing the slope of zero attenuation will reduce the real, or in phase, component of Aβ at the upper part of the wanted range. While this may not affect the overall frequency characteristic, it will impair both impedance and distortion reduction obtained through the large Aβ product at mid-frequencies.

The success of the application of these principles to the amplifier of Fig. 1 is evidenced by the performance curves. At low frequencies, a stepping network is not required, since the coupling capacitors are large, and the screen and cathode bypass impedances small. In this way, the shunt reactance of the output transformer is instrumental in reducing the Aβ product to less than unity at the frequency of 180° phase shift. The extended low-frequency response is indicated in Fig. 2. A rise of from 1 to 1.5 db is evident in the 5 to 8 cycle region. The restriction of this rise to the limits shown gives an adequate amplitude margin of 8 db.

In other words, the gain within the feedback loop, or the negative feedback, may be increased by 8 db before low-frequency oscillation or motorboating will occur. At high frequencies, a network to provide a step of zero attenuation is required, as discussed above. This consists of the 20,000 ohm resistor and 250 mmf condenser in shunt with the plate

(Continued on page 100)

load of V1. This network becomes effective in producing a step at about 60,000 cycles, where from Fig. 2 the tendency for the response curve to rise is evident. At high frequencies, the connected load power factor exerts great control over the phase of the feedback voltage. It is necessary, therefore, in a general purpose amplifier to provide adequate $A\beta$ phase margins to make instability unlikely with widely varying or loudspeaker loads. In the amplifier of Fig. 1, the transformer asymptote is extended to high frequencies by maintaining a maximum primary leakage reactance of 15 mh or less from any secondary impedance tap. The stepping network R5, C3 introduces an attenuation of small slope, producing a large phase margin and satisfying these conditions.

In the occompanying curve-drawings and illustrations, performance of the power amplifier is shown. Fig. 2 demonstrates the frequence-response over an extended range for all output taps at low power output. Here it may be noted that response is unifrom within + 0.2 − 0.3 db from 20 to 20,000 cps, and within + 1 − 2 db from 10 to 90,000 cps for all taps. A flat frequency characteristic outside the limits of the audio range has no importance as far as listening is concerned except in its effect on other characteristics of the amplifier.

For instance, a sharply dropping response curve above 20,000 cps is an amplifier with large overall feedback would indicate that feedback had ceased to be effective in the neighborhood of 20,000 cps and that at some much lower frequency, say 5,000 cps, the feedback may still be insufficient, because of phase shifts in the amplifier loop, to reduce distortion to the low levels obtained at mid-frequency operation.

Conversely, a peak of 5 to 10 db at some very high frequency, often encountered in feedback amplifiers, will give rise to large undamped oscillations accompanying transient signals. The oscilliations may be of sufficient magnitude to overload the amplifier during otherwise normal operation and to produce severe distortion, particularly intermodulation distortion. The rise in response is indicative of unstable operation, and output loads other than purely resistive can cause uncontrolled oscillations at a frequency near the response peak.

The power-response curves of Fig. 3 show power output of the amplifier at 2% and 5% total harmonic distortion from 20 to 20,000 cycles.

(*Continued on page* 110)

Color TV

(*Continued from page* 61)

chromaticities in the I.C.I. system of specification:

	x	y
Red (R)	0.67	0.33
Green (G)	0.21	0.71
Blue (B)	0.14	0.08

12. The color signal is so proportioned that when the color subcarrier vanishes, the chromaticity reproduced corresponds to illuminant C ($x=0.310$, $y=0.316$).

13. Gamma correction is such that the desired pictorial result is obtained on a display device having a transfer gradient (gamma exponent) of 2.75. However, the equipment used is capable of an overall transfer gradient of unity. The voltages E_Y, E_R, E_G and E_B in the expression in Specification 10, above, refer to the gamma-corrected signals.

14. The color subcarrier frequency is 3.898125 MC $\pm$ 0.001%, with a maximum rate of change not to exceed 1/3 cps per second.

15. The horizontal scanning frequency is 2/495 times the color subcarrier frequency. This corresponds to 15,750 cps.

16. The bandwidth assigned to the monochrome signal E_Y is in accordance with the FCC standard for black-and-white transmissions, as noted in Specification 6 above.

17. The bandwidth assigned prior to modulation to the chromatic signals ($E_B - E_Y$) and ($E_R - E_Y$) is not less than 1 MC at 6 db attenuation. A gradual cutoff characteristic is used.

18. The bandwidth assigned to the modulated color subcarrier extends to at least 1 MC at 6 db attenuation below the color subcarrier frequency and to at least 0.4 MC at 6 db attenuation above the color subcarrier frequency.

19. To assure that all the components of the color signal shall coincide in time at the second detector of the receiver, delay compensation is used such that a sinewave, introduced at the transmitter color-signal input terminals, produces a radiated envelope having a relative time delay vs. frequency characteristic within plus 30% and minus zero per cent of that specified in Fig. 13 of RMA report TS 1.2-3005-A (Fig. 1 herewith), except that the ordinate scale may be multiplied by a factor of 1.0 to 1.5.

20. The color phase alternation implied by the ($\pm$) sign in Specification 10 is such that the color subcarrier phasor representing ($E_R - E_Y$) shall lead the phasor representing ($E_B - E_Y$) during the scanning field following the vertical sync pulse in diagram (1) of Appendix I of the FCC Standards of Good Engineering Practice Concerning Television Broadcasting Stations, Dec. 19, 1945, and shall lag following the vertical sync pulse shown in diagram (2) of that Appendix. The stationary axis of the color phase alternation corresponds to the ($E_B - E_Y$) phasor.

21. The color synchronizing signal is

that shown in Fig. 2. This signal corresponds to amplitude modulation of a continuous sinewave of frequency $\omega/2\pi$.

22. Signals outside the assigned channel shall be attenuated at least 60 db below the peak visual signal amplitude.

NOTES ON FIG. 2.

1. This waveform is that which exists at the studio before transmission over limited bandwidth circuits.
2. The burst frequency shall be 3.898125 Mc ± 0.001% with a maximum rate of change not to exceed 1/3 cycle per second per second. The horizontal scanning frequency shall be 2/495 times the burst frequency.
3. The burst follows each H. pulse. It is omitted following the equalizing pulse and during the broad vertical pulse.
4. Vertical blanking 0.07 to 0.08V.

"Handie-Talkie" Now Trademarked

Editors, TELE-TECH:

Motorola Inc.'s trademark HANDIE-TALKIE has been improperly used recently and we will appreciate it if you will inform your readers correctly on this matter.

The portable transceiver (SCR-536) which became so widely known during World War II by the trademark HANDIE-TALKIE, was invented by a Motorola engineer in 1940, and the first units were demonstrated to the U. S. Army Signal Corps at Fort Monmouth in March 1941. Beginning in 1942 HANDIE-TALKIE was extensively publicized by Motorola in national advertising as the trademark for this unit which they were then manufacturing for the Armed Services, and use of the trademark has continued to the present time. Motorola Inc.'s various radio transmitter and receiver units sold currently under this trademark have many important radio communication functions for both industry and the Government.

HANDIE-TALKIE is not a generic word nor is it in the public domain, and portable radio sets may not be designated by this term except when made by Motorola Inc. Then it is the identifying trademark, not the noun to describe the sets.

Trademark Registration No. 542,561 on HANDIE-TALKIE was issued to Motorola Inc. by the United States Patent Office on May 22, 1951, and the trademark is their exclusive property.

A. S. GOURFAIN, JR.
Gourfain-Cobb Advertising Agency, Inc.
Wrigley Building, Chicago
Advertising Agency for Motorola Inc.

Cuba Gets TV Film Equipment

Complete Du Mont film telecasting equipment has been shipped to Circuito CMQ S.A., Havana, Cuba, for use in a chain of TV stations to extend across the island of Cuba. The equipment to be used by CMQ-TV for the telecasting of films and teletranscriptions includes two complete inconoscope film chains with 16mm "Ike" projectors, console and monitoring facilities, film dolly and power supplies.

PERSONAL

Carl E. Scholz has been elected vice-president and chief engineer of the American Cable & Radio Corp. He has been associated with the I.T.&T. system and its affiliated companies since May 1917, when he joined the Federal Telegraph Co. as an engineer.

H. Laurence Kunz has been appointed general manager of the capacitor division, Sangamo Electric Co., of Springfield, Ill. He will make his headquarters at the Marion, (Ill.) factory. Mr. Kunz has served as sales manager of the division during the past six years.

Dr. David C. Miller has been appointed assistant director of research of Philips Laboratories, Inc., Irvington-on-Hudson, N. Y., and administrative assistant to the president, Dr. O. S. Duffendack. He will maintain liaison between the Laboratory and associated Philips Companies and represent it in dealings with the government and commercial companies.

Dr. Irving Wolff has been named director of research for the RCA Laboratories Division of the Radio Corporation of America, the headquarters of which are at the David Sarnoff Research Center, Princeton, N. J.

Dr. Wolff, a uhf specialist, and a pioneer in radar, has been director of Radio Tube Research for RCA Laboratories.

Dr. Wolff joined the RCA research staff in 1928. He concentrated on research in the audio field, developing one of the most-used loudspeakers of the '30s. He later shifted his field of interest to the development of equipment for the generation of microwaves.

Howard Rothenstein, executive of Arco Electronics, Inc., New York City, is in Los Angeles to temporarily direct activities of a recently established branch in that city. Cooperating with Mr. Rothenstein in the organization of this latest Arco activity is Carl Drillick, well-known to the electronic trade in that area for many years. Mr. Drillick has been appointed sales manager of Arco Capacitors, Inc., and he will be in charge of all Arco west coast operations.

Carl F. Miller, a holder of important radio tube patents, has been appointed manager of Westinghouse receiving tube development and design engineering. From 1940 to 1943 he was a design and development engineer at the Corning (N. Y.) Glass Works.

Robert L. Wolff has been appointed director of Centralab products engineering at Milwaukee. Wolff, who has been with the company for fourteen years, was formerly chief radio-electrical engineer. He is a University of Chicago graduate and came from Chicago to Centralab with a background of radio manufacturing. His new responsibility will include ceramics and special products as well as volume controls switches, printed circuits and capacitors.

Alfred Bernard Goldstein, formerly with Kent Television as chief engineer, is now with Tech Master as quality control engineer.

Leigh A. Brite has been appointed director of research and development for the Transmitter Equipment Mfg. Co., Inc., 345 Hudson St., New York 14, N. Y., manufacturers of electronic apparatus for the military services and the communications industry.

James L. Brown, with 14 years of experience as an electronic tube and apparatus sales executive and engineer, has been named sales manager for receiving tubes and cathode-ray tubes for Westinghouse.

Kenneth B. Boothe has been appointed manager of the Instrumentation Div. of Audio & Video Products Corp., 730 Fifth Ave., New York 19, N. Y. In this capacity, he will supervise the sales and service of special magnetic tape equipment and supplies designed for telemetering and data recording. Before joining Audio & Video, Mr. Boothe was chief engineer and technical supervisor for the United Nations Sound & Recording Department. He organized and directed the engineering for the Paris General Assembly and supervised the simultaneous interpretation and recording installations for the U. N. in Geneva and Havana.

Paul Hines has been appointed director of engineering for The Workshop Associates, Division of The Gabriel Co., and will be in direct charge of the Workshop laboratory now being built in Natick, Mass. He will supervise all Workshop engineering at both Natick and the older Needham plant, including the electrical, mechanical, drafting and modelshop departments. Mr. Hines comes to Workshop Associates from the Raytheon Manufacturing Company where he was head of the antenna group.

News of MANUFACTURERS' REPS

Quam-Nichols Co., Chicago, has announced the appointment of **W. Bert Knight Co.**, 10373 W. Pico Blvd., Los Angeles, as sales representatives for the Quam lines of speakers and electronic products in Southern California.

Harry Estersohn, manufacturers representative at 395 East Clivedeon St., Philadelphia, Pa., has announced the addition of **Lester Brown** to his organization. Concurrently the name of the organization is being changed to Harry Estersohn & Co. The Estersohn organization covers southern New Jersey, eastern Pennsylvania, Delaware, Maryland, the District of Columbia and Virginia.

Ray M. Rand has been appointed sales representative for the Audio-Video Recording Co., Inc., 730 Fifth Ave., New York 19, N. Y.

Maithland K. Smith has been appointed Southern representative for The Workshop Associates, Division of The Gabriel Co. Assisted by John Thompson and Ed Kain, he will cover a territory including Florida, North Carolina, South Carolina, Georgia and Alabama.

Charles W. Pointon, Toronto, Ontario, has been named exclusive Canadian representative for **Thomas Electronics, Inc.**, Passaic, N. J. The Pointon organization now carries a complete stock of Thomas products in their Toronto warehouse.

Sealtron Representatives

Nine new sales representatives have been appointed for products of the Sealtron Co., Cincinnati, Ohio, manufacturer of glass-to-metal hermetic seals, according to W. C. Sage, general sales manager of the company. They are: S. Victor Malta, Box 205, Camden, N. J.; Richard Snetsinger, 1836 Euclid Ave., Cleveland, Ohio; Richard B. Harper, 814 Fisher Bldg., Detroit, Mich.; M. L. (Marve) Williams, 5720 Glengate Lane, Cincinnati 13, Ohio; Dave Dolin, 2635 S. Wabash Ave., Chicago 16, Ill.; Jackson Edwards, 2946 Belden Drive, Los Angeles 28, Calif.; Richard B. Harper, 4356 Maryland Ave., St. Louis, Mo.; Edward F. Aymond, Jr., 4308 Maple Ave., Dallas 9, Texas and Harry Schwartz, 145 Normand St., Montreal, Quebec.

Quartz Crystal Manufacture

A one-hour color 16mm film showing the step-by-step manufacture of crystals has been produced for the James Knights Co., Sandwich, Ill. It records in dramatic detail the processing of crystals from raw quartz through X-raying, testing, mounting and calibrating to bring them up to final precision standards.

Inductor Design

(*Continued from page 56*)

keeping all dimensions the same, will thus produce the family of straight lines in Fig. 2. These rather odd values of permeability were chosen because they are the actual values manufactured in the molybdenum permalloy cores. For simplification, only one size of core will be considered for each permeability here. The design will then be carried out as if there were only four possible cores to choose from, instead of the 33 or so actually available.

It is interesting to note the effect that changing core dimensions will have. It is easily shown from Equation 2 that if all the dimensions of the coil are assumed to be changed in proportion, the dissipation factor will be inversely proportional to the square of the linear dimensions. Or in terms of volume: $D_c \sim 1/V^{2/3}$ This is in accordance with practical experience that the smaller the coil, the smaller the Q.

Eddy Current Losses

The second of the two most fundamental losses in the coil is that due to the eddy currents in the core. This loss can be represented in terms of a resistance constant with frequency on the shunt basis. The dissipation factor equation is then the inverse of that for the series resistance used before, or: $D_e = (WL)/R_e$.

The dissipation factor due to eddy currents in the iron is thus directly proportional to frequency, and on log-log paper, the plot will be a line sloping upward to the right at an angle of 45° (slope = +1).

The variation with permeability, too, is the reverse of the previous case, as can be seen from Equation 5, Table I.

Successive halvings (approximately) of the permeability from 125 to 60, 26, and 14 will now result in successive shifts of the dissipation factor line downward and to the right. The result for the four permeabilities is a family of curves shown in Fig. 3, superimposed upon the previous plot of the D_c lines.

One more very significant fact is apparent from Equation 5. It can be seen that this dissipation factor due to eddy currents in the core is dependent only on the physical constants of the core material. It is completely independent not only of inductance, but also of any of the dimensions of either core or winding. Thus only four lines, of the

(*Continued on page 109*)

FOREIGN TV STATIONS (Continued from page 37)

LOCATION	CALL LETTERS	STATUS	OWNER/LICENSEE	CHANNEL	ERP (KW)	STANDARDS Lines Frames
GERMANY (Est. recvrs.—2,400)						
Hamburg	—	on air	Norwestdeutscher Rundtunk	(F)	1*	625-25
Berlin	—	exper.	Allied High Command		1*	625-25
Frankfurt	—	exper.	Allied High Command	(G)	1*	625-25
ITALY (Est. recvrs.—750)						
Turin	—	exper.	Radio Italiana	—	5*	625-25
Turin	—	exper.	Radio Italiana		5*	525-30
Vatican City	—	on air	Radio Vatican	(B)	—	819-25
JAPAN						
Kamad (nr. Tokyo)	—	exper.	Radio Regulatory Comm.	—	.5*	525-30
Ichigaga Heights (nr. Tokyo)	—	purchased	Radio Regulatory Comm.	—	10*	525-30
MOROCCO						
Casablanca	—	purchased	Adm. de la Radiodifusion et de la Television	(B)	2.5*	819-25
Rabat	—	pending	Adm. de la Radiodifusion et de la Television	—	1*	819-25
NETHERLANDS (Est. recvrs.—1,500)						
Utrecht	—	on air	Nederlandse Radio Unie	(M)	5*	625-25
Eindhoven	PAB-2	exper.	Phillips Ltd.	(H)	3*	625-25
Eindhoven	PAB-3	pending	Postal T.&T. Administration	(E)	—	625-25
Kootwijk	PAB-6	pending	—	(H)	—	625-25
SPAIN						
Madrid	—	exper.	Radiodifusion Nacional	—	—	625-25
Madrid	—	purchased	—	—	5*	625-25
Barcelona	—	purchased	—	—	5*	625-25
SWEDEN						
Stockholm	—	exper.	—	—	1*	625-25
SWITZERLAND						
Zurich	—	exper.	—	—	.4*	625-25
UNITED KINGDOM (Est. recvrs.—1.2 million)						
London	—	on air	British Broadcasting Co.	(I)	27	405-25
Birmingham	—	on air	British Broadcasting Co.	(L)	84	405-25
Manchester	—	on air	British Broadcasting Co.	(J)	100	405-25
Cardiff	—	purchased	British Broadcasting Co.	(E)	100	405-25
Edinburgh	—	purchased	British Broadcasting Co.	(K)	100	405-25
YUGOSLAVIA						
Belgrad	—	pending	Radiodifusion Beograd	(N)	5*	625-25
Zagreb	YZO-3	pending	Radiodifusion Beograd	(D)	5*	625-25
Liubliana	YZO-2	pending	Radiodifusion Beograd	(P)	5*	625-25

type shown here, are necessary to represent this dissipation factor for all of the 33 or so different molybdenum permalloy cores available.

If the dc resistance losses and eddy current losses in the iron were the only two losses in an inductor, it is apparent that the D_c and D_e lines for corresponding permeabilities on Fig. 3 could be added graphically to give total dissipation factor curves for the four particular cores considered there, and that the result would be a family of four smooth, symmetrical curves, similar to those in Fig. 4.

These two losses are not, of course, the only ones of interest in an iron cored coil, and so Fig. 4 does not represent the complete picture. With one exception, to be mentioned later, however, these two losses are the only ones which influence the choice of the core directly. Once the frequency at which the coil is to operate is known, a plot such as that in Fig. 5 makes it possible to tell which core is the best to use.

Consider, the design of a typical coil which was actually constructed for use in the laboratory. The following were the specifications which had to be met: 1. Q as high as possible; 2. L = 1.3 henries; 3. Frequency of operation = 6 KC.

A glance at Fig. 5 will show that core A, with a permeability of 125 is the best one to use. Any of the other cores would give a much higher dissipation factor at the desired operating frequency. Core A was therefore the one which was used in the actual coil.

Although only one core for each permeability is being considered here, it is interesting to note what effect changing core dimensions will have. It has been pointed out already that the dissipation factor due to copper losses will be inversely proportional to the square of the linear dimensions of the core, while that due to eddy currents in the core will be independent of it. That is, the D_c line will move to the left an amount proportional to the square of the increased linear core dimensions, while the D_e line will remain fixed. It is not difficult to see that both the value of the minimum total dissipation factor and the frequency at which that minimum occurs will thus be inversely proportional to the linear core dimensions. In terms of core volume $D_{min} \sim 1/V^{1/3}$, and $f_{opt.} \sim 1/V^{1/3}$.

Finally, a word of caution. This extremely simple picture of core selection is only strictly true for very low inductance coils. The distributed

(*Continued on page* 111)

Audio Amplifier

(*Continued from page* 100)

Dropping-off of power output at the extremes of the curve may be partially ascribed to the effects mentioned above, where phase shifts in the amplifier loop have reduced the effective feedback. Reactance of the transformer primary inductance is the prime source of reduced power at low frequencies. Power output is seen to be uniform within + 0 − 3 db from 20 to 20,000 cps and within + 0 − 1 db, 30—20,000 cps. These results, as well as those shown in the following figures, were obtained using the 16 ohm output. No degradation of performance is incurred from either the 4 or 8 ohm outputs.

Distortion at fixed frequencies and over a wide range of output levels is illustrated by Fig. 4. Harmonic distortion falls to a level close to that contained in the signal source at outputs 2 db below rated power from 50 to 7,500 cycles. More detailed information for a 600 cps signal is presented in Fig. 5. Here the signal generator distortion was reduced to approximately .05% (−66 db) by filtering, and the output components to the seventh harmonic were read with a harmonic analyzer. Total distortion was calculated from the root of the sum of the squares of the components. Using this method to obtain the difference between generator and output distortion, we have .052% distortion at 1 watt and 0.21% distortion at 15 watts from the amplifier.

In Fig. 6 intermodulation distortion is depicted. Two curves appear, one for 40 and 2,000 cps at a 4 to 1 ratio, and the other for 100 and 2,000 cps at a 4 to 1 ratio. The difference in power outputs at 8% intermodulation for the two signals is about 0.1 db showing very little difference in power capabilities of the amplifier at 40 and 100 cps near full output.

A useful, quick check of amplifier performance is furnished by the square wave pictures of Fig. 7. In Fig. 7 a and b, low frequency patterns with characteristic sloping tops are shown. The slope is a very sensitive indication of phase-shift, that of the 20 cps figure representing about 10° time delay and that of the 50 cps figure about 3°.

Beginning in Fig. 7c, at 1,000cps, a small, nearly critically damped, oscillation appears. Comparison of half-cycle durations of the square wave and the parasitic transient shows a resonance at about 60,000 cps, corresponding to the slight peak in the response curve at this frequency. In Fig. 7e, a square wave whose fundamental frequency is one-tenth of the upper half-power frequency of the amplifier presents slightly sloping sides and a tendency to round-off at the top of the leading-edge of the wave. Absence of short-duration pulses and dips in the wave forms points to smoothly changing phase and frequency distortion at very high frequencies.

Feedback affords a reduction of output impedance in the ratio of 13.5 to 1. Source impedance on the 16 ohm output is thus 1.2 ohms. Since the electrical impedance of loudspeakers increases at the resonant frequency of the speaker, it is often thought desirable to employ amplifiers with less perfect output regulation, allowing the output voltage to rise at the same time that speaker impedance rises and acoustical output falls off. It is quite desirable, however, to equalize the speaker impedance characteristics with an electrical network ahead of the amplifier, and maintain high output damping factor to reduce transients in the speaker system.

Part Two will appear in the February issue.

(*Continued from page* 109)

capacitance loss, to be considered later, affects the fundamental shape of the curves which are used for core selection so that these curves will be modified. The basic principles however, remain precisely as outlined here.

The proper core having been selected, the next step is to determine the number of turns to be wound upon it. This is easily done by making use of the relation for inductance. Equation 1 in Table I. For if the core is always wound full of wire, it will be noted that every term in Equation 1 will be a constant for different coils on the same core except for the inductance and the number of turns. In other words, the number of turns that must be put on the core will be directly proportional to the square root of the inductance which is desired: $N \sim \sqrt{L}$.

A plot of this relationship on log-log paper is a straight line of slope ½, so that if the inductance of one coil wound on a given core is found, either by measurement or calculation, it becomes possible to plot a straight line graph from which the number of turns for a coil of any inductance wound on that core can be determined.

Suppose that the number of turns for the 1.3 henry coil used previously as an example were desired. It would then be necessary to go to the plot shown in Fig. 5 for the particular core A which was selected as being the best, and find the number of turns corresponding to an inductance of 1.3 henries. As indicated by the dotted lines this number here turns out to be 2800 turns, and this was the number which was wound upon the coil.

The derivation of a relation giving the total outside diameter of the wire follows much the same lines of reasoning as was used for finding the number of turns. It is obvious that if the winding volume is kept the same for all coils wound on a given core, there will be a unique relation between the diameter of the wire being used and the number of turns of it which can be put upon the core, and therefore between the diameter of the wire and the inductance of the coil. Beginning with the inductance formula and making a few substitutions from the geometry of the winding it can be shown that this relation is:

$$d_w^4 = \left[\frac{32}{\pi^2}\mu\frac{V_w^2}{\ell^2} h \ln\frac{r_2}{r_1}\right]\frac{1}{L} \quad \ldots\ldots (15)$$

As before there are only two of

(*Continued on page* 113)

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these quantities which change for different coils wound upon the same core, so that the wire diameter that must be used can be seen to be inversely proportional to the fourth power of the inductance which is desired. The corresponding plot on log-log paper will be a straight line of slope —¼, such as is shown in Fig. 6 for the particular core A which has been discussed. As before, it is only necessary to find one point on this curve, either by measurement or calculation, to allow the line to be drawn for any particular core.

For the example of a coil of 1.3 henries which is being carried along, it is apparent that the proper wire diameter will be about 11 mils, corresponding to number 31 wire on the B & S wire gauge.

Part Two will appear in the February issue.

Microwaves

(*Continued from page* 63)

to a conveniently located video distribution point is a very handy feature, and makes it possible to take maximum advantage of height.

The microwave relay channels in the remote pickup range of 6875 to 7125 MC are 25 MC wide, providing eleven channels. It has been the practice for one channel to be unofficially reserved for each TV channel in a city; that is, the allocation is made according to the applicant's channel in the VHF-TV band. Suggestions have been made that a company be established which owns a number of these remote pickup units which could lease them out for telecasts or closed circuit operations. But the FCC's rules confining the licensing of such equipment to holders of broadcast licenses has ruled out such operation.

F. E. Cahill Elected President of SMPTE

Frank E. Cahill, Jr., of the Warner Bros. Circuit Management Corp., N. Y., has been elected financial vice president of the Society of Motion Picture and Television Engineers.

Other newly elected officers of SMPTE are: treasurer, Barton Kreuzer, RCA Engineering Products Dept., Radio Corp. of America, Camden, N. J.; engineering vice president, Fred T. Bowditch, National Carbon Div. of Union Carbide and Carbon Co., Cleveland. Mr. Bowditch was reelected to this post.

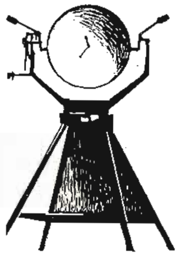
Newly elected governors of the society include Axel G. Jensen, Bell Telephone Laboratories, Murrayhill, N. J.; Joseph E. Aiken, Naval Photographic Center, Anacostia, D. C.; George W. Colburn, G. W. Colburn Laboratories, Chicago; Ellis W. D'Arcy, DeVry Corp., Chicago; John K. Hilliard, Altec-Lansing Corp., Beverly Hills; and Fred G. Albin, American Broadcasting Co., Hollywood.

Sylvania Tube Plant

Sylvania Electric Products, Inc., has announced the official opening of their new Sylvania radio tube plant in Shawnee, Okla. It will manufacture radio tubes of the miniature type to supplement the output of radio tubes from many Sylvania plants throughout the country. The new plant has approximately 34,297 sq. ft. of production area and a property area of 171,150 sq. ft. including 12,800 sq. ft. under the general factory floor.

New Loudspeaker Firm

The formation of Audicraft, Inc., has been announced recently by Alan Abrahams, president. The Brooklyn firm, located at 77 South 5th St., will manufacture horn loudspeakers featuring their exclusive "Fideliflare" horn shape and "Self-Instal" Diaphragm Assembly. Arnold J. Siegel will handle sales.



BULLETINS

Metallic Rectifier Design

An article entitled "Metallic Rectifier Design and Application", written by Julian Loebenstein of Radio Receptor Co., Inc., New York, has just been released in booklet form. Totaling 16 pages and cover, and thoroughly illustrated with application photographs, drawings, diagrams and charts, the booklet reviews the background of metallic rectifiers and clarifies the various factors in their application to electronic circuits. It is available free upon request to Radio Receptor Co., Inc., Seletron Rectifier Division, 251 West 19 St., New York 11, N. Y.

Ferroxcube Ferrites

A new 12-page engineering bulletin, entitled "Introduction to the Application of 'Ferroxcube'", is now available without charge from the Advertising Dept., Ferroxcube Corporation of America, Saugerties, N. Y. Bulletin FC-5100, gives basic data on the use of ferromagnetic ferrites as magnetic cores in electronic and electrical circuits. It is of particular interest to designers of coils and r-f inductors.

Rotary Solenoids

G. H. Leland, Inc., Dayton 2, Ohio, has published a new booklet describing the Ledex line of rotary solenoids. Many production applications of these units are described. Six models are available.

Potentiometers

The DeJUR-Amsco Corp. Industrial Division, 45-01 Northern Blvd., Long Island City 1, N. Y., has issued a new four-page catalog (T-L) covering its complete line of series L-400 precision wire-sound potentiometers. Complete specifications are furnished for these small-size, highly accurate potentiometers showing a wide variety of applications for single and multiple-ganged units.

Test Equipment

A new 80-page catalog, summarizing for the first time under one cover, all of the General Electric testing and measuring equipment for laboratory and production line use, has been announced as available from the company, Schenectady 5, N. Y. To be used primarily as a reference to the apparatus available for the complex measurements to be made in industry, the new catalog (GEC-1016) contains more than 150 photographs and diagrams and describes the uses, features, specifications and prices of GE testing and measuring equipment.

Magnetic Tape Recorder

A four-page brochure has just been published which describes the brand new Ampex Model 307 three-speed magnetic tape recorder with frequency response out to 100,000 cps. The Ampex Model 307 is primarily designed for telemetering data recording, vibration studies, shock analysis and other such special recording work which is found in the fields of scientific and military research.

Parts Catalog

Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill., has announced publication of its new 1952, 212-page catalog, covering "everything in radio, television, and industrial electronics." There are detailed listings of standard and special-purpose electronic tubes, test instruments, voltage stabilizers, transformers, resistors, capacitors, rheostats, relays, switches, rectifiers, tools, wire and cable, batteries, sockets, generators, power supplies, and a wide variety of other electronic equipment and components.

Transformer Chart

Now available from Standard Transformer Corp., Chicago, is the new Stancor Output Transformer Chart (Stancor 375) which lists 129 of the most frequently used output transformers and the tubes with which they should be used. This handy guide simplifies the selection of the proper transformer for use as replacement in radio receivers or in the construction of audio amplifiers.

Tele-Tech

Advertisers - January 1952

While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

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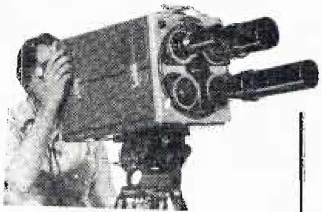

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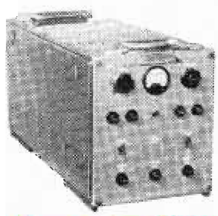

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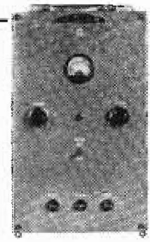

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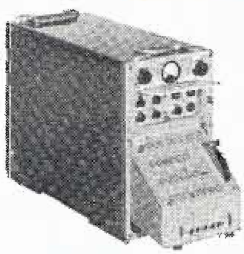

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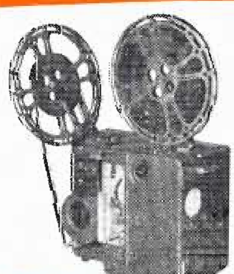

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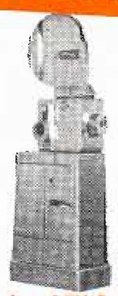

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