TELE-TECH
& Electronic Industries

THERMISTORS

Dynamic Electronic Control Component!

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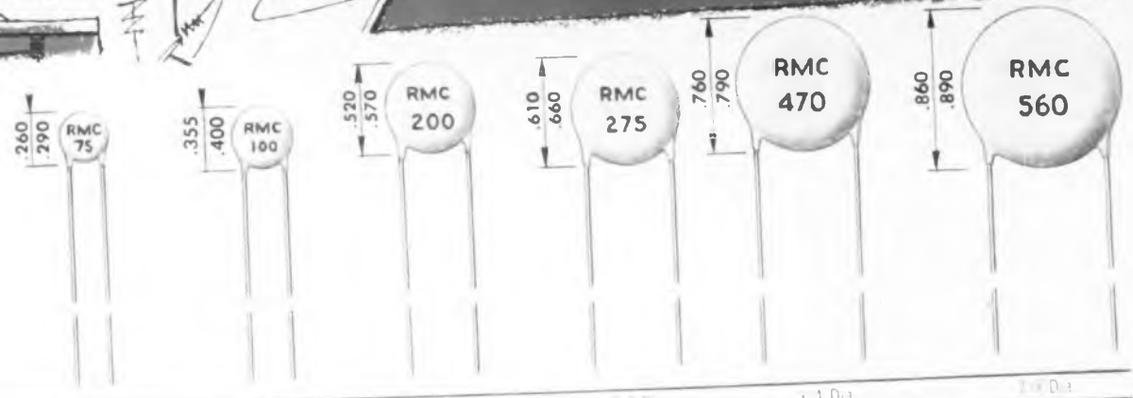

TC	1-3 Dia.	3-16 Dia.	1/2 Dia.	5/8 Dia.	3/4 Dia.	7/8 Dia.
P 100	1- 3 MMF	3- 7 MMF	10- 30 MMF	61- 75 MMF	76-100 MMF	101-150 MMF
NPO	3- 12	11- 27	28- 60	61- 75	76-100	101-150
N 33	3- 15	15- 27	28- 60	61- 75	76-120	121-150
N 75	3- 15	15- 27	28- 60	61- 75	76-140	141-150
N 150	3- 15	16- 30	31- 60	76-100	101-150	151-190
N 220	3- 15	16- 30	31- 75	76-100	101-150	151-190
N 330	3- 15	16- 30	31- 75	90-120	121-200	201-240
N 470	3- 20	21- 40	41- 90	151-200	201-280	281-350
N 750	5- 25	26- 56	57-150	200-250	251-330	331-560
N 1400	15- 50	51-100	101-200	201-275	276-470	471-560
N 2200	47- 75	76-120	121-200			

The design of Type C temperature compensating DISCAPS has stood the test of more than four years of volume production.

Now universally specified as a money-saving replacement for tubular ceramic and mica capacitors, Type C DISCAPS are available in a wide range of capacities and temperature coefficients for many applications. They feature smaller size, lower self inductance, and greater dielectric strength. Rated at 1000 working volts, Type C DISCAPS assure trouble-free performance on VHF or UHF applications. Their lower initial cost and greater mechanical strength permit a substantial lowering of production costs.

If you have a design problem requiring a standard or special type of ceramic capacitor why not let RMC engineers solve it for you.

SPECIFICATIONS:

POWER FACTOR: Over 10 MMF less than .1% at 1 megacycle
Under 10 MMF less than .2% at 1 megacycle

WORKING VOLTAGE: 1000 V.D.C.

TEST VOLTAGE (FLASH): 2000 V.D.C.

CODING: Capacity, tolerance and TC stamped on disc

INSULATION: Durez phenolic-vacuum waxed

INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms

AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms

LEADS: No. 22 tinned copper (.026 dia.)

TOLERANCES: ± 5% ± 10% ± 20%

These capacitors conform to the RTMA specification for Class I ceramic condensers.

The capacity of these capacitors will not change under voltage.

SEND FOR SAMPLES

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS CORPORATION

GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.

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TELE-TECH
& Electronic Industries

APRIL, 1954

SECTION ONE:

FRONT COVER: THERMISTORS—Highly versatile thermally sensitive resistors provide low-cost reliable means for measuring and controlling many functions. Among the numerous industrial and communications applications are control of temperature, air flow, servo motors, radiation, amplifier gain and liquid level. Other uses include voltage regulation, microwave power measurement, filament protection, and circuit compensation for ambient conditions. For complete technical details and list of thermistor manufacturers, see page 73.

DEPARTMENTS

SECTION TWO: ASSOCIATIONS SERVING THE ELECTRONIC INDUSTRIES

TELE-TECH®, Vol. 13, No. 4. Published monthly by Caldwell-Clements, Inc. M. Clements, Presidents; M. H. Newton, Assistant to President; John J. Borghi, Vice President and Secretary; Marguerite B. Clements, Treasurer. Acceptance under section 34.64 Postal Laws and Regulations authorized at Bristol, Conn., February 8, 1952 with additional entry at New York, N. Y. 75c a copy. Annual Subscription Rates: United States and Possessions: $7.00; Canada: $8.00. All Other Countries: $10.00. Please give title, position and company connection when subscribing.

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Publishers also of MART and TECHNICIAN

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TELE-TECH'S CIRCULATION, 21,000

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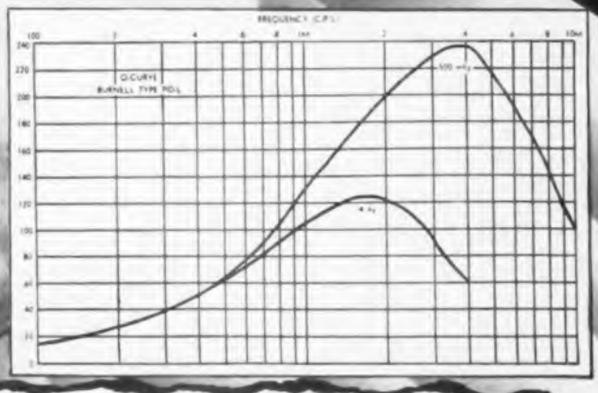
*A New Level in Engineering is Achieved in the Functional Design of Toroidal Decades**

This unique development permitting precision toroids to be combined in decade steps of inductance will appeal to all engineers who are familiar with the disadvantages of the ordinary type of inductance decade box.

All the decade units in the plug-in decade series are higher Q toroids such as are employed in the Burnell attenuation filters. They are guaranteed to a tolerance of 1% of the marked inductance and have extremely good stability of inductance vs. voltage and temperature.



PLUG-IN DECADE COILS CAN ALSO BE DESIGNED WITH SPECIAL CHARACTERISTICS FOR SLIGHT EXTRA CHARGE. UNITS GENERALLY AVAILABLE FROM STOCK ARE AS FOLLOWS:

P.I.D.	1 (MHYS)*
P.I.D.	2 "
P.I.D.	3 "
P.I.D.	4 "
P.I.D.	8 "
P.I.D.	10 (MHYS)*
P.I.D.	20 "
P.I.D.	30 "
P.I.D.	40 "
P.I.D.	80 "
P.I.D.	100 MHYS
P.I.D.	200 "
P.I.D.	300 "
P.I.D.	400 "
P.I.D.	800 "
P.I.D.	1000 MHYS
P.I.D.	2000 "
P.I.D.	3000 "
P.I.D.	4000 "
P.I.D.	8000 "
P.I.D.	10000 MHYS
P.I.D.	20000 "
P.I.D.	30000 "
P.I.D.	40000 "
P.I.D.	80000 "

*Also available in P.I.D.-H Type for higher frequency range.

*Pat. Applied for

OTHER RECENT *Burnell* ACHIEVEMENTS IN TOROIDS AND FILTER NETWORKS

SIDE BAND FILTERS

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

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

MINIATURE TELEMETERING FILTERS

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

SUB MINIATURE TOROIDS

Toroids for intermediate frequencies of 100KC to 1 megacycle. A wide variety of coils ranging in size from ⅝ inch provides high Q in the frequency range betweeen audio and RF.

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

Literature for all the above available on request

Write for new and enlarged 16 page catalog 102A
See us at the I R E show booth 678 Kingsbridge Armory, N. Y. City, March 22-23-24-25,
Exclusive Manufacturers of Communications Network Components

Burnell & Company
YONKERS 2, NEW YORK
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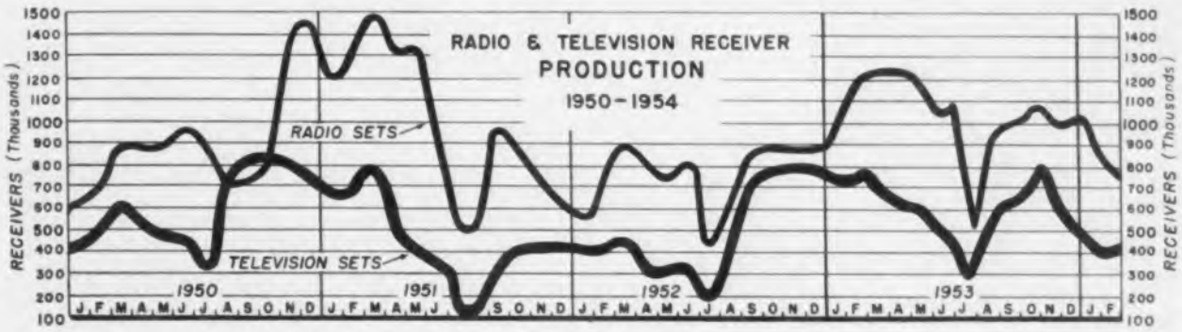
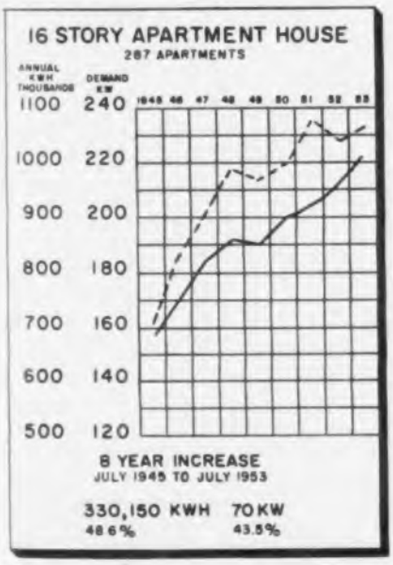
ELECTRONIC INDUSTRIES TOTALS



Broadcast Stations in U.S.

	AM	FM	TV
Stations on Air	2467	533	243 VHF 130 UHF
Under Construction	134	62	79 VHF
(CPs) Commercial			134 UHF
Under Construction			12 VHF
(CPs) Educational			15 UHF
Applications Pending			247 VHF 54 UHF

GROWTH OF DEMAND for electrical power by consumers is dramatically portrayed by the 8 year increase curve for a 16 story apartment house as shown below. Appearing in the Adequate Wiring Reporter and made available through Con Edison of New York City, report also mentions that 74% of the metropolis population live in apartment houses



A survey conducted by the American Society of Tool Engineers reveals that industry itself considers the following facilities to be obsolete:

Machining equipment and processes	30%	Metal forming processes	28%
Automation equipment and processes	28%	Grinding-finishing equipment	23%
Inspection methods	34%	Production welding equipment	25%

What It Takes to Earn Taxes

The Tax Foundation, 30 Rockefeller Plaza, New York, has compiled the time taken to earn the following current expenses by a worker receiving $4500 yearly.

Food	8:00 to 9:36 AM	36 minutes
Transportation	9:36 to 10:11 AM	35 "
Housing	10:11 to 11:54 AM	44 "
Taxes	1:00 to 3:34 PM	154 "
Medical	3:34 to 3:56 PM	26 "
Recreation	4:27 to 4:44 PM	17 "
Other Items	4:44 to 5:00 PM	16 "
Clothing	3:56 to 4:27 PM	31 "

MAJOR MANUFACTURERS REPORT 1953 SALES

Name Mfr.	Sales (Thousands) 1952	1953	Net Income (000) 1952	1953	Earning Share (Cmn) 1952	1953
GE	$2,623,888	$3,128,127	$151,720	$165,728	$5.26	$5.75
RCA	†853,000	693,941	‡32,325	35,022	2.10	2.27
Stromberg Carlson	*48,098	65,242	1,241	1,667	3.28	3.40
Sylvania	*235,023	293,267	6,961	9,536	3.04	3.10
Western Electric	1,311,332	1,507,953	47,082	52,605	—	—
Westinghouse	1,454,272	1,582,047	68,581	74,322	4.23	4.53

* Net Sales † Gross Income ‡ Net Profit

GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contracts awarded by government procurement agencies in February 1954.

Actuator Assys	$ 102,486	Generators	1,467,592	Relay Box Assys	28,407
Amplifiers, magnetic	78,437	Kits, flight tester	209,332	Squadron Guidance Equipment	991,100
Anodes, silver	25,480	Kits, receiver parts	29,716	Switchboard	58,544
Autopilot Comp.	438,935	Lamps, incandescent	46,771	Switchboard Generator Control	95,798
Cable	590,344	Milliameter	1,594	Switches, rotary	132,938
Cable Assys	76,140	Millivoltmeter	2,006	Test Sets, crystal unit	86,826
Connectors, shell	58,464	Oscillograph, direct inking	28,044	Test Sets, electron tube	24,741
Control, switchboard generator	95,792	Oscillograph Processing System	108,983	Transformers	87,443
Couplers, directional	35,940	Power Units	65,772	Tubes, electron	754,581
Crystal Units	32,410	Radiosondes	245,400	Tubes, magnetron	45,600
Dummy, load	102,582	Receivers	152,235	Wattmeter, r-f	168,577
Electrodes, covered	65,620	Resistors, welding	36,600	Wire	161,578

Type 1217-A Unit Pulser . . . $195

. . . features pulse durations from 0.2 to 60,000 μsec and wide range of repetition rates . . . 0.05 μsec rise time and minimum overshoot . . . internal oscillator makes unit independent of external synchronizing signals

- Pulse Repetition Rates — 12 different repetition frequencies from 30 c to 100 kc.
- Pulse Widths — durations are continuously variable from 0.2 to 60,000 μsec — accuracy of ±15% or 0.2 μsec, whichever is the greater — stability is excellent
- Good Pulse Shape — rise time, 0.05 μsec — fall time, 0.15 μsec (depending on load characteristics) — overshoot less than 5% of half maximum amplitude — pulse top flat to within 5% of maximum amplitude, at all durations.
- Variable Amplitude — zero to 20-v, open circuit, for pulses of either polarity — pulse amplitude adequate for direct use on oscilloscope deflection plates.
- Output Impedance — 200 ohms for positive pulses; 1500 ohms for negative.
- Provision for External Synchronization — (either pulses or sync waves may be used for continuous locking from 15 c to 100 kc).
- Sync Signal for Scope — sync leads pulse by 1/10 μsec so that leading edge will be visible on scope.
- Power — Type 1203-A Unit Power Supply recommended.
- Dimensions 10⅜ x 5¾ x 6¼ inches — net weight, 5¼ lbs.

Type 1206-B Unit Amplifier . . . $45

General-Purpose Unit Amplifier

. . . Uses new single-ended push-pull circuit . . . unique design eliminates need for customary output transformer with its low and high-frequency limitations.

- Wide Frequency Range — essentially flat from 20 c to 100 kc.
- Low Distortion — less than 1% harmonic distortion with 2-watts output over most of frequency range — negligible a-c hum.
- High Power — less than 1-volt input gives 3-watts into 600 ohms — 50-to-1 voltage gain.
- Faithful Pulse Amplification — 2 μsec rise time in passing 50-v peak-to-peak square wave.
- Input Impedance — 100,000 ohms in parallel with 35 μμf.
- Power Required — amplifier plugs directly into Type 1203-A Unit Power Supply ($40 additional cost).
- Compactness — dimensions are 9⅞ x 5¾ x 6¼ inches — 4 lbs., net weight.

Type 1212-A Unit Null Detector . . . $145

Type 1951-A Filter **$75**

. . . a Sensitive Voltage Indicator for Bridge Measurements from 20 c to 5 Mc . . . three-stage, logarithmic amplifier gives on scale range of 120 db

- High Sensitivity — less than 40 μv at 1 kc for 1% meter deflection, yet takes 50 v to drive needle off scale — 2 μv sensitivity with accessory Type 1951-A Filter for use from 400 cycles to 1 kc ($75 additional cost) — with filter and earphones, minimum detectable signal is approximately 0.25 μv.
- Good Stability — balanced meter circuit and regulated power input insures good stability — shock mounted amplifier shelf minimizes microphonics.
- Operating Conveniences — zero control on panel — sensitivity control sets meter to full scale for voltage display range required.
- Power — Type 1203A recommended.
- Dimensions 9½ x 5⅜ x 6 inches — net weight is 5½ lbs.

Low-Cost General-Purpose Unit Instruments

For Research, Development and Educational Laboratories

G-R Unit Instruments are compact and reliable test and measuring apparatus, which incorporate one basic electronic circuit in each unit. Refinements such as attenuators and output meters are not built-in; they are available instead as accessory plug-in units, making for low cost and maximum versatility. Plate and filament power are obtained from external Unit Power Supplies in most cases.

Type 1216-A Unit I-F Amplifier $365

Basic element in a High-Frequency Null Detector . . . converts and reliably detects frequencies from 50 Mc to 5000 Mc when used with the G-R Type 874-MR Mixer Rectifier and appropriate Unit Oscillator

- High Gain — 90 db gain at 30-Mc center frequency makes for great sensitivity; less than 2 μvolt from 400 ohms gives 1% meter deflection.
- Wide ¾-Mc Bandwidth—makes possible detection of pulsed signals — modulation on signal is amplified by cathode follower with 0.4 Mc bandwidth and passed to binding posts on panel
- Convenience in Use — accurate 70-db attenuator permits reliable measurement of relative signal levels — large panel meter is calibrated linearly and in db.
- Two Internal Power supplies — one for the amplifier and one for the local oscillator supplying the heterodyning signal.
- Dimensions 5⅜ x 10½ x 7⅛ inches — net weight is 8¼ lbs.

Type 12[illegible] A UHF Unit Oscillator . . . $235

. . . delivers 200 mw from 250 to 920 Mc . . . the well known butterfly tuning unit assures smooth frequency adjustments and avoids sliding contacts and other difficulties inherent in u-h-f tuning elements.

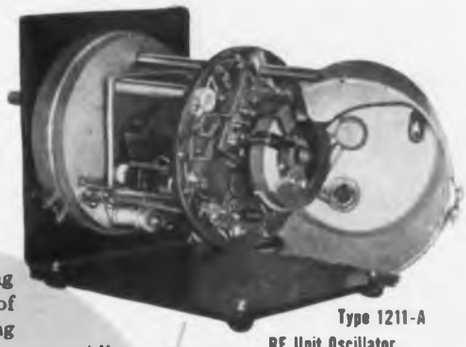
A cylindrical casting mounted on a panel houses the gears which spread the 90° rotation of the butterfly over 270° on the tuning dial—frequency calibration is ± 1%—an aluminum cover supplies adequate shielding—variable output is obtained through an adjustable magnetic loop which couples to the field about the "butterfly"—dimensions are 7 x 6½ x 9¼ inches; net weight is 6¼ lbs.

Type 1209-A
VHF-UHF Unit Oscillator

. . . (similar to Type 1209-A) . . . has very wide 65 to 500 Mc range . . . utilizes light-house tube and simultaneously variable condenser and inductor built in a single unit . . . provides as much as ½ watt. Price: **$190**

Type 1215-A
VHF Unit Oscillator . . . 50 to 250 Mc

. . . semi-butterfly tuning circuit varies inductance and capacitance simultaneously to supply at least 80 mw into 50 ohms . . . slow-motion drive gives 1% accuracy in dial settings. Price: **$190**



Type 1211-A
RF Unit Oscillator

. . . 2 watts from 500 kc to 5 Mc; 200 mw above . . . this instrument's 100:1 frequency span is obtained in two ranges by a unique design. Price: **$295**

Type 1214-A Unit Audio Oscillator

. . . supplies either of two fixed audio frequencies, 400 c or 1000 c . . . gives 0.2 watt into 8000 ohms . . . it is intended primarily as a modulating source for the high-frequency unit oscillators, but also finds use as a general-purpose tool in college and industrial lab . . . it has its own built-in power supply, unlike other Unit Instruments. Priced at only **$68**

Interconnections between these basic building blocks permit the formation of a wide variety of assemblies and measuring systems of varying complexity. This is the G-R "Unit" concept . . . providing industry and university with laboratory-quality instrumentation of greatest adaptability.

UNIT OSCILLATORS
for complete coverage from 500 kc to 920 Mc

These oscillators are efficient, well-shielded sources of power with unusually wide frequency ranges. They are built for maximum utility in research laboratory, production test department and college experimental class. Features include compactness, rugged-construction, accurate dial-calibration, variable power output, and terminals for direct modulation over the audio-frequency range.

The popular G-R Type 874 Coaxial Accessories, including attenuators, filters, rectifiers, coupling devices and many other elements, plug directly into these oscillators, as well as other unit instruments, to form many different measuring setups.

Type 1213-A
Unit Crystal Oscillator

. . . supplies 10-kc, 100-kc, 1-Mc signals, and harmonics as high as 1000 Mc . . . short-term stability is *one part per million* when adjusted to WWV . . . this oscillator and a good communications receiver permit measurements to an accuracy of 0.0002% or better to 15 Mc (limiting factor is receiver calibration) **$130**

Type 1203-A Unit Power Supply shown plugged-into Oscillator

Unit Power Supplies

Small, convenient and inexpensive—They provide suitable a-c heater and d-c plate power for all G-R Unit Instruments (not incorporating their own supplies) . . . plug directly into other units to form compact assemblies

Type 1203-A Unit Power Supply

. . . provides 3 amps, maximum, at 6.3 volts ac; 50 ma, max, at 300 volts dc . . . negligible hum . . . both d-c and a-c supplies isolated from ground and from each other . . . Dimensions are 5 x 5¾ x 6¼ inches . . . 5½ lbs net weight . . . **$40**

Type 1204-B Unit Variable Power Supply

. . . supplies fixed a-c heater voltage and variable d-c voltage for laboratory use . . . output is 3 amps at 6.3 volts ac and maximum of 100 ma at 300 volts dc . . . Variac control on panel conveniently adjusts dc from zero to full value . . . large panel meter indicates d-c voltage and current . . . operates from ordinary 115 v, 60-cycle lines and takes 75 watts at full load . . . 9⅞ x 5¾ x 6¼ inches, overall, and 11½ lbs . . . **$90**

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THE ELECTRONIC INDUSTRIES DIRECTORY

Published annually as an integral section of TELE-TECH in June

TAPE WOUND CORES

Are you ready for a revolutionary concept in the electrical and electronic industry—the Magnetics, Inc. "Performance-Guarantee" on Tape Wound Cores. Guaranteed to meet your specifications, *and sold at standard prices,* these Cores mean truly economical production of high permeability magnetic devices in your plant.

TABLE A
BASIC PHYSICAL CONSTANTS OF COMMON MAGNETIC MATERIALS

Trade Name	% Ni	% Fe	Other	Grain Structure	Satur. Flux Density Gausses	Resistivity Microhm-Cm	Curie Point 0°C	Dens. Grams per cc
Hy Mu 80	79	17	4 Mo	"random"	8,700	57	420	8.72
48 Alloy	48	52		"random"	16,000	45	500	8.3
Orthonol	50	50		oriented	15,500	45	500	8.25
Magnesil		97	3 Si	oriented	20,000	48	700	7.65

TABLE B
TRADE NAMES OF SIMILAR MATERIALS

Hy-Mu 80	48 Alloy	Orthonol	Magnesil
4-79 Permalloy	Carpenter 49	Orthonik	Armco Oriented T
Mo-Permalloy	Allegheny 4750	Permeron	Hypersil
Mu Metal*	Hypernik	Deltamax	Orthosil
		Hypernik V	Silectron

Typical of the unusual scope of the material contained in Catalog TWC-100 are Tables A and B, reproduced from Page 4 of "Performance-Guaranteed Tape Wound Cores."

GET THE COMPLETE STORY

A wealth of new and unusual material on Tape Wound Cores is available to you in Catalog TWC-100, "Performance-Guaranteed Tape Wound Cores." Tables A and B of the catalog, reproduced on this page, present a striking illustration of material not to be found compiled together elsewhere.

Data and descriptive details on high permeability materials . . . factory core matching . . . free engineering design services . . . pages of characteristic graphs and tables . . . are yours for the asking. Simply write on your company letterhead.

MAGNETICS inc.

DEPT. TT-7, BUTLER, PENNSYLVANIA

NEW!

NEW!

for convenient point-to-point wiring . . .

MINIATURIZED 5 AND 10 WATT WIRE-WOUND RESISTORS!

AXIAL LEAD Blue Jackets®

Here are two *truly miniaturized* self-mounting wire-wound power resistors to simplify your TV and industrial electronic production where space is a factor. They're ideal for point-to-point wiring, terminal board mounting, and processed wiring boards, where they fit in admirably in dip-soldered subassemblies.

Axial lead Blue Jackets are rugged vitreous enamel power resistors built to withstand the severest humidity performance requirements As for *economy*, these newest members of the Sprague Blue Jacket family are low in cost . . . eliminate need for extra hardware . . . save time and labor in mounting!

You can get these outstanding new Blue Jacket Resistors without delay in any quantity you require. Sprague Engineering Bulletin 111 gives full data on these and all other commercial Blue Jacket Resistors. Send for your copy.

SPRAGUE ELECTRIC COMPANY
233 Marshall Street, North Adams, Mass.

SPRAGUE TYPE NO.	WATTAGE RATING	DIMENSIONS L (inches)	D	MAXIMUM RESISTANCE
27E	5	1⅛	5/16	17,500 Ω
28E	10	1⅞	5/16	35,000 Ω

Standard Resistance Tolerance: ±5%

SPRAGUE

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

NORTH ADAMS, MASSACHUSETTS

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

As We Go To Press...

Punched Card Phone "Conversation"

Development of a punched card transmitter that "talks" over regular telephone circuits at the rate of almost 1,000 alphabetic or numeric characters a minute has been announced by IBM. Also capable of checking the accuracy of its rapid-fire "conversations" by listening in on them, this new development insures the exact, fast duplication of punched card data between points thousands of miles apart.

When information is to be sent to a distant point, the transceiver reads the data recorded in IBM cards in the form of punched holes. As the cards are being read, electronic circuits generate coded impulses in the form of "beeps," each series of sounds representing a hole in the card. These sound signals actuate the punching mechanism in the distant receiver which simultaneously creates exact duplicates of the cards being transmitted. The newly-created punched cards then become immediately available for accounting machine and computer processing.

Instantaneous duplication of punched cards over telephone networks performed by new transceiver

Unique Single-Tube Color Camera

A single pick-up tube, all electronic TV camera having simultaneous output in three colors is under development by Color Television, Inc. It is designed to be used with a single standard monochrome camera tube such as the image orthicon. Portions of the camera have been tested experimentally, but a complete unit of this type has not yet been constructed. The key to the problem is a special optical system which analyzes the color information in the scene viewed, and presents it in the form of a pattern which yields the required modulated signal when scanned. This optical filter causes a phase shift of the CIE diagram in accordance with the dominant wavelength of any color. It also provides amplitude modulation of the subcarrier according to the luminance difference between the primaries.

Tetrode Transistor Commercially Available

Tetrode junction transistors originally developed by Bell Telephone Labs. and described in the Nov. 1952 issue of TELE-TECH & ELECTRONIC INDUSTRIES are being mass produced for commercial availability by Germanium Products Corp., 26 Cornelison, Jersey City, N.J. These units, which have a fourth electrode connected to the center junction layer, offer high gain at frequencies much higher than is possible with conventional types. They are different than the dual-triode "tetrode" transistors announced during the past year.

Sudden Tube Failures

The Navy Department reports that one in exery six vacuum tube failures are of a sudden nature, according to a surveillance program carried out by Aeronautical Radio, Inc. Combined tube returns from all military bases which were monitored indicate following causes of return: 28.7% electrical, 21% mechanical, 18.5% miscellaneous, and 31.8% no defect found.

RETMA Acts on TV Interference

RETMA Board Chairman Robert Sprague has appointed Dr. W. R. G. Baker to head a committee with broad powers to establish procedures and possible testing facilities, after consultation with the FCC, so that TV set manufactures can eliminate possible sources of spurious radiation which interfere with the reception of TV signals by other receivers. An industry program for voluntary compliance is expected to head off any possible government intervention.

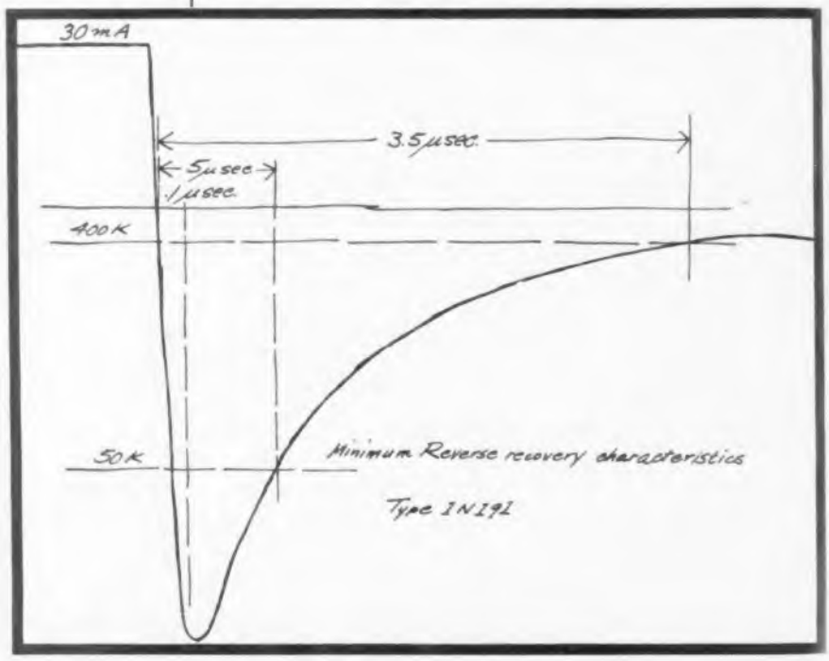
MORE NEWS on page 14

Hughes Diodes for Computer Applications

Types 1N191 and 1N192

Actual dimensions of diode body: .265" X .130"

The reliability of Hughes Germanium Diodes in many types of computer applications has been recognized in the field for some time. Their performance—frequently under severe operating conditions—continues to add to this reputation.



Now, as part of the continuing program to meet the expanding requirements for computer components, Hughes announces the registration of Diode Types 1N191 and 1N192. Both are selected for their outstanding performance in computer service.

These computer type diodes, like all Hughes diodes, are designed to ensure extremely high moisture resistance... thermal stability... electrical stability... subminiature size... thorough dependability. These features mean long life with minimum maintenance.

Recovery Time Characteristics *at 25° Centigrade*

Type 1N191
50 KΩ @ 0.5 μsec and 400 KΩ @ 3.5 μsec maximum.
Type 1N192
50 KΩ @ 0.5 μsec and 200 KΩ @ 3.5 μsec maximum.

To measure pulse recovery for both types, diodes are pulsed at 30 mA in the forward direction and then a back voltage of −35 volts is applied.

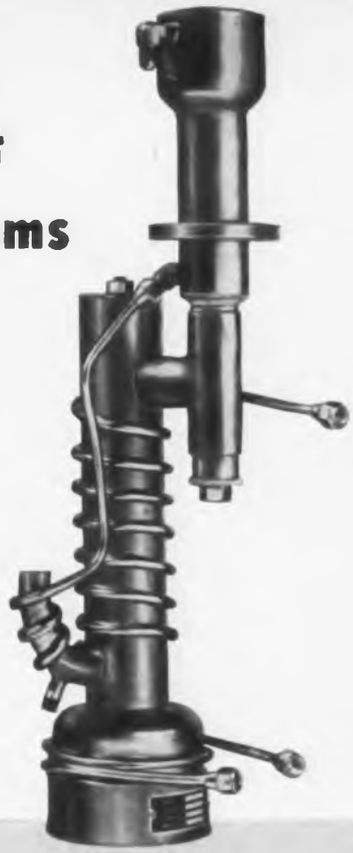
Maximum Back Current *at 55° Centigrade*

Type 1N191
.025 mA @ −10V and .125 mA @ −50V.
Type 1N192
.05 mA @ −10V and .25 mA @ −50V.

If you need special computer type diodes, chances are that we can furnish them on a production basis—because we are constantly producing and providing *many* types to meet literally hundreds of electronics and communications applications. Among these are high forward conductance, low-voltage diodes, used for certain computer applications. Write for new descriptive brochure.

NEW YORK CITY CHICAGO

It's easy to convert tube exhaust systems with these pump and port units



For most rotary exhaust machines—

CVC's Oil Diffusion Pump model MB-10 and port type TP-02 offer the maximum compactness and performance:

- Together they measure only 8¾" high; operate through any sweep and sliding valve combinations.
- The pump speed is 10 liters/second; ultimate pressure in the port is 10^{-3} mm Hg or lower; high limiting forepressure is 0.5 mm Hg.
- The two-position *mechanically* operated port and valve with its rugged mounting flange is easily attached to standard rotary machines.
- There's a readily removable jet assembly; jet parts separate to facilitate cleaning.
- The heater operates directly from any 115 volt power supply.

For large size TV picture tube exhaust—

CVC's Fractionating Oil Diffusion Pump type MCF-60 with the quick closing port produces pressures of 10^{-5} mm Hg and lower before getter flash in the large size picture tubes. Illustrated above is *CVC's* model MCF-60-013 (19½" high) having a rated speed of 60 liters/second and provided with:

- Water-cooled port for protection of rubber sealing gasket during bakeout.
- Quick opening compression type tubulation seal.
- Easily removable jet assembly.
- Properly located glass trap and clean-out port.

It's pumps like these that make *CVC inline* and *rotary exhaust systems* so efficient and economical to operate.

Whether you require just the pumps or a completely engineered exhaust unit, we welcome the opportunity of talking with you. *Consolidated Vacuum Corporation, Rochester 3, New York* (A subsidiary of Consolidated Engineering Corporation, Pasadena, Calif.)

CVC

formerly DPi Vacuum Equipment Dept.

Consolidated Vacuum Corporation

Rochester 3, N. Y.

designers and manufacturers of high vacuum equipment

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NOISE PROBLEMS SOLVED INSIDE

Let ASTRON'S Filter Engineering Laboratory analyze your noise suppression problems. We will recommend the proper RF interference filter for your specific needs, or we will *design and produce* a special unit meeting your most exacting electrical and mechanical requirements.

You benefit from ASTRON'S well-earned reputation as the leading manufacturer of quality filters. Employing the finest materials and components, Astron has developed the most modern manufacturing methods which insure production of the right filter for the job and faultless performance.

ASTRON has perfected new techniques of filter miniaturization by using miniature capacitor elements, subminiature metallized paper capacitors, the latest type inductance materials — resulting in high impedance, low voltage drop and minimum heating.

Write today, listing your requirements, to Department TT

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255 Grant Avenue, E. Newark, N. J.

Manufacturers of a complete line of capacitors, standard and subminiature filters for every television, radio and electronic application.

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In Canada Charles W Pointon 6 Alcina Ave . Toronto 10, Ontario

ceramics and metal are permanently and accurately combined

The metal bands on the rotor shafts shown at the left, above, are concentric with the shaft to within 0.001 in.

Stupakoff assemblies

Your production procedure is simplified when you use high-precision Stupakoff ceramic-to-metal assemblies. Extensive experience in the field of electrical and electronic ceramics, thorough familiarity with methods of metallizing, and the use of modern precision manufacturing methods insure the high quality and uniformity of Stupakoff Assemblies.

Among the assemblies made by Stupakoff are: rotor shafts, strain and spreader insulators, stand-offs and trimmers. Ceramic bodies are specially formulated for the intended service; metals used include silver, copper, brass, stainless steel and monel. Stupakoff's broad experience in this field insures the selection of a method of assembly best suited to meet service conditions.

A few types of Stupakoff Ceramic-to-Metal Assemblies are illustrated in the photographs on this page.

STUPAKOFF CERAMIC & MANUFACTURING COMPANY

LATROBE, PENNSYLVANIA

Some of the larger types of Stupakoff metallized ceramic parts.

Small metallized ceramic parts are accurately made and dependably uniform.

As We Go To Press . . . *(Continued)*

Conference Coordinating Committee Established

Six trade associations have organized a committee for the purpose of coordinating regional conferences. The associations include NEDA, WCEMA, RETMA, Sales Managers Club, Assoc. of Electronic Parts and Equipment Mfrs., and The Representatives.

Thermoelectric Comparator Sorts Metal

A fast non-destructive instrument for sorting different types of metal has been revealed by General Motors. The unit, known as the thermoelectric metal comparator, can also detect chills in castings and measure the thickness of metallic plating. It contains a thermocouple-type loop of two different metals, and the part being tested forms part of the loop circuit. The instrument's two probe tips are the hot and cold junctions where they touch the metal under test. Since the temperatures of the two junctions are kept constant, the resulting reading is a measure of the metal's composition.

Speedy Response

Within two days after radio station KRIB, Mason City, Iowa, was burned off the air, it was back on again thanks to the immediate emergency shipment of equipment by Collins, and crystal grinding by James Knights.

GIANT TOWER

WHIO-TV, Dayton, Ohio, now has a 1104-foot TV tower in operation. The tower's builder, the Blaw-Knox Co., reports it to be the world's tallest. It weighs 600,000 lbs., is mounted on a 832,000-lb. concrete base, is 14-ft. triangular, and has an elevator to top

New Diode Process

Sylvania Electric Products has announced the development of a manufacturing process that will increase greatly the stability and life of germanium diodes which are used widely in military and commercial electronic equipment. The process produces germanium with a molecularly stable surface. Diodes made in the past have occasionally developed a second unwanted barrier on the surface of the germanium, causing the characteristics to drift.

Empire State Asks TV Rent Raise

The seven New York City TV stations with antenna installations on the Empire State Building mast are negotiating a proposed rent increase within the terms of the present lease which expires on April 30, 1954. The rent raise from $70,000 to $200,000 for each station has been requested. This amount does not include presently occupied transmitter and office space.

Picture Tube Production Discontinued

Federal Telephone and Radio is discontinuing the production of black-and-white TV picture tubes. The facilities thus made available will be utilized to increase production of other commercial products.

Color Broadcast Catalog Issued

The first catalog of color TV broadcasting equipment to be released by RCA contains detailed descriptions covering all essential items of color networking and test equipment. Units are available either individually or as a package. Networking equipment is priced at $9455, and test gear for $8833. RCA has also announced that it will provide, free of charge, the parts and service required to modify its TV transmitters for color, at the time color terminal equipment is installed.

Bell TV Network Expands

With the connection of KTXL-TV, San Angelo, Tex., to the Bell Telephone System's nationwide network of TV facilities, network TV programs are now available to 280 stations in 176 cities in the U.S.

TWO-WAY RADIO ON THE GOOD BLIMP "RANGER"

Aerial eyes are the latest aid to public safety utilized by Miami, Fla. The blimp "Ranger" is equipped with Motorola two-way VHF radio, enabling its crew to contact land-sea mobiles

New Tape Firm

A new company, Magne-Tronics, Inc., 122 E. 42 St., New York 17, N. Y., has been formed. Its primary interest is the reproduction of sound on magnetic tape. P. L. Deutsch is president, and J. F. Hards is vice-president.

RCA Enters RR Communications Field

The Engineering Products Div. of RCA has entered the railroad communications field. The company is offering a line of VHF and microwave equipment capable of handling telephone, telegraph and signal functions.

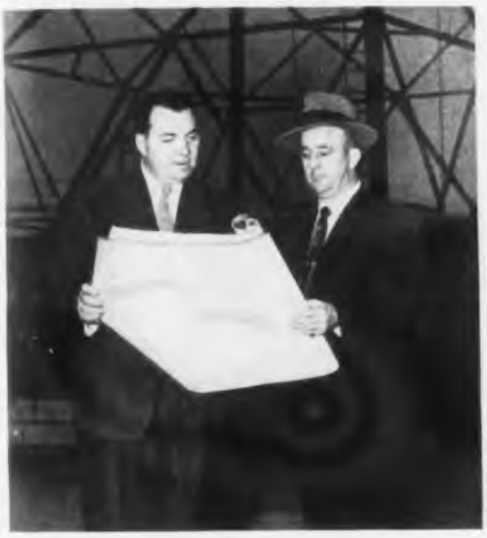
Color TV Rental

Based on the belief that the public would be reluctant to pay about $1000 for early color TV receivers with small screens Emerson has set up a rental program which allows the customer to pay for the set on a month-to-month rental basis. The fee, which has not been disclosed yet, would include installation and service.

MOBILE RADIO FOR RACERS

Two-way GE radio system serves as communication link between pit truck and two stock racing cars during 160-mile race at Daytona Beach, Fla. Lap, track conditions and gas supply information was relayed between drivers and p

first --choice----→ GPL again!



Checking construction blueprints: owner Robert W. Rounsaville (left) with Lee Smith, station manager in Louisville.

ROBERT W. ROUNSAVILLE PICKS GPL EQUIPMENT FOR THREE NEW TV STATIONS

WQXI-TV ATLANTA

WQXL-TV LOUISVILLE

WQXN-TV CINCINNATI

• With three new TV stations in highly competitive markets, Robert W. Rounsaville picked GPL equipment because "I just had to have both quality and economy . . . the quality to match existing stations; the economy to withstand the financial competition.

My engineers studied the field . . . looked at all lines. GPL was the final choice: for engineering quality and operating economy. With three stations, the savings from this equipment are mighty important. In fact, they mean profit or loss."

Whether you have one, three or five stations, General Precision products can do two major things for you: give you the best pictures on the air today, and save you operating costs. If this sounds too good . . . ask for proof. GPL engineers will bring equipment to your studios, work with your cost figures, to prove the double benefits.

THREE-STATION ORDER INCLUDES:

- 6 GPL-Pye Camera Chains
- 3 GPL-Continental Transmitters
- 3 Videcon Film Chains
- 6 GPL Projectors
- 3 Antennas and associated equipment

Write, wire or call for complete information.

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Camera Chains • Film Chains • GPL-Watson Varifocal Lenses • Theatre TV Equipment • GPL-Continental Transmitters

As We Go to Press . . . .

Transistorized Film Projector Introduced

Ampro Corp. is introducing an optical-magnetic motion picture projector using a transistor. The company reports this to be the first

Transistorized 16-mm film playback projector

transistor application to such equipment. The transistor replaces a bulky transformer, allowing the complete system to be housed in a single case.

Defense Expenditures

Department of Defense electronic and communications expenditures for the fiscal years 1954 and 1955 are expected to be over $1.5 billion, bringing the total expenditures for the five-year period 1951-1955 to about $4.4 billion. It should be noted that much more has been spent on electronic equipment in different budget classifications such as guided missiles and ships.

First DuMont Mobile Radio

The first two-way mobile radio equipment designed by Allen B. DuMont Labs. has been announced by the company's new Mobile Communications Dept. It is the MCA-101A, rated at 35 watts at 25-45 MC, and 30 watts at 45-54 MC. Equipment for 150-160 and 450-470 MC is under development.

Excise Tax Campaign On

RETMA is conducting a campaign to lower the excise tax on black-and-white TV receivers, and to exempt color sets from such tax. It is attempting to convince the House Ways and Means Committee to amend the Reed Bill to institute a proportional tax reduction, cutting the TV excise from 10% to 8%, and to follow the traditional policy of withholding any tax on a new product such as color TV.

New "Lighthouse" Tube

A new "lighthouse" triode transmitting tube, GL-2C39-B, has been developed by GE. Rating are 2500 MC, 100 watts, and 400 *g* shock resistance.

COMING EVENTS

April 2-3—Biennial Rice Exposition of Engineering Science and Arts, The Rice Institute, Houston, Texas.

April 5-8—A.M.A. 23rd National Packaging Exposition, Convention Hall, Atlantic City, N.J.

April 5-10—International Congress Soundtrack Recording, Paris, France.

April 15-16—RETMA Engineering Department Conference on Reliability of Electrical Connectors. Illinois Institute of Technology, Chicago, Ill.

April 19-20—Symposium on Automatic Production of Electronic Equipment, sponsored by Stanford Research Institute and U.S. Air Force, Fairmont Hotel, San Francisco, Calif.

April 22-23—AIEE Conference on Feedback Control, Claridge Hotel, Atlantic City, N.J.

April 22-23—Joint Meeting of Radio Technical Commission for Aeronautics, Franklin Inst. Labs., and IRE Professional Group on Aeronautical and Navigational Electronics. Franklin Institute, Philadelphia, Pa.

April 24—Eighth Annual TV Conference, IRE Cincinnati Section. Cincinnati, Ohio.

April 26-29—1954 Metal Powder Show. Sponsored by Metal Powder Association, Drake Hotel, Chicago, Ill.

April 26-30—Tenth Biennial ASTE Industrial Exposition, Philadelphia Convention Center, Phila., Pa.

April 27-29—AIEE Electronic Components Conference, Washington, D.C.

April 28-30—RTCM Spring Assembly Meeting, St. Francis Hotel, San Francisco., Calif.

May 3-6—URSI, U.S.A. National Committee and IRE Professional Group on Antennas and Propagation. Joint Spring Technical Meeting. National Bureau of Standards, Washington, D.C.

May 4-6—1954 Electronics Components Symposium, RETMA and others, U.S. Department of Interior Auditorium, Washington, D.C.

May 4-7—1954 AWS National Spring Technical Meeting, Hotel Statler, Buffalo, N.Y.

May 4-9—SMPTE 75th Annual Meeting, Statler Hotel, Washington, D.C.

May 5-7—Third International Aviation Trade Show, 71st Regiment Armory, New York, N.Y.

May 5-7—IRE Seventh Region Conference and Electronic Exhibit, Multnomah Hotel, Portland, Ore.

May 5-7—AIEE Northeastern District Meeting, Schenectady, N.Y.

May 5-8—1954 Welding and Allied Industry Exposition, Memorial Auditorium, Buffalo, N.Y.

May 7-8—IRE North Atlantic Region, New England Radio Engineering Meeting, Sheraton Plaza Hotel, Boston, Mass.

May 7-9—AFCA National Convention, Shoreham Hotel, Washington, D.C.

May 10-12—IRE National Conference on Airborne Electronics, Dayton Biltmore Hotel, Dayton, Ohio

May 17-20—Basic Materials Exposition. International Amphitheatre, Chicago

May 17-20—1954 Electronic Parts Show Conrad Hilton Hotel, Chicago, Ill.

May 17-20—New York Import Show, 34th St. Armory, New York, N.Y.

May 24-26—IRE, AIEE, IAS, ISA 1954 National Telemetering Conference, Hotel Morrison, Chicago, Ill.

May 25-27—NARTB Convention Engineering Conference, Palmer House, Chicago, Ill.

June 13-18—ASTM Annual Meeting, 11th Exhibit of Testing and Scientific Apparatus and Laboratory Supplies and Ninth Technical Photographic Exhibit, Sherman and Morrison Hotels, Chicago, Ill.

June 15-17—RETMA Convention, Palmer House, Chicago, Ill.

June 16-18—High Vacuum Symposium, Berkely Carteret Hotel, Asbury Park, N.J.

June 21-25—AIEE Summer General and Pacific Meeting, Hotel Biltmore, Los Angeles, Calif.

July 6-9—International Conference on Electron Microscopy, Joint Commission on Electron Microscopy of International Council of Scientific Unions, London, England

July 8-12—Convention British Institution of Radio Engineers, Christ Church, Oxford, England.

July 13-15—Plant Maintenance Show, Pan Pacific Auditorium, Los Angeles, Calif.

Aug. 25-27—Western Electronic Show and Convention. Los Angeles and San Francisco IRE sections and WCEMA sponsored. (Show) Pan-Pacific Auditorium, Los Angeles. (Convention Hq.) Ambassador Hotel, Los Angeles, Calif.

September—First International Scientific Radio Union, Amsterdam, Holland.

Sept. 1-16—Golden Jubilee Meeting of the International Electrotechnical Commission, University of Pennsylvania, Philadelphia, Pa.

Sept. 15-21—ISA First International Instrument Exposition, Convention Hall, Philadelphia, Pa.

Sept. 30-Oct. 2—High Fidelity Show, International Sight and Sound Exposition, Inc., Palmer House, Chicago.

Oct. 4-6—Tenth Annual National Electronics Conference, Hotel Sherman, Chicago, Ill.

Oct. 8-20—RETMA Radio Fall Meeting, Hotel Syracuse, Syracuse, N.Y.

Oct. 13-16—Audio Fair-Audiorama 1954, Sponsored by AES, Hotel New Yorker, New York N. Y.

ACM: Assoc. for Computing Machines.
AES: Audio Engineering Society.
AFCA: Armed Forces Communications Assoc.
AIEE: American Institute of Electrical Engineers.
AMA: American Management Association.
ASTE: American Society of Tool Engineers.
ASTM: American Society for Testing Materials.
AWS: American Welding Society.
IAS: Institute of Aeronautical Science.
IRE: Institute of Radio Engineers.
ISA: Instrument Society of America.
NACE: National Assoc. Corrosion Engineers.
NARTB: National Assoc. of Radio and TV Broadcasters.
RETMA: Radio-Electronics-TV Manufacturers Assoc.
RTCM: Radio Technical Commission for Marine Service.
SMPTE Soc. of Motion Picture and TV Engineering.
URSI: International Scientific Radio Union.
WCEMA: West Coast Electronics Manufacturer's Association
WESCON: Western Electronics Show & Convention.

TELE-TIPS on page 43

PATENTED

Welded Terminals

Proved by Years of Service

NOW AVAILABLE IN ALL

OHMITE®

WIRE-WOUND RESISTORS

Provide a Perfect, Permanent Connection between Resistance Wire and Terminal

WELDED RESISTANCE WIRE

All Ohmite resistors now have the resistance wire welded to the terminals instead of soldered or brazed. This provides a resistor with superior characteristics.

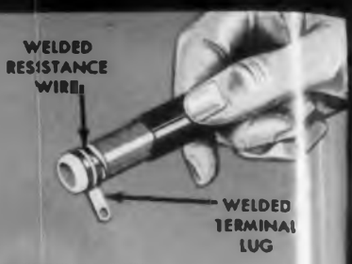
WELDED TERMINAL LUG

Another Ohmite resistor feature is the welded terminal band. The band is permanently held together around the resistor tube by means of welding, providing a strong, permanent fastening.

SEE NEXT PAGE ➡

Now in All Sizes . . .

Welded Terminals



ON OHMITE® RESISTORS

PATENTED OHMITE PROCESS ASSURES PERFECT WELDS

Ohmite has perfected and patented a new welding technique, and has developed a method of testing every weld between the resistance wire and terminal. Thus, with every Ohmite resistor, you are assured of permanent terminal connections, unaffected by vibration or high temperatures.

PERFECT ELECTRICAL CONNECTIONS

The fusion of the metal in the resistance wire and terminal lug provides a perfect and permanently stable electrical connection. This is extremely important in eliminating noise in audio circuits or instability in other highly sensitive circuits.

HIGH-STRENGTH ALLOY TERMINALS

The terminals on Ohmite resistors are made of a special high-strength alloy, which has a coefficient of expansion that is properly related to that of the enamel, ceramic core, and wire. This keeps the terminal firmly anchored, and prevents cracking of the enamel.

The resistance wire is welded practically flush with the terminal, so there is no projection extending from the surface. Hence, the connection and terminal are as well covered and protected by the vitreous-enamel coating as the winding itself.

PROVED IN TEN YEARS OF SERVICE

Ohmite developed welded terminals more than ten years ago. Since that time, this construction has been gradually extended to cover the entire Ohmite line. Millions of these welded resistors have proved their reliability in the toughest kind of service.

WRITE on Company Letterhead for Catalog and Engineering Manual No. 40.

Plus THESE OTHER OHMITE FEATURES

Ohmite resistors provide other important advantages, too—a superior vitreous-enamel covering, which holds the winding rigidly in place, preventing "hot spots," and protecting the winding from moisture and fumes; strong ceramic core that is unaffected by cold, heat, fumes, or high humidity; and hot tinned terminal lugs for ease in soldering. For unfailing dependability, specify Ohmite resistors.

OHMITE MANUFACTURING CO.
3662 Howard Street, Skokie, Illinois (Suburb of Chicago)

Be Right with

OHMITE®

RHEOSTATS • RESISTORS • TAP SWITCHES

DESIGNER'S NEWS

—from the RCA Tube Division

(length 6¼")
(diameter 1")

New Vidicon for TV Film Cameras

RCA-6326 is a small camera tube utilizing a photo-conductive layer as its light sensitive element and offering 600-line resolution. With it you can televise motion-picture film with an average high-light illumination of only 100-300 foot-candles on the tube face—and transparencies and opaques with a constant illumination of approximately 10 foot-candles on the tube face.

(RCA-6198 Vidicon is for Industrial TV)

(length 5⅛")

New Multiplier Phototube for Fast-Coincidence Scintillation Counters

Among the features offered by the RCA-6342 are its small spread in electron transit time and its relative freedom from after-pulses. It offers a "head on" design with flat face which allows excellent optical coupling between the cathode and the phosphor crystal. In addition, it has a focusing electrode to permit optimizing the magnitude, uniformity, or speed of the response in critical applications.

(length 15¼")
(diameter 3")

New Color-TV Image Orthicon

RCA-6474/1854 Image Orthicon is a television camera tube intended for use in color-TV cameras utilizing the method of simultaneous pickup of the studio or outdoor scene to be televised.

Features of this Image Orthicon include: exceptional sensitivity; a spectral response approaching that of the eye; and an ability to translate colors very accurately. Because it operates on a substantially linear signal-output characteristic, it can produce signals for pictures having natural tone values and accurate detail.

New Beam Power Tube for UHF!

RCA-6448 is a beam power tube featuring a coaxial electrode structure. The tube is intended for operation as a grid-driven power amplifier to provide high gain at frequencies up to 1000 Mc. Sync-level power output is 15 Kw at 500 Mc in color or black-and-white TV operation—and 12 Kw at 900 Mc. RCA-6448 also features water-cooled electrodes, and a multi-strand thoriated-tungsten filament for economical operation, high emission capability, and long life.

(length 7-23/32" max)
(diameter 11⅝" max)

RCA—"Headquarters" for

Tricolor Kinescopes, Receiving Tubes, Components, Power Tubes, Pickup Tubes, and Test Equipment for Color-TV—

- Thyratrons
- Magnetrons
- TV Camera Tubes
- Rectifier Tubes
- Transistors
- Voltage Regulator Tubes
- Cathode-Ray Tubes
- Vacuum-Gauge Tubes
- Transmitting Tubes
- Germanium Diodes

RCA Tube Division
Commercial Engineering, Section D-50 R
Harrison, N. J.

Please send me technical data on:

- ☐ Multiplier Phototube, RCA-6342
- ☐ Beam Power Tube, RCA-6448
- ☐ Film-Camera Vidicon, RCA-6326
- ☐ Image Orthicon, RCA-6474/1854

Name_____

Firm_____

City_____

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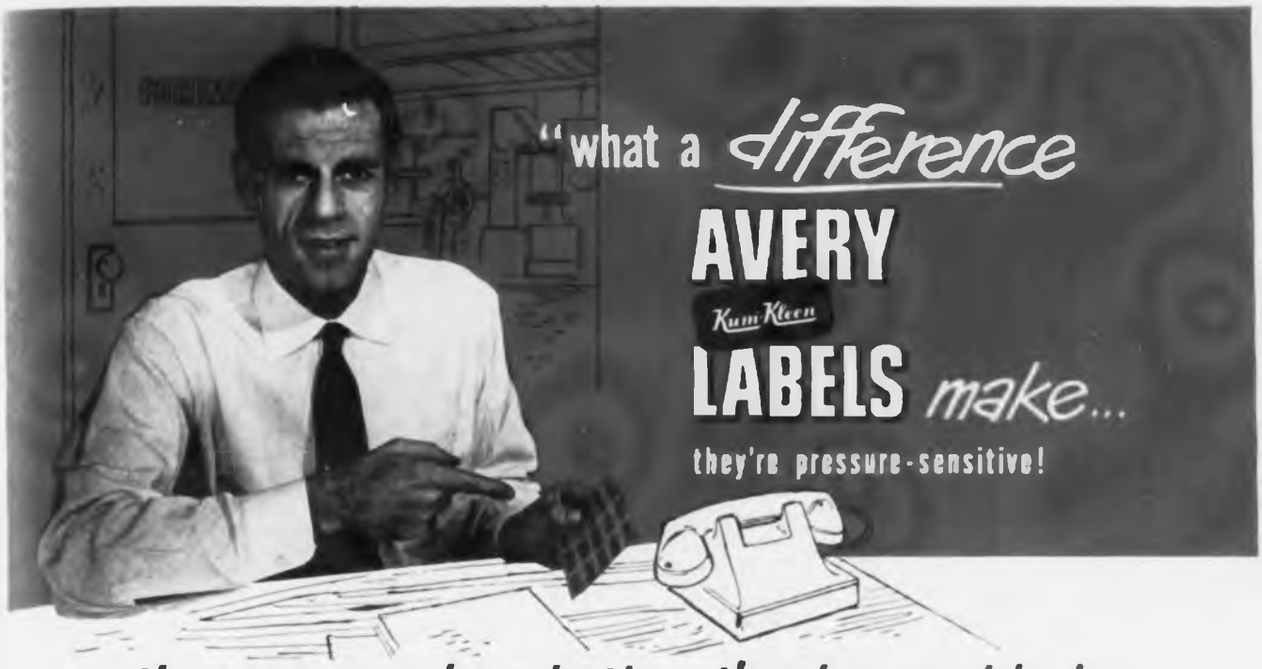
RADIO CORPORATION of AMERICA
ELECTRON TUBES
HARRISON, N. J.



"what a *difference* AVERY Kum Kleen LABELS *make...*

they're pressure-sensitive!

they sure speed production...there's no moistening —no waste motion!"

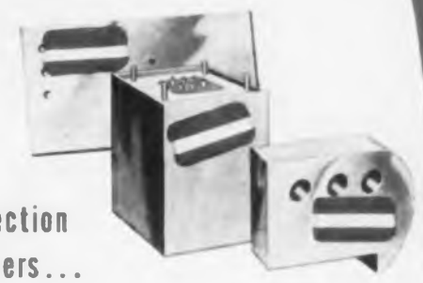
Consider these practical labeling advantages!

■ *All waste motions are eliminated*—for unlike ordinary labels, Avery Pressure-Sensitive Labels are applied dry! An automatic dispenser pops them out—the operator simply *lays* the label in place on the product or package—*without moistening*. That's all there is to it!

■ *Production line speed*—Avery dispensers speed every type of labeling job—whether it's a single item or a thousand. Labels are fed, *one-at-a-time*, ready for instant application. There's no sorting of loose labels... no messy glueing or licking...no soiled, spoiled packages.

■ *They stick, and stay stuck*—Avery Kum-Kleen Labels stick to any clean, smooth surface—*right now*—and will not curl, peel or pop off! That's why Avery Kum-Kleen *Pressure-Sensitive* Labeling is different... it's practical and economical. Write now for details—free sample labels—case histories!

SPECIFICALLY SPEAKING...



inspection stickers...

An ideal application...removable, Kum-Kleen Inspection Stickers provide a quick, positive means of designating whether an item is accepted, rejected, to be reworked or scrapped. Avery Kum-Kleen Labels are faster, safer and more efficient than chalk, grease pencil or gummed labels... they're quickly applied *without moistening*—and stick tight to all clean, smooth surfaces. They never curl or pop off—yet they're easily peeled off (without leaving a mark) when the job is done!

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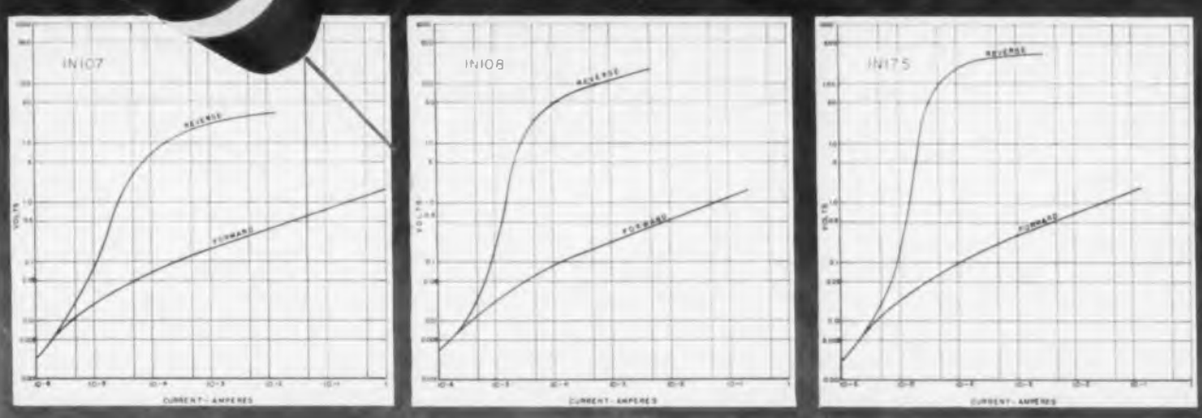
*Company*_____

*Address*_____

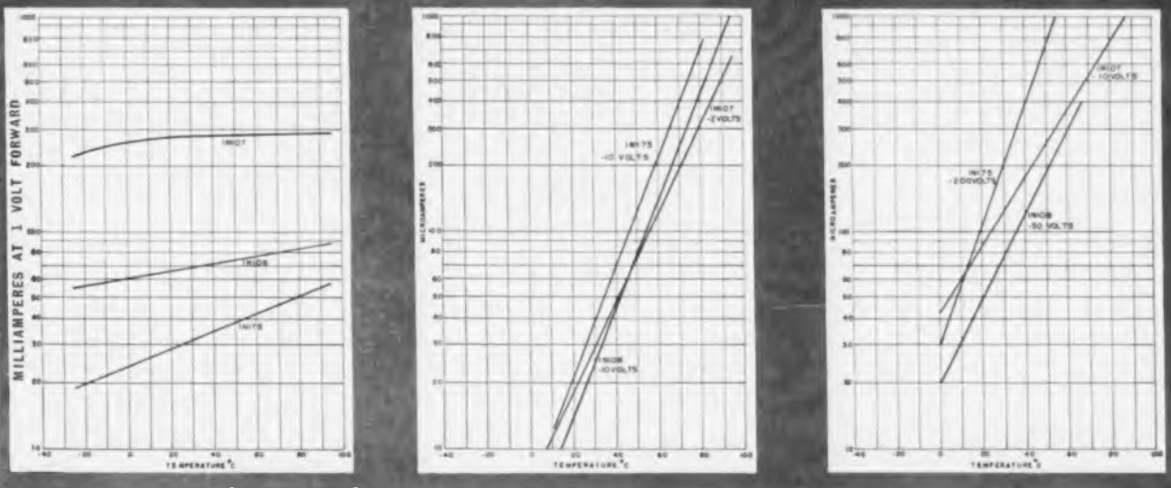
*Our Business Is*_____

temperature & low voltage characteristics

N.U. UNION DIODES



FORWARD & REVERSE CHARACTERISTICS OVER CURRENT & VOLTAGE RANGES



FORWARD & REVERSE CHARACTERISTICS UNDER TEMPERATURE CHANGES

ACTUAL SIZE

Your inquiries are invited on the many uses of Union Diodes exclusive with National Union. You will find that Union Diodes have characteristics particularly useful to the circuit designer interested in small signal and pulse applications. For example, the turn-on and turn-off time of the 1N107 is equal or superior to most point-contact diodes.

The accompanying charts show the Union Diode's behavior with temperature variations. Also plotted, over wide ranges of voltage and current, are their forward and reverse characteristics.

Important to you is the fact that Union Diodes are produced by the electronics engineers who helped pioneer the original research and development leading to such devices.

NATIONAL UNION RADIO CORP.

HATBORO, PENNSYLVANIA

here's what's behind the  crystal that's so far ahead

The Midland Factory shown above is the world's largest plant devoted exclusively to producing crystals for frequency control. It is equipped with the finest and most complete production and testing machinery ever developed for this purpose. Here Midland pioneered development of crystals for color television, and is now ready for full-scale production.

All this is important to you for just one good reason: Every Midland crystal you use has been produced by such advanced techniques and under such rigid quality controls that you can be sure it will prove its completely reliable quality under every operating stress.

Midland Critical Quality Control extends through every step of crystal production, and includes precise angular control by X-ray. Uniform accuracy is maintained to the millionth part of an inch.

Whatever your Crystal need, conventional or highly specialized,
When it has to be exactly right, contact

Midland MANUFACTURING COMPANY, INC.
3155 Fiberglas Road, Kansas City, Kansas

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ANDREW HELIAX

n important "for the first time" story...

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ELIAX is the first cable to deliver both characteristics. It is as flexible in application as solid dielectric cable, but has the same ficiency as copper air dielectric. HELIAX is superior in design, in efficiency and in electrical performance at microwave and lower frequencies, yet it is comparable in cost to lower frequency cables.

e of installation (HELIAX can be pulled through conduit and bent tately without changing its characteristics) means substantial savings nstallation costs.

LIAX is crush proof, may be removed from one installation, coiled and stalled. Now available in 7/8" size in continuous lengths. Soon available arger sizes. Send the coupon for detailed specifications.

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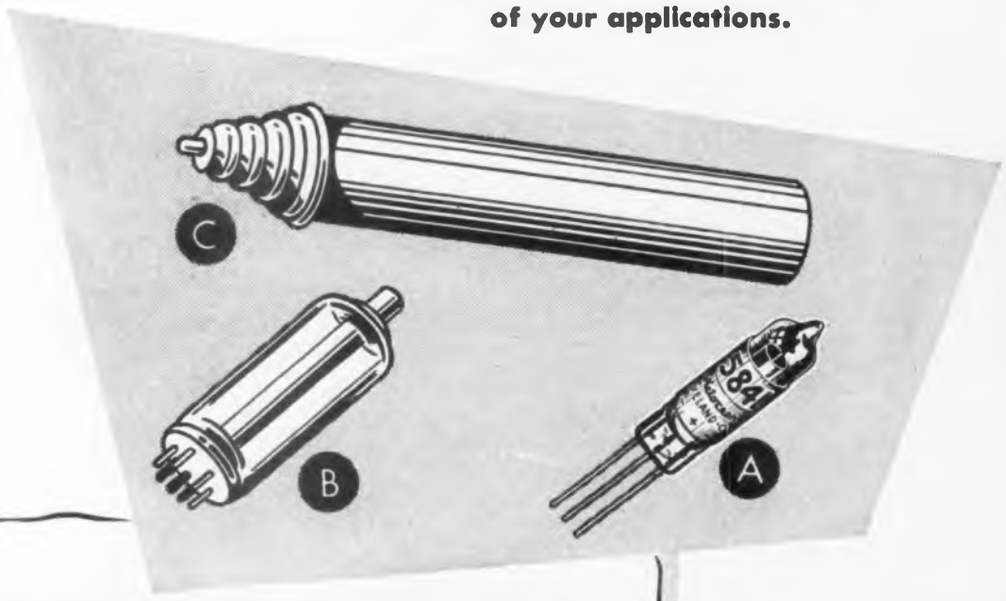
. . . as simple as ABC to select a Voltage Regulator Tube from Victoreen's unsurpassed variety of tube types.

Victoreen's customary high quality of material and workmanship assures long, reliable operation in all of your applications.



A List of the Most Frequently Used Voltage Regulator Tubes

Many other voltage regulator tubes are available — from 50 to 50,000 volts.

	TUBE TYPES	STARTING VOLTAGE (D.C.)	NOMINAL VOLTAGE (D.C.)	VOLTAGE REGULATION	CURRENT RANGE (Max.)
A T–3 GLASS ENVELOPE	VXR–400	430	400	1.5%/50 μa	100 μa
	VXR–500	530	500	1.5%/50 μa	100 μa
	VXR–600	630	600	1.5%/50 μa	100 μa
	5950	735	700	1.5%/50 μa	100 μa
	VXR–800	835	800	1.5%/50 μa	100 μa
	5841	940	900	1.5%/50 μa	100 μa
	VXR–1000	1050	1000	1.5%/50 μa	100 μa
	6143	1260	1200	1.5%/50 μa	100 μa
	VXR–1500	1570	1500	1.5%/50 μa	100 μa
	VXR–1800	1890	1800	1.5%/50 μa	100 μa
	6119	2100	2000	1.5%/50 μa	100 μa
B T 5–1/2 GLASS ENVELOPE	VXR–2500	2700	2500 ±5%	3%/100 μa	250 μa
	VXR–1401	1475	1400 ±5%	5–55 μa 1.5%	250 μa
	VXR–2002	2100	2000	3%/100 μa	250 μa
	VXR–4000	4500	4000 ±5%	3%/100 μa	250 μa
	VXR–5000	5500	5000 ±5%	3%/100 μa	250 μa
C SPECIAL ENVELOPE	VXR–10KV	10500	10,000	2%/100 μa	1000 μa
	VXR–12KV	12500	12,000	2%/100 μa	1000 μa
	VXR–14KV	14500	14,000	2%/100 μa	1000 μa
	VXR–16KV	16500	16,000	2%/100 μa	1000 μa
	6392	20000	18,000	2%/100 μa	1000 μa
	6353	21000	19,300	1.5%/250 μa	1000 μa

SPECIFY

quality components by

COMPONENTS DIVISION

Victoreen Instrument

3800 PERKINS • CLEVELAND 14, O.

. . . producer of a greater variety of voltage regulator tube types than any other manufacturer.

For a complete catalog of electronic components request form 3016A.

TEST TAPES

"THE MEASURE OF YOUR TAPE RECORDER'S PERFORMANCE"

D-110 — 5" reel, 7½ ips
D-111 — 7" reel, 15 ips

Recorded on REEVES SOUNDCRAFT **LIFETIME** magnetic tape made of DuPont "Mylar" Polyester film.

The only tape for indicating:

- Wow and Flutter
- Head Azimuth Alignment
- Frequency Response
- Signal to Noise Ratio
- Signal Level
- Tape Speed

for technical data see following page

TEST INDICATOR

D-500 TEST LEVEL INDICATOR

For use with any test tapes and test records....

The only accurate, yet inexpensive substitute for a good voltmeter. Consists of three bulbs calibrated to light up at 3 db intervals when connected across speaker leads.

TEST RECORDS

"THE MEASURE OF YOUR PHONOGRAPH'S PERFORMANCE"
D-100—12" vinyl disc, 33⅓ rpm

The only record for measuring:

- Frequency Response
- Rumble and Hum
- Wow and Flutter
- Tracking

"THE MEASURE OF YOUR PHONOGRAPH'S EQUALIZATION"
D-101—12" vinyl disc, 33⅓ rpm

The only record with these response curves:

- Columbia LP
- AES
- NARTB
- RCA's "New Orthophonic"

IN ADDITION... **AUDIO EQUIPMENT**
OF TESTED QUALITY IS FULLY STOCKED
at the **DUBBINGS** co., inc.

FOR YOUR CONVENIENCE . . . AN ADDRESSED, POSTAGE FREE ORDER ENVELOPE IS AT RIGHT

Simply detach along perforated lines, fill out and mail today

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To Calibrate for Peak Hi-Fidelity . Performance use

AUDIO TESTS

exclusively engineered by the **DUBBINGS** *co., inc.*

ORDER NOW WITH THIS CONVENIENT POST-FREE, ADDRESSED ENVELOPE

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Enclosed find ☐ CHECK ☐ MONEY ORDER

Quantity		Amount
☐	**D-110 TEST TAPE 5" reel 7½ ips** INTRODUCTORY OFFER @ $10.95 (For Orders Received After May 15, 1954, cost is $12.50)	$
☐	**D-111 TEST TAPE 7" reel 15 ips** INTRODUCTORY OFFER @ $15.95 (For Orders Received After May 15, 1954, cost is $17.50)	$
☐	**D-500 TEST INDICATOR @ $3.95** For use with any test tapes or records	$
☐	**D-100 TEST RECORD @ $3.50** "The Measure of Your Phonograph's Performance"	$
☐	**D-101 TEST RECORD @ $4.95** "The Measure of Your Phonograph's Equalization"	$

Simple, complete instructions enclosed with all the above.

DETACH ALONG PERFORATION

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*SECOND FOLD HERE

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☐	Fresh 7" Reel of REEVES SOUNDCRAFT **LIFETIME** Tape ($9.75 list) @ $6.50	$
☐	Fresh 10½" Reel of REEVES SOUNDCRAFT **LIFETIME** Tape ($19.80 list) @ $13.20	$
	Postage & Handling	$ .50
	(*Enclose Remittance Between First and Second Folds) **TOTAL**	$

☐ New 1954 Audio Catalog ☐ Recording Service Bulletin

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LISTEN... TO WHAT AUDIO EXPERTS ARE SAYING...

SEE PRECEDING PAGE FOR VITAL FACTS

GEORGE MAERKLE, Chief Engineer, Fisher Radio Corporation.
"The DUBBINGS' D-110 and D-111 Test Tapes are the first to fill the long standing need for accurate and easily used means of evaluating and improving performance of magnetic recording equipment..."

ROBERT J. MARSHALL, Chief Engineer, Fairchild Recording Equipment.
"DUBBINGS' new Test Tapes are welcome companions to this company's series of fine test records. They demonstrate the same high calibre and are the only practical means for truly measuring the high fidelity tape recorder's performance. Getting all the important tests on a single reel is a tribute to advanced engineering know-how."

HAROLD D. WEILER, *author of "High Fidelity Simplified," in his forthcoming book, "Tape Recorders and Tape Recording," states: "The DUBBINGS' Test Tapes are an absolute must for anyone interested in obtaining and maintaining peak performance from his tape recorder. Their use insures better tapes. They are more than just test tape..."*

comprehensive technical specifications on

DUBBINGS':

AUDIO TESTS

SEE PRECEDING PAGE FOR VITAL FACTS

D-110 TEST TAPE—"The Measure of Your Tape Recorder's Performance" 5" reel 7½ ips, REEVES SOUNDCRAFT LIFETIME Tape

WOW AND FLUTTER–3,000 cps tone • HEAD AZIMUTH ALIGNMENT–5,000 cps tone • FREQUENCY RESPONSE–30 to 7,500 cps in 13 steps 30, 50, 100, 200, 400, 700, 1 kc, 2, 3, 4, 5, 6, 7.5 kc. Recorded with standard NAB characteristic for 7½ inches per second. • SIGNAL TO NOISE RATIO –400 cps tone, 15 to 50 db in 5 db steps with announcements • MAXIMUM SIGNAL LEVEL–zero level, 400 cps, 3% total harmonic distortion • TAPE SPEED–timing beeps at 0, 5 and 10 minutes. Detailed instruction book enclosed.

D-111 TEST TAPE—"The Measure of Your Tape Recorder's Performance" 7" reel, 15 ips, REEVES SOUNDCRAFT LIFETIME Tape

WOW AND FLUTTER–3,000 cps tone • HEAD AZIMUTH ALIGNMENT–10,000 cps tone • FREQUENCY RESPONSE–30 to 15,000 cps in 14 steps 30, 50, 100, 200, 400, 700, 1 kc, 2, 4, 6, 8, 10, 12, 15 kc. Recorded with standard NAB characteristic for 15 inches per second. • SIGNAL TO NOISE RATIO–400 cps tone, 15 to 50 db in 5 db steps with announcements • MAXIMUM SIGNAL LEVEL–zero level, 400 cps, 3% total harmonic distortion. • TAPE SPEED–timing beeps at 0, 5 and 10 minutes. Detailed instruction book enclosed.

D-500 TEST LEVEL INDICATOR

RANGE–Calibrated for 3 db increments in level; 1 db increments can be judged easily • SENSITIVITY–Indicates at listening volume level when connected across 3 to 16 ohm loudspeaker terminals • FREQUENCY RESPONSE –Non-frequency discriminating, equally accurate at any frequency. Precision made, durable construction. Leads and alligator clips supplied. Detailed, easy to use instruction book enclosed.

D-100 TEST RECORD—"The Measure of Your Phonograph's Performance" 12" pure vinylite disc, 33⅓ rpm microgroove.

FREQUENCY BANDS–30, 50, 100, 250, 400, 700, 1 kc, 2, 4, 6, 8, 10, 12 kc. 4½ db/oct. attenuation below 500 cps. Constant velocity above 1 kc at 6 cm/sec level • ACCURACY–Within 1 db • WOW AND FLUTTER–3,000 cps tone • TRACKING TEST–5 bands of 400 cps tone at increasing levels 2.5, 4, 6, 8½, 11 cm/sec. • UNMODULATED GROOVE–to check rumble, noise and hum. Both sides of record identical. Detailed, easy to use instructions on record cover.

D-101 TEST RECORD—"The Measure of Your Phonograph's Equalization" 12" pure vinylite disc, 33⅓ rpm microgroove.

FREQEUNCY BANDS–30, 50, 100, 250, 400, 700, 1 kc, 2, 4, 6, 8, 10, 12 kc for each of the following recording curves, Columbia LP, NARTB, AES and the RCA "New Orthophonic." An additional 1 kc reference band before each frequency run • ACCURACY–within 1 db. Detailed, easy to use instructions on record cover.

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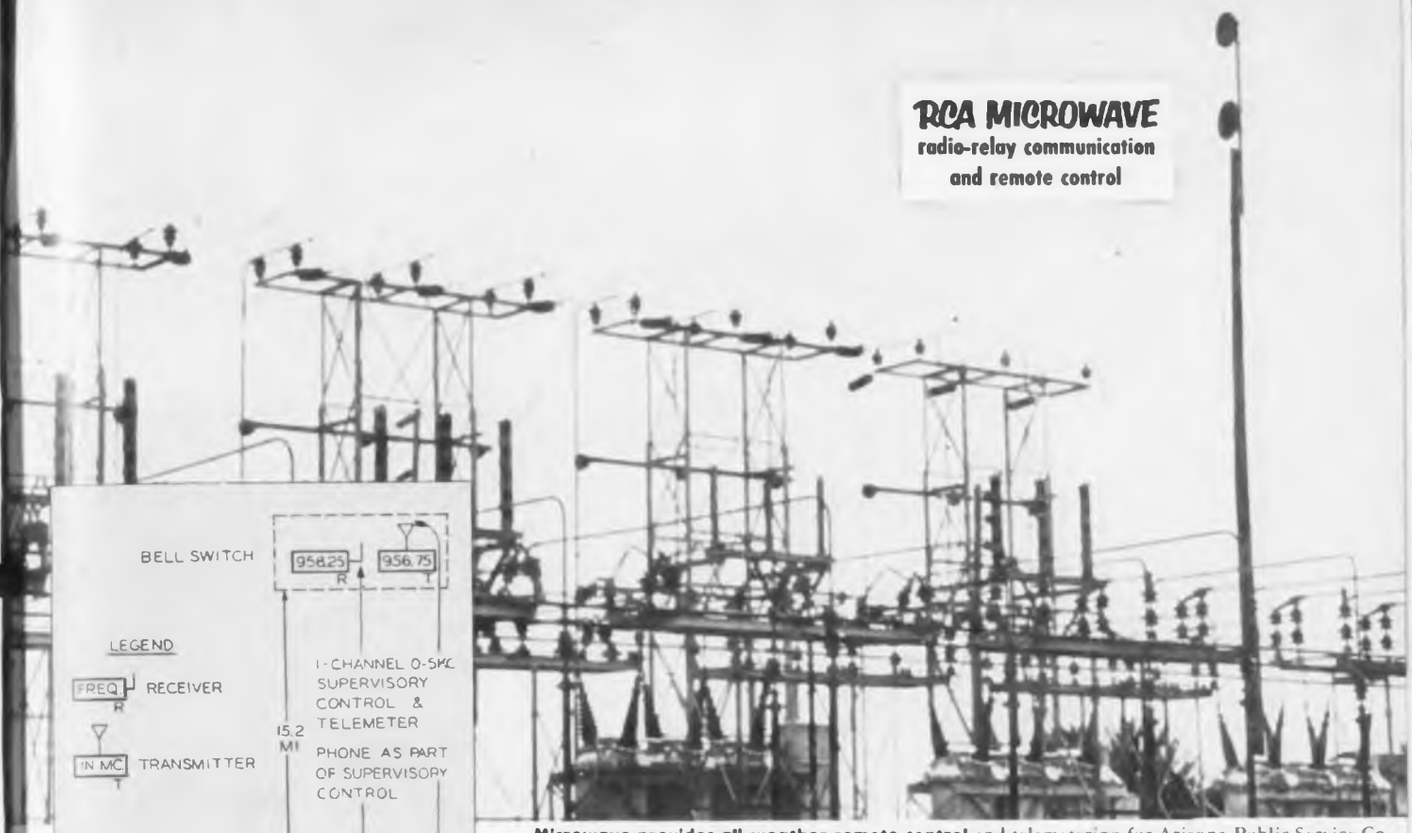
RCA MICROWAVE
radio-relay communication and remote control



Microwave provides all-weather remote control and telemetering for Arizona Public Service Co. Unattended substations receive control impulses from steam plant at Phoenix

Arizona Public Service Co. 960-mc Microwave system. Selector switch connects transmitter to either antenna at Phoenix steam plant

Through severest heat, sand, electric storms . . . Arizona Public Service Company's remote supervisory control system (via Microwave) stays on the job

Since 1949 Arizona Public Service Company has used RCA Microwave for remote supervisory control of two substations from a steam-electric plant. One installation provides remote control and indications on five 69-kv breakers, telemetering of voltage and current, and a 2-way voice channel. The other installation controls two breakers and provides telemetering and voice channels between plant and switching station. (*See schematic.*)

Four years of operation under trying conditions have proved the reliability of RCA Microwave. Through ambient 140-degree heat, high winds, severe sand and dust storms, violent rain and electric storms—Public Service's supervisory control system has stayed on the job. Here was a link which was independent of the transmission lines it services . . . providing reliable communications and control when needed most.

MANY ENGINEERING ADVANTAGES

Sound engineering features led Public Service to select microwave rather than high-line carrier. Microwave offered good noise and distortion characteristics, easy tie-in with mobile radio, greater channel capacity, reasonable freedom from interference, and relative ease of maintenance.

The economy factor also favored RCA Microwave. While a one-channel microwave system generally costs more than carrier to install, *in this particular case* it cost $9,000 less because crowded carrier frequency space would require considerable new equipment. In addition, RCA Microwave's built-in provisions for extra channels make it the *least expensive form of communication per channel mile.*

A PRACTICAL SYSTEM

Outage time of RCA Microwave is next to zero. "Dish" antennas beam highly directional radio signals from one relay station to the next. The radio transmissions follow a line-of-sight path—can approximately parallel power lines. Equipment uses easy-to-service familiar circuits and readily available tubes. It can interconnect with existing telephone lines, switchboards and mobile radio installations. One RCA Microwave system will handle up to 25 voice channels (or 25 x 18 telemetering and control channels).

You can prepare now for your expanding communications needs, *before they develop.* The booklets listed below provide quickly digested facts to help with future planning. *Mail the coupon—there's no obligation on your part.* And remember, the RCA Service Company provides nation-wide installation and service facilities.

RADIO CORPORATION of AMERICA
COMMUNICATIONS EQUIPMENT — CAMDEN, N. J.

Dept. D119, Building 15-1

Without obligation on my part, please send me your *free* booklet on: ☐ Microwave for Telemetering and Supervisory Control ☐ Electric Utility Microwave Systems

Name_____ Title_____

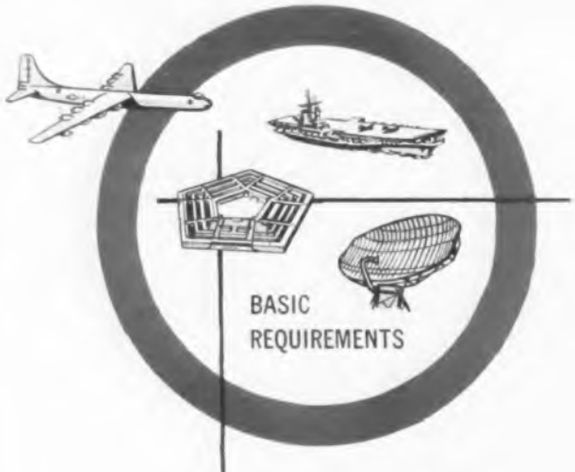
Company_____ Address_____

City_____ Zone_____ State_____

☐ Have an RCA communications specialist get in touch with me

Automatic testing and recording permits accurate evaluation of greater numbers of resistors

ONLY IRC MAKES SO MANY JAN AND M

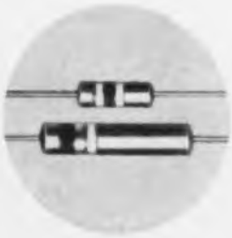


JAN and MIL Specifications are basic guideposts for electronic advancement, whether used as engineering reference points or as procurement standards. IRC's dual emphasis on mass production and frequent, accurate performance testing assures you of the highest performance standards at the lowest possible cost.

56 different IRC resistors is today's figure—all equivalent to JAN or MIL specifications. And all are standard units, available on excellent delivery cycle! If you manufacture end-equipment for the armed forces and must meet these specifications, or if you apply them as standards to your own requirements, depend on IRC for everything you need. For, manufacturing the widest line of resistors in the industry—127 different types in all—IRC is logically your best source of JAN and MIL type units.

JAN-R-29 *specification*

For all requirements of JAN-R-29 Specification, Amendment 4, IRC sealed precision Voltmeter Multipliers function efficiently even when exposed to the most severe humidity. Used with 1-milliampere DC instruments, they enable voltage measurements to be made up to 6000 volts. Send for Bulletin.



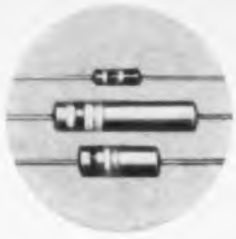
JAN-R-184 *specification*

Unusually stable and inexpensive, IRC BW Wire Wounds meet JAN-R-184 Specification, Amendment 5, at ½ and 1 watt. Resistance element is uniformly and tightly wound on insulated core. Molded housing provides full insulation. Widely used in meters, analyzers, high stability attenuators, low-power ignition circuits, etc. Send for Bulletin.

MIL-R-26B *specification*

For high power dissipation, IRC Power Wire Wounds meet every commercial requirement of MIL-R-26B Specification, Characteristic G. Tubular, flat, fixed, adjustable, inductive, non-inductive, lead, lug and ferrule types provide resistors for virtually any circuit. From 5 to 225 watts. Send for Bulletin.

MIL TYPE RESISTORS



MIL-R-11A *specification*

IRC Advanced BT Resistors meet and beat MIL-R-11A Specification, Amendment 2. Filament-type resistance element and other exclusive features afford extremely low operating temperature and superior power dissipation in a compact, light, fully insulated unit. Available at ¼, ½ and 1 watt to MIL specification and 2 watts to commercial specification. Send for Bulletin.

NEW *product*

HERMETIC *sealing terminal*

Overcomes limitations of other types of hermetic sealing terminals.

Molded KEL-F* body—chemically inert to organic solvents, acids, oils, fumes.

Rugged construction—tough and resilient; withstands constant vibration.

Type HS-1 Feed-Thru Terminals provide assured hermetic sealing for electrical and electronic components. Exclusive IRC molding Technique bonds Kel-F* to metal in a superior seal. Designed to the sealing requirements of MIL-T-27. Send coupon for full data.

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IRC

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

Send me data on ☐ MF Voltmeter Multipliers, ☐ BW Resistors, ☐ Power Wire Wounds, ☐ Advanced BT Resistors, ☐ HS-1 Terminals.

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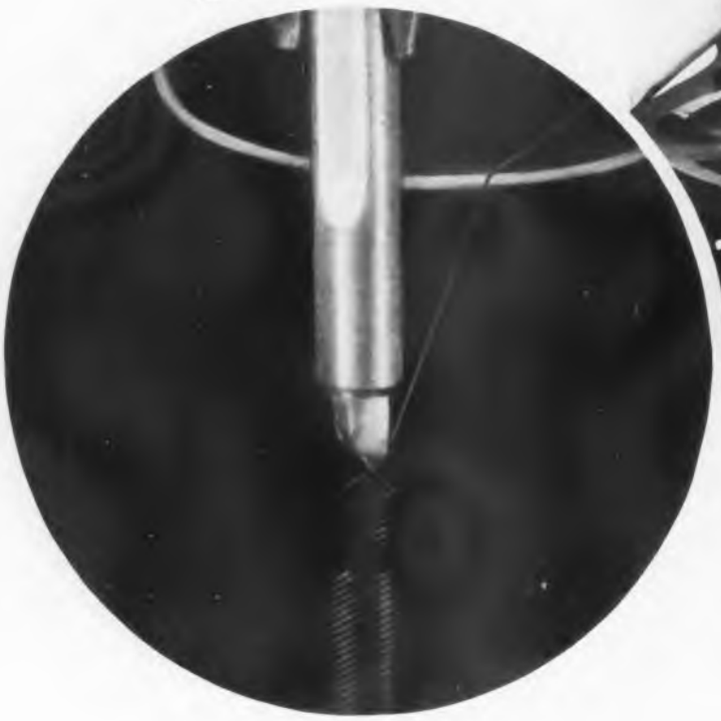
NOW...try the revolutionary new Soundcraft MicroLac®

RECORDING DISCS



proved best throughout the recording cycle

After months of exhaustive pre-testing in leading recording studios throughout the country, Soundcraft brings you its all-new MicroLac Recording Discs.

These revolutionary new discs:

1. Are unmatched for play-back perfection.
2. Carry a far quieter, wider range signal straight through from your cuttings to your final stampers.

Check these qualities to see why the new MicroLac Discs are the finest high-fidelity recording discs in the world:

- **Noise level well below that of your own recording equipment.**
- **Perfected thread throw, especially for microgroove recordings.**
- **Quieter with cold stylus than most discs with hot stylus.**
- **Unsurpassed silvering qualities, for finer masters, mothers and stampers.**
- **Mirror-flat surfaces providing . . .**
- **Constant depth of cut, with or without advance ball.**

Soundcraft MicroLac Discs are made on the finest aluminum bases, optically tested for flatness and smoothness . . . degreased for permanent lacquer adhesion . . . deburred for perfect edge seal.

Their new lacquer coating is forced through eight stone filters to a maximum particle size of less than one micron. It is applied automatically in a 250-foot-long sealed tunnel in which four air conditioners in series, each with a Precipitron, remove the last possible traces of dust.

Revolutionary as the new MicroLac Discs are their brand new, high strength, parcel post and tumble tested shipping containers. They deliver your discs factory new. They open easily as a drawer. They make ideal permanent storage chests, with numbered spaces for individual disc titles.

Try the sensational new Soundcraft MicroLac Discs right away. See and hear for yourself why we believe them to be the world's finest!

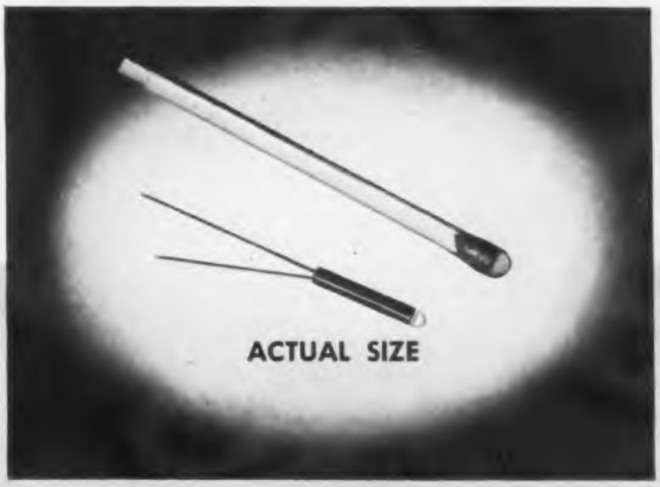
REEVES SOUNDCRAFT CORP.

Dept. N4, 10 East 52nd Street, New York 22, N. Y.

HIGHLY SENSITIVE...COMPACT IN SIZE!

SYLVANIA PHOTODIODE

1N77A



The Sylvania 1N77A is a highly sensitive compact junction photodiode.

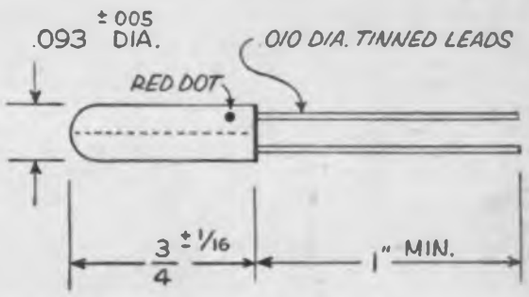
Its useful sensitivity covers the visible spectrum and extends into the infrared region where it peaks at approximately 1500 Angstrom Units.

Consider these advantages:

1. **Hermetically sealed in glass.**
2. **Extreme stability in operation.**
3. **High sensitivity (5.0 volt peak to peak across a 100 k-ohm load).**
4. **Low dark current (500 μa @ −50 volts).**

The high sensitivity and compact packaging of the 1N77A should provide the answer to many light-sensing application problems. *Still more reasons why it pays to specify Sylvania.*

DETAILED DRAWING



FOR FULL DETAILS about the complete line of Sylvania diodes write to Dept. 4E-4404 at Sylvania.

SYLVANIA

Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg. St. Catherine Street, Montreal, P. Q.

LIGHTING • RADIO • ELECTRONICS • TELEVISION

New Alkyd Uses at IRE Show

Many applications of the various types of alkyd molding compounds are being exhibited by the Barrett Division of Allied Chemical & Dye Corp. at the IRE National Convention, Kingsbridge Armory, New York City, including one that holds a key position in making color television a reality.

The Tube Div. of RCA is having the base of the first commercial color picture TV tube molded of Plaskon granular alkyd, because it will provide, with minimum leakage, the required insulation for the 11,000 volts applied to one of the base pins of this tube. Alkyd was chosen also because of its higher resistance to the adverse effects of humidity and moisture.

Two other qualities which alkyd possesses were also factors in its selection for the color TV tube base. Alkyd can withstand high temperatures for long periods without damage; and, secondly, it is easily molded, making large-scale production possible.

Aircraft Application

Several new applications for molded plastics have been found by the aviation industry including one which eliminates 140 assembly operations, recently announced by Westinghouse Electric Corp. It involves the chassis of a centralized, electrical control system which is made of molded fibrous glass reinforced alkyd.

The Westinghouse application is an approach to aircraft wiring which brings numerous electrical components from throughout the plane into one spot on a single panel. This panel is designed as a removable, "plug-in" unit that can be readily exchanged so that the aircraft can be returned to operation while the replaced panel is being serviced.

Control Chassis Provides Insulation

Using Plaskon alkyd 440A, Westinghouse engineers designed a single, tray-like chassis on which a major portion of the electrical components of a control panel are mounted. This molding replaces, in one step, an alternate design requiring 140 separate assembly operations. The chassis itself provides insulation of one connection from another, and is highly arc resistant. It made possible a rearrangement of components for easier wiring and assembly, and enabled designers to reduce the overall height of the unit by 1½ in.

Amperex NOW BRINGS YOU 2 NEW RUGGEDIZED TRIODES

SPECIALLY DESIGNED FOR HEAVY DUTY RF INDUSTRIAL APPLICATIONS

TYPE 6333 (WATER COOLED)

Plate Dissipation 10 kilowatts. Furnished with grid connector for direct interchangeability with type 892 without any equipment modifications. Suitable for communications as well as industrial applications. Available in air-cooled version, Type 6445.

TYPE 6446 (WATER COOLED)

A heavy wall triode capable of dissipating 20 kilowatts continuously. Massive anode (7/16" thick), provides high heat storage capacity for heavy intermittent duty. High dissipation reserve allows extreme mismatch of load to tube impedance. The tube is therefore protected against maladjustment or misuse of equipment. Uses only ½ the water flow required for type 892, for equivalent anode dissipation. Available in air-cooled version, Type 6447.

OPERATING DATA, 6333
RF POWER AMPLIFIER and OSCILLATOR CLASS C TELEGRAPHY

	MAXIMUM RATING per tube	TYPICAL OPERATION one tube	
AC Filament Voltage	—	22	volts
DC Plate Voltage	15000	12000	volts
DC Grid Voltage	3000	1600	volts
Plate Load Resistance	—	3500	ohms
Peak RF Grid Voltage	—	2600	volts
DC Plate Current	2	1.55	amps
Plate Input	30	18.60	kw
Plate Dissipation	10	4.35	kw
DC Grid Current (approx.)	400	165	ma
Driving Power (approx.)	—	420	watts
Plate Power Output	—	14.25	kw
Tube Power Output	—	745	BTU/min.

OPERATING DATA, 6446
RF INDUSTRIAL OSCILLATOR

(3 PHASE, FULL WAVE, UNFILTERED SUPPLY)

Plate Volts and Input—Max. For Frequencies Indicated	100 5	75 12.5	50% 20(mc.)

	MAXIMUM RATING per tube	TYPICAL OPERATION one tube	
AC Filament Voltage	—	22	volts
DC Plate Voltage	15000	15000	volts
DC Grid Voltage	— 3000	— 1250	volts
Peak RF Grid Voltage	—	2400	volts
Plate Current	2	2	amps
Plate Input	30	30	kw
Plate Dissipation	20	18	kw
DC Grid Current	400	250	ma
Drive Power (approx.)	—	620	watts
Plate Power Output	—	20	kw
Tube Output	—	1138	BTU/min.

DIRECT INTERELECTRODE CAPACITANCES

Grid to Plate	32 μμf
Grid to Filament	17 μμf
Plate to Filament	1.8 μμf

LIST PRICES

6333 (Water Cooled)	$230.00
6445 (Forced Air Cooled)	375.00
6446 (Water Cooled)	255.00
6447 (Forced Air Cooled)	400.00

ACCESSORIES

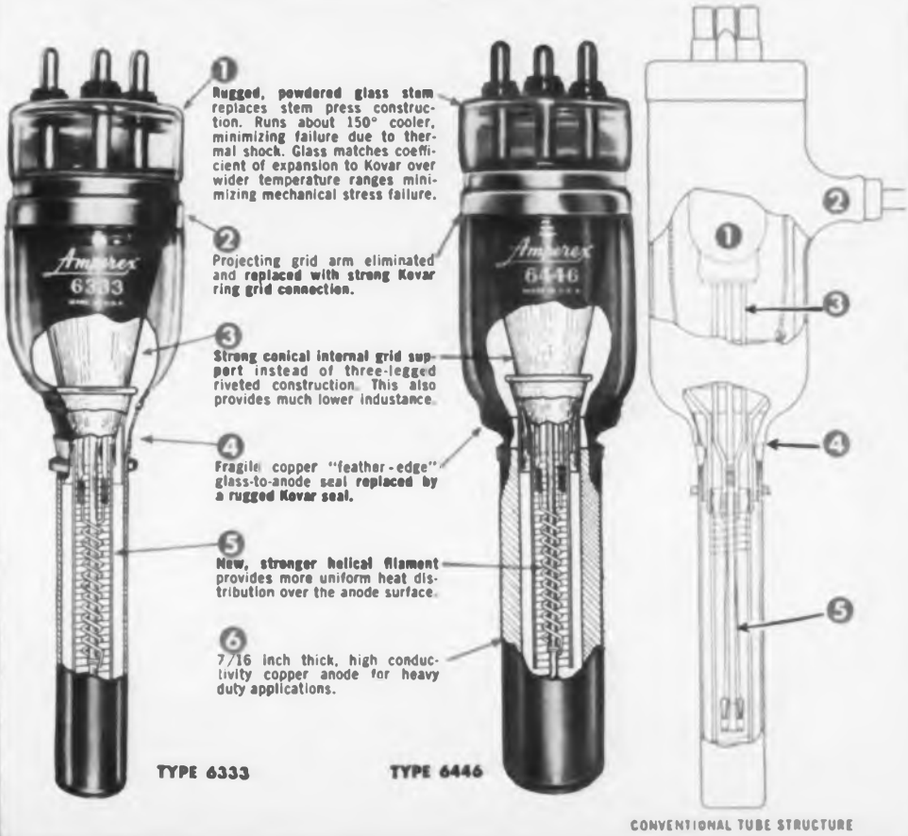
Tube Type	Water Jacket	Grid Connector
6333	DW-1580	Y-13326 (Supplied with tube without charge)
6446	S-15096	Y-13326 (Supplied with tube without charge)

Complete technical data available from our Application Engineering Department

POWER TUBE SELECTION CHART

. . . yours for the asking! Comprehensive colored chart shows ratings in power output and frequency for typical applications. Also gives a correlated table of FCC frequency allocations. Helps you find, in a moment, the tube or tubes that will fit your industrial and communication jobs.

AMPEREX tubes give you better performance and longer life, Physically and Electrically, through these exclusive RUGGEDIZING techniques:



Available At Your Local Parts Distributor

AMPEREX ELECTRONIC CORP.

230 Duffy Ave., Hicksville, Long Island, N. Y.

In Canada: Rogers Majestic Electronics Ltd.

News of MANUFACTURERS' REPS

Leonard Zlowe, formerly with th Burndy Engineering Co., has been ap pointed sales engineer on the staff c Frederick I. Kantor, 4010 Saxon Ave New York 63, N.Y. to augment the firm' audio and electronic coverage of indus trials and distributors in the New Yor area.

Associated Engineering Service, Inc 1 Thomas Circle, N.W. has been named the representative for Shasta Div. o Beckman Instruments, test equipmen manufacturer, in the Washington, D.C area. **The Jack C. Gilbert Co.**, 4034 Ben ton Blvd., has been appointed at Kansa City, Missouri. The **Instrument Service Labs, Ltd., 21 W. Broadway, Vancouver B.C.**, for western Canada. **Loren F Green & Assoc.**, 4949 W. Diversey Ave in Chicago, Ill. **Land-C-Air Sales**, 42 Oak Ave. in Tuckahoe, New York; **G. E Moxon**, 422 La Jolla Avenue, in San Mateo, California; **Murphy & Cota**, 1409 Peachtree St., N.E. in Atlanta, Georgia; **Pikney & Hine**, 552-3 Plymouth Bldg. in Minneapolis, Minn.

Cargo Packers Special Products Co., 73 Rutledge St., Brooklyn, N.Y. has been appointed national distributor for Radio Receptor's Thermatron Packaging Sealer.

John C. Lee has been named district sales representative for the American Silver Co., close tolerance strip manufacturers, to cover the Kentucky, southern Ohio and southern Indiana area, from offices at 2111 Carew Tower, Cincinnati, Ohio.

Thomas L. Stevens Co., 1151 S. Broadway, Los Angeles, will cover the southern California area for Dale Products, Inc., manufacturers of resistors and electronic components.

Gawler-Knoop Co., with three offices at: 178 Eagle Rock Ave., Roseland, N.J.; 901 Pershing Drive, Silver Spring, Maryland; and 835 Glenside Ave., Wyncote, Pa., has been named sales representative by Waveline, Inc., microwave instrument manufacturer. Similar appointments went to **Everette Associates, Inc.**, at 6744 N. California Ave., Chicago, Ill.; Box 6236, Speedway City, Indianapolis, Indiana; and 1629 East 31st Street, Kansas City, Missouri. Also, **Robert A Waters, Inc.**, 4 Gordon Street in Boston, Mass.; and at 1150 Whalley Ave., New Haven 15, Conn.; **John B. Tubergen Co.**, 2232 West 11th St., in Los Angeles, California and **Edward A. Ossmann & Associates**, located at 3 Juniper St., Rochester 10, N.Y. and 308 Merritt Ave., Syracuse, N.Y.

Alden (Pat) Bowser, until recently deputy chief of CAA electronics, has been appointed engineering representative of Lenkurt Electric Sales Co. San Carlos, Cal.

3 twin power triodes

...for voltage regulation

CHATHAM
TYPE 6336
NEW TWIN TRIODE FEATURING HIGH PLATE DISSIPATION

The new Chatham Type 6336 is a twin power triode with special suitability for voltage regulating applications. Used as a series tube, it will pass a minimum of 150 milliamperes per section with 40 volts, D.C. plate voltage. Special features include a hard glass envelope, an 8-pin button stem with Jumbo Octal Base.

CHARACTERISTICS *(PER SECTION)*

- PLATE DISSIPATION: 30 WATTS
- AMPLIFICATION FACTOR: 2.7
- TRANSCONDUCTANCE: 11,000 MICROHMS
- PLATE RESISTANCE: 250 OHMS
- HEATER REQUIREMENTS: 6.3 V., 4.75 AMPS.

The tubes shown are typical items from the complete Chatham line of general and special purpose tubes. Included in this line are Amplifiers, Mercury and Inert Gas Rectifiers, also Mercury, Inert Gas and Hydrogen Thyratrons.

Most Chatham tubes are available directly from stock and can be supplied promptly. Chatham also designs, develops and manufactures special tubes to exact customer specifications — inquiries are invited.

TYPE 6394
TWIN TRIODE
Similar to Type 6336 in every respect except for Heater Requirements which are 26.5 volts, 1.25 amps.

CHATHAM TYPE 6AS7G IMPROVED TWIN POWER TRIODE —

This Chatham Twin Triode is built to close tolerance — features plate current and GM characteristics held within ±10%, very low microphonics, improved triode balance, absence of grid current and greatly reduced plate current drift. Plate current is 125 milliamperes at 40 volts, D.C. plate voltage. The characteristics of this tube recommend it especially for voltage regulation circuits. Base is Medium Shell Octal.

CHARACTERISTICS: *(PER SECTION)*

- Plate Dissipation: 13 Watts
- Amplification Factor: 2.0
- Transconductance: 7,000 Micromhos
- Plate Resistance: 280 Ohms
- Heater Requirements: 6.3 Volts 2.5 Amps.

CHATHAM ELECTRONICS CORP.

Executive and General Offices: LIVINGSTON, NEW JERSEY
Plants and Laboratories: NEWARK and LIVINGSTON, NEW JERSEY

THE NEW DOUGLAS *DC-7*

Diamond Connectors at work in DC-7 radio equipment, helping to insure reliable communication.

Depends on DIAMOND CO-AXIAL CABLE CONNECTORS

As dependability in electronic circuits becomes more critical, coordinated engineering and manufacturing effort of a highly refined degree becomes an unqualified "must".

This Company is proud that its product has been selected for use in THE NEW DOUGLAS DC-7.

DICO

DIAMOND MANUFACTURING CORPORATION

7 North Avenue, Wakefield, Massachusetts

for *Unattended* OPERATION
THE *Gatesway* is THE COMPLETE WAY!

When you buy Gates remote control, you certainly do not buy half a loaf. — The Gatesway is indeed the whole loaf in reliable equipment for unattended operation.

Gates remote control includes rack cabinets for both studio and transmitter, completely wired and ready to use. Motors for remote tuning are supplied with adjustable brackets to fit nearly every application. The antenna and lead-in are standard equipment — or, to the point, we don't believe you will need the help of your local hardware or electrical store to complete the installation.

And no equipment of this kind is complete without a national sales and service organization such as Gates can offer. There are five Gates major branches plus a field engineer near you, no matter where you are.

Available for the asking is a new 8-page brochure on Gates complete remote control systems. — By having this informative brochure you will quickly discover why the Gatesway is the COMPLETE WAY and yet costs, in many instances, actually less.


COMPLETE STUDIO REMOTE CONTROL


COMPLETE TRANSMITTER CONTROL IN UNDER-WINDOW CABINET

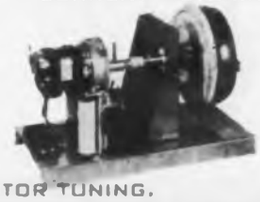

FM MONITOR RECEIVER


TOWER LIGHT INDICATOR


DIODE ANTENNA CURRENT METERING


PRIMARY CONTACTOR


POWER SUPPLIES ARE PLUG-IN


MOTOR TUNING. ALL MOUNTINGS PROVIDED

GATES

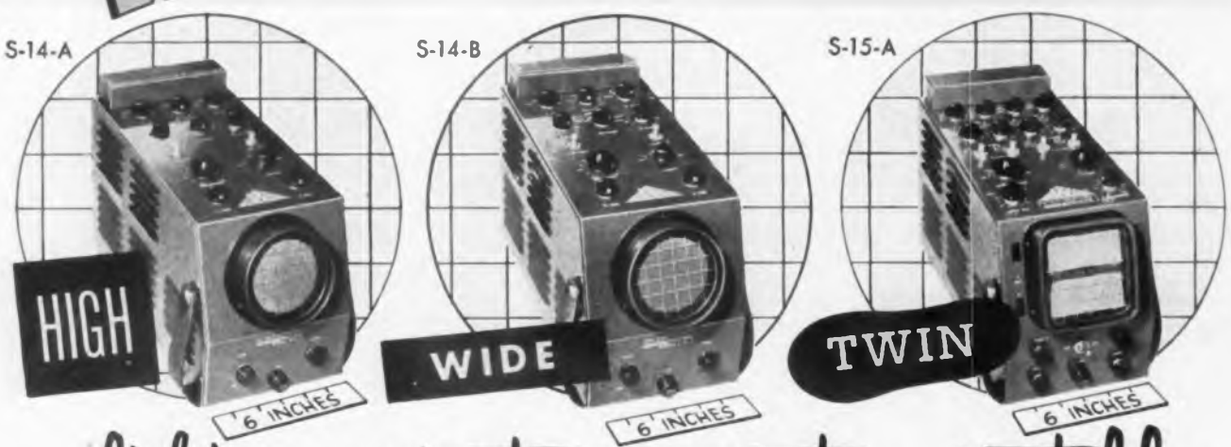
GATES RADIO COMPANY QUINCY, ILL., U. S. A.

Manufacturing Engineers Since 1922

Houston 2700 Polk Avenue
New York 51 East 42nd Street
Washington D. C. Warner Bldg.
Los Angeles 8501 Sunset Blvd.
New York [illegible] 13 East 40th St.
Atlanta, 13th & Spring Sts.
Montreal, Canada—Marconi Co.

Waterman POCKETSCOPE

The Pocket-Size Oscilloscope



...light...compact...accurate...portable

Featuring small size, light weight and outstanding performance the HIGH, WIDE and TWIN POCKETSCOPES have become the "triple threat" of the oscilloscope field. Their incomparable versatility, reliability and accuracy have skyrocketed this team of truly portable instruments into unparalleled demand. Each oscilloscope features DC coupled amplifiers in both vertical and horizontal channels.

HIGH

The S-14-A HI-GAIN POCKETSCOPE provides the optimum in oscilloscope flexibility for analysis of low-level electrical impulses. Extremely light weight (12¾ lbs.), compact in size (12 x 5¾ x 7 in.), dependable and accurate in performance. Vertical and horizontal channels: 10mv rms/inch with response within 2DB from DC to 200 KC and pulse rise of 1.8 μs . . . non-frequency discriminating attenuators and gain controls with internal calibration of trace amplitude . . . repetitive or trigger time base with linearization from ½ cycle to 50 KC with ± sync or trigger.

WIDE

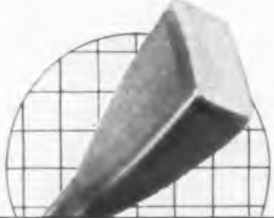
The S-14-B WIDE BAND POCKETSCOPE is ideal for investigations of transient signals, DC signals, aperiodic pulses or recurrent waveforms. Vertical channel: 50 mv rms/in. within —2DB from DC to 700 KC . . . pulse rise time of 0.35 μs. Horizontal channel: 0.15v rms/in. within —2DB from DC to 200 KC . . . pulse rise of 1.8 μs. Attenuators and gain controls are non-frequency discriminating . . . trace amplitude calibration . . . repetitive or triggered time base from ½ cycle to 50 KC . . . ± sync or trigger . . . trace expansion, filter graph screen and many other features . . . 14 lbs. . . . 12 x 6 x 7 inches.

TWIN

The S-15-A POCKETSCOPE is a portable, twin tube, high sensitivity oscilloscope with two independent vertical as well as horizontal channels. It is indispensable for investigation of electronic circuits in industry, school and laboratory. Vertical channels 10 mv rms/in. with response within—2DB from DC to 200 KC and pulse rise time of 1.8 μs . . . horizontal channels 1v rms/in. within —2DB from DC to 150 KC . . . non-frequency discriminating controls . . . internal signal amplitude calibration . . . linear time base from ½ cycle to 50 KC, triggered or repetitive, for both horizontal channels.

S-11-A

The S-11-A INDUSTRIAL POCKETSCOPE is a small, compact (5x7x11 inches), and lightweight (8¾ lbs.) instrument for observing electrical circuit phenomena. The flexibility of the POCKETSCOPE permits its use for AC measurements as well as for DC. The vertical and horizontal amplifiers are capable of reproducing within —2DB from DC to 200 KC with a sensitivity of 0.1v rms/in. . . . repetitive time base from 3 cycles to 50 KC continuously variable throughout its range . . . variations of input impedance, line voltage or controls do not "bounce" the signal—the scope stabilizes immediately.



RAYONIC CATHODE RAY TUBES BY WATERMAN

TUBE	PHYSICAL DATA		STATIC VOLTAGE		DEFLECTION*		LIGHT OUTPUT**
	FACE	LENGTH	A3	A2	VERT	HOR	
3JP1	3"	10"	3000	1500	111	150	357
3MP1	3"	8"		750	99	104	33
3RP1	3"	9.12"		1000	61	86	44
3SP1	1.5x3"	9.12"		1000	61	86	44
3XP1	1.5x3"	8.875"		2000	33	80	218

*Deflection in volts per inch.
**Light output of an element of a raster line (one mm long and not exceeding .65 mm in width) in microlumens.

The basic properties of the cathode ray tube that concern the designer or the user are: deflection sensitivity, unit line brightness, line width, static voltage requirements and physical size. A comparison between cathode ray tubes manufactured by Waterman Products Company is shown in the table adjoining. These tubes are available in P1, P2, P7 and P11 phosphors. 3JP1, 3JP7, 3SP1 and 3XP1 are available as JAN tubes.

Visit our Booths (158 and 160) at the IRE Show March 22 to 25.

PULSESCOPE by Waterman

The Oscilloscope that Portrays the Pulse

Classic Examples of Precision Engineering...

The PULSESCOPES are cathode ray tube oscilloscopes that portray the attributes of the pulse: shape, amplitude, duration and time displacement. All PULSESCOPES have internally generated markers with the basic difference that in the SAR PULSESCOPE the markers initiate the sweep while in the others the sweep starts the markers.

BROAD The S-6-A BROAD BAND Scope is a PULSESCOPE in performance, POCKETSCOPE in size. The instrument measures DC as well as AC signals. Unique DC calibration methods permit rapid measurements of either positive or negative, AC or DC signals. Vertical amplifier sensitivity of 0.2v rms/inch, and response to 5 mc within 3DB . . . pulse rise time of 0.1 μs . . . internal markers from 1 to 1000 μs . . . repetitive or trigger sweep from 5 cycles to 500 KC with 5X sweep expansion . . . sweep, marker and DC calibrating voltage available externally. Size 8½ x 6¾ x 13¾ in. Weight 22 lbs. Operates from 50 to 400 cycles at 115 volts AC.

LAB The S-5-A LAB PULSESCOPE is a JANized (Gov't Model No. OS-26) portable, AC, wide band-pass, laboratory oscilloscope ideal for pulse as well as general purpose measurements. Internal delay of 0.55 μs permits observation of pulse leading edge. Includes precision amplitude calibration, 10X sweep expansion, internal trace intensity time markers, internal trigger generators and many other features. Video amplifier 0.1v p to p/inch . . . pulse rise time of .035 μs or response to 11 mc. 1.25 to 125,000 μs triggered or repetitive sweep . . . internally generated markers from 0.2 to 500 μs . . . trigger generator from 50 to 5000 pps. for internal and external triggering. Operates from 50 to 400 cycles at 115 volts AC.

SAR The S-4-C SAR PULSESCOPE is a JANized (Gov't Model No. OS-4) portable instrument (31.5 lbs.) for precision pulse measurements for radar, TV and all electronic measurements. Portrays all attributes of the pulse . . . internal crystal controlled markers of 10 and 50 μs available for self-calibration . . . in R operation a small segment of the A sweep is expandable for detailed observation with a direct-reading calibrated dial accurate to 0.1%. Video amplifier band-pass up to 11 mc . . . optional video delay 0.55 μs . . . pulse rise and fall time better than 0.07 μs . . . R pedestal (sweep) 2.4 to 24 μs . . . video sensitivity of 0.5v. p to p/inch. Easily convertible from μs to yards. Operates from 50 to 400 cycles at 115 volts AC.

RAKSCOPE Because the panel is only 7" high and fits any standard rack, the S-12-B RAKSCOPE admirably fills the need for a small oscilloscope of wide versatility. With all the features of the S-11-A POCKETSCOPE, the RAKSCOPE is JANized (Gov't Model No. OS-11), and has many additional advantages; the sweep, from 5 cycles to 50 KC, is either repetitive or triggered . . . vertical and horizontal amplifiers are 50 mv rms/inch with band-pass from 0 to 200 KC . . . special phasing circuitry for frequency comparison.

WATERMAN PRODUCTS CO., INC.

WATERMAN PRODUCTS

PHILADELPHIA 25, PENNA., U.S.A.

CABLE ADDRESS, POKETSCOPE, PHILA.

Manufacturers of POCKETSCOPES® • RAKSCOPES® • PULSESCOPES® and RAYONIC® TUBES

TELE-TIPS

"MOST UNDERSTANDING WIFE of the year" citation went to Mrs. J. Stan Surber, whose husband spends 19 hours weekly on his amateur radio hobby, for helping her spouse to win GE's Edison Radio Amateur Award for outstanding public service in 1953.

DELIGHTFUL NONSENSE is contained in humorous tale published in the Feb. 1954 Hoffman *Transmitter*. It is entitled "There's No Place Like Ohm . . . a fable for engineers in which the hero conquers a hard-boiled erg and wins the coil." The story opens with, "Once upon a time when t equals zero, there lived in a small cavity in a dielectric medium, a poor struggling dipole by the name of Eddy Current. He was deeply in love with a beautiful coil by the name of Ann Ion. . . . However, her father, a rich magnet and power factor, had laid down a strict set of boundary conditions for her future husband."

MOST RADIO AND TV stations (87%) do not pay newspapers for publishing their program logs, according to a recent NARTB study. Those not asked to pay are in population areas representing about 66 million people. Some 27% in areas containing 9 million people are being asked to pay, but only 13% are doing so. The 14% refusing to pay use their own promotional devices, and none reported dissatisfaction with their present methods.

PHONE-ANSWERING instrument called the "Metaphone," being made by The Bristol Co., permits a public utility employee to phone a remote, unattended reservoir to obtain data on storage conditions at any time. The reading is determined by the length of time a buzzer sounds, which is proportional to water height or gas pressure.

"ELECTRONIC TIN CUP" is what some people are calling the Chicago project to solicit funds for an educational TV station. It seems that contributors are being sold on the idea that the station would be used for charitable fund-raising campaigns such as March of Dimes and Red Cross.

(*Continued on page* 46)

NEW

truly functional

TUBECHECKER

by

WESTON

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

- Provides accurate meter measurement o leakage resistance as high as 5 megohms be tween tube elements.
- Permits high transconductance measure ments, with ranges 3000/6000/12000/2400(micromhos.
- Multiple switching protects against early obsolescence, allows making any combinatior of tube connections.
- Element switching permits checking and comparing individual sections of twin-section tubes without changing selector switch.
- Only *one* socket for each type tube base eliminates plugging tubes into wrong sockets.
- Sockets for all type bases . . . including acorn and 7 and 8 pin subminiatures.
- 19 filament voltage settings—.65 to 115 volts. 5 plate voltages — 20 to 177 volts. A 45-volt source for testing subminiature types.
- Grid bias, plate voltage and meter sensitivity adjustable.
- Large, readable fan-shaped meter . . . new roll chart with complete, up-to-date data on all tubes.

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

5539

Available through leading distributors

WESTON
Model 981 Type 2

WESTON *Instruments*

TELE-TIPS

(*Continued from page* 43)

DIVERSIFICATION is illustrated in the product line of Brown Instruments. Ninety-four years ago the company made a pyrometer. Today, 20 classes of products form the basis for more than 15,000 different applications covering 450 industries.

THUMBS UP view by CBS-TV President J. L. Van Volkenburg says that TV and education will become increasingly concerned with each other through the coming years, and what each will contribute to the other may prove quite as significant as any other development in our national life.

THUMBS DOWN view by Robert Hutchins of Univ. of Chicago says that astronomers have discovered a kind of moss on the planet Mars, and he takes this to be a race of humans reduced by TV to the life of the vegetable.

MOTHER EARTH is 4.5 billion years old, according to recent studies by Univ. of Chicago atomic scientists. This bears out speculations by astronomers. Previous findings by geologists had indicated that the earth was only a youthful 2.5 billion years old.

SERVICE DELUXE is provided by the telephone company in Vienna, Austria. A customer can learn who is singing that night at the opera, or when the next eclipse of the moon will occur. Sports enthusiasts can call for football and racing results. Musicians can hear the normal A sounded for them. Housewives are told the recipe of the day. Even the kiddies may phone for a story from "Aunt Fairytale."

JUST THE FACTS MA'AM—A number of years ago when IRC was in its infancy (and again during World War II), a few FBI agents came down to investigate. It seems that some overly anxious ladies had heard about this group, busily at work doing goodness knows what. With a name like International Resistance they feared that this was the outpost of bloody revolution. A quick look around convinced the FBI

(*Continued on page* 48)

Now...at no increase in price...

HERMETICALLY SEALED Germanium Diodes

JAN TYPES

A. Ceramic Case
B. Solder
C. Germanium Pellet
D. Weld
E. Platinum-Rhuthenium Whisker
F. Weld
G. Solder
H. Nickel Pin
I. Weld
J. Leaded Copper Clad Wire

COMPLETE METAL TO CERAMIC SEAL. Gas-tight ceramic cases with metalized ends permit solder seal to nickel pins.

MOISTURE PROOF. These new diodes exceed the requirements of JAN humidity specifications.

REQUIRED ELECTRICAL PROPERTIES. More than two years of development were necessary to perfect this combination of hermetic seal and superior performance.

MECHANICAL STABILITY. Platinum-rhuthenium whisker is welded to the germanium pellet.

LONG-LIFE. The elimination of moisture effects adds years to the life of your equipment!

MAXIMUM RATINGS (At 25°C)

Hermetically Sealed DIODES	1N69	1N70	1N81*
Peak Inverse Voltage	75	125	50
Continuous Operating Inverse Voltage	60	100	40
Min. Forward Current (MA) at + 1V	5.0	3.0	3.0
Max. Inv. Current (μa a) At — 50V At — 10V	850 50	300 25	— 10
AV Rectified Current (MA)	40	30	30
Peak Rectified Current (MA)	125	90	90
Surge Current (MA)	400	350	350

*JAN approval applied for

Production quantities of hermetically sealed types 1N69, 1N70, and 1N81 are now available. Hermetically sealed commercial types are expected to be ready in a few months. Be sure to include them in your design planning now! For complete information write: *General Electric Company, Section 4844, Electronics Park, Syracuse, New York.*

You can put your confidence in—

GENERAL ELECTRIC

NEWS FROM OUR ADVANCED DEVELOPMENT LABORATORIES

● A four-terminal junction transistor has been developed having a region of negative output impedance. This switching device is unique in that two coincident trigger signals are required to turn it on. Thus two gating functions may be accomplished by a single transistor.

This advertisement will appear April, 1954, in *Tele-Tech*

TELE-TIPS

(Continued from page 46)

that there wasn't a trace of the subversive present. This story is true. Not even the names have been changed to protect the innocent.

WHO WILL BUY COLOR TV? A recent Emerson survey indicates that consumer interest is tied up with individual income. The breakdown is:

9%—will buy color TV when cost is no higher than $500. (76% of this group were in the $7,500 to $15,000 bracket and 24% earned more than $15,000).

41%—will buy color TV when the price is no higher than $400 and the sets have at least 19-in. screens. (98% of this group were in the $5,000 to $7,500 bracket).

42%—will buy color TV only when sets become available at less than $300 with 21-in. screens. (The members of this group were almost entirely in the under-$5,000 bracket).

4%—say they will never buy color TV. All were in the under-$5,000 bracket. The typical response was, "We will get the color programs in black-and-white on regular TV sets."

"THE ONLY TIME you ever succeed when you are an inventor is the last time you try . . . So we have to teach people to fail intelligently."—Charles F. Kettering.

BOOKS

Television, A World Survey

Edited and prepared by the United Nations Educational, Scientific and Cultural Organization. Published 1953 by Columbia University Press, 2690 Broadway, New York 27, N. Y. 181 pages. Price $1.75.

Here is one of the most comprehensive global examinations of the TV medium. It is based on data available during the first quarter of 1953, so it does not account for expansion during the past year. Nevertheless, its detailed coverage of 45 countries and territories, as well as the United Nations, make it an interesting and authoritative source book worthy of favorable recommendation.

The worldwide status of TV is summarized in the introductory chapter on "The Structure of Television." This is followed by specific information about each country, including history of TV development, legal and organizational structure, source of revenue and advertising policy, and standards and technical facilities. Also, information is presented on programming, number and types of receivers, license fees, production of equipment, and professional training.

(Continued on page 60)

Can't it

is a word

ADLAKE engineers don't understand!

Often, a problem that "can't be solved" is merely one which hasn't yet been brought to the right people. When such problems come in to ADLAKE relay engineers...problems requiring special relays for unusual installations...they promptly drop the "can't". For, if there is no ADLAKE Relay to answer a specific need, one will be designed and manufactured to fill it.

ADLAKE Mercury Relays have proved their ability to stand up under the most adverse conditions of temperature and moisture. Their time delay characteristics are fixed and non-adjustable...normal line voltage fluctuations or ambient temperatures from −38° to 200° F. have no material effect on these characteristics.

Yes, in chick incubators or diesel locomotives... wherever sensititivy and dependability are required...ADLAKE Relays can be counted on. Send for complete Relay catalog today...The Adams & Westlake Company, 1175 N. Michigan, Elkhart, Indiana. In Canada, write PowerLite Devices Ltd., of Toronto.

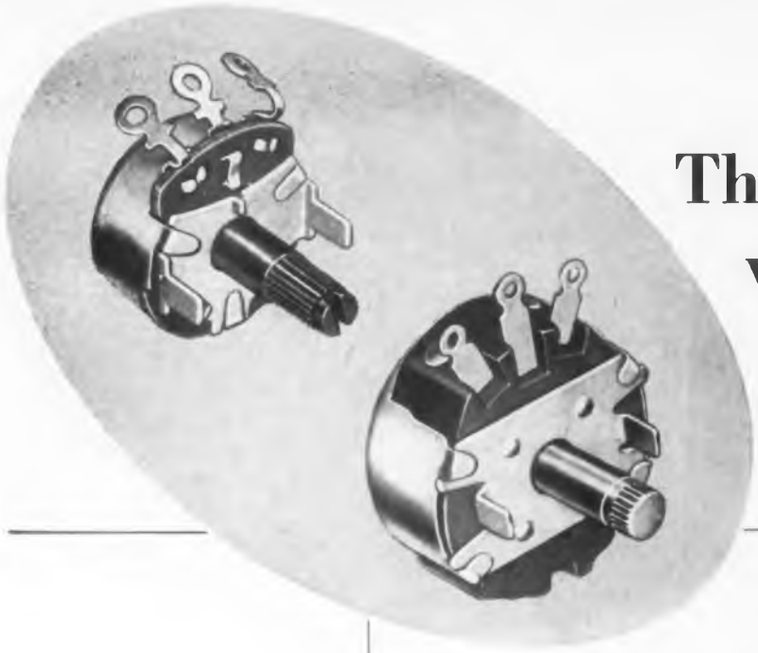
EVERY ADLAKE RELAY IS TESTED
—AND *GUARANTEED*
—TO MEET SPECIFICATIONS!

Type 1045 Quick-Acting Relay contact either normally open or normally closed.

THE Adams & Westlake COMPANY

Adlake 97th year of serving the transportation and building industries

Established 1857 • ELKHART, INDIANA • New York • Chicago
Manufacturers of ADLAKE Hermetically Sealed Mercury Relays



These tab-mounted variable controls can trim your assembly costs

Looking for cost-cutting ideas? Mallory bushingless tab-mounted controls, either carbon or wire-wound, may be just what you need. They save you money in several ways:

Easier mounting: just twist the tabs, and the control is installed on the chassis. Extra built-in *stabilizing points* increase rigidity of mounting . . . prevent rocking.

No hardware needed: you save the cost of a lock washer and nut, besides obtaining a less expensive control.

Ideal for service adjustments in television receivers, these controls afford the high standards of Mallory performance at economical price. Both carbon and wire-wound types are available in choice of ratings, with or without attached switch. The carbon controls offer additional economies: an optional phenolic shaft at lower cost than steel, and a rotational stop that gives the effect of a fixed and variable resistor in a single unit.

For complete information, write today for the new Mallory Technical Bulletin.

Specifications:

	Carbon Controls	*Wire-Wound Controls*
Resistance:	200 ohms to 10 megohms	3 to 15,000 ohms
Tolerance:	+30% standard; ±20% available	+10% (closer tolerance on request)
Wattage:	Linear: ½ watt Other tapers: ¼ watt	2 watts
Size:	$\frac{15}{16}$" dia., $\frac{17}{32}$" deep	$1\frac{19}{64}$" dia., $\frac{5}{8}$"—.640" max.
Tapers:	Linear, logarithmic, reverse logarithmic	Linear (standard); others on request
Shaft:	Steel or phenolic	Steel
Mounting:	Two mounting lugs on $\frac{7}{16}$" radius	

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ELECTRONIC TEST INSTRUMENTS

TEST VOLTAGE PROBLEMS 1/100 cps to 10 mc?

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

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

-hp- 200CD AUDIO OSCILLATOR

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

-hp- 204A Battery-Operated Oscillator

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

-hp- 650A Resistance-Tuned Oscillator

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

-hp- 202A Low Frequency Function Generator

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

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

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Instruments for Complete Coverage

6 wonders of the age?

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GLASS TUBING CUTTING MACHINE
HORIZONTAL TYPE

AUTOMATIC EXHAUST MACHINE

Built into the automatic machinery shown on this page is knowledge of every phase of electronic tube production...

Kahle's "6 Wonders" are engineered to mass-manufacture Sub Miniature Tubes so that the burden of "knowing how" to make the product falls upon the machinery itself instead of the manufacturer. Forty-six years of intimate contact with the design and construction of custom machinery together with a long history of pioneering successes in electronics and allied industries, produce the "know-how" in such combinations of machines as the models depicted above. Kahle executives have vast experience in the actual manufacturing of the end products which such machinery produces. This cumulative knowledge is built into the machinery to solve bottlenecks and gives a smooth uninterrupted flow of the finished products.

"Built-in know how" is what makes Kahle's name the password in the electronics and glass industries where production difficulties can be overcome with custom machinery.

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Call on Kahle and learn how you can benefit from the company which enjoys the respect of the industry's leaders.

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MICROWAVE SIGNAL GENERATORS

Complete coverage of the range 950-10,800 mcs /sec.

with Polarad single dial operation

Four new Microwave Signal Generators covering the range 950-10,800 mcs/sec. All with famous **Polarad single dial operation.** Each provides the maximum working range possible in one compact signal generator. And, additional Polarad Signal Generators are available to cover 12.8 to 39.7 kmc.

These features on all MSG units assure fast and simple operation: direct reading, single dial frequency control that tracks reflector voltages automatically . . . direct reading attenuator dial . . . conveniently placed controls, in logical sequence . . . high visibility on the face of each instrument.

Polarad Signal Generators are built to the same high standards required for military equipment. They are practical for the factory assembly line—engineered ventilation assures continuous and stable operation of all instrument functions. Components are readily accessible for easy maintenance. And laboratory accuracy is guaranteed under the most rigorous operating conditions.

Write directly to Polarad or your nearest Polarad representative for details.

	MSG-1		MSG-3	
Frequency Range	950-2400 MCS/sec.	2150-4600 MCS/sec.	4450-8000 MCS/sec.	6950-10,800 MCS/sec.
	(Frequency set by means of a single directly calibrated control)			
Frequency Accuracy	±1%	±1%	±1%	±1%
Power Output	1 MW	1 MW	.2 MW	.2 MW
Attenuator Range	120 db	120 db	120 db	120 db
Attenuator Accuracy	±2 db	±2 db	±2 db	±2 db
Output Impedance	50 ohms	50 ohms	50 ohms	50 ohms
Input Power	115V±10% 60 cps	115V±10% 60 cps	115V±10% 50-1000 cps	115V±10% 50-1000 cps
Internal Pulse Modulation:				
Pulse Width	0.5 to 10 microseconds			
Delay	3 to 300 microseconds			
Rate	40 to 4000 pulses per second			
Synchronization	Internal or external, sine wave or pulse			
Internal FM:				
Type	Linear sawtooth			
Rate	40 to 4000 cps			
Synchronization	Internal or external, sine wave or pulse			
Frequency Deviation	±2.5 MCS	±2.5 MCS	±6 MCS	±6 MCS
External Pulse Modulation:				
Polarity	Positive or Negative			
Rate	40 to 4000 pulses per second			
Pulse width	0.5 to 2500 microseconds			
Pulse separation	(For multiple pulses) 1 to 2500 microseconds			
Output Synchronizing Pulses:				
Polarity	Positive, delayed & undelayed			
Rate	40 to 4000 pps			
Voltage	Greater than 25 volts			
Rise time	Less than 1 microsecond			
Size | Approx. weight	17" long x 13¼" high x 15½" deep | 60 lbs.		17" long x 15" high x 19½" deep | 100 lbs.	

*Also available—MSG 4A: 6,950—11,500 MCS/sec.

"THE FINEST SIGNAL GENERATORS OF THEIR KIND"

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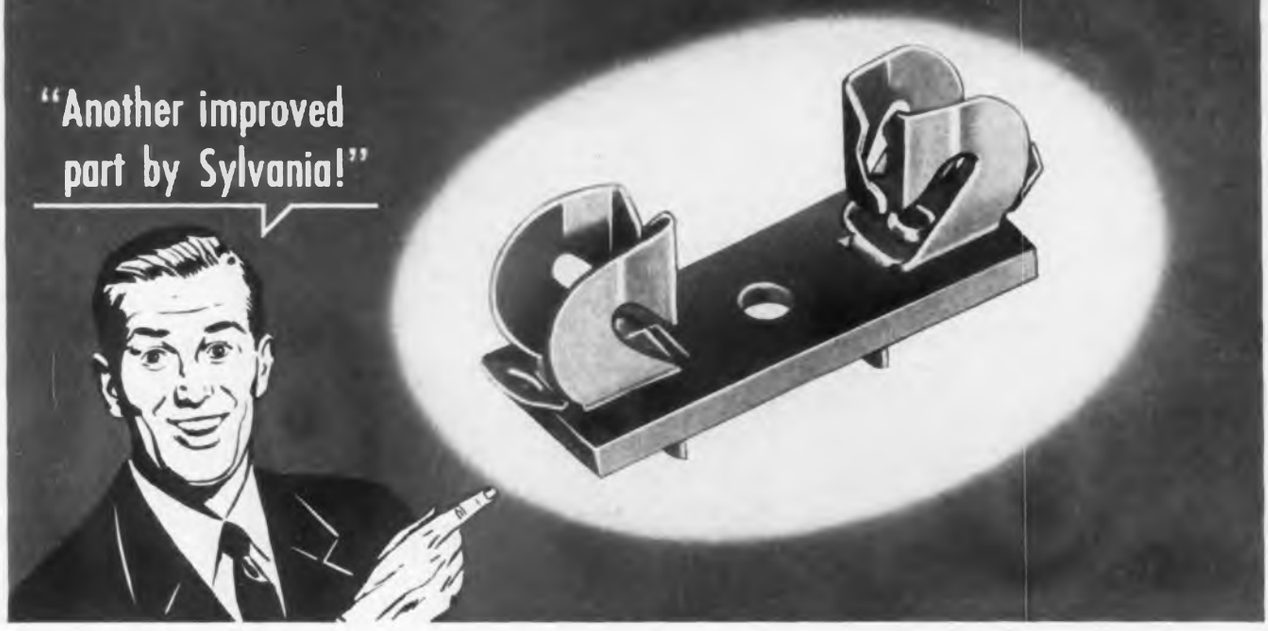
A new, efficient crystal diode holder

Sturdy Sylvania Holder Contacts Provide High Retention for Diodes



Here's a brand new, extremely efficient Crystal Diode Holder designed for you by Sylvania.

The contacts retain diodes with terminal leads ranging from .078 to .125 diameter, with ease of insertion and withdrawal. The centerline of retention is specially located at sufficient distance from the surface of the mounting plate to allow installation of large diameter Crystal Diodes. Mounting plate is made of laminated phenolic and the contacts can be furnished in either phosphor bronze or brass with silver plating. Eyelets are made of nickel-plated brass.

For detailed specification sheets concerning this improved diode holder or any other Sylvania part write to Sylvania today!

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Sylvania Electric Products Inc., Dept. 4A-4404, 1740 Broadway, New York 19, N. Y.

In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg., St. Catherine St., Montreal, P. Q.

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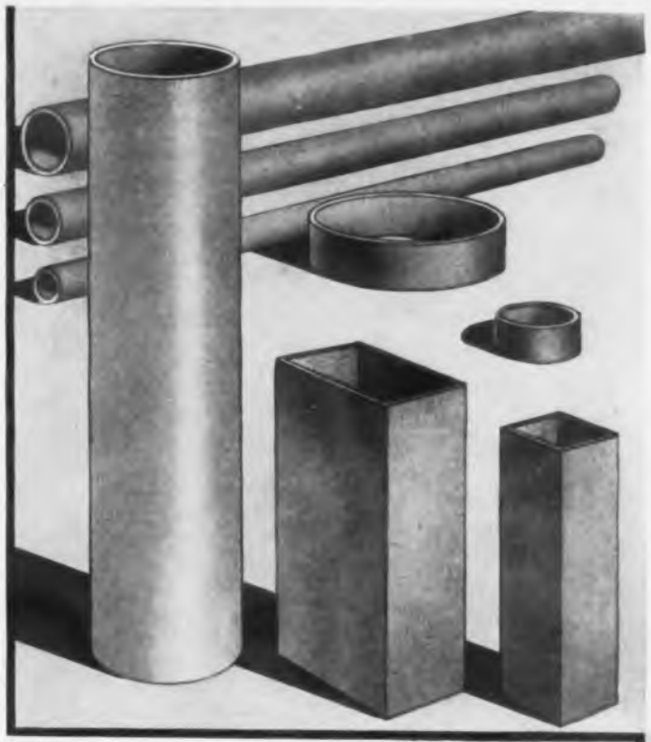

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Our Design and Production Departments are geared to customers' needs in every way. Deliveries are prompt!

WRITE to The Cleveland Container Company plant nearest you for a copy of our CLEVELITE brochure . . . of value to every Engineering Department.

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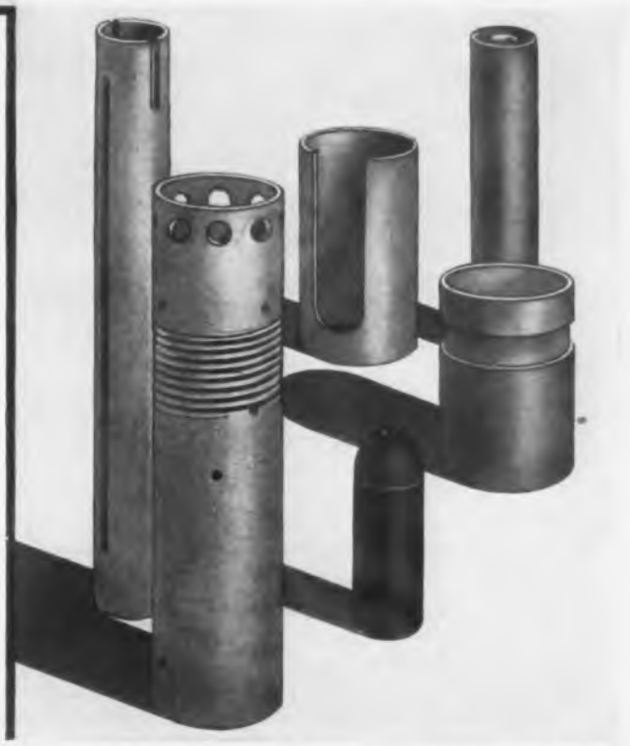

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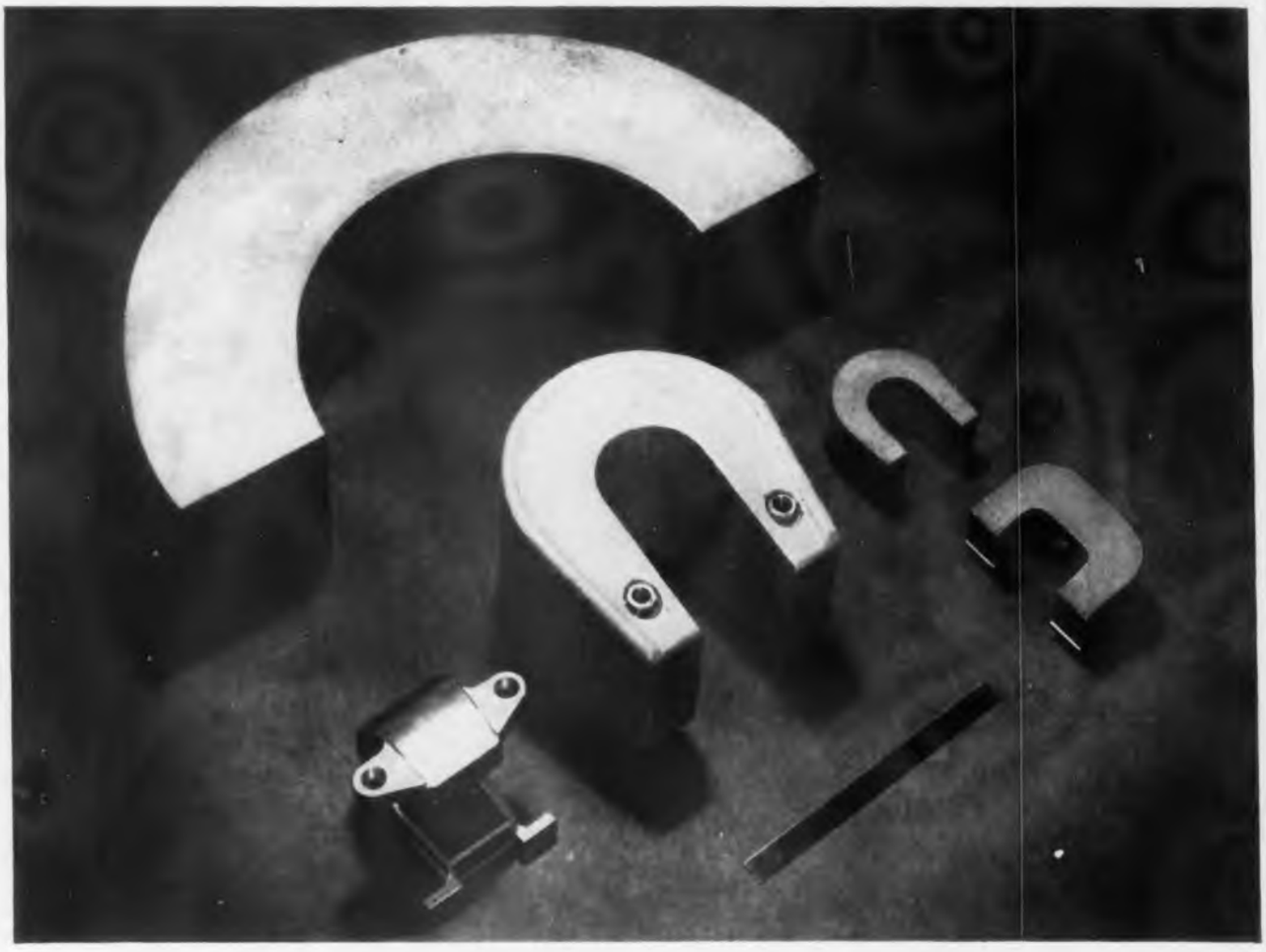

PERMANENT MAGNETS and ASSEMBLIES for Magnetrons and Traveling Wave Tubes

The group of magnets illustrated above, weighing from a fraction of a pound up to 75 pounds, are indicative of the wide range of Arnold production in this field. We can supply these permanent magnets in any size or shape you may need, with die-cast or sand-cast aluminum jackets, Celastic covers, etc. Complete assemblies may be supplied with Permendur, steel or aluminum bases, inserts and keepers as specified . . . magnetized and stabilized as desired. ● *Let Arnold handle your magnetron and traveling wave tube permanent magnet requirements.*

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The shortest distance between two points is a straight line — and the best way to bridge that distance is via electronics, for both sight and sound.

The greatest name in *modern electronics* now brings you two-way mobile communications equipment that is scheduled to set new standards of performance, reliability, and value. Du Mont, manufacturers of fine electronic equipment, are now setting the stage for the introduction of mobile communication products designed to fill your needs better.

DU MONT *communications equipment includes:*

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television broadcasting

television receivers

television transmitters

cathode-ray instruments

BOOKS

(Continued from page 48)

Theory and Design of Electron Beams (2nd Ed.)

By J. R. Pierce. Published 1954 by D. Van Nostrand Co., Inc., 250 Fourth Ave., New York 3, N. Y. 222 pages. Price $4.50.

This valuable addition to the growing list of technical books in the Bell Laboratories Series includes the most important facets of electron flow as applied to electron tubes. In a way, it is the minimum amount of information that an advanced engineer or physicist must have for a really good understanding of electron flow and focusing in devices other than electron microscopes and image tubes. In the author's own words, "No attempt is made to deal with problems of experimental technique; concerning these I offer nothing but sympathy."

The first seven chapters cover the basic principles and equations concerning electron beams, and go into magnetic and electric lenses. The next three chapters include the effect of thermal velocities, space charge in electron beams, and electron guns. The eleventh chapter, which was not in the first edition, discusses periodic focusing fields and their advantages over magnetic or electric fields which do not vary with distance. Considering the complexity of the subject, the author has done an excellent job in making this volume easily readable and highly useful. AJF

BOOKS RECEIVED

Radio Amateur's Handbook (31st Ed.)

Edited and published 1954 by the American Radio Relay League, Inc., West Hartford 7, Conn. 800 pages. Price $3 in U.S., $3.50 in U.S. Posessions and Canada, $4 elsewhere. Book includes radio fundamentals, tube charts, and wealth of practical design and operating information. Among topics covered are semiconductors, UHF, single-sideband, and superselectivity.

Magnetic Fields of Cylindrical and Annular Coils

Prepared by National Bureau of Standards. Published 1953 by Government Printing Office, Washington 25, D.C. 29 pages. Price $.25. In terms of Legendre functions which involve ratios of significant dimensions of coils, data provides basis for computing magnetic field itself in full detail, point by point. No formulas for this purpose have been readily available hitherto.

Scientific American Reader

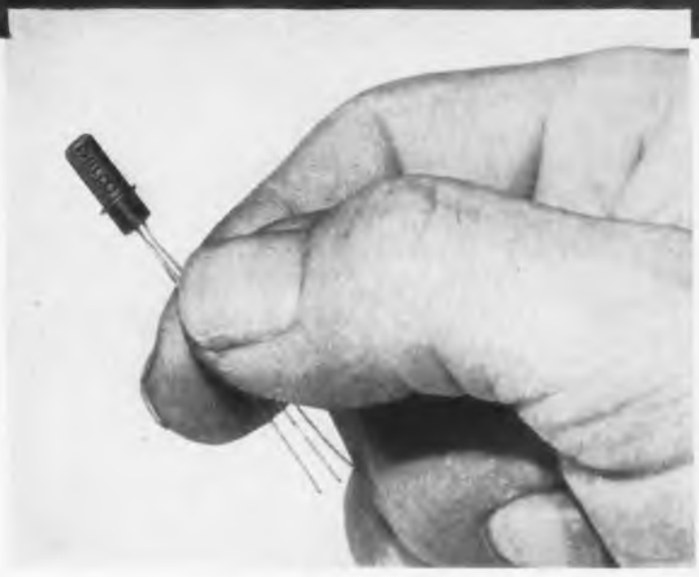
Edited by staff of Scientific American. Published 1954 by Simon & Schuster, 630 Fifth Ave., New York 20, N. Y. 596 pages. Price $6. Selected articles provide comprehensive picture of entire world of science. Informative section of book discusses computers, business machines and automation.

Investigation of Electron Tube Reliability in Military Applications

Prepared and published 1954 by Aeronautical Radio, Inc., 1523 L St. N.W., Washington 5, D.C. (Refer to L. E. Davis). 97 pages. Price $.50. Results of tube surveillance program conducted for Army, Navy, and Air Force under Bureau of Ships contract. Evaluation of factors affecting reliability discussed.

PHILCO ANNOUNCES

TRANSISTOR



New Diffused Alloy Junction Type Has Amazing Advantages...

Philco now presents to industry a new diffused alloy junction transistor with uniformity of characteristics never before attained in production.

Design engineers will welcome the predictable performance of circuits incorporating this superior transistor.

At last, here is a transistor that will operate with the same high degree of excellence in mass-produced units as in laboratory models—*eliminating the need for individual selection of transistors or associated components to meet equipment specifications!*

Now in production at Philco, this new transistor meets the high standards required for production applications. It is one of the smallest transistors ever produced. Leads are fused in glass—the entire transistor is enclosed in a metal envelope—an instantaneous resistance weld hermetically seals the complete unit. Advanced processing techniques and new mechanical design features assure excellent characteristics and uniformity throughout the life of the transistor. Phone, write or wire Philco today for descriptive literature and specifications on this revolutionary transistor.

- **Minimum size.**
- **Hermetically sealed, resistance-welded metal case . . . leads sealed in glass.**
- **Uniform characteristics.**
- **Designed to meet typical military environmental conditions.**

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5 NEW P

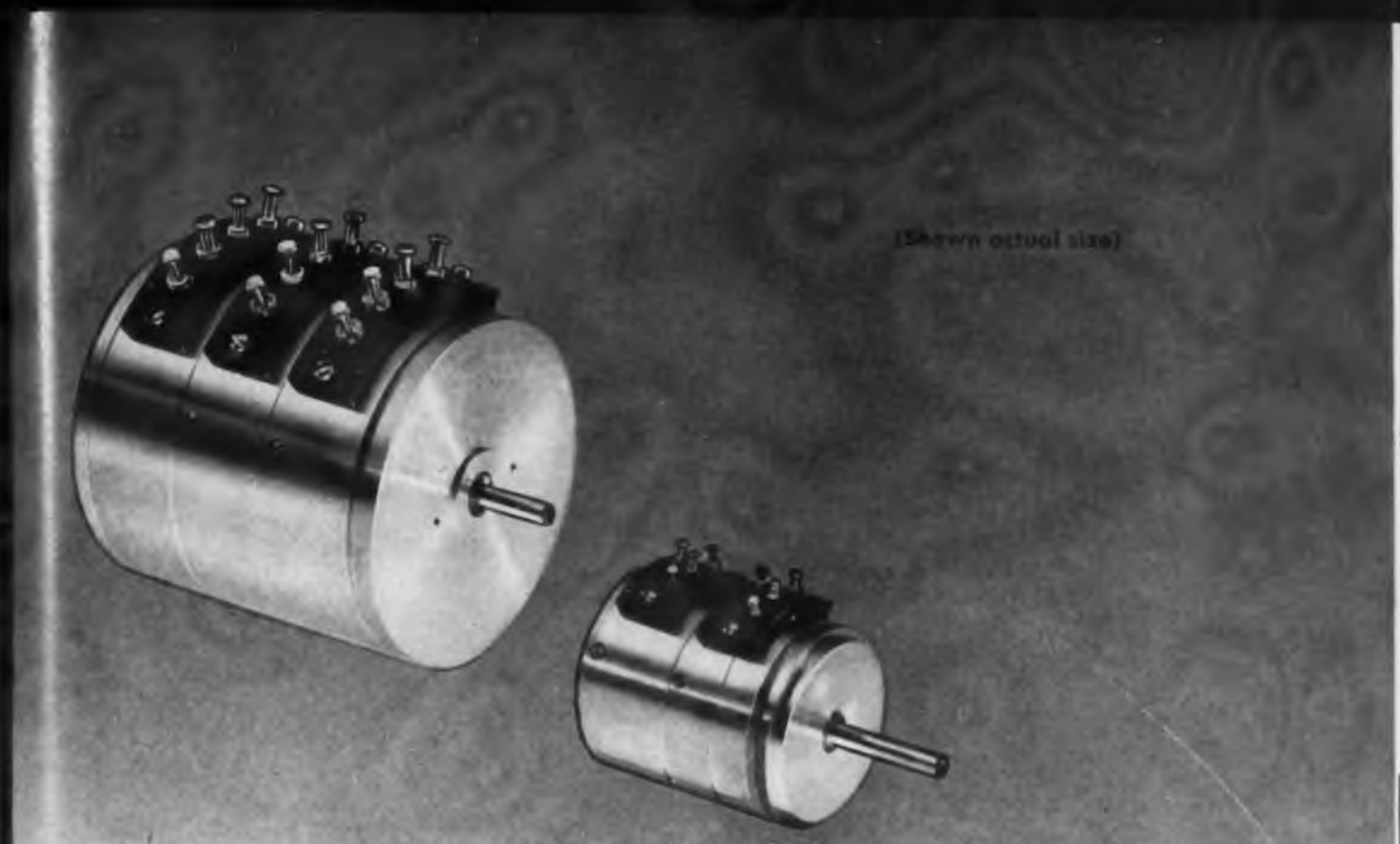
5 More reasons why FAIRCHILD can meet al

TYPE 753 – Sine-cosine potentiometer – Full sine-cosine function without mechanical cams and linkages – can be ganged up to 6 cups. 20,000 ohms per quadrant; linearity, ±0.5% peak-to-peak; 3" diameter, 1¼" long from front of servo flange to rear of cup. Also available as straight sine function.

TYPE 745 – 10-turn helical potentiometer – Meets rigid government requirements for humidity, salt spray, altitude, temperature, vibration, shock, sand, dust and fungus resistance. High electrical accuracy (linearity ±0.025%); resistance range 100 to 300,000 ohms. 2" diameter, 2$\frac{5}{32}$" long from front of servo flange to end of case. Mechanical and electrical rotation, 3600° (+2° –0°).

See the complete Fairchild line of pots at the IRE Show, Booth 648, Radio Road and Circuits Avenue.

TYPE 771 – The FilmPot, metallic film potentiometer – Infinite resolution, high temperature operation (225°C). High wattage dissipation and exceedingly wide resistance range (100 to 200,000 ohms). Only ¾" in diameter and ½" long. Resistance element is precious metal deposited on an inorganic base. Available with servo flange or threaded bushing mounting.



POTENTIOMETERS

all your precision potentiometer needs

TYPE 754—2" linear potentiometer—Resistance range from 800 ohms to 100,000 ohms. High linearity (±0.15% standard). Internal clamp rings permit ganging up to 8 cups on single shaft without increasing over-all diameter. AIA standard 2" servo mount. Depth is 1" with .594" added for each cup section ganged. Gold-plated terminals are easier to solder and have better resistance to corrosion.

TYPE 741—1⅛" linear potentiometer—Internal clamp rings permit ganging up to 5 cups on a single shaft without increasing the over-all diameter. Resistance range 500 to 25,000 ohms; linearity ±0.5% standard. Electrical angle 350°. Only 1⅛" in diameter and ⅛" long; starting torque is 0.25 oz.-in. The simplified slip ring construction and a one-piece paliney wiper give longer life and lower noise.

● ***Available immediately in sample quantities.*** Look to Fairchild for assistance in solving all your precision potentiometer problems. Fairchild has, or can make, a potentiometer to fit any requirement. For information write: *Fairchild Camera & Instrument Corp., Potentiometer Division, 225 Park Avenue, Hicksville, L. I., N. Y., Dept. 140-45EI.*

FAIRCHILD
PRECISION POTENTIOMETERS

engineers are critical people

(We know, because we're engineers, too)

Radio and TV stations, recording studios, commercial and industrial film studios, testing laboratories, program production organizations and a host of others have long needed a thoroughly professional, well designed, easily maintained tape recorder.

More than a year ago, Presto's top engineers were assigned to the development of such a recorder. Months later a test model was completed which not only met these specifications, but embodied a completely new principle of recorder design . . . unitized construction: the entire capstan drive is a separate, easily removed unit.

The instrument was designated "Model RC-11," and then a series of rigorous tests were begun. The RC-11 was run continuously for hours at a time under the most adverse conditions. These tests resulted in further improvements.

Finally, when we were satisfied that this was the finest tape recorder of its type that could be built, we tooled up and put it into production.

By reputation engineers are the most critical people on earth. (We know, because *we're* engineers, too.) And, some of the most qualified recording engineers who have seen and operated the RC-11 share one opinion . . . that here is the finest, easiest to operate, best performing tape recorder available today.

PRESTO RC-11 TAPE RECORDER

IN CONSOLE WITH 900-A3 AMPLIFIER

- **Self-contained Capstan Drive Unit—3 motor drive.**
- **Three magnetic heads in metal enclosure.**
- **Push button function switches.**
- **Reel capacity to 10½" diameter.**
- **Response: 50 to 15,000 cycles ± 2 db.**
- **Flutter: less than 1½% at 15"/sec.**
- **Signal to noise: 55 db. at 2% distortion.**

PRESTO RECORDING CORPORATION

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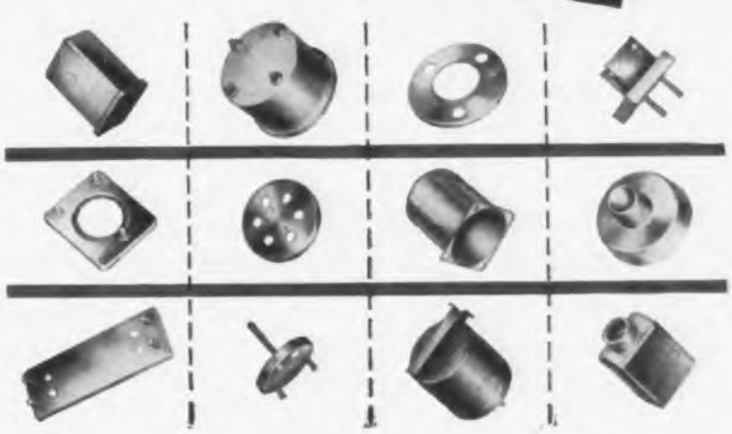
CONSULT THE HUDSON CATALOG OF STANDARDIZED PARTS! Contains complete specifications on hundreds of different standard catalog items. All are available for fast delivery. Call or write for your copy, now!

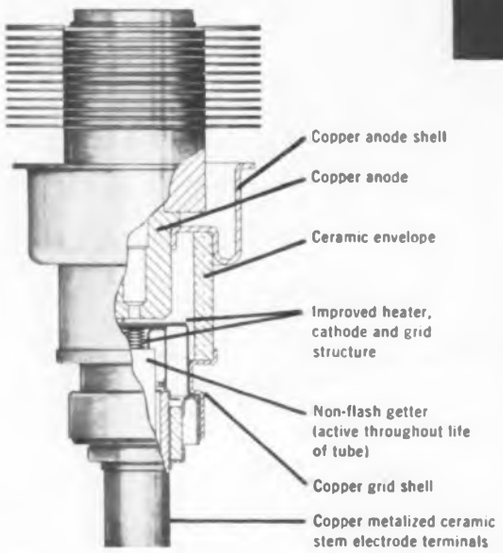


HUDSON TOOL AND DIE COMPANY • INC
118-122 SO. FOURTEENTH STREET, NEWARK 7, NEW JERSEY

EIMAC announces

the 2C39B

- **Ruggedness of ceramic**
- **High conductivity of copper**



TYPICAL OPERATION

(RF Oscillator 2500mc)

D-C Plate Voltage	**900v**
D-C Grid Voltage	**-22v**
D-C Plate Current	**90ma**
D-C Grid Current	**27ma**
Useful Power Output	**15w**

The Eimac 2C 39B, unilaterally interchangeable with the 2C 39A, is a new tube type with advancements that provide longer life, more useful power output, efficiency and stability, and greater immunity to thermal and physical shock. Rugged, low loss ceramic replaces glass throughout the Eimac 2C 39B and highly conductive, heat dissipating copper is utilized in the anode, anode shell and grid shell. Use of ceramic and copper, an exclusive Eimac feature, allows higher operating temperatures and minimizes RF losses. Electrode terminals are formed in the stem by copper metalizing the ceramic stem surface. All external contact surfaces are silver-plated. New heater, cathode and grid structures, plus a non-flash active getter, add to long life and stability. These features, born out of Eimac experience over the past few years in research and production of glass and ceramic 2C 39As, make the Eimac 2C 39B an incomparable planar-type 100 watt triode for UHF operation through 2500mc.

● *Eimac, one of the world's largest designers and manufacturers of electron-power tubes, presents its 20th Anniversary display at the March IRE show—booths 549-551*

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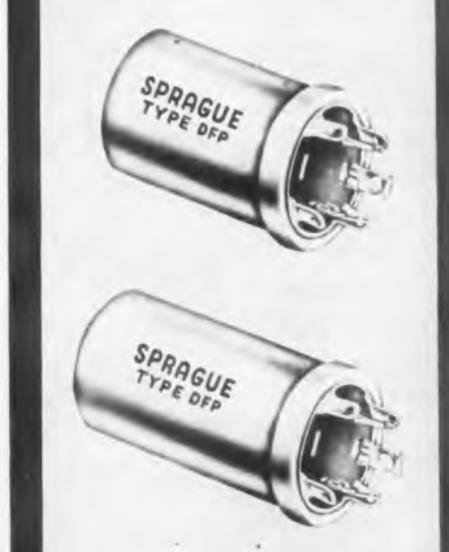
MARK OF EXCELLENCE IN ELECTRON-POWER TUBES

DEPENDABILITY

is why Sprague Type DFP Twist-Loks* are the *preferred*

ELECTROLYTIC CAPACITORS



Leading television set makers rely on Sprague as their major source for electrolytic capacitors.

Stability under maximum operating conditions plus outstandingly l-o-n-g service life are the engineering reasons for this preference.

From the business standpoint, it makes good sense to deal with a supplier whose quality of product is uniformly excellent and who has the largest production facilities in the industry.

And now a new plant is being completed to permit Sprague to accept an even larger portion of your requirements.

SPRAGUE ELECTRIC COMPANY
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SPRAGUE

WORLD'S LARGEST CAPACITOR MANUFACTURER

TELE-TECH
& Electronic Industries

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

Electronic Engineering Associations and You

As we go to press with this issue, the Institute of Radio Engineers starts its 42nd national convention in New York City. The growth of this organization which is dedicated to the furtherance and advancement of electronic engineering in all its phases, is truly symbolic of the rapid growth of our industries. Organized in 1912 and boasting some 46 members in that year, the society's primary interests then focused on radio and electrical communications. Now with some 37,000 members, the scope of activity has broadened tremendously and we have, besides the main membership body, some twenty one major professional groups interested in as many specialized fields of electronic engineering. (See page 101 for a listing of these groups and a capsule summary of their principal objectives.) We are proud to salute the achievements of the Institute of Radio Engineers and its members on this occasion.

Associations Support Our Industry

On this occasion also, we should like to call attention to the nearly seventy other societies and organizations which, through the years, have come to play very important direct and indirect roles in our activities. As a second section to this issue we have listed these groups in the first of our Electronic Industries Reference Library Series. We are certain that each of our readers, in reviewing this section, will find one or more organizations that will be of especial direct interest.

It is significant to note that the great forward steps taken by all of these organizations toward establishing workable technical standards and smooth industry operating procedures comes in large measure from individuals who give willingly and freely of their time and energies. Many of these individuals are assisted by their business organizations who, in recognizing the need for such groups, encourage the engineer members of their staffs to take active parts. In many instances, these companies also underwrite the dues, traveling expenses and the time from the regular work week necessary for their participants.

Engineering Associations Must Grow

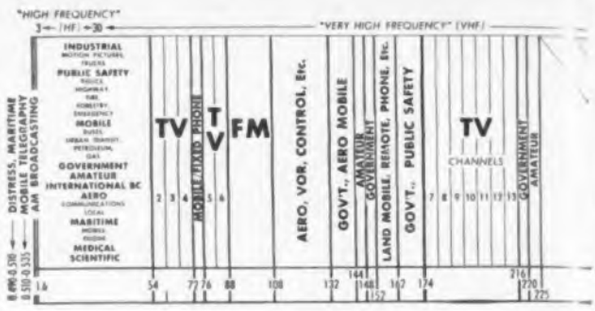
We hope that these engineering associations will continue to grow and we hope too that many more engineers as well as their employing organizations will see the desirability of taking active parts in those groups that are of especial moment to them. For it is through the efforts of these groups that we can formulate coordinated means to: a) overcome industry adjustments or recessions as they occur; b) contribute to our government in times of need the best electronic engineering brains in the world producing the finest electronic weapons; c) perpetuate our industries by attracting and making it possible for the creative members of our younger generations to find absorbing and lucrative fields of endeavor.

A New Association Horizon

During World War II many particularly difficult electronic research problems had to be overcome and it became a practice for the government to arrange cooperative research programs with colleges and manufacturing organizations. While this activity is still being carried on to some degree, there are signs that these programs are slowing up. We find now, too, that the number of new students entering college engineering courses each year is barely enough to meet industry demands. Perhaps in the light of these two factors, engineering associations will see a new objective horizon. By working through the schools and colleges, the engineering associations could provide comprehensive scholarship programs that would attract many more new electronic engineering students and that could continue an active research program which would be directed toward improving the every-day life of the American citizen.

RADARSCOPE

Revealing important developments and trends throughout the spectrum for radio, TV and electronic research, manufacturing and operation



SELF-POWERED TRANSISTORS are undergoing intensive laboratory study, and announcements proclaiming the development of the first experimental models may be forthcoming within the year. Units will depend upon built-in radioactive materials to provide power.

ELECTRONIC COMPUTERS will feature three different types of amplifying devices in 1956 commercial models, according to present indications. These include magnetic amplifiers, transistors *and* vacuum tubes.

HIGH-VOLTAGE RESISTOR rated at 20 kv, and quite suitable for color TV, is expected to make its bow in the not too distant future. The big news about this component is the low selling price—under 10 cents hopes the manufacturer.

WORLD'S FASTEST PRINTER should step out of the laboratory about one year from now. It should solve many computer problems caused by output devices much too slow for the computing system. Based on a thermal principle, this printer can print a digit on a piece of paper in 1 microsecond.

RECORD VALUE of corporate securities were offered for sale by the communications industry in 1953, reports the Securities and Exchange Commission. The total of $856 million accounted for about 10% of all corporate issues during the year.

TECHNICAL WRITERS and editors have formed their own professional society at a meeting in the American Academy of Arts and Sciences in Boston.

TAX REVISION proposals published by the National Machine Tool Builders Association, 10525 Carnegie Ave., Cleveland, Ohio, should be of considerable interest to electronic industries management.

BRITISH TV is struggling under the weight of excessively restrictive labor agreements. This little-publicized fact is one of the important reasons BBC has not been able to expand as much as it is capable.

SALES RECORDS for 1953 were reported by General Electric ($3.128,127,000—19% over 1952), RCA ($853,-000,000—22.9% over 1952), and Sylvania ($293,267,408—24.8% over 1952).

RESILIENCE, machinability and light weight are factors favoring the increasing use of magnesium in electronic and communications equipment, particularly portable military types.

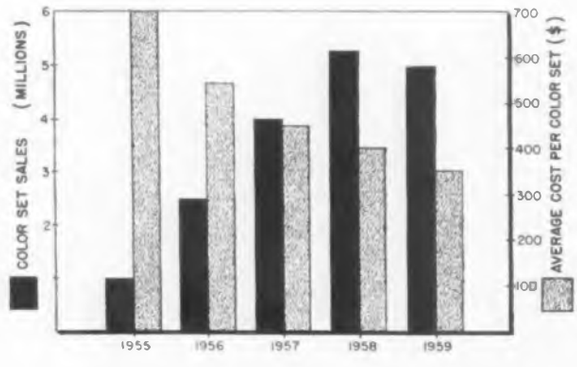
CONELRAD FOR AVIATION radio services has been proposed by the FCC in cooperation with the CAA. During an emergency, all aviation stations except those required for traffic control would maintain radio silence.

TRANSISTOR FRAUD has been perpetrated on some unwary organizations. In one case, shrewd operator in France promised to rejuvenate unworkable transistors for a trifling 40 cents each. What happens to them after they are sent abroad is anybody's guess.

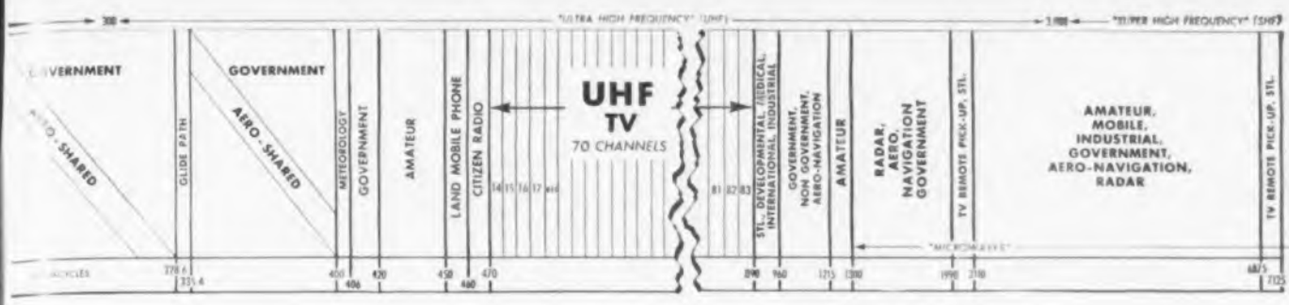
BEST GUESS to date on annual rate of transistor production is 2,000,000 to 3,000,000 per year, including both military and commercial.

GETTING COLOR TV on the road to public acceptance is a ticklish problem, particularly since prices are high, screens are small, programming is at a minimum, and service contracts are expected to cost $250 to $300 per year. For these reasons, Emerson's imaginative plan to rent, not sell, its first color receivers is causing a stir in the industry. Other companies are turning over idea of rent-or-sell option.

COLOR TV GROWTH



Sales of color TV receivers for 1955-1959 has been predicted in a new survey prepared by Dr. A. R. Oxenfeldt for "Fortune" magazine. Results shown above indicate decreasing cost per set, and increasing sales leveling off in 1958-1959. Report also forecasts total of 53,000,000 sets in 1959, with 18,000,000 of these being color. Dollarwise comparison with predictions published in Sept. 1953 TELE-TECH & ELECTRONIC INDUSTRIES, page 17, indicates almost identical estimate for 1957 sales ($1.8 billion), but new survey shows more rapid rise is anticipated for 1955-1956



ETHICS can mean a great deal to an industry because it encourages public confidence. And it seems all the more necessary when the industry is as competitive as the TV-electronic field. In widely separated quarters there is talk of adopting some sort of "Code of Ethics Seal," as was recently done by the Industrial Equipment Div. of the Gas Appliance Manufacturers Association. The next step needed is a formal proposal.

INDUSTRIAL

DECENTRALIZATION of factories is motivated by several factors, including lower labor costs, cheaper land, improved access to raw materials, etc. Sometimes the justifiable savings resulting from a plant move are attended by more headaches than the saving is worth. Drawing upon the experience of several manufacturers who have moved—and are glad they did—there are several points to keep uppermost in mind. These include willingness of public carriers to add transportation facilities, receptiveness of community, obtaining prospective employee lists, and local publicity. Fortunately, a number of states will perform related services free of charge. If the company would be happier if the workers did not unionize, it is imperative that the pay scale be higher than the legal minimum, and even higher than the going rate in the area.

COMPONENTS

A WORD OF CAUTION to electronic manufacturers overly anxious to get into large production of high-priced specialty components just because a new development or material shortage comes along. Color TV rush recalled shortage of critical materials at start of Korean War. One manufacturer spent a pile of money to tool up for a special component made of non-critical materials. After tooling up, the critical material became plentiful again, and the investment was lost. Something similar may be expected for color TV because engineers are busy designing expensive specialties out of receiver circuits.

ECONOMICS

STATUS OF INDUSTRY is no cause for joy in top management circles. Value of unfilled orders held by all U.S. manufacturers has fallen $17 billion or 20% during the past year. Business inventory rose $5 billion, and unemployment rose well over 2 million. However, things are far from black. Industrial production has been running only 2% under the 1953 average, interest rates are lower, and money is loosening up. Significant tax cuts have been enacted, and more may be forthcoming. 1954 looks like a reasonable time to accelerate the introduction of new technical developments, and to put the proverbial shoulder behind some aggressive selling.

GERMANIUM PURIFICATION

New and simple refining method for producing germanium of near-perfect purity (99.99999999%) has been developed by Bell Telephone Labs. This is equivalent to a pinch of salt in 35 freight cars of sugar. The new process is being used to purify many substances other than germanium. It is based on the fact that impurities are not equally soluble in the solid and liquid states. Therefore, circular induction heaters move a narrow molten zone slowly along an ingot, "sweeping" impurities to one end. The molten zone holds the impurities while the ingot solidifies into a purer state. W. G. Pfann (l), inventor of the zone-melting process, is shown operating the refining equipment while J. H. Scaff holds a large single germanium crystal

Thermistors: Components for

Fig. 1: Washer, disc and rod type thermistors made by Victory Engineering. Note washer mounting (l)

Versatile thermally-sensitive resistors open new design horizons. Innumerable industrial and communications applications include temperature compensation, AGC, regulation, surge protection, oscillators, radiation detection

By ALBERT J. FORMAN, Associate Editor
TELE-TECH & ELECTRONIC INDUSTRIES

THERMISTORS are one of the most versatile circuit elements ever developed. They offer innumerable opportunities to improve performance and reduce costs of many electronic control and measuring devices. Although they have been in existence for a number of years, thermistors have been favored with renewed interest only recently, possibly due to the demands of current trends in electronic equipment design, coupled with new developments which have improved thermistor performance characteristics.

Briefly, thermistors are thermally sensitive resistors made of a class of ceramic-like semiconducting material such as metallic oxides. They do not rectify. Because they have a negative temperature coefficient, as they become heated their resistance decreases. There are three primary ways of changing thermistor temperature: Externally, directly and indirectly. In the externally heated method, resistance changes as the ambient temperature varies. In the directly heated method, an electric current passing through the thermistor raises its temperature. The indirectly heated method depends upon a separate heating coil in thermal, though not electrical, contact to maintain constant temperature irrespective of ambient.

One or more of three main characteristics are utilized in most applications. The resistance-temperature characteristic (Fig. 3) provides large changes in resistance for small changes in temperature, and over the range −100°C to +400°C the ratio of cold to hot resistance may conceivably decrease several million to one.

The voltage-current characteristic (Fig. 4) follows Ohm's law provided the power dissipated in the thermistor does not raise its temperature measurably above ambient. Therefore, increasing the current up to a point will produce a proportional voltage drop, just as in a conventional resistor. A further current increase will cause the voltage drop to remain constant, and a still further current increase will cause the voltage to decrease because of the negative resistance characteristic.

The rate of thermistor temperature rise is dependent upon power dissipation and thermal mass. For a particular applied voltage, the current will rise to a maximum and remain essentially constant. The time required for the current to go from minimum to maximum determines the thermistor's dynamic current-time characteristic (Fig. 5).

Thermistor Function Symbols

There are several important symbols which represent thermistor functions. R_o is the cold resistance, measured at a specified temperature with a power small enough to keep the thermistor from heating. At 25°C, different thermistors may generally be obtained with R_o of 2 ohms to as high as 5 megohms. Typical tolerance values are between 5% and 20%.

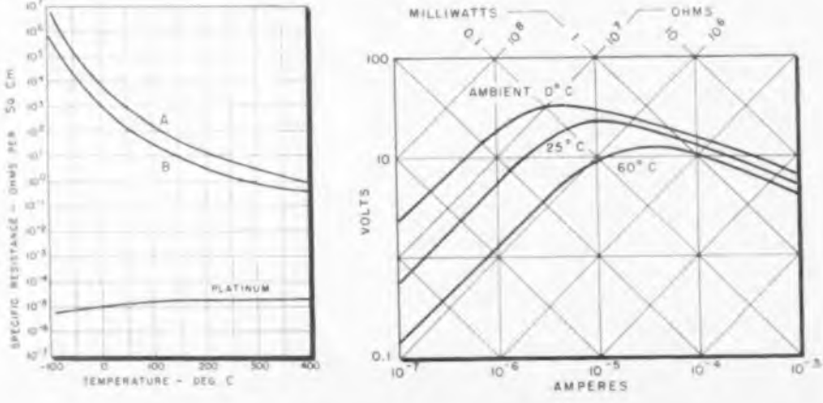
The temperature coefficient of resistance, α, is the ratio of the rate of change of resistance with temperature to the resistance of the thermistor. Representative values are from 3.0 to 5.5%/°C.

B is a material constant, and is usually about 3500 to 4000°K.

The dissipation constant, C, is a proportionality factor of power dissipation to consequent temperature change. C may be as low as 60 mw/°C to as high as 30 mw/°C. Special mountings may increase this value several times.

The highest rating for maximum continuous ambient temperature, T,

Fig. 3: (l) Typical thermistor resistance-temperature characteristic compared to platinum. Fig. 4: (r) Logarithmic plot of voltage-current characteristics. Note power and resistance values



is usually about 300°C, but it could be much higher. Maximum current may range from 25 ma to 7 amps in different types.

The thermal time constant, τ, is the time required for a thermistor to change 63% of the difference between its initial value and that of its surroundings when no electrical power is being dissipated in it. Depending on conditions, it may be anywhere from several milliseconds to five minutes, or even longer.

Although circuit designers usually use the manufacturer's performance curves, it may be helpful to approximate a thermistor's resistance, R, at an absolute temperature, T.

$$R = R_0 e^{B\left(\frac{1}{T} - \frac{1}{T_0}\right)}$$

where e is 2.7183.
Another useful relationship is

$$\alpha = \frac{B}{T^2}$$

Before discussing the application of thermistors to specific circuits, it will be worthwhile to examine the physical construction of different thermistor types.

The washer type thermistor (Fig. 1) is used when it is desirable to clamp the unit to a body to follow the temperature of the large body, or to increase the thermistor's current carrying capacity. Typical size may be 0.15 in. thick, 0.75 in. O.D., and 0.28 in. I.D. Most thermistor contact areas are silver coated.

The disc type thermistor (Fig. 1) is similar to the washer type, but it may be obtained with leads, and does not have a center hole. It is generally a low resistance element, and employed where space does not restrict its use. Size may range from 0.2 to 0.6 in. O.D., and 0.04 to 0.5 in. thick.

Fig. 2: Bead types made by American Radio. Unit at left is in bulb, others exposed or in glass

The rod type thermistor (Fig. 1), often produced by an extrusion process, is used when a high resistance is required or when space demands a slender element. High temperature grades are coated with glass glaze. Diameters as small as 0.05 in. are available.

The bead type thermistor (Fig. 2) consists of a small sphere of material, between 0.006 and 0.1 in., deposited on two parallel platinum wires. They may be enclosed in glass or mounted in evacuated or gas-filled bulbs. This type is extremely

THERMISTOR MANUFACTURERS

American Radio Co.
135 Broadway, New York 6, N.Y.

Bendix Aviation Corp.
Friez Instrument Div., 1454 Taylor Ave.,
Baltimore 4, Md.

Electron-Radar Products
1041 N. Pulaski Rd., Chicago 51, Ill.

General Electric Co.
Carboloy Dept., 11157 E. 8 Mile Rd.
Detroit 32, Mich.

Keystone Carbon Co.
1935 State St., St. Marys, Penna.

Micro-Circuits Co.
New Buffalo, Mich.

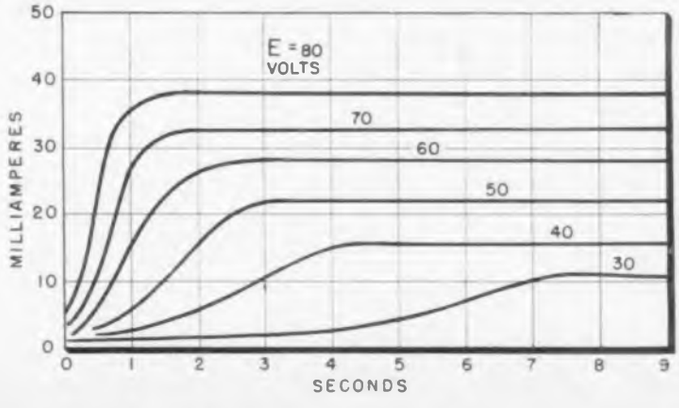
Servo Corp. of America
2020 Jericho Turnpike, New Hyde Park, L.I., N.Y.

Stupakoff Ceramic & Mfg. Co.
Latrobe, Penna.

Victory Engineering Corp.
Springfield Rd., Union, N.J.

Western Electric
Contact Graybar Electric Co.
420 Lexington Ave.
New York 17, N.Y.

Fig. 5: (l) Dynamic time-current characteristics at various voltages are important in thermistor time delay and negative resistance devices. Fig. 6: (r) Printed circuit thermistors made by Micro-Circuits. Resistive material may be sprayed or painted on



small, very sensitive, and has a short time constant.

The flake type thermistor is made by cutting a film of the oxide material into flakes, and then firing the flakes on a smooth ceramic surface. Possible dimensions are 0.0004 to 0.002 in. thick, 0.05 to 0.5 in. long, and 0.01 to 0.05 in. wide. They are excellent for detecting radiant energy.

The printed circuit thermistor (Fig. 6) is a recent innovation. It may be similar to the rod or disk type, except that the resistor paint is silk-screened or sprayed on the base.

Thermometry

The thermistor is a very desirable device for the control, measurement or compensation of temperature. By taking advantage of the temperature-resistance characteristic, it can be used as a resistance thermometer

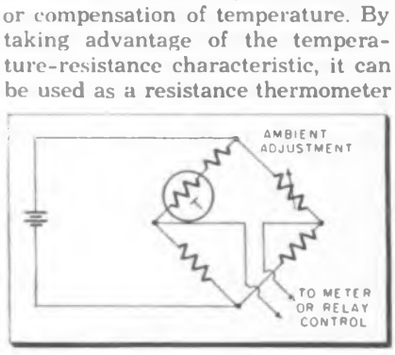


Fig. 7: Thermistor in temperature measuring bridge. Output could actuate heat control

with greater sensitivity than is possible with a thermocouple and does not contaminate. By connecting the thermistor in a resistance measuring device such as a Wheatstone bridge (Fig. 7), temperatures may easily be measured with a precision of 0.001°C or better. Some units are sensitive to a change as small as 0.000001°C.

For extremely accurate measurement of temperature differential, a thermistor may be used in each of two adjacent bridge arms. For ordinary measurement, a simple thermistor in series with a resistor and meter will indicate temperature by passing more current when the temperature rises. The added resistor is necessary to limit the current which would otherwise cause self-heating in the thermistor. These sensitive devices are excellent for remote temperature indication.

Temperature control may be achieved by a slight modification of the measuring circuit. Instead of indicating on a meter, the increased current caused by higher temperature is fed to a relay or servo control system which actuates a heating or cooling mechanism. The critical temperature environment of much electronic equipment could benefit from such control.

Changes in the resistance of circuit elements may be compensated by a thermistor. For example, the increased resistance of a copper coil (+0.4%/°C) may be offset by a series thermistor of one-tenth the resistance and −4%/°C at a reference temperature. Another alternative is to place the thermistor in parallel with a resistor. (See Fig. 8.) One application of such compensation is for dc motor windings, where higher temperature increases copper resistance, thereby reducing motor speed perhaps 10%. A thermistor in series with the winding may keep the speed correct to 5%. Other similar applications include temperature (and consequently frequency) stabilization of communications systems, and compensating for core material heating with attendant inductance variation. Without going into detail, it is easily seen how thermistors may be similarly applied in calorimetric, light sensitive, medical and alarm devices.

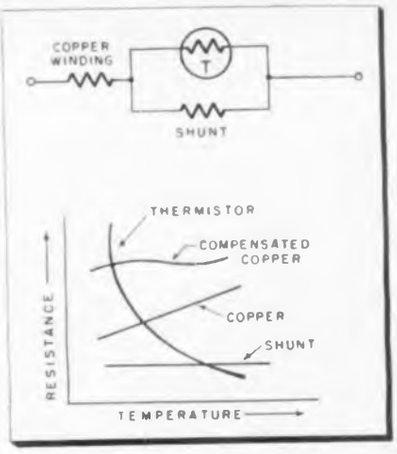


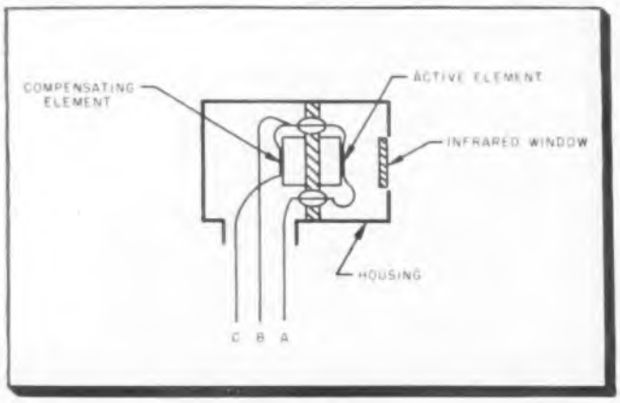
Fig. 8: Temperature compensation of copper winding accomplished by thermistor and shunt

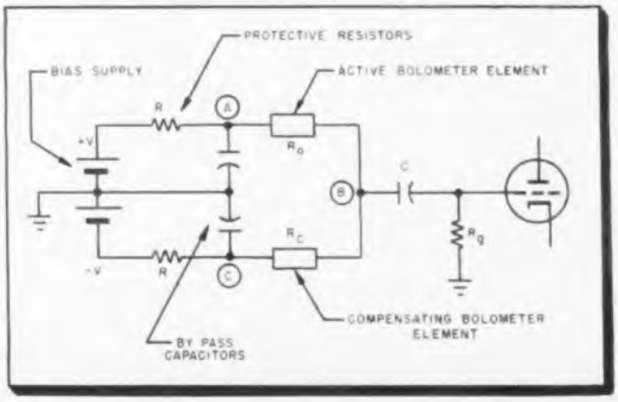
Whether radiations are infra-red or high-frequency r-f, thermistor bolometers can measure, locate, or control them. At infra-red wavelengths of 1 to 15 microns, flake type thermistors can detect a few degrees deviation from ambient at a considerable distance, or even 1/1000 μwatt. Used as a pyrometer, they can be employed as a direction finder to point out heat sources, or to indicate overheated parts in a jet plane or factory.

In a typical construction, the active thermistor element receives radiation through a selective window (Fig. 9) which passes heat, but not light. In the same housing is a compensating thermistor which automatically adjusts for ambient variations. Because these elements operate at a few microvolts, the associated amplifier must have low noise. DC is used on the preamplifier filaments because hum is in the spectrum of the thermistor time constant. Furthermore, to use an ac amplifier, the heat source is usually chopped mechanically at 15 to 30

(*Continued on page* 170)

Fig. 9: (l) Flake thermistor radiation detector made by Servo Corp. of America employs temperature compensation. Fig. 10: (r) Associated circuitry





Self-Oscillating UHF Transistors

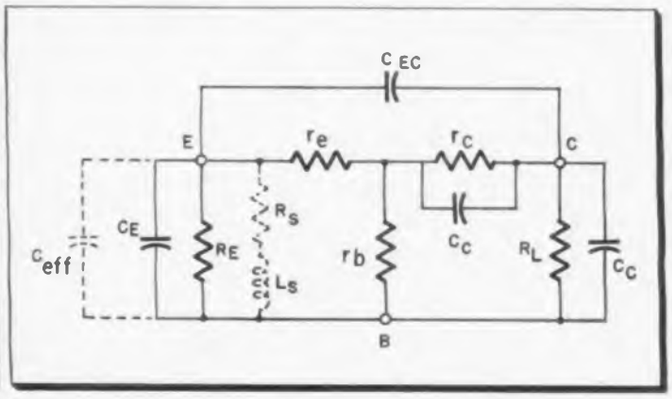


Fig. 1: (l) Photo of transistor oscillator with internal self-excitation.
Fig. 2: (r) Equivalent circuit of transistor surrounded by its cold capacities.

Discovery of interesting phenomenon in standard point-contact types offers new possibilities for 600 mc operation. Oscillations occur exclusively within transistor without external resonator. Microwave generation foreseen

By DR. HANS E. HOLLMANN
U. S. Naval Air Missile Test Center
Point Mugu, Calif.

TRANSISTORS and conventional electron tubes operating on the principle of space-charge control are duals in that the transistor effect is a type of current control, more accurately a control of the current transfer or current distribution in a semiconductor, whereas the functioning of vacuum tubes is based on an electrostatic control of the space charge around the grid. With a grain of salt, the duality may be expressed in terms of the ratio between input and output resistances, which is extremely high in the field of electron tubes, but very low in the field of transistors.

On the other hand, there exists also an electronic dual of the conventional triode in the form of the aperiodic positive-grid or retarding-field tube whose functioning is based on an equivalent control of the current transfer in vacuum instead of in a semi-conductor.[1,2] Since the retarding-field tube operates in the region of a saturated grid current, its output impedance is infinitely high and its impedance ratio is zero: The retarding-field tube may be visualized to be the prototype of an ideal transistor which, with semiconductors, can only be approached to a certain degree but never fully accomplished.

The retarding-field oscillator, in which the tube drives an external tank circuit of any arbitrary resonant frequency by virtue of feedback, is the perfect example for a transistorized Hartley oscillator.[3] With this picture in mind, the question arises as to whether the transistor may be simulated by a positive-grid tube even up to the transit-time region, i.e., up to frequencies where the transit-time effects of the charge carriers govern the entire self-excitation. The most famous phenomena are the free electron-oscillations discovered by Barkhausen and Kurz.[4] In order to gain a fundamental insight, let us consider parallel-plane electrodes and let it be assumed that the cathode-grid and grid-plate spacings are equal. For the fundamental mode of operation, the electrons take a full period to travel from the cathode to the plate and back. With zero plate-potential, the frequency is related to the positive grid-potential V_g by the Barkhausen-relation $\lambda^2 V_g = \text{const.}$ or $f^2_o / V_g = \text{const.}$ Despite this simple formula, the mechanism of self-excitation is rather complicated because all electrons are required to "dance" inphase by virtue of velocity-modulation and bunching effects.

In the field of transistors, equivalent self-oscillations of the charge carriers, the electrons or holes, have not been observed and are very unprobable because of diffusion, etc. Nevertheless, the author succeeded in the observation of internal oscillations in point-contact transistors (Fig. 1) which, to a certain degree, resemble the electron-oscillations in that they occur without any external resonator being present, and in that their frequency is related to the operational conditions by a formula as simple as the Barkhausen-relation.

Induced Emitter Inductance

The mechanism of internal transistor oscillations may be understood by reference to the basic circuit depicted in Fig. 2. The transistor is considered to be in the grounded-base connection and is surrounded by its "cold" electrode and socket capacitances C_E, C_{EC}, and C_C. In addition, there is the barrier-layer capacitance C_c across the collector resistance r_c.

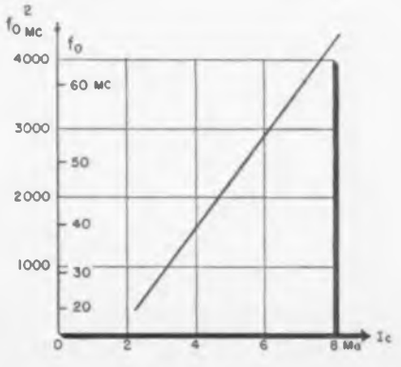
As it is well known, the input impedance of the grounded-base transistor is given by the simplified formula.[5]

$$Z_{in} \cong r_e + r_b (1 - \alpha_o). \qquad (1)$$

Up to the vicinity of the alpha-cutoff value f_c, the short-circuit current gain α_o becomes complex and may be expressed in terms of the empirical approximation[5, 6]

$$\alpha = \frac{\alpha_o}{1 + jf/f_c} = \alpha_o \frac{1 - jf/f_c}{1 + (f/f_c)^2} \qquad (2)$$

Fig. 3: Internal oscillation frequency-current



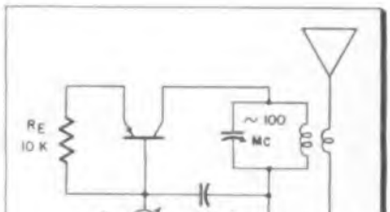


Fig. 4: Schematic of FM transmitter with multiplication of internal transistor frequency

Introducing Eq. (2) into Eq. (1) gives the input impedance

$$Z_{in} \cong r_e + r_b\left(1 - \frac{\alpha_o}{1 + (f/f_c)^2}\right) + j\,\alpha_o r_b \frac{f/f_c}{1 + (f/f_c)^2} \qquad (3a)$$

which can easily be seen to be the series connection of the resistance

$$R_s \cong r_e + r_b \frac{1 + (f/f_c)^2 - \alpha_o}{1 + (f/f_c)^2} \qquad (3b)$$

and inductance

$$\omega L_s = \alpha_o r_b \frac{f/f_c}{1 + (f/f_c)^2} \qquad (3c)$$

according to the imaginary term with the positive sign.

If we consider the external capacitances including the collector capacity to be concentrated in an effective value C_{eff} between emitter and base, this capacity together with the induced inductance L_s forms a series-resonant circuit having the frequency

$$f_o = f_c\,[2\,\pi\,f_c\,\alpha_o r_b\,C_{eff} - 1]^{-1/2}. \qquad (4a)$$

Self-excitation occurs as soon as the series resistance $R_s \leqq 0$ which leads to a critical current gain

$$\alpha_c = \left[1 + \frac{r_e}{r_b}\right]\left[1 + \left(\frac{f_o}{f_c}\right)^2\right] = 1 + \frac{r_e}{r_b} + \frac{1}{2\pi f_c r_b C_{eff}}. \qquad (4b)$$

Transistors having a sufficiently great α_o are capable of exciting their internal resonators the frequency of which, in a first order approximation, is proportional to the square root of the cutoff frequency f_c.

Let an r-f transistor be given having the parameters $r_e = 300$ ohms; $r_b = 200$ ohms; $\alpha_o = 10$; $f_c = 40$ MC; and $C_{eff} = 4$ μμf. With these values, the term $2\pi f_c r_b C_{eff} = 2/\alpha_o$ and Eq. (4b) gives $\alpha_c = 7.5 < \alpha_o$ so that internal oscillations with the frequency $f_o \cong f_c = 40$ MC can be expected.

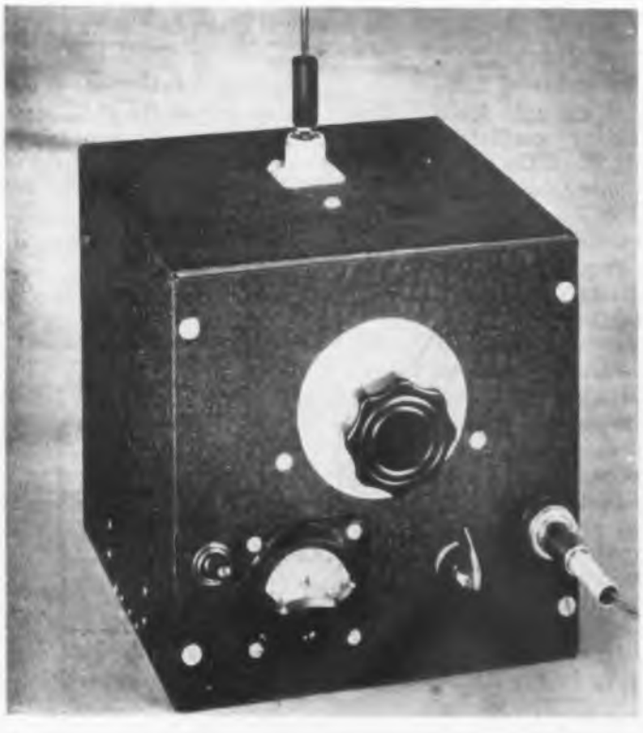
The developed philosophy of internal transistor oscillations may be compared with that of the electron oscillations in a positive grid tube. In the latter, there is no resonant system except the "dancing" electrons themselves whose displacement current also leads to a negative resistance. In transistors, the collector capacitance is reflected into the emitter circuit with opposite polarity and thus represents an induced inductance which, in turn, resonates with the natural transistor capacities.

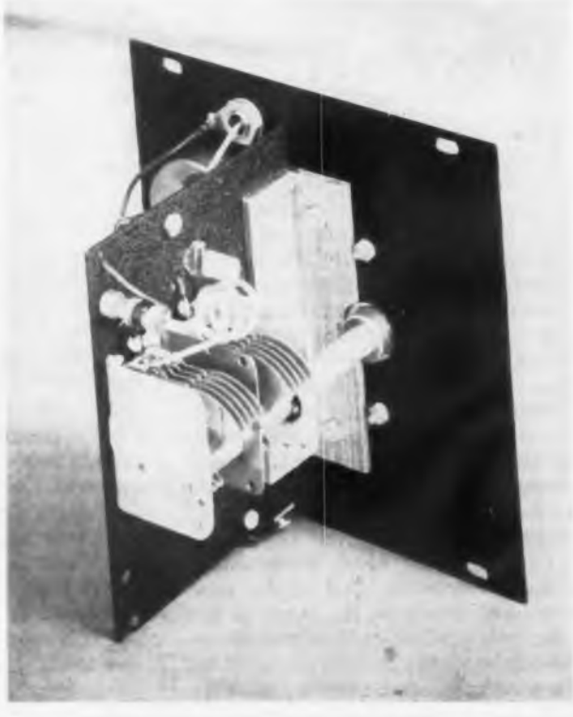
"Dual Miller Effect"

Although the origin of the induced emitter inductance is fully disclosed by the analysis, an analogy may be helpful for obtaining a simpler insight. Acording to the Miller effect, the grid capacity of a vacuum triode increases considerably because the grid- and plate-voltages are in phase-opposition so that the displacement current is proportional to the voltage amplification. In transistors, this phenomenon is reversed because input and output voltages are in phase.

If the voltage amplification is one, there is no voltage difference between emitter and collector potential and the collector capacity C_c is charged exclusively by the collector current. As soon as the voltage gain exceeds unity, the collector voltage exceeds the input voltage so that the emitter "sees" the collector capacitance with opposite sign, i.e., in the form of an inductance. Although

Fig 5: (l) Transistorized FM transmitter. Fig. 6: (r) Construction of FM transmitter, showing location of transistor and associated components





this explanation exhibits certain drawbacks, the origination of the induced emitter inductance may be attributed to a "Dual Miller Effect."

Transistor Oscillation

Transistors with a sufficiently large α_0 such as the RCA 2N33 produce internal oscillations whose frequency depends solely on the operating conditions, i.e., on α_0 and r_b but, in addition, also on C_{eff}. Fig. 1 shows an RCA transistor supported by its preresistors in the emitter and collector circuit each one of the

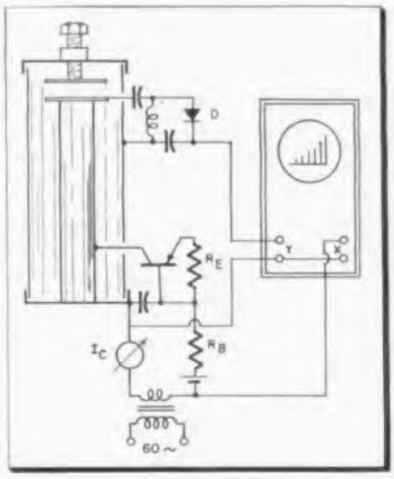


Fig. 8: Test device for producing UHF spectrum

value of 10 kohms. The internal oscillations are powerful enough to be measured by means of a grid dip meter in close vicinity of the oscillating transistor.

Fig. 3 illustrates the reciprocal values of the second power of measured frequencies f_α versus the collector current. The line reveals the transistor-oscillation formula

$$f^2_0 / I_c = \text{constant}$$

which is the dual of the Barkhausen relation. With collector currents ranging from 2 to 8 ma., the frequency of the internal oscillations rises from 25 MC up to 75 MC, depending on the characteristic parameters of the individual transistors.

For frequency stabilization, an external resonator such as a tank circuit may be inserted into the collector circuit. In this case, the free oscillations lock-in as do the electron oscillations in a Barkhausen tube.

As has been shown at lower frequencies, the high nonlinearity of transistors causes not only distortions but, at the same time, makes the resonators nonharmonic. Both effects result in an efficient frequency multiplication which has been called a "Circular Frequency Multiplication"[3] because it occurs exclusively within the transistor and its attached resonators. A circular frequency multiplier may be visualized as a linear multiplier cascade wound around a single active element.

Consequently, a tank circuit resonating at a high order of harmonics can easily be inserted into the collector lead thus resulting in the simple oscillator circuit diagrammed in Fig. 4. Figs. 5 and 6 show photos of a test transmitter operating at the second or third harmonic, thus producing frequencies in the range of 100 MC. FM is achieved by merely causing the collector current to fluctuate a minute amount around its zero value. Thus, for example, the output voltage of a record player with a piezoelectric pickup in the magnitude of 100 mv suffice to produce a 100% frequency swing and a high-fidelity FM of unsurpassable simplicity.

Fig. 7 shows the photo of a UHF oscillator with an RCA 2N33 transistor and a cavity resonator. The extremely high sensitivity of the fundamental frequency requires a constant-current supply which is achieved by means of a saturated vacuum tube. The output energy is measured by means of a crystal diode near the top of the cavity and feeding the galvanometer. In this way, signals down to 50 cm (600 MC) have been produced powerful enough

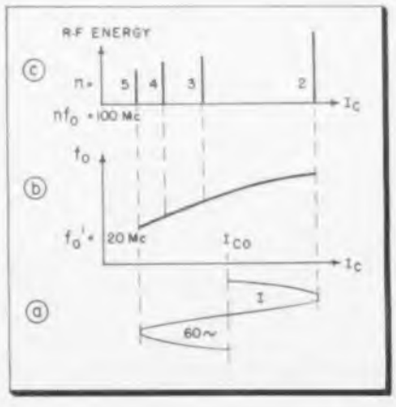


Fig. 9: Frequency modulation (a) of internal oscillations (b), and resulting spectrum (c)

to be observed with the aid of a microwave absorption meter.

600 MC is by no means the upper limit. High harmonics will permit production of microwaves, particularly with high alpha cutoff types.

In order to investigate the production of high-order harmonics, the testing device diagrammed in Fig. 8 has been built around the described cavity oscillator. The collector current is modulated around a dc value by means of a superimposed ac component of 60 CPS. The output of

Fig. 7: Transistorized UHF oscillator and cavity resonator. Supply current is stabilized with the aid of a saturated vacuum tube

the diode D produces the Y-deflection of the CRO whose X-deflection occurs in synchronism with the power line. Fig. 9 illustrates the resulting frequency spectrum in a qualitative manner. $I_{\alpha\alpha}$ is the main supply current which is swept by the ac current I~ in the range between $I'_{\alpha\alpha}$ and $I''_{\alpha\alpha}$. The current sweep results in an associated frequency sweep (b) which may cover the band from $f'_{\alpha\alpha} = 20$ MC to $f''_{\alpha\alpha} = 50$ MC. If we assume the output resonator to exhibit the resonant frequency $nf_{\alpha\alpha} = 100$ MC, for example, resonance occurs every time the frequency ratio passes a whole number n from 2 to 5. As a result, a frequency spectrum according to the diagram (c) can be seen. The rf energy increases, of course, with increasing current until it reaches the permissible load.

After it has been shown that a large $\alpha_{\alpha\alpha}$ is the prerequisite for the internal self-excitation, it is quite evident that a delicate selection of transistors even of the same type is necessary to obtain satisfactory performance. Although most of the RCA 2N33 types functioned satisfactorily, they must be protected against overloading which causes a sudden reduction of $\alpha_{\alpha\alpha}$.

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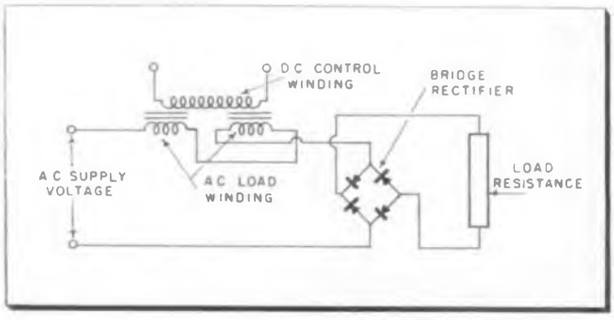
Industrial Applications



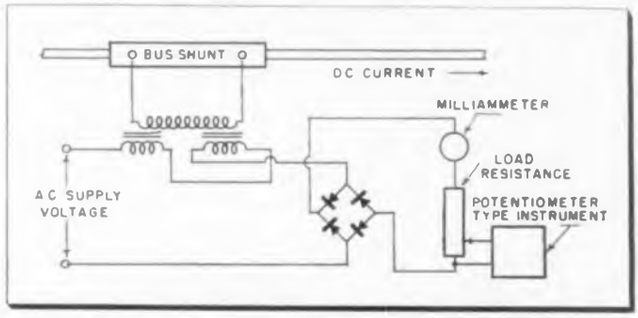


Fig. 1: (l) Basic transductor circuit contains dc control common to pair of ac load windings. Fig. 2: (r) Single-ended current transductor

Magnetic amplifiers preserve electrical isolation while metering voltages and currents. Major applications also include detection of arc-back in mercury rectifiers and over-current detection for selection tripping

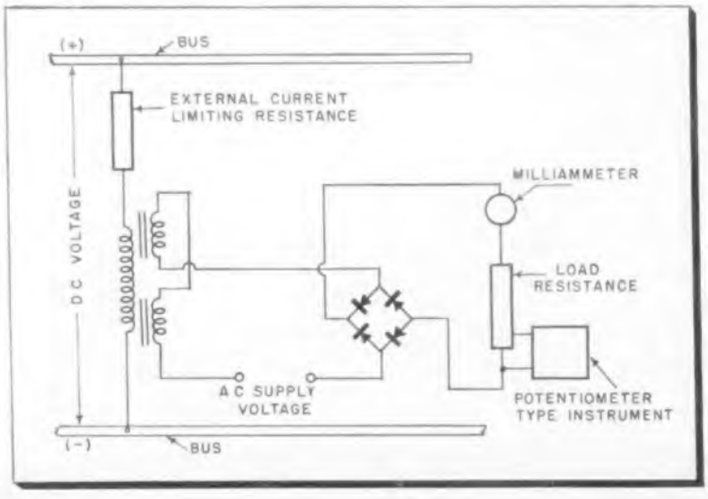
By R. J. RADUS, Westinghouse Electric Corp., 7325 Penn Ave., Pittsburgh 8, Penna.

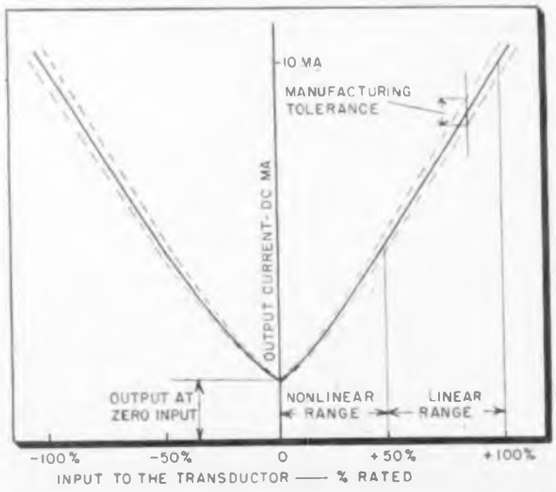
TRANSDUCTORS are magnetic amplifiers of the saturable reactor type that are used as auxiliary metering devices in high-potential dc systems. They can be used to obtain electrical isolation between the bus potential and the associated and control circuits because the load winding which feeds the metering circuit is electrically isolated from the control winding which is fed from the d-c system. The relationship between the signal fed to the control winding and the signal that feeds the metering circuit (i.e. input vs. output) is linear to the extent that transductor operation is compatible with industrial metering accuracies. The linear relationship between the input and output currents of a saturable reactor is inherent when high permeability "square-loop" core material is used. A number of technical papers have been written describing in full the operation of saturable reactor circuitry.[1,2] This paper will not be concerned with such a description. The operating limits of the transductors developed to date are ±¼% on accuracy for single-ended transductors, ±1% on accuracy for push-pull transductors and 3300 v dc on working voltage. This 3300 v dc does not represent a maximum value, however, it is the highest value that has been specified to date.

The basic transductor circuit used throughout this paper is the conventional series-connected saturable reactor with the addition of a bridge rectifier for conversion to dc output. As shown in Fig. 1, the reactors consist of a pair of cores with individual a-c or load winding and a d-c or control winding common to both cores. The operation of transductors as auxiliary metering devices depends upon their ability to sense a current or voltage in the system and to provide an output to the metering or control circuit which accurately represents the average value of the system current or voltage (i.e. they must function as the instrument transformers of ac systems).

Transductors of a current measuring type (Fig. 2) have been developed to sense the voltage drop developed across a standard bus shunt and to respond to changes in this shunt voltage.[3] The actual current rating of the shunt is of minor importance for most applications because the transductor responds to

Fig. 3: (l) Single-ended potential transductor for sensing bus voltage changes. Fig. 4: (r) Characteristic curve of single-ended transductor





# of Transductors

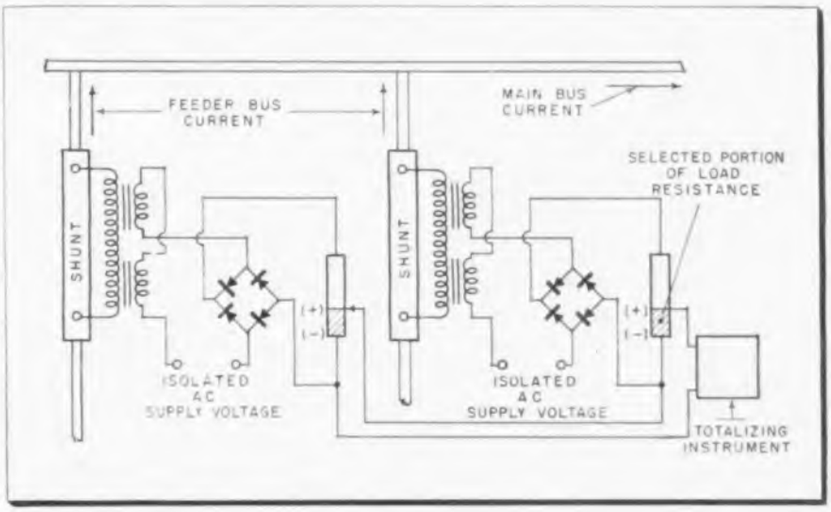


Fig. 5: Totalizing arrangement using single-ended transductors and linear part of curve in Fig. 4

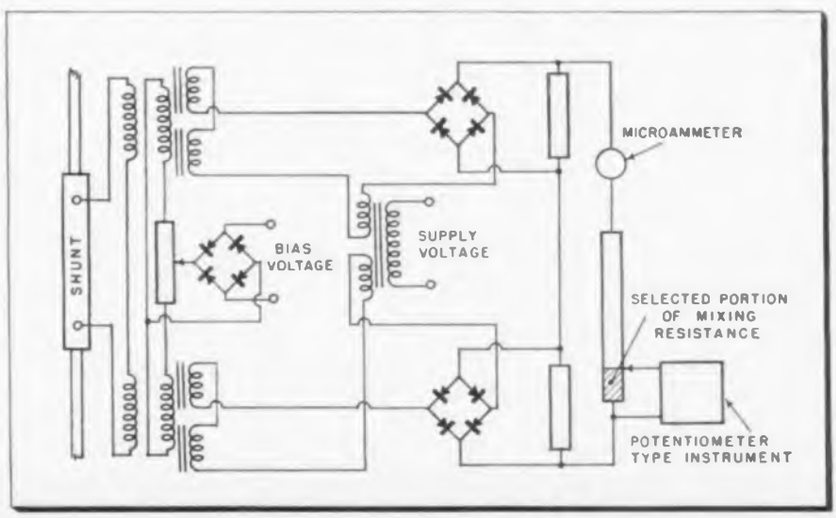
the percent rated shunt voltage. For applications in which the transductor causes appreciable loading of the shunt, the error can be calculated and compensated for at the time of installation.

Transductors of the potential measuring type (Fig. 3) have been developed to sense the bus voltage of a system and to respond to changes in this voltage. External resistance is added in series with the d-c or control winding to limit the current to approximately 10 ma. Operation with different nominal bus voltage requires only the proper value of external limiting resistance.

Transductors can be applied in the metering of individual currents and voltages or of networks where it is necessary to provide a scheme for totalizing a group of individual currents and voltages.

A typical application of single-ended circuitry as applied for metering individual unidirectional current is shown in Fig. 2. A potential transductor is applied for metering individual unidirectional voltage in the same way except that the control winding is connected as in Fig. 3. The operation of the single-ended circuit when applied as shown in Figs. 2 and 3 is typified by the characteristic curve of Fig. 4 when the relationship of input to output is expressed as percent rated input to the transductor versus output in milli-amperes of dc current. The dotted lines of Fig. 4 indicate that manufacturing tolerances are to be expected in production units. The operating characteristics of the single-ended circuitry can be interpreted for the instruments of Figs. 2 and 3 from the curve of Fig. 4. At zero input there is a finite output current flowing to the instrument. This is the magnetizing current of the reactors in Figs. 2 and 3 and it will move the calibrated zero upscale by roughly 15% of full scale deflection. The curve is not linear from zero to 50% rated input, so the meter scale will not be linear for this range. The curve is linear for range of input, 50% rated to 100% rated, so the meter scale will be linear for this range. Actually this type of application does not need linear operation of the transductor since a particular meter scale is calibrated for each transductor. The instrument used in the circuits of Figs. 2 and 3 can be either a dc milliammeter or a null-balancing potentiometer type instrument or both. The milliammeter is connected in series with the load resistance and is activated by the output current. The potentiometer type instrument is connected across a portion of the load resistance and is activated by the voltage developed in this selected resistance by the load current. The calibration of the milliammeter is made by obtaining full-scale deflection on the instrument at 100% rated input to the transductor. The calibration of the potentiometer type instrument is made by selecting the portion of the load resistance which develops the full scale input voltage of the instrument at 100% rated input to the transductor. The instrument scales can then be calibrated on a point by point basis over the desired range.

Fig. 6: Push-pull current transductor for metering individual unidirectional current



Typical Application

A typical application which does utilize the linear section of the curve of Fig. 4 is given in the totalizing scheme of Fig. 5.[4] Totalizing is accomplished by measuring the currents of the individual feeder buses with transductors and using each of the outputs to activate the same potentiometer type instrument. Assuming that the shunts in the feeder buses have the same current and voltage ratings, the relationships between input to the transductor and output to the totalizing instrument for each transductor must be identical if equal values of current in each of the feeder buses are to cause equal deflections on the potentiometer type instrument. This means that the characteristic curves of all transductors used in a totalizing

(*Continued on page* 126)

Compatible Color Signal Content

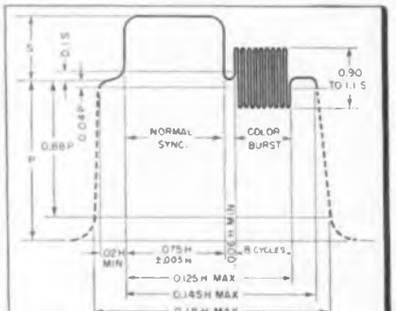
By E. S. WHITE, Chief Engineer
& M. H. KRONENBERG,
Sr. Project Engineer
CBS-Columbia
3400 37th Avenue
Long Island City, N. Y.

THE NTSC signal is essentially the same signal as is currently being transmitted and received in the standard black-and-white TV system except that additional chrominance information has been "tucked in" and a reference burst added to the horizontal back porch. Compatibility with existing black and white receivers, which has been one of the prime system considerations, is assured because such receivers are unable to respond to the additional NTSC signal content, and see the signal as a standard black-and-white transmission.

The realization that the additional information contained in the signal has been trimmed down because of the physiological and psychological limitations of the true terminal device—the human observer—is fundamental to any further discussion. The outstanding factors considered are:

1. Color detail carried by modulating frequencies greater than about 1.5 MC is not appreciated by the eye. This, of course, simplifies the problem of "tucking in" additional information in the existing bandwidth.

2. The employment of a color subcarrier frequency equal to a high odd harmonic of one-half the line frequency results in the subcarrier and all its color sidebands appearing in the unused portions of the existing spectrum, midway between the monochrome sideband clusters. In addition to providing much needed spectrum space, this device takes advantage of the integrating property of the eye to produce cancellation of the color subcarrier and color sideband frequencies which appear on the kinescope. Since the kinescope is not a linear device nor the eye a perfect integrator, this frequency interleaving effect does not result in complete cancellation, in the practical case, but rather in low visibility of the unwanted frequencies.



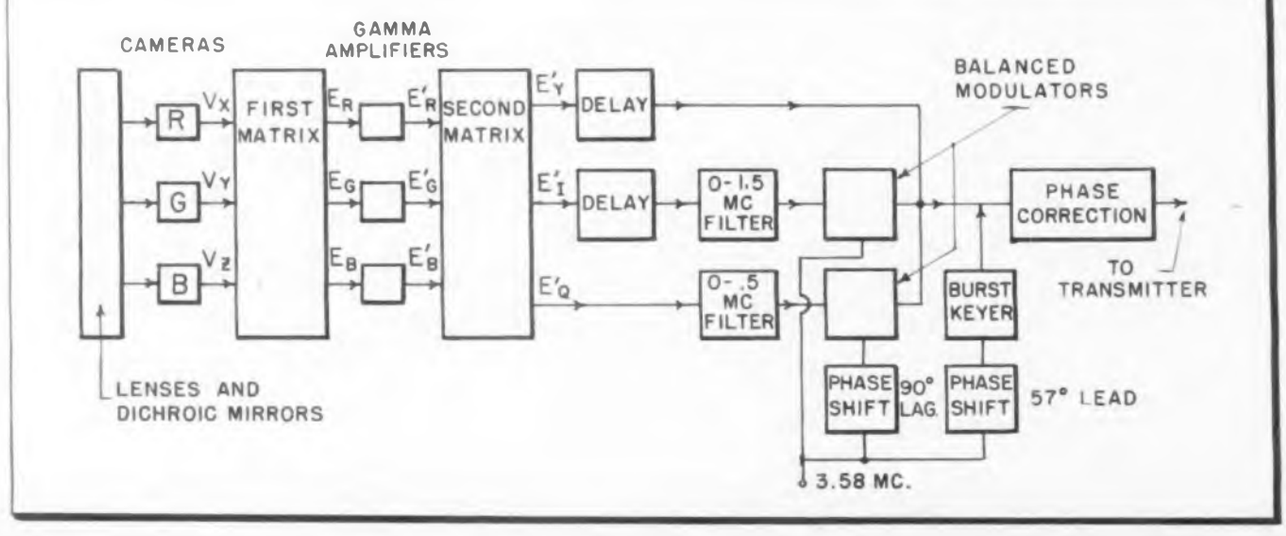
NTSC waveform, showing color burst

3. Although the eye requires good color presentation in large areas, in smaller areas (detail carried by modulating frequencies from about 0.5 MC to 1.5 MC) it is limited in appreciation and will accept a two, instead of three, color rendition along a C I E chromaticity diagram locus. Experiments have confirmed that a large reduction of such color detail lying along the green-magenta direction is acceptable to the eye. Therefore, color detail in this region transmitted only along the orange-cyan direction (orthogonal to green-magenta) is highly satisfactory. This physical consideration leads directly to the narrowband Q and wideband I concept of signal content.

4. The eye is relatively more sensitive to variations in green, less to red, and least to blue. This is related directly to the brightness sensation effects of the three colors; i.e., the eye sees a given energy level green as brighter than the same energy level red which appears brighter than the same energy level blue. The construction of the monochrome portion of the NTSC signal is based on this important phenomenon.

5. While variations of the luminance content of a scene are readily noticed by the eye, variations in chromaticity (hue and saturation) are not. If the signal were so devised that the receiver chrominance channels did not respond to externally introduced luminance variations, significant noise and interference improvements would result. Since the kinescope display depends on what occurs both in the receiver's monochrome and chrominance channels, any reduction in the latters' contribution to the overall noise and interference would be exceedingly helpful. This approach, called the constant-luminance system, has been incorporated into the NTSC specifications. It is of interest to note that, subject to certain restrictions, once the monochrome portion of the signal has been constructed in accordance

Fig. 1: A simplified block diagram that illustrates the arrangement of the NTSC pickup and signal generating processes



and Transmission

Developing a practical viewpoint toward, and sound-working concepts of, the NTSC color signal standards

with the principles expressed in 4, a constant-luminance system is obtained automatically.

Fig. 1 is a simplified block diagram arrangement of the pick-up and signal generating processes. Both the color and the monochrome details of the scene are first sent through a lens and dichroic-mirror arrangement, at the output of which the red, green, and blue content of the scene is automatically sorted out and channelized to the red, green and blue cameras. Note that all the information in the scene is picked up *simultaneously*, and this simultaneous feature is retained throughout the system. Electrical voltages V_x, V_y, and V_z are produced at the camera outputs, and these voltages are functions of the lens, dichroic-mirror, and camera spectral characteristics as well as of the scene itself. To produce the required red, green and blue voltages (V_R, V_G, and V_B) specified by the NTSC, different amounts of V_x, V_y and V_z must be combined; i.e., matrixed. This is accomplished in the first matrix unit. Calibration is obtained when an Illuminant C white light pick-up produces equal voltages V_R, V_G, and V_B.

In all further discussions, V_R, V_G, and V_B are individually referenced to those values of V_R, V_G, and V_B which produce the maximum luminance value of an Illuminant C white light pick-up. For example, when the maximum luminance Illuminant C is being viewed:

$$\frac{V_R}{V_{R_{max.\ C}}} = E_R = 1$$

$$\frac{V_G}{V_{G_{max.\ C}}} = E_G = 1$$

$$\frac{V_B}{V_{B_{max.\ C}}} = E_B = 1$$

Table I indicates the numerical values of E_R, E_G, and E_B for some typical scenes.

E_R, E_G, and E_B are then sent through gamma amplifiers which produce outputs:

$$E'_R = E_R^{\frac{1}{n}}$$

$$E'_G = E_G^{\frac{1}{n}}$$

$$E'_B = E_B^{\frac{1}{n}}$$

Since the pick-up device itself provides some inherent gamma correction, the value of n is chosen so that the overall transfer gradient, γ, associated with each primary color is 2.2. The importance of gamma correction in providing more pleasing picture rendition and improved signal to noise ratio is universally accepted in black and white television. Its increased importance and complexity in dealing with color reproduction and hence, three, instead of one, channels of information can be readily recognized. At the present state of the art, the accepted method of gamma correction is not all that could be desired, and, as a matter of fact, results in a departure from constant-luminance operation.

Second Matrix

E'_R, E'_G, and E'_B are linearly added and subtracted in the second matrix to produce the following three outputs:

$$E'_Y = k_1 E'_G + k_2 E'_R + k_3 E'_B \quad (1)$$

where $k_1 = 0.59$, $k_2 = 0.03$, $k_3 = 0.11$

$$E'_I = 0.74\,(E'_R - E'_Y) - 0.27\,(E'_B - E'_Y) \quad (2)$$

$$E'_Q = 0.48(E'_R - E'_Y) + 0.41\,(E'_B - E'_Y) \quad (3)$$

E'_I and E'_Q are shown expressed in terms of the color difference signals $(E'_R - E'_Y)$ and $(E'_B - E'_Y)$. An alternative representation, in terms of the color voltages, is obtained by substituting (1) in (2) and (3):

$$E'_I = -0.27\,E'_G + 0.60\,E'_R - 0.32\,E'_B \quad (4)$$

$$E'_Q = -0.52\,E'_G + 0.21\,E'_R + 0.31\,E'_B \quad (5)$$

The values of k_1, k_2, k_3, in Eq. (1) are of great importance. E'_Y is the gamma corrected monochrome portion of the NTSC signal, and the k's are the relative brightnesses of the three primary colors, as discussed previously. Note that an improved signal to noise ratio results since the color, green, to which the eye is most sensitive to noise variations, receives the greatest amplification, while the color, blue, to which the eye is least

Fig. 2: Vector relations at outputs of balanced modulators

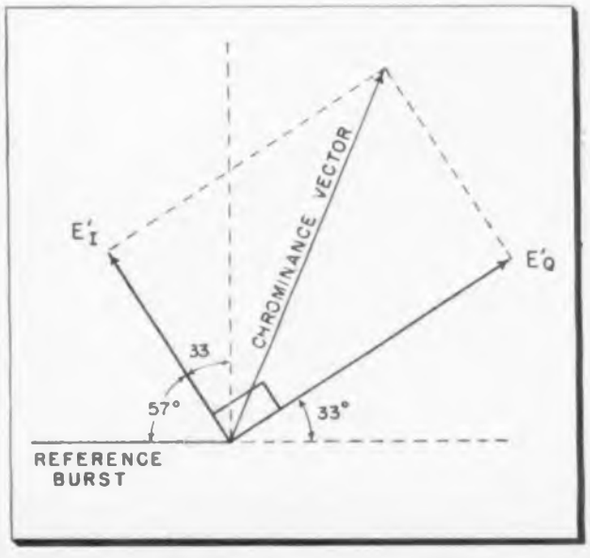
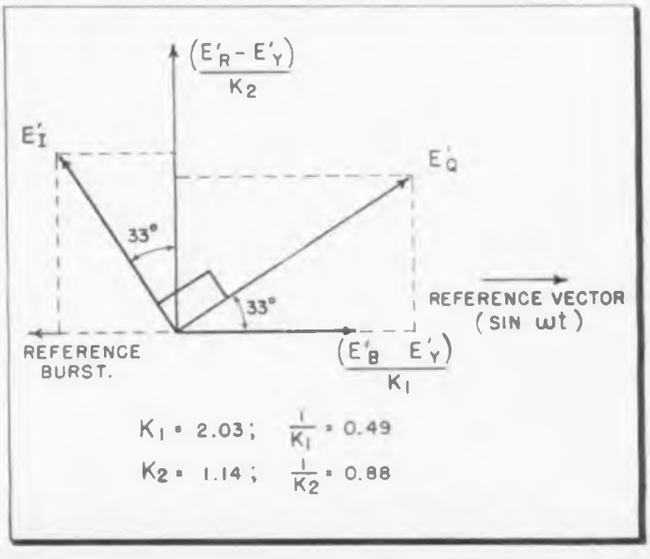


Fig. 3: (Right) Relationship between E', E' and color difference signals



sensitive to noise, receives the least amplification. Also, photographic experience has indicated that the most pleasing monochrome rendition of a colored scene results when the colors are permitted to make their relative brightness contributions. It should be remembered, further, that this choice of k values, with certain additional restrictions, results in constant-luminance operation.

Discussion of the coefficient values of E'_I and E'_Q in Eq. (2) and (3) is best deferred until after the balanced modulator operation has been reached.

Color Elimination

As pointed out previously, for detail corresponding to frequencies above 0.5 MC, the elimination of color lying along the green-magenta CIE chromaticity diagram locus is acceptable to the eye. Since this corresponds to the E'_Q information, a low pass (0 to 0.5 MC) filter substantially reduces the higher frequency amplitudes in this channel. On the other hand, the E'_I channel, containing orange-cyan information, is permitted to pass modulating frequencies up to 1.5 MC, the practical limit of color appreciation of the eye.

Since the time delay of a low pass filter section is inversely proportional to the cut-off frequency, the 0 to 1.5 MC E'_I filter will introduce less delay than the 0 to 0.5 MC E'_Q filter. To insure that both the E'_Q and E'_I information will arrive at the balanced modulators in time coincidence, an additional delay of the order 0.5 μs is inserted in the E'_I channel. Because there is no filtering in the E'_Y channel, additional delay of the order of 1.0 μs is inserted to insure time coincidence of the three channels at the output of the balanced modulators.

In the encoding process, E'_I is fed to one balanced modulator while E'_Q is fed to the other. A carefully controlled 3.58 MC color subcarrier sine wave frequency is introduced at this point, and three separate outputs, differing in their respective phase relationships, are obtained. One output is applied to the I modulator, another output, 90° lagging, is applied to the Q modulator, and the third output, 57° leading, is supplied to a burst keying circuit providing the reference burst on the horizontal back porch. The resulting vectorial relationship at the modulator outputs is shown in Fig. 2, together with the total chrominance vector which is the vectorial sum of its orthogonal E'_I and E'_Q components.

The I modulator is arranged so that there is no output when E'_I is zero. Similarly, no output is obtained from the Q modulator when E'_Q is zero. This insures that there is no color subcarrier output when a monochrome scene is being picked up. Furthermore, since the dc component of a colored scene must be inserted, both the color subcarrier and its side-band frequencies appear at the output whenever color is picked up.

Color Difference Signals

Returning to the coefficient values of E'_I and E'_Q in (2) and (3), their determination may best be understood by recalling that, in an earlier version of the NTSC signal, it was the $(E'_R - E'_Y)$ and $(E'_B - E'_Y)$ color difference signals which were specified. Fig. 3 shows the color difference signals and their relationship to the E'_Q and E'_I vectors. The 33° rotation of the vectors expresses electrically the colormetric shift to the green-magenta and orange-cyan loci of operation.

In this earlier NTSC version, the color difference signals, $(E'_R - E'_Y)$ and $(E'_B - E'_Y)$, were passed with equal bandwidths, and both were operated in vestigial side-band manner in the receiver. The resulting quadrature cross-talk was sufficiently annoying so that CPA (Color Phase Alternation) was required for acceptable correction. The use of CPA, however, gave rise to additional system aberrations. The NTSC, therefore, finally adopted the narrowband E'_Q and wideband E'_I system which minimized quadrature cross-talk and eliminated the use of CPA.

Numerical Values

In specifying the numerical values of K_1 and K_2 shown in Fig. 3, the following constraints were imposed in this earlier version:

1. The monochrome portion of the total video signal must be the same as Eq. (1) to achieve constant-luminance operation: i.e.,
$E'_Y = 0.59\,E'_G + 0.30\,E'_R + 0.11\,E'_B$
2. When gray or white is picked up; i.e., $E'_B = E'_G = E'_R$, the chrominance portion of the video signal must vanish.
3. The color difference signals must be orthogonal to each other.
4. Consistent with favorable signal to noise ratios, K_1 and K_2 should be small enough so that the amplitudes of the 3.58 MC color subcarrier and its sideband frequencies appear on the receiver kinescope through the monochrome channel of a color receiver or through a black-and-white receiver do not swing the beam intensity beyond black. This nonlinear operation of the kinescope would work against the desired low visibility effect achieved by frequency interleaving.

Peak Amplitudes

It is of interest to note that while the values of K_1 and K_2 are individually dependent upon the peak amplitudes specified, their ratio K_1/K_2 is fixed as soon as the first three constraints are imposed. The values determined were:

$$K_1 = 2.03$$
$$K_2 = 1.14$$

Since it would be most desirable to maintain equivalence between the already specified color difference vectors and the E'_I, E'_Q vectors, the projections of the latter on the for-

(*Continued on page 201*)

TABLE I

TABLE I: VALUES of E_R, E_G, and E_B at OUTPUT of FIRST MATRIX

Scene	Values at Output of First Matrix		
	E_R	E_G	E_B
Maximum white	1	1	1
Gray midway between maximum white and black	0.5	0.5	0.5
Black	0	0	0
Saturated red at max luminance	1	0	0
Saturated green at max luminance	0	1	0
Saturated blue at max luminance	0	0	1
Saturated yellow at max luminance	1	1	0
Saturated magenta at max luminance	1	0	1
Saturated cyan at max luminance	0	1	1
Saturated red with luminance midway between max and min	0.5	0	0
Saturated yellow with luminance midway between max and min	0.5	0.5	0

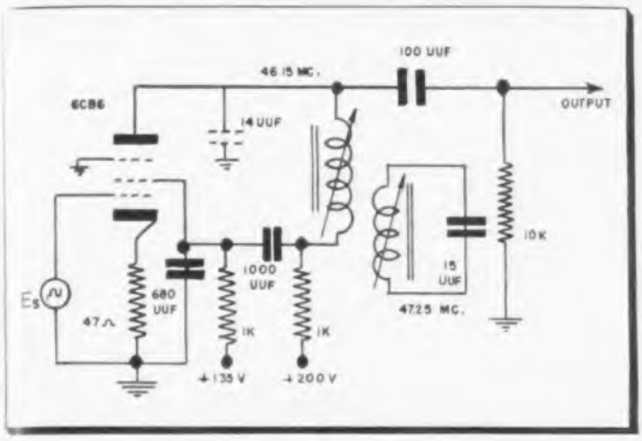


Fig. 1: (l) Stagger-tuned stage showing inductively coupled trap.

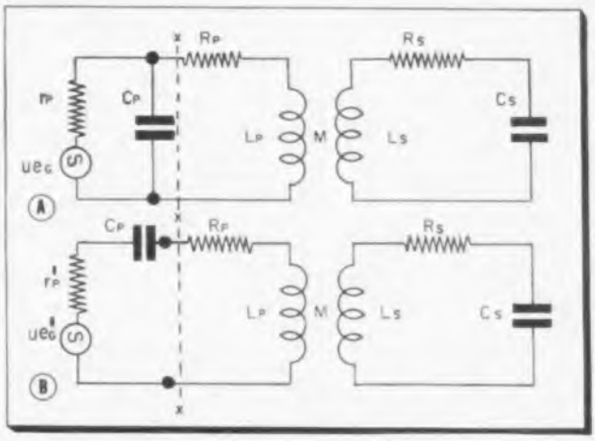


Fig. 2: (r) Equivalent circuit (a) and Thevenin reduction (b)

Designing Inductively Coupled Traps

Comprehensive analysis serves as practical guide to engineers faced with video i-f and similar network problems. Special emphasis given to effect on "electrical fidelity"

By WILLIAM F. GARLAND,
Allen B. DuMont Labs.,
750 Bloomfield Ave., Clifton, N. J.

THE video i-f system of a TV receiver is a complex network because of the many functions it must perform, the most pertinent being the prevention of interference from the adjacent channel sound and video carriers. However, the primary function of the i-f system is to amplify the video signal at the output of the tuner mixer to a substantial level at the video detector. Also, it must amplify with a minimum amount of distortion to the video signal, a band of frequencies from 3 to 4.5 MC wide in order to take full advantage of the high frequency components of modulation.

In as much as the video i-f network is a wideband system, it becomes susceptible to interference from signals within the bandpass as well as those near the extremes of the pass band. The interfering signals within the bandpass are in general special cases and cannot be readily eliminated by any particular design technique. However, those interfering signals found at the extremes of the bandpass, namely the adjacent channel sound and video carriers are adherent to the system and may be approached from the analytical standpoint. For this reason it is necessary to employ some means of eliminating these unwanted frequencies since the tuner mixer output contains both the desired picture and sound i-f signals as well as picture and sound i-f signals of the adjacent channels.

The simple video i-f response curves obtained by either stagger tuned or double tuned networks are not sufficient to reject some of these undesired signals effectively and yet maintain the video i-f qualities of adequate gain, selectivity, sensitivity and stability. Therefore, a need of additional circuitry for eliminating these undesired frequencies arises, the simplest and most economical

Fig. 3: Theoretical response curves showing effects of coupling traps to 2-terminal net

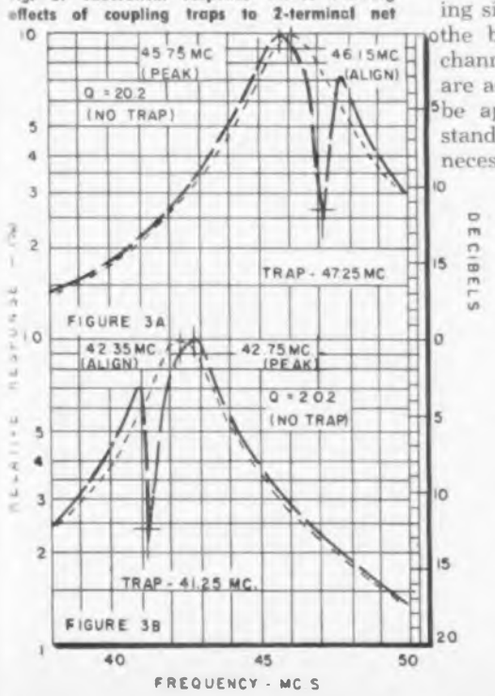
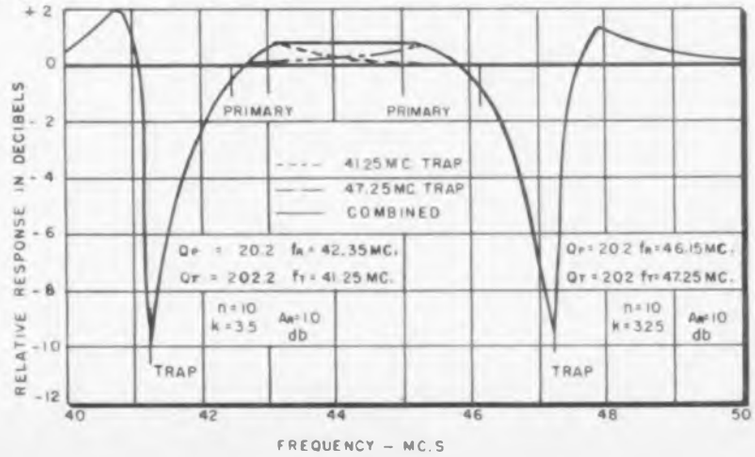


Fig. 4: Response of individual trap networks and effect through 41.25 mc spectrum



means being the inductively coupled trap.

Generally, in the majority of TV areas, 30 db of attenuation between the undesired carriers with respect to the picture carrier frequency is suitable to eliminate video and sound beat interference from the desired video signal. High "Q" trap circuits must be employed that offer a sharp attenuation at these unwanted frequencies without destroying the gain and picture quality of the video i-f system. Receivers operating in fringe areas may require additional adjacent channel traps although these are unnecessary in the majority of TV areas.

The associated sound carrier on the other hand is always present and this trap should possess the following characteristics: first, the ability to attenuate the 4.5 MC sound beat to a level where it becomes negligible in the video picture; secondly, a flat response in the region of the sound carrier frequency must be maintained so that FM slope detection in the form of horizontal bar interference in the video picture does not become apparent. Again the trap should not alter the bandwidth of the video i-f response to the point where it effects the "Electrical Fidelity" of the system.

Analytical Analysis

The analytical analysis presented in this paper is a modification of the familiar double-tuned network theory. It is based on the principle of having a network tuned to a desired rejection frequency coupled to another tuned network fed from a high impedance constant current generator namely, a pentode tube. A mathematical equation relating the attenuation coupling and phase characteristics of an inductively coupled trap was devised on the basis of the usual narrow bandwidth assumptions. The analysis is particularly applicable to stagger-tuned amplifiers, since the networks used in such a system are generally two terminal networks. This analytical expression permits the usual design practices to be followed so that the amplitude and phase characteristics of the trap circuit may be added to that of the system in order to determine the net overall amplitude and phase responses of the amplifier.

If the analysis is applied to any four-terminal network, modification of the driving point impedance must be made before proceeding with the analysis. This modification of driving point impedance may simply be acquired by multiplying the trap response equation by the driving point impedance equation of the system in question. This modified driving point impedance then becomes the complex impedance of the network including the effects from the traps. Figs. 1 and 2 show an example of a stagger-tuned stage illustrating the principle of the inductively coupled trap network.

A mathematical relationship for the trap response may be expressed as a function of the following parameters namely, the attenuation, coupling factor, separation frequency between the networks, a generalized frequency separation, and "Q" ratio. The trap response equation is:

(Amplitude)

$$|A| = \left[\frac{|(k+1) - nB(B-B_1)|^2 + [nB + B - B_1|^2}{|1 - nB(B-B_1)|^2 + [nB + B - B_1|^2}\right]^{1/2}$$

(Phase)

$$\theta = \mathrm{Tan}^{-1}\left[\frac{k|(B_1 - B) - nB|}{k|1 - nB(B-B_1)| + \sqrt{(n^2B^2+1)[1+(B-B_1)^2]}}\right]$$

The terms in the above equations are defined as follows:

k — coupling factor

B_1 — frequency separation between the primary and the secondary circuits

n — ratio's of "Q's" (Q_s Q_p = n)

$B = 2Q_p\Delta = 2Q_p(W - W_s)/W_s$

B — generalized frequency separation

$B = 2Q_p\Delta = 2Q_p(W - W_s)/W_s$

$B_1 = 2Q_p\Delta_p = 2Q_p(W_p - W_s)/W_s$

It becomes desirable to know the relationship that exists between the coupling and the attenuation especially at the resonant frequency of the trap, where B, the generalized frequency separation, becomes zero. Solving the trap response equation in terms of Ar the attenuation ratio for B = 0, we find that the coupling factor k becomes a function of two parameters, namely B_1 or the frequency separation factor between the primary and trap circuit, and the attenuation ratio Ar. These three parameters are related to each other by the following equation:

$$(Ar^2 - 1)(B_1^2 + 1) = (k^2 + 2k)$$

Design Technique

To show how the mathematical equation for the amplitude as well as the phase characteristics of an inductively coupled trap are used, a typical design problem in the form of a Butterworth stagger-triple-tuned network employing inductively coupled traps will be given as an example. Since the networks employed in a stagger-tuned system are two terminal networks, and since the analytical expressions for the inductively coupled trap circuit were based on having the trap circuit coupled to a two terminal network, the relative trap response may then be simply added to that of

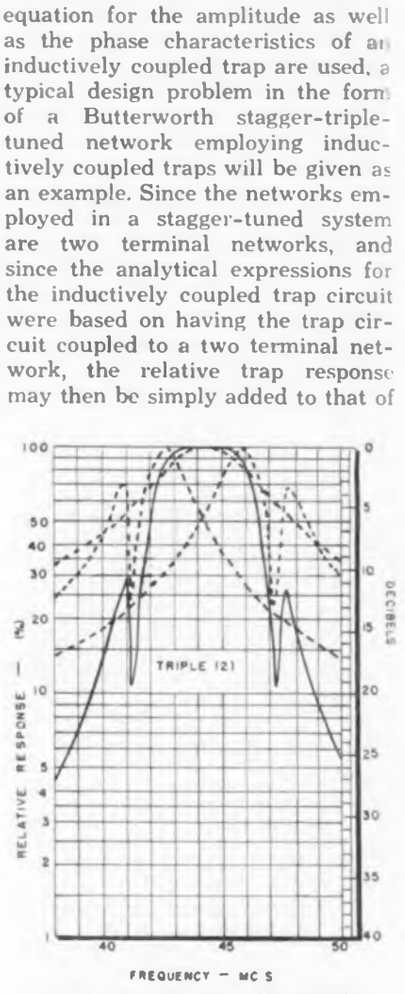
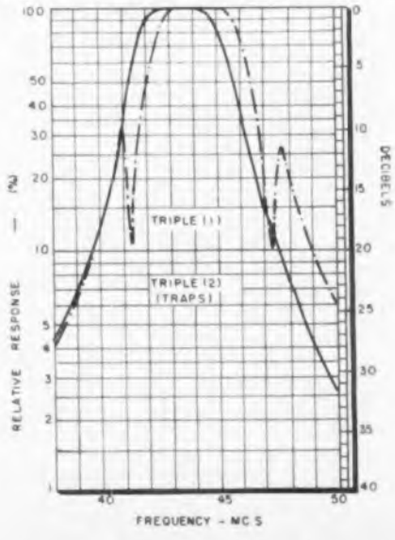


Fig. 5: Theoretical curves for networks

Fig. 8: Triple-tuned network response curves



the staggered system, with a net result being a mathematical formula for the response of the network including the effects from the traps.

An adjacent channel sound carrier trap as well as an associated sound carrier trap were employed in the case of a typical 41.25 MC stagger tuned amplifier. It has been previously determined by experimental data, that inductively coupled trap Q's in the order of 200 and attenuations in the vicinity of 10 db are not unreasonable design factors at this frequency. Also it may be shown experimentally as well as analytically that the trap network should be coupled to a network in the system which is adjacent in frequency to that of the trap circuit. This must be so if the designer wishes to minimize the degree of in-band amplitude and phase distortion for a given trap attenuation ratio. On the basis of this experimental information as well as the fact that a simple stagger-tuned system is composed of a number of two terminal networks, the trap coupling problem becomes relatively simple. The associated sound carrier trap will then be coupled to that network of the staggered system determining the lower limit of the desired response, while on the other hand the adjacent channel sound carrier trap will be coupled to that network specifying the upper limit of the bandpass.

Response Curves

Figs. 3a and 3b are theoretical response curves showing the effects of coupling these traps to their respective two terminal network of the staggered system. The response of the network without the trap is also plotted for a means of comparison. From these results it may be readily seen that the trap network tends to shift the frequency of staggering in the direction where the net bandwidth of the overall system is reduced. Also, because of the double peaked response of the trap network a certain amount of energy in the form of a "kick-back" appears in the undesired region of the bandpass. For this reason it becomes apparent that it would be desirable to have very high Q traps, so that the amount of energy appearing in the outer bandpass region be of insignificant amplitude. Also, it would be desirable to have the frequency separation between the network and the trap circuit as small as possible, so as to minimize the amount of in-band amplitude and phase distortion presented by the trap circuit. Again, in tuning the system on the basis of a single frequency alignment technique, the original frequencies of staggering must be used even though the net result of tuning shows the peak of the response to be at some other frequency. Reference to the analytical analysis found in the appendix will show the reason for this tuning procedure.

Fig. 4 is a relative response in db of the individual trap networks and their cumulative effect throughout the entire 41.25 MC video i-f spectrum. It will be well to note that traps add a small amount of gain to the desired bandpass region of the video i-f spectrum. Also from the individual trap responses shown the amount of energy present in the outer pass region is small, which fact may be basically attributed to the high Q and closeness in tuning between the trap circuit and the network to which it has been coupled.

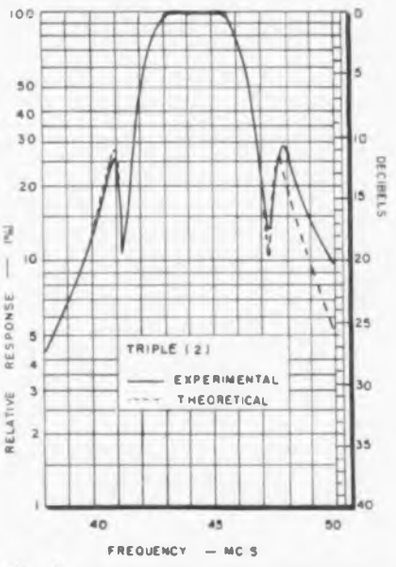


Fig. 6: Experimental curves confirm theory

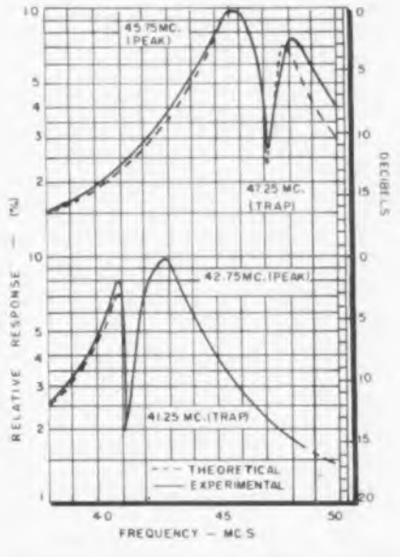


Fig. 7: Experimental data comparing networks

Fig. 9: Triple-tuned network without traps

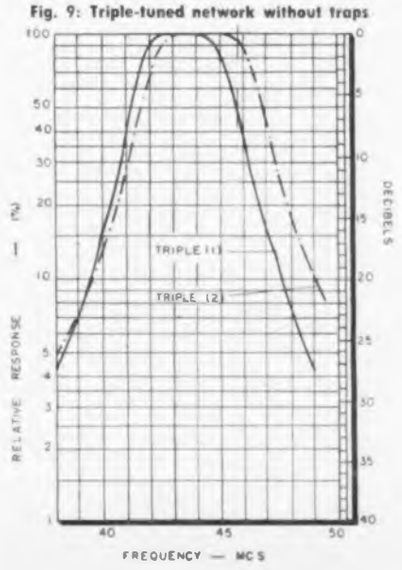
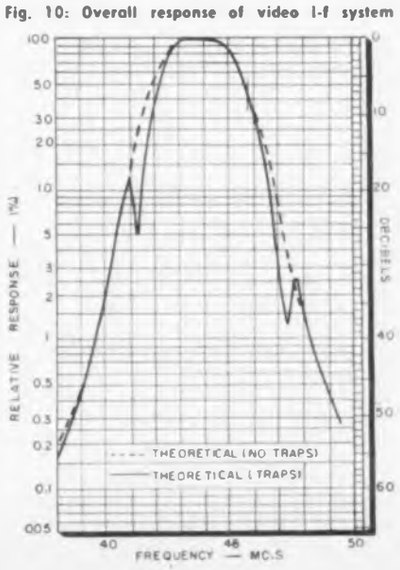


Fig. 10: Overall response of video I-f system



Degree of Accuracy

Fig. 5 contains theoretical curves of the individual networks of the staggered system as well as the over-all response. Fig. 6 contains experimental curves confirming these theoretical computations. The degree of accuracy between the theoretical and experimental results is quite high and tends to prove the validity of the original design assumptions for Q and attenuation. Fig. 7 contains experimental data comparing the individual networks to which the traps were coupled with their respective theoretical response. The results here show a slight discrepancy in the theoretical

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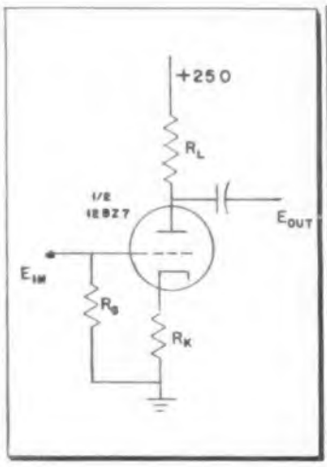
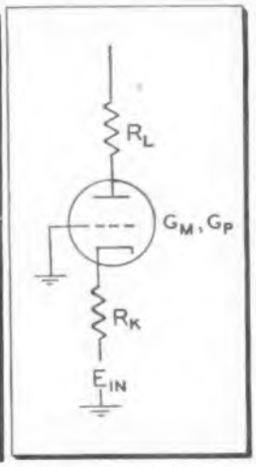




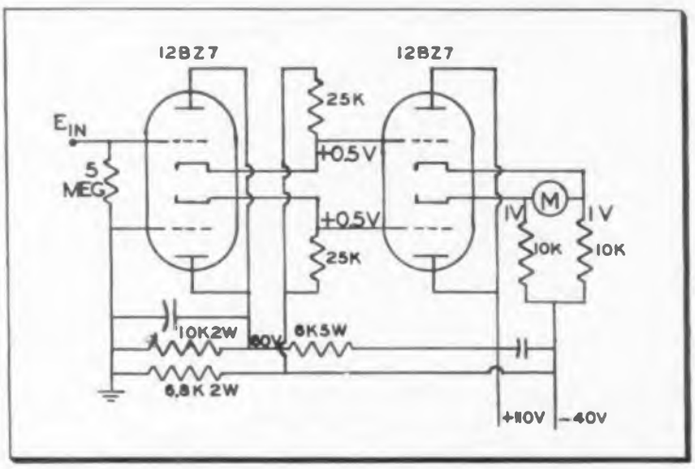


Fig. 1: Triode degenerative amplifier Fig. 3: (Center) Grounded grid amplifier Fig. 4: (Right) Vacuum tube voltmeter circuit

G-Curves and

THE establishment of design equations for amplifier circuits capable of generating signal output voltages at one or more points in addition to the normal output terminals requires considerable care. All equations established for a tube circuit refer the tube voltages to the potential of the cathode. Where the cathode is not at ground signal potential, a cathode signal voltage term must be included. The derivation of the operating equation of the cathode degenerative triode amplifiner is carried out in full in order to show the technique in a typical problem. Equations for other circuits, derivable in similar manner, are quoted without derivation.

By Dr. KEATS A. PULLEN
Ordnance Dept.
U. S. Army Ballistic Research Labs.
Aberdeen Proving Grounds, Md.

Triode Degenerative Amplifier

The triode degenerative amplifier (Fig. 1) develops a signal voltage across the cathode impedance as well as across the output impedance. As a consequence, the grid to cathode voltage and the plate to cathode voltage must include the voltage component developed across the cathode impedance, R_K. The basic plate current Eq. (1) then takes the form of (2)

$$i_p = G_M e_g + G_p e_p \qquad (1)$$

$$i_p = G_M (E_{ic} - i_p R_K) + G_P (i_p R_K - i_p R_L) \qquad (2)$$

Checking the grid mesh circuit and the plate mesh circuit (or junction pair equivalent) shows that the multiplier of G_M is exactly the grid to cathode voltage, and the multiplier of G_P the plate to cathode voltage.

Solving Eq. 2 for the voltage amplification gives

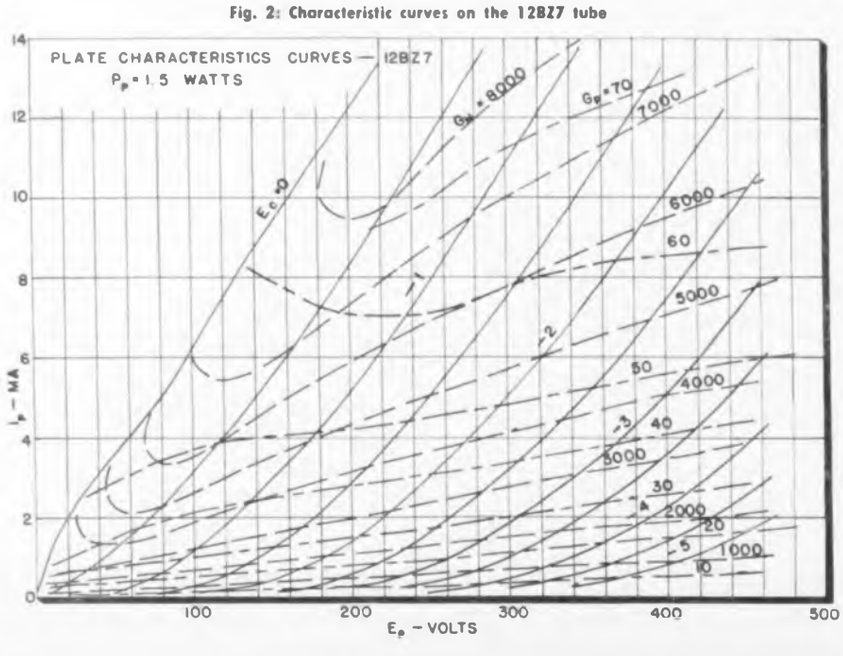
$$VA = G_M R_L / [1 + (G_M + G_P) R_K + G_P R_L] \qquad (3)$$

The parenthesis term in the denominator of Eq. 3 gives the effect of cathode degeneration. By comparison, one sees that the effect of plate conductance is to introduce what might be called plate degeneration.

Effective Stabilization

When the parenthesis term of the denominator is large compared to the first and last terms of the denominator, appreciable degeneration results. Then, if the plate conductance is small compared to the transconductance, the amplification will be just slightly less than R_L/R_K. The amplification approaches this ratio more and more closely as the plate conductance becomes smaller and smaller com-

Fig. 2: Characteristic curves on the 12BZ7 tube



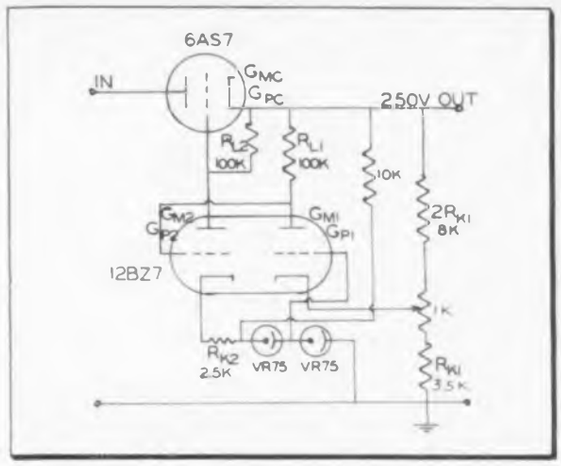


Fig. 5: Compound voltage regulator circuit

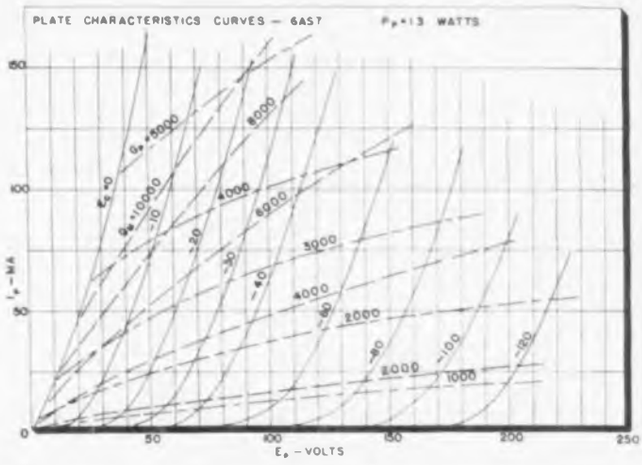


Fig. 6: Characteristic curves on 6AS7 tube

Degenerative Amplifiers

Seventh in the series of articles describing vacuum tube conductance curve design techniques

pared to the transconductance. Effective stabilization of an amplifier requires first that the parenthesis term of the denominator of (3) be large compared to the balance of the denominator, and second that G_P be small compared to G_M.

Design Example

As an example of the design of a degenerative amplifier, assume that an amplifier is required to provide a stabilized amplification of approximately 35. The output peak to peak signal voltage required is 140 v. A supply voltage of 250 v. is available.

A 12BZ7 tube triode section makes an excellent choice for this degenerative amplifier. Examination of the curves of the 12BZ7 tube (Fig. 2) indicates that choice of a 100,000-ohm load resistance should be a good initial choice. The range of plate voltage change indicates that the 140 volts required should be available. With R_K equal to zero, amplifications at zero bias and at -1 v. and -2 v. bias respectively are 68, 72, and 57. Cathode degeneration may be inserted to reduce the stage amplification to 40. A cathode resistor of 1000 ohms resistance, if unbypassed, will reduce the amplifications to 40.5, 42, and 36.2 at zero bias, -1 v., and -2 v., respectively. The resulting feedback reduces the distortion to approximately half the value without feedback.

Drawing the load line corresponding to 100,000 ohms load resistance on Fig. 2, and reading the plate current change caused by a change of bias from zero to minus two volts, one finds that the plate current changes from 2.3 ma. to 0.8 ma. This 1.5 ma. current change produces a 150 v. output for a grid to cathode bias change from zero to -2 v. The input signal required from grid to ground in the cathode degenerated amplifier is the sum of the grid to cathode signal voltage and the cathode to ground signal voltage. The cathode voltage change resulting from the signal voltage may be found from multiplying the value of the cathode resistance by the plate current change. The cathode amplification factor may be found from

$$VA = G_M R_K/[1 + (G_M + G_P) R_K + G_P R_L] \quad (4)$$

The grid to ground signal voltage required to provide the two volt grid to cathode voltage change is found to be 3.5 v. in the problem under consideration.

Grounded Grid Amplifier

The form of grounded grid amplifier commonly used in TV may often be represented as in Fig. 3. The amplifier equations derived from Fig. 3, for plate and cathode, are

$$VA_P = (G_M + G_P) R_L/[1 + G_M + G_P) R_K + G_P R_L] \quad (5)$$

$$VA_K = (1 + G_P R_L)/[1 + G_M + G_P) R_K + G_P R_L] \quad (6)$$

Examination of Eq. 6 shows that the cathode gain is one half when

$$(G_M + G_P) R_K = 1 + G_P R_L \quad (7)$$

Where the input voltage E_{in} is dependent on the value of R_K, the maximum amplification in a grounded grid amplifier may not occur when R_K is zero. If, for example,

$$E_{in} = E_1 k \sqrt{R_K},$$

then maximum amplification occurs when

$$R_K = (1 + G_P R_L)/(G_M + G_P) \quad (8)$$

CONDUCTANCE CURVE

techniques for additional design applications are described by the author in the following issues of TELE-TECH & ELECTRONIC INDUSTRIES:

Sept. 1953: "G Curves & Impedance Amplifiers"
July 1953: "Conductance Curves Speed Pentode R-C Amplifier Design"
May 1953: "Conductance Curves Speed Triode R-C Amplifier Design"
Feb. 1953: "UHF Oscillator Design Notes"
Nov. 1950: "Use of Conductance, or G, Curves for Pentode Circuit Design"
Aug. 1949: "Using G Curves in Tube Circuit Design," Pt. I
July 1949: "Using G Curves in Tube Circuit Design," Pt. II

Examination of Eqs. 5 and 6 provides information on the tube design characteristics desired for grounded grid operation. The first of these characteristics is a high transconductance. With high transconductance, reasonable amplification may be obtained in the presence of moderate amounts of electrode capacitance. The second is a small plate conductance. With a low plate conductance the tube loading can be small enough to achieve adequate amplification.

The 12BZ7 tube appears to be nearly ideal for a grounded grid amplifier application. With a plate voltage of 125 v. and a tuned circuit

(*Continued on page* 164)

New Test Tape for

By JULIUS A. KONINS, Chief Engineer,
The Dubbings Co., Inc., 41-10 45th St., Long Island City 4, N.Y.

THE growing popularity of magnetic tape recorders for professional audio and broadcast services, as well as home entertainment, has fostered the need for a relatively simple means of measuring recorder performance. This means should require a minimum of auxiliary equipment and set-up time, and should retain accuracy over a long period of time.

The test tape is capable of meeting these requirements. A few manufacturers have developed test tapes designed to measure one particular function, such as head alignment or frequency response, on a reel. The need still appeared to exist for a test tape, which on a single reel would provide the means for testing practically all of the important functions of a tape recorder.

Test Tape Development

It was with this in mind that The Dubbings Co. undertook the development of the D-111 test tape, "The Measure of Your Tape Recorder's Performance." Besides enabling the user to see how well his recorder is performing, it enables him to obtain peak performance by correcting those electrical and mechanical difficulties indicated by the performance symptoms. Also, the D-111 permits a potential recorder purchaser to evaluate the differences between various makes and models—and they often vary considerably.

The D-111 is a full-track 7-inch reel, and runs for close to 15 minutes at 15 in./sec. Since this tape acts as a standard reference, it is most important that it be free from stretching, remain uniform under extreme storage conditions, and resist breaking and curling. Consequently, the new Reeves Soundcraft "Lifetime" tape is used exclusively. This tape, made of DuPont mylar polyester film, fulfills the requirements. Production recordings are made on the finest professional tape machines manufactured by Fairchild Recording Equipment Co.

Six of the most important tests for a magnetic recorder are recorded on the tape. See Fig. 2. Voice announcements are included. The tests are for wow and flutter, head azimuth alignment, frequency response, signal-to-noise ratio, maximum signal level, and tape speed. Only a vacuum tube voltmeter or similar instrument is required to make most of the tests.

Wow and Flutter

Frequency wow is a modulation effect which is caused by periodic variations of the tape speed. Flutter is a similar, though higher frequency, cyclic deviation from true frequency. This may be detected by ear if the change in pitch is as small as 0.5%. The D-111 has a 30-second 3000-cycle tone recorded on it. Very high quality recorders are often rated for 0.1% rms wow and flutter, while average quality machines range from 0.3% to 0.4%. If the ear, which is very sensitive to changes in pitch at 3000 cycles, cannot detect any wow, the recorder wow is probably under 0.5%.

A simple trick to make the magnitude of wow more evident is to induce a wow by touching the reel during operation. If a light touch causes a considerable increase in wow, the normal level most likely is well under 0.5%. On the other hand, if a heavier touch does not materially increase the total wow, rest assured that the wow was excessive to begin with.

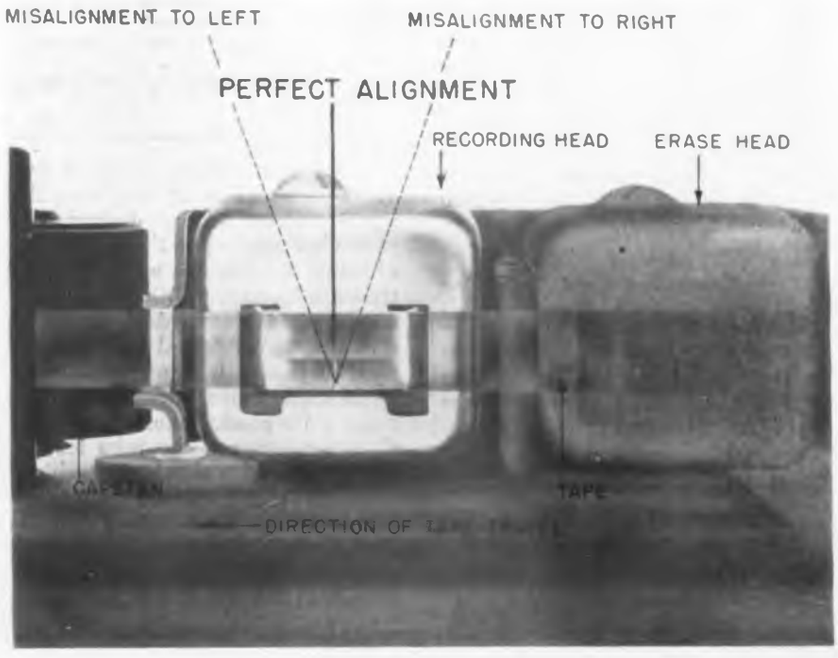
Abnormal wow is a clue for the troubleshooter. It may lead to a faulty capstan, worn idler, defective motor, or distorted reel. Also, all friction surfaces should be checked for oil, spring tensions tested, and any tape binding in the guides noted; however, eccentric rotating parts are generally the prime offenders.

Head Alignment

At first it was intended to evolve a means by which the user could tell exactly how much the recorder head deviated from perfect azimuth alignment merely by playing the test tape. A method was developed to do this. It consisted of recording seven sections of tape, with the fourth section aligned vertically. The other sections were recorded with the head at increasing increments of deviation from the vertical. On playback, maximum output would be achieved at that section corresponding to the playback head alignment. This method worked well in experimental tapes but was abandoned after it became apparent that the angle of deviation was of little consequence, the important thing being the high frequency loss that the misalignment created.

A simpler, yet more conclusive, method was decided upon for inclusion in the D-111. It consists of a 10,000-cycle tone recorded by a head in perfect vertical alignment. To determine if the machine under test has a properly positioned head, gently touch the top and bottom of the moving tape with a pencil or

Fig. 1: Relative positions of tape, capstan and heads. Correct azimuth alignment is indicated



Magnetic Recorders

Peak performance may be achieved by using six most important tests recorded on single reel. These include wow and flutter, head alignment, frequency response, signal-to-noise ratio, maximum signal level, timing

similar object, thereby changing the relative azimuths of the tape and head a small amount. If the resulting output drops when the tape is skewed in both directions, then the head is properly aligned because output is maximum when the tape is untouched. Conversely, if touching the tape top or bottom increases output, then the head is not accurately aligned and should be adjusted until maximum output is obtained.

For machines with a separate record head, this too may be adjusted after the playback head has been corrected. Record a 10,000-cycle tone on a piece of scrap tape, using a signal generator, test record, or the test tape on a second machine as the source. Play the scrap piece back on the corrected head, and touch the top and bottom. If the record head is perfectly aligned, touching the tape will cause a drop in output. See Fig. 1.

Frequency Response

The D-111 test tape includes two test runs of 14 steps covering the range 30 to 15,000 cycles recorded with NARTB standard characteristic. The first run goes rapidly through the entire range, allowing a few seconds for each step. Its purpose is to allow the user to set the volume level according to the response peak for the main frequency run which follows. The overall frequency response may be plotted by noting the output level for each voice-announced twelve-second step. These frequency steps are: 30, 50, 100, 200, 400 and 700 CPS, and 1, 2, 4, 6, 8, 10, 12 and 15 KC.

A top quality professional or high-fidelity recorder may be expected to have a frequency response of ±2 db from 50 to 15,000 cycles, at 15 ips. Moderately priced machines depart quite sharply from such flat response. Should the resulting response data indicate that the recorder is not performing according to its capability, there are several trouble spots worth checking. The fault may lie with either the record or playback amplifier if either has improper equalization. Low bias may be the cause of poor low frequency response, and too high bias may result in poor high frequency response. A worn head or inadequate tape-to-head contact, as may be caused by tape rub-off, will attenuate high frequencies. Other troublemakers, such as head misalignment and incorrect tape speed, may be corrected with tests on the D-111 specifically intended for the purpose.

Signal-to-noise ratio is a measure of the difference between signal level and noise. In general, the better the recorder, the higher the S/N ratio. A first class professional machine might have a S/N ratio of 50 to 55 db, while a good home recorder's S/N ratio would probably be around 35 to 45 db at 15 ips.

The D-111 provides the means for measuring S/N ratio from 15 to 50 db, based on a zero level of 3% distortion, which is the NARTB standard. For most recorders, this section of the test tape is an exact S/N measure: for the best quality machines, it indicates the lowest maximum ratio, 50 db, which may be tolerated.

The recording consists of a series of 400-cycle signals, each diminished in volume in steps of 5 db. During each tone period, the playback volume of the recorder should be increased to maintain constant volume output. Naturally, the noise level of the recorder increases simultaneously with the upward adjustments of the volume control. Eventually a level is reached where the noise during the few quiet seconds between voice-announced tone levels is as loud as the tone just heard. The level noted at this interval is the recorder's signal-to-noise ratio.

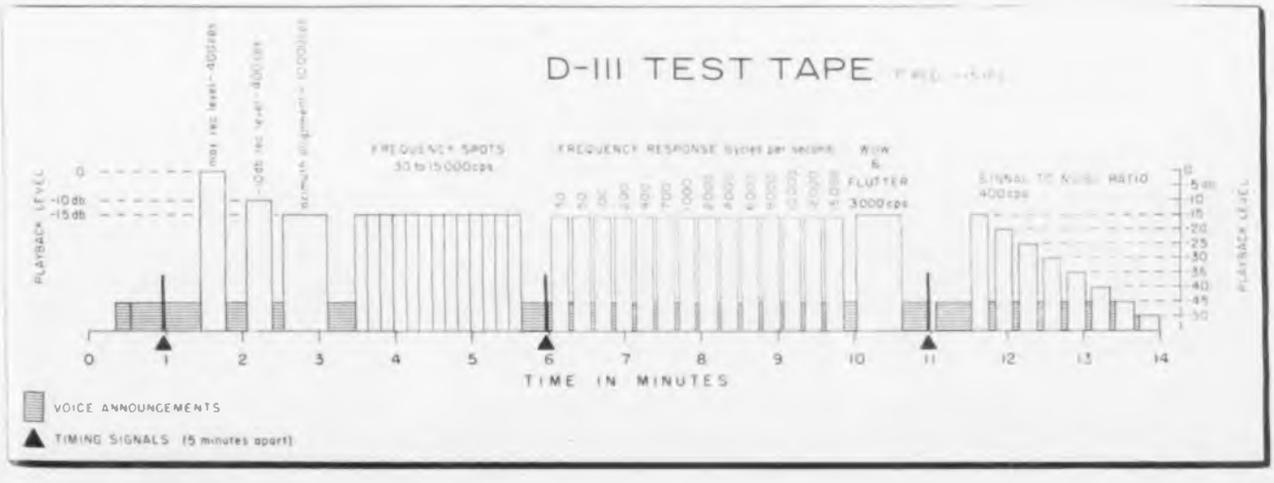
A S/N ratio which turns out to be worse than expected would indicate the necessity for checking certain key points which may be the noise source. These include a head with remanent magnetization, excessive vacuum tube noise, or hum induced by stray fields.

Maximum Signal Level

A 400-cycle tone on the test tape provides an excellent means of calibrating for the optimum level at which all future tapes should be recorded. It is recorded at zero level, based on the NARTB standard of 3%

(*Continued on page* 180)

Fig. 2: Playback level, time of signal steps, and frequencies on tape which tests recording level, alignment, response, timing, wow, and S/N



Contouring TV Antenna

Advent of high gain antennas demands close attention to null regions. Adjustment of vertical plane pattern, in conjunction with height, location, gain and transmitter power requirements, can insure desired coverage

By L. O. KRAUSE, Supervisor
Antenna & Relay Engineering
General Electric Co.
Syracuse, N.Y.

The advent of high gain antennas for television has aroused interest in the manner of insuring adequate signal in the so-called "null-regions." Generally, four factors—average antenna height, antenna location relative to population and terrain, antenna gain, and transmitter power—enter into coverage consideration. Adjusting the antenna vertical plane pattern to provide certain signal levels based on the requirements of these four factors may be defined as pattern contouring.

The present trend in antenna use has been toward greater tower heights, and greater distance from antennas to primary city. Thus, some of the problems of applying high gain antennas have increased. These problems are fundamental, and greater care and study have been required to provide adequate installation of such antennas. The answer to most of these problems has been to modify the normal pattern of the antenna.

Fig. 1 illustrates the vertical plane antenna pattern. It is that pattern which lies in a vertical plane passing through the axis of the antenna, the magnitude of the field being plotted versus angle when taken at constant distance. Usually, such patterns are measured with the antenna horizontal simply for physical reasons. In order to get a general idea of what is meant by contouring, see Fig. 2. Here is a standard antenna pattern with basic nulls, overlaid on one side by a tilted pattern and on the other side by one with null fill-in. In general, contouring employs these two basic factors—tilt and null fill-in.

Nulls

Nulls are fundamental in antenna arrays. An antenna array is composed of a prime element having its own pattern, multiplied by the array factor which will be defined. Nulls will exist where either the array factor becomes zero, or where the prime pattern has a null. Generally the prime pattern is broad in vertical shape, and its nulls are usually at low angles which do not cause difficulty. However, the array factor resulting from a large vertical aperture, produces nulls at high angles or near the horizontal. These are the nulls which usually cause difficulty. Therefore, in the following, the discussion will tend to center around array factor nulls.

The array factor is basically a summation of vectors. Fig. 3 illustrates a two-element system, showing how the distant field is made up of the sum of two components. I_1 is the current flowing in element 1 and I_2 is the current flowing in element 2. The angle ϕ corresponds to

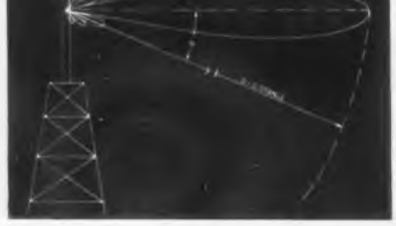


Fig. 1: Geometry of the vertical plane, illustrating the vertical pattern of an antenna

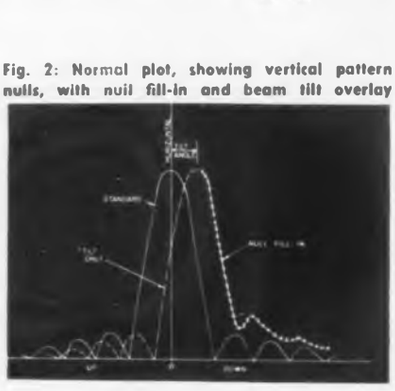


Fig. 2: Normal plot, showing vertical pattern nulls, with null fill-in and beam tilt overlay

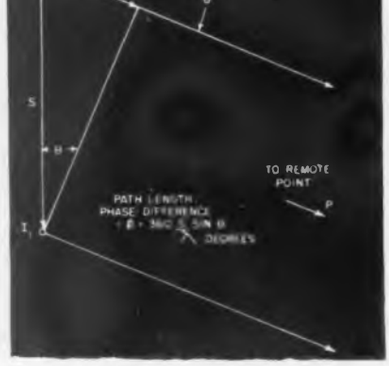


Fig. 3: Fundamental sketch of 2-element array

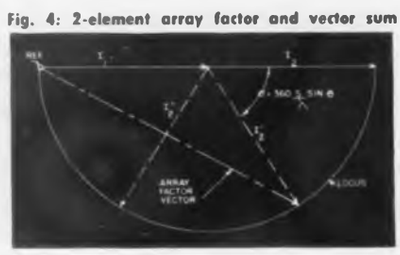


Fig. 4: 2-element array factor and vector sum

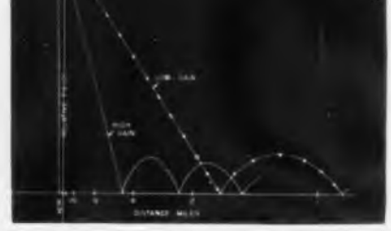


Fig. 5: Overlay of low-gain and high-gain antenna. Note nulls move to greater distance

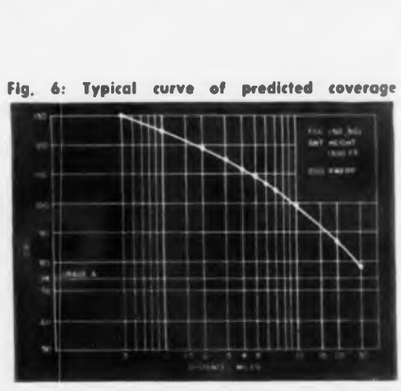


Fig. 6: Typical curve of predicted coverage

Patterns

the path length phase difference. The phase angle ϕ is a function of the angle below the horizontal, and equals [S sin θ/λ] 360 degrees where S is the element spacing. Fig. 4 shows how the sum of the vector components makes a locus which constitutes the amplitude and phase of the array factor. Note that when ϕ equals 180° the array factor passes through zero and gives a null. Nulls exist any time the locus passes through the reference. More complex graphical array factors will be shown later, and this point should be borne in mind.

Factors which may affect the pattern contouring required may be enumerated as:

1. The antenna gain.
2. The antenna height.
3. The transmitter power.
4. Terrain, and location relative to the principal area to be covered.

For example, let us consider antenna gain. If the gain of the antenna is increased the pattern nulls move farther away from the antenna. This effect is shown in Fig. 5. Also, of course, as the antenna height is increased, the nulls again move farther away from the antenna in proportion to the height.

Thus the combination of increased gain and increased antenna height, which is becoming more and more common practice today, leads to nulls becoming quite distant from the transmitting site. As this distance becomes greater, the effective signal level in the null naturally becomes lower. The amount of transmitter power being employed then becomes an important factor. The higher the transmitter power, the greater the relative depth of null which may be tolerated, since the total level of signal is increased.

Terrain effects enter in that the ground may slope away abruptly on one side and be relatively flat on the other side. A combination of electrical and mechanical beam tilting may be necessary to handle such a situation. In this way, a city lying immediately below the antenna may be covered by adequate signal, while a city on the flat side may also be covered.

Null Fill-In Required

A good place to start in trying to determine the amount of null fill-in required is from a typical predicted coverage curve based on FCC Propagation Data. This curve is shown in Fig. 6 for 200 kw ERP and antenna height of 1300 ft. For example, note that at a distance of 5 mi., a tolerable null depth of 34 db exists for grade A. Now, if the ERP is dropped by 10 db, for example, by using a 1 kw transmitter instead of a 10 kw transmitter, the needed null fill-in steps up in the same proportion, or 10 db more null fill-in to a level of 24 db is required. Now if the antenna were 470 ft. high, so that the most distant null fell at 1.8 mi., note that no more null fill-in would be required at 20 kw ERP than with the previous level of 200 kw ERP and the higher antenna. This shows the tie-in between antenna height, gain and transmitter power.

A typical graph of null location, made for the G.E. 4 and 5 bay UHF helical antennas is shown in Fig. 7. It is very simple to calculate the location of these nulls by placing certain conditions on the array factor. In some cases it may be desirable to estimate quickly where the nulls will fall. A quick rule of thumb method for the most distant null is to take the antenna gain times the antenna height. For example, with a UHF antenna gain of 25, and antenna height of 1,000 ft., the most distant null will fall at 25,000 ft. or almost 5 mi.

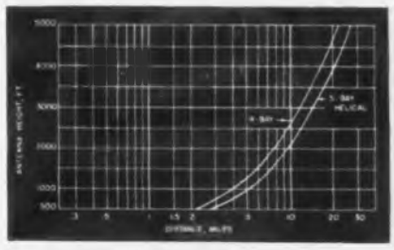


Fig. 7: Nul location for UHF helical antennas

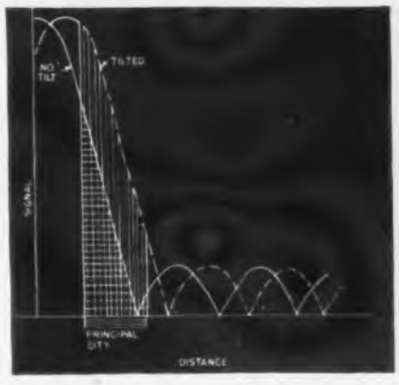


Fig. 8: Overlay of normal and tilted beam, showing effect on the medium distance area

Fig. 9: Two-element array factor showing the effect of amplitude to prevent null formation

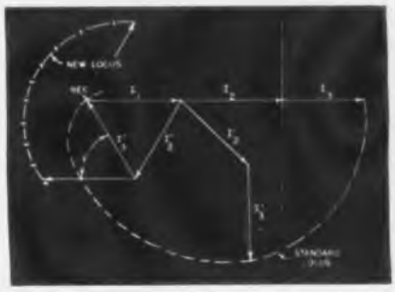
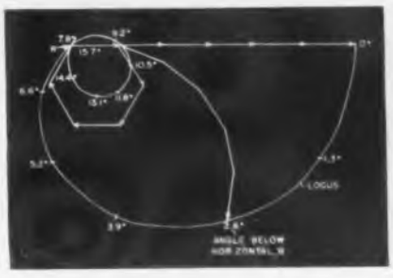


Fig. 10: Three-element array factor showing the effect of phase to prevent null formation

Fig. 11: VHF six-bay standard array factor



This rule of thumb method assumes that the antenna gain is close to the antenna aperture in wave lengths. Sometimes the gain is altered by feed line losses or other factors to a large degree. To obtain a more accurate estimate for such antennas, it may be desirable to use the antenna aperture in wavelengths times the height of the antenna. The actual simplified expression is $d = hns/m\lambda$, where h = antenna height, n = number of elements, s is elemtn spacing, λ = wavelength, m = number of null (the most distant occurring when $m = 1$), d is the distance and comes out in same terms as h.

Once we know where the nulls will fall and what ERP is to be transmitted, the amount of null fill-in required may be obtained. We arrive now at the problem of determining how to accomplish the filling of these requirements.

Beam Tilting

Beam tilting as such usually helps solve a high gain coverage problem in the medium distance range. Also, some beam tilting may be desirable for maximum range, since the horizon is depressed from the horizontal, the amount of depression increasing

with antenna height.

To demonstrate how beam tilting may solve the problem of covering medium distances, see Fig. 8. Note that without beam tilt, the area at a medium distance from the antenna may have large variations in signal across the area. However, by tilting the beam a small amount, this medium area may be brought up to a high level point on the beam without much variation in average signal.

Simple beam tilting is accomplished by the technique known as phase shift. In other words, uniform phase advance is put in each primary unit of the antenna array from bottom to top. In a two-element array, the maximum signal will occur at a distance below the horizon at that angle where ϕ is equal to the phase lead angle, gamma. The same principle applies to larger arrays.

It should be noted that phase shift on a two-element array will not produce null fill-in but only beam tilt. No matter what the relative phases are, the array factor locus will always pass through the reference, and produce a null. Even an antenna array comprising many elements may be broken into groups such that a total of only two groups may be operated on. For example, a 12-bay antenna might be broken into two groups of six, and each group of six may be represented as one primary element of the array. Then relative phase shift between these two groups will produce beam tilt but not null fill-in.

The actual amount of total deviation to be made from the standard pattern distribution, to secure a certain amount of null fill-in, may require a considerable amount of trial and error work. However, certain general principles do apply.

Previously, it was noted that null fill-in cannot be accomplished by using two-element array phase shift. However, by using relative amplitude deviations, null fill-in can be accomplished in a two-element array system. This is shown in Fig. 9. Note that with the currents in one element reduced as compared to that in the other, the array factor locus no longer passes through the reference. In a two-element array employing amplitude deviations, the degree of null fill-in may be observed immediately, as represented by the remaining vector as the locus crosses the axis at point A. The fact that the basic element may have nulls must be included in the overall picture.

Null fill-in can be accomplished by phase shift if more than two elements are used in the operation. The minimum basic array which may be employed to produce null fill-in by phase shift is three. The use of this technique is illustrated in Fig. 10. Note that with uniform phase and amplitude distribution, a null occurs when the three currents form an equilateral triangle causing the locus to pass through the reference point. Now, however, if the top current I_3 is given a phase lead, the array factor locus shifts a new patch which does not pass through the reference. No null will then exist in the region where one previously existed. Quite often, it may not only be the first or most distant null which is concerned, and then the array factor must be analyzed for a greater region. After making such an analysis, it may be found that a combination of amplitude and phase deviation may be desirable.

Generally speaking, the amount of fine control which may be achieved depends on the number of elements employed in the array. For example, to produce null fill-in by phase shift, say on a 12-bay antenna, the antenna must not be broken down to less than three elements of four bays each. Thus, the extension of these fundamental operations to larger arrays is possible, but may be time consuming in order to produce the results desired.

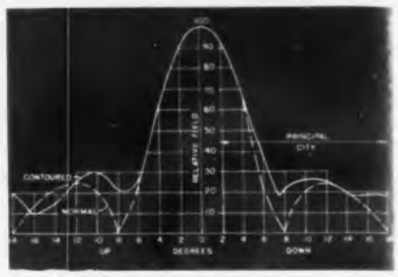


Fig. 12: VHF six-bay contoured pattern, showing range of principal city, with overlay

For VHF the highest gain antenna usually employed is the 12-bay super turnstile. In many cases, some contouring of the pattern of this antenna is desirable. However, before discussing contouring the 12-bay pattern, let us examine the well-known six-bay antenna. Even though this antenna is not of particularly high gain by present standard, there are some applications which make contouring of its pattern required.

The array factor of a standard six bay antenna is shown in Fig. 11. The degree marks located on the array locus correspond to degrees below horizontal. The complete array factor is not shown, since it would become quite crowded around the reference region, since the array factor circles through the reference point several times before again unwinding. As was the case with the previously discussed two-element array factor, every time the locus passes through the reference point, a null exists.

A particular application in Brazil called for a six-bay antenna, but with the principal city lying very close to the transmitting site in the range from 2° to 23° below the horizontal. Simple beam tilting alone could not handle this situation. Fig. 12 shows a standard six-bay pattern showing how this particular city lay almost completely in the null and side lobe region. The only answer here was contouring the pattern, as shown by the solid line.

For most applications of 12-bay antennas, only a small amount of fill-in of the most distant null is required. A very simple way to accomplish this is by 90° phasing of the top or bottom bay of the antenna. In order to illustrate the effect of such phasing, the applicable portions of the array factor are shown in Fig. 13. Note that 90° lag in the bottom bay shifts the reference point as shown on the slide. The array locus then fails to pass through this reference, and so null fill-in has been accomplished.

When such phasing is done, the 12-bay pattern undergoes a small

(Continued on page 138)

Fig. 13: VHF 12-bay array factor, standard and 90° phasing of the top or bottom bay

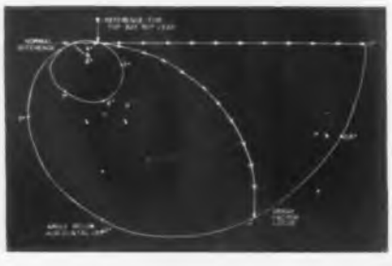
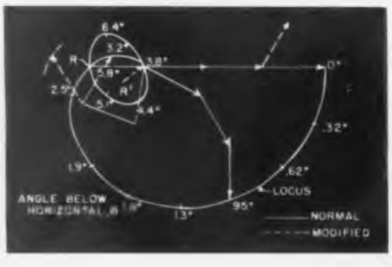
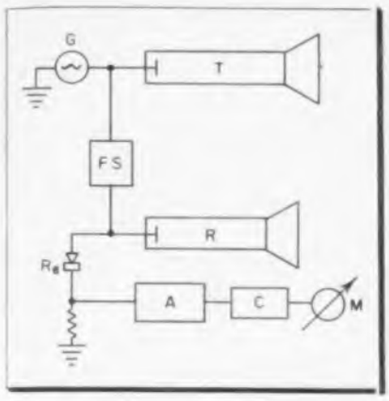


Fig. 14: Standard 4-bay UHF array factor. The angles on locus are those below the horizontal





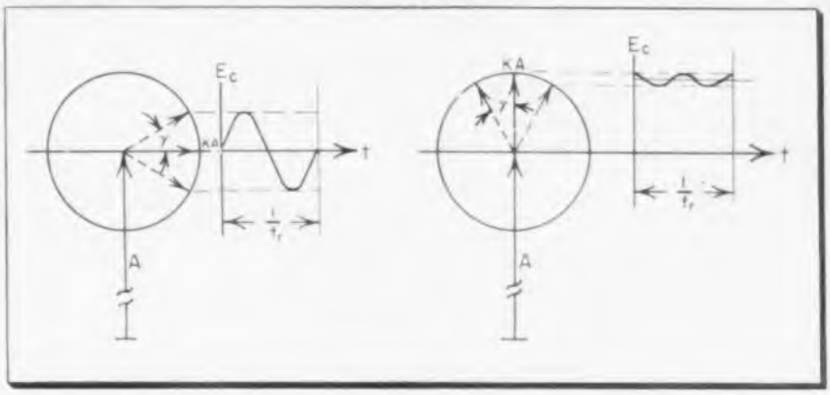


Fig. 1: (Left) Block diagram of FM altimeter. 10,000 MC FM generator (G); Transmitter (T); Phase shifer (FS); Ground signal receiver (R); Mixer rectifier (Re); Amplifier (A); Count averaging mechanism (C). Fig. 2: (Right) Vector representation of FM altimeter operation. Max carrier signal amplitude (A); Received signal (KA); γ distance above ground; fr is repetition frequency of transmitter.

Low-Level FM Altimeter

New NBS development enables helicopter operator to know position of craft within 2 ft. of landing surface

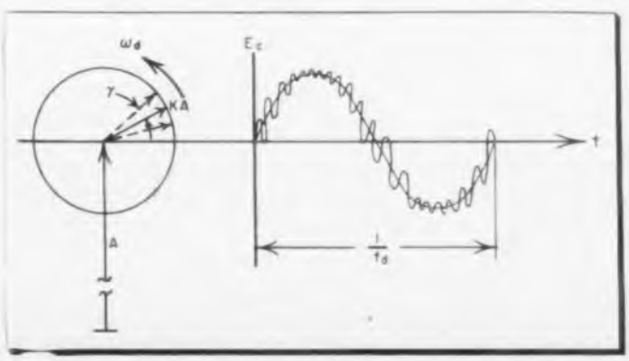
BY using appropriate frequency shifting and by modifying existing techniques for recognizing short-distance information, the National Bureau of Standards has developed an altimeter that will measure altitudes as low as two feet. This instrument, called the nonquantized frequency-modulated altimeter, was designed by H. P. Kalmus, J. C. Cacheris, and H. A. Dropkin as part of the Bureau's research in ordnance electronics. The NBS altimeter makes it possible, for instance, for a helicopter pilot to know when his craft is within several feet of the landing surface, whereas conventional altimeters give information only to the closest 10 or 20 feet. An operating frequency in the X-band of the radio spectrum (10,000 MC) facilitates the use of equipment and techniques resonably well established and technologically available.

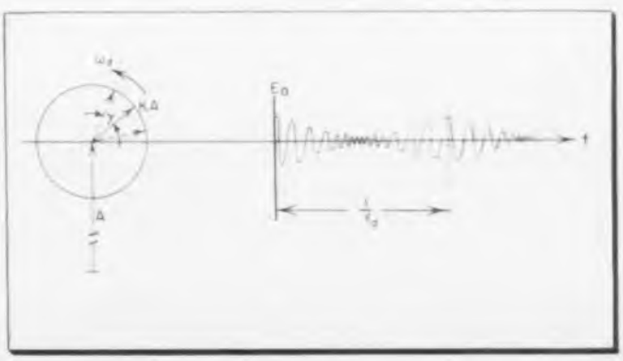
Most FM altimeters for aircraft generate high-frequency signals and direct the radio energy along a narrow path. When the radiated energy strikes a reflecting surface (the deck of a ship, for instance), it returns to the transmitter-receiver location essentially along the same path. Electronic circuits translate into feet or miles the period elapsed between the time the signal left the transmitter and the time it returned to the receiver. Ideally, the transmitter frequency of such an altimeter should be continuously variable, starting at zero frequency and continuing to higher and higher frequencies. The distance between the transmitter and the ground would then be computed electronically from the frequency difference between the received signal at one instant and the transmitted signal at that same instant. With such a continuously variable generator, the frequency of the received signal would always be lower than the transmitted signal by an amount dependent on the instantaneous distance from the ground.

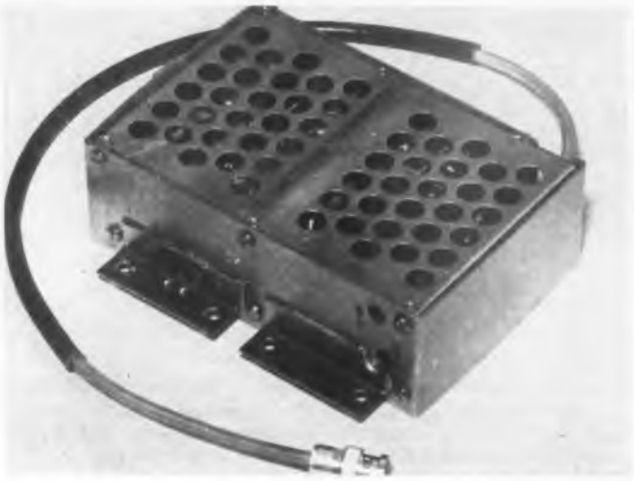
Because transmitters cannot be continuously varied between zero and an infinitely high frequency, altimeters in actual practice generate a relatively narrow band of frequencies and transmit this range at a recurring rate. The distance-dependent time delay between the transmitted and received signals still forms the basis for measuring altitude, but in conventional models the recurrence of like frequencies within short intervals introduces an error that prohibits the accurate detection of altitudes less than 10 or 20 feet. Furthermore, conventional altimeters operate under a quantized system, in which integral distances (10, 20, 30 feet) are added and the average over a period of time is a measure of the altitude of the transmitter. This system is efficient and accurate in the measurement of

(*Continued on page* 182)

Fig. 3: (Left) Detected signal of nonquantided FM altimeter incorporating an amplifier with a uniform frequency characteristic. Fig. 4: (Right) Detected signal of FM altimeter incorporating a circuit that filters out from the counter energy at frequency fd.







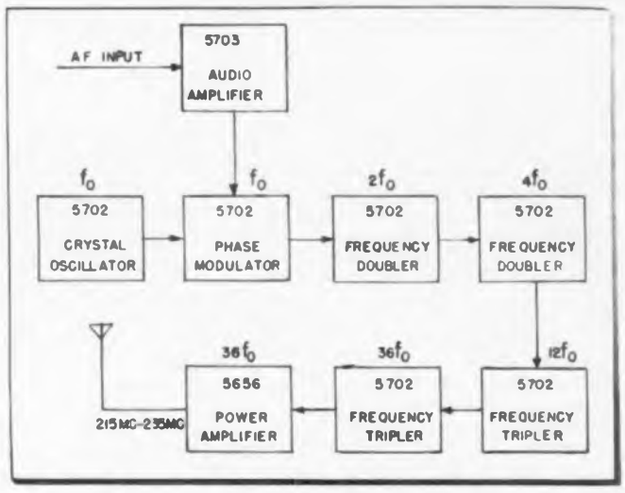


Fig. 1: (l) Crystal-controlled telemetering transmitter. Fig. 2: (r) Block diagram shows oscillator, modulator, multipliers and amplifiers

A Ruggedized FM

By R. G. SPANN, Sperry Gyroscope Co., Great Neck, L.I., N.Y.

TELEMETERING requirements have fostered the need for a transmitter with a stable carrier frequency, and one that would be reliable under rather severe conditions. Consistent operation with 100 g shocks, 50 g accelerations, vibrations of 2 to 10 g's in the frequency range of 10 to 500 CPS, and on ambient temperature range from −65°C to +90°C were required. Reliability was of utmost importance since the time consumed by weeks of preparation for one test run would have been lost by a transmitter failure.

As a start, all the commercial telemetering transmitters that could possibly fill the application were examined in the hope that one of them could be used. All had free running oscillators which allowed intolerable carrier drifts of up to 0.5MC. Their spurious sideband radiations were not within the FCC or military specifications. Distortion averaged around 5%. Their physical construction cast doubt upon their reliability under the required service conditions. Hence, it became apparent that it would be necessary to develop a new telemetering transmitter.

Subminiature Tubes Used

The unit shown in Fig. 1 is the final product. It is crystal controlled with a nominal power output of 2 watts and operates in the 215 MC to 235 MC telemetering band. Subminiature tubes are used throughout with the exception of the power output tube which is a miniature type. This unit has been produced on a large scale and has been used in a diversified number of applications. The carrier frequency changes are less than ±0.005% over a −20°C to +90°C ambient temperature range. The spurious sideband radiation is greater than 50 db down from the carrier level. The distortion, at a modulation index of 2.0, is less than 2.3% for any modulating frequency between 1500 CPS and 50 KC. The transmitter bandwidth is 3.1 MC. The unit is compact, measures about 5½ by 4 x 1½ in. and weighs 2 lbs.

A transmitter with these characteristics can be used advantageously for three general applications.

1. Applications that require several transmitters operating in the same telemetering band; for instance, where data are required from more than one mobile vehicle, or where more channels of data are desired than one transmitter is able to handle. Two or more transmitters would make it unnecessary to have complex switching of data on the sub-carriers.

2. Applications under rugged operating conditions; for instance, rockets, aircraft, or mobile applications over rough terrain.

3. Applications where dependability is paramount; for instance, in unattended telemetering stations, or projects in which weeks of preparation would be nullified on the test run by a transmitter failure. In an FM-FM system, failures can occur in the sub-carrier modulators and the greater portion of the data will still come through. However, if the transmitter fails none of the data channels are transmitted.

Fig. 2 is a block diagram of the circuit. The oscillator is a crystal controlled high impedance type circuit. The crystal frequency is approximately 6 MC and is multiplied 36 times to the carrier frequency by four frequency multipliers. The crystal now used has a stability of ±50 cycles/MC over a temperature range of −20°C to +90°C. If operation over a greater temperature range is desired, there are crystals now available that have the same frequency stability over a −55°C to +120°C.

Frequency Multiplier Chain

The frequency multiplier chain consists of four stages—2 doublers and 2 triplers—all double-tuned. The circuits have been stabilized against temperature changes by the use of compensating capacitors of the correct temperature coefficients. The use of several double tuned stages provides a dual advantage. First, spurious radiations are more effectively attenuated and second, the larger the multiplication factor used the less distortion obtained. The stages are adjusted by tuning for maximum grid drive at the succeeding stage. Test points are provided in the grid circuit of each stage and are so shunted that a standard dc milliameter with an internal resistance of 100 ohms can be used as a tuning indicator. The power output stage consists of a miniature type push-pull amplifier tube whose nominal power output is 2 watts, giving the transmitter a possible line of sight range of about 100 miles. The output signal is fed to an antenna by a 50 ohm coaxial cable.

The transmitter is phase modulated at the crystal frequency. The modulator is a standard circuit that

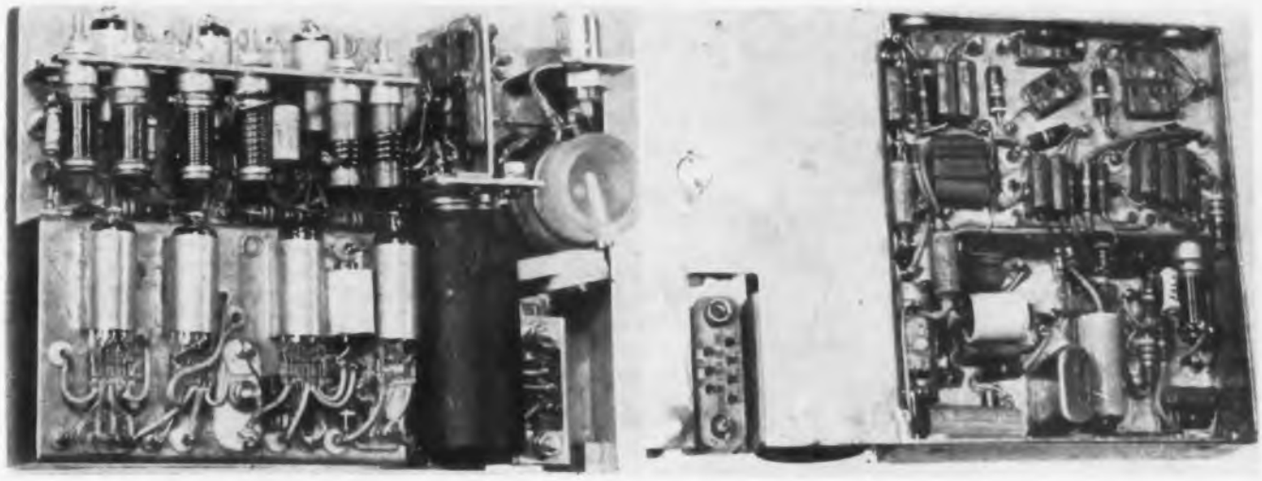


Fig. 3: (l) Top view of transmitter chassis. Note absence of terminal boards. Fig. 4: (r) Underside of chassis showing point-to-point wiring

Telemetering Transmitter

Crystal-controlled system designed to provide reliable operation over extreme range of shock, vibration and temperature. Examination of environmental conditions

has been modified so that large deviation values of the carrier will not increase the distortion to undesirable amounts.

The audio amplifier increases the amplitudes of subcarriers which are considerably attenuated by the subcarrier oscillator isolating resistances, to the level required by the modulator. This amplifier-modulator combination provides a modulation frequency range between 1500 CPS and 50 KC. It requires 0.02 v to give a modulation index of 2.0. The modulator input impedance is 10,000 ohms and 510 μμf.

Low Microphonic Noise

5702 tubes were chosen for the frequency multiplier stages in preference to other types because they produced low microphonic noise under vibration. A 6K4A and a 5703 were compared for the audio stage but the 5703 was superior microphonically. The 5763 and 5656 were both considered for the output tube. The 5673, rated at 2.83 watts at 175 MC, produced less than 1 watt at 219 MC however, and was discarded.

Fig. 3 shows the top side of the transmitter chassis. The components are mounted to glass-insulated feedthrough terminals on a 3-deck chassis. No terminal boards are used. The holders designed for the subminiature tubes provide for good shock mounting and good heat conduction. Located in order from left to right on the top deck are the audio, oscillator, modulator, and first doubler tubes. The lower deck contains the interstage coupling coils with their respective 5702 frequency multiplier tubes mounted beneath. The 5656 output stage is located to the left of the chassis. The tank coil is wound on the polystyrene cylinder to the left of the 5656 tube. Because of the high temperature developed a teflon insulated coaxial cable is used. For all uses where high shock and vibration are experienced the slugs are sealed in the coil forms after tuning and shafts of the coils are secured with a thermoplastic type cement.

Component location on the chassis was determined with the aid of a vibration table. Components were oriented or shifted and chassis resonant points damped in order to reduce vibration modulation to a minimum Many time-consuming changes that would have been discovered later in type tests of the pilot models were eliminated by this procedure.

Fig. 4 illustrates the underside of the transmitter. The crystal is located at a low temperature spot on the lower deck. Point to point wiring is used throughout. This chassis structure was favored over potted circuit techniques because the rugged and space saving advantages of potting were outweighed by the difficulty of manufacture, test, and repair, and by the uncertain dielectric properties of potting compounds at high frequencies.

The power supply requirements are relatively small. The B+ draws approximately 100 ma at 200 volts; filament 1.8 amps at 6.3 v. The unit continues to operate within specifications with plate and filament voltage changes of ±10% of their nominal values. These power characteristics make the unit adaptable to either conventional rectifier, dynamotor or battery type power supplies.

The transmitter is, upon completion of assembly, sprayed with a resinous coating, to provide a sealing against moisture and resistance to fungus. The units are then heat cycled three times between −20°C and +90°C in order to heat stabilize the the components before they are tested and tuned.

Test Unit Designed

To provide a rapid and consistent means of testing the transmitter, a test unit was designed which incorporates in one unit most of the equipment required. This telemetering transmitter test unit is shown in Fig. 5. It contains variable heater and B+ supplies, an r-f wattmeter, a carrier frequency meter, a modulation meter and an RF level meter. The test unit is built around a crystal controlled super-heterodyne receiver. The first limiter grid current is metered for the r-f level indication, the audio output is measured by a three range AC vacuum tube voltmeter calibrated in KC deviation, and the dc output of the discriminator is connected to a balanced dc vacuum tube voltmeter and is used to indicate any change in transmitter frequency. The transmitter output is fed to the r-f wattmeter and then through a 60 db attenuator to the receiver input. Meters are provided in order that the filament and

(*Continued on page* 160)

CUES for BROADCASTERS

Practical ways of improving station operation and efficiency

Monitor Amplifier

FOREST J. PINKERTON, Chief Engineer, WWOD, Lynchburg, Va.

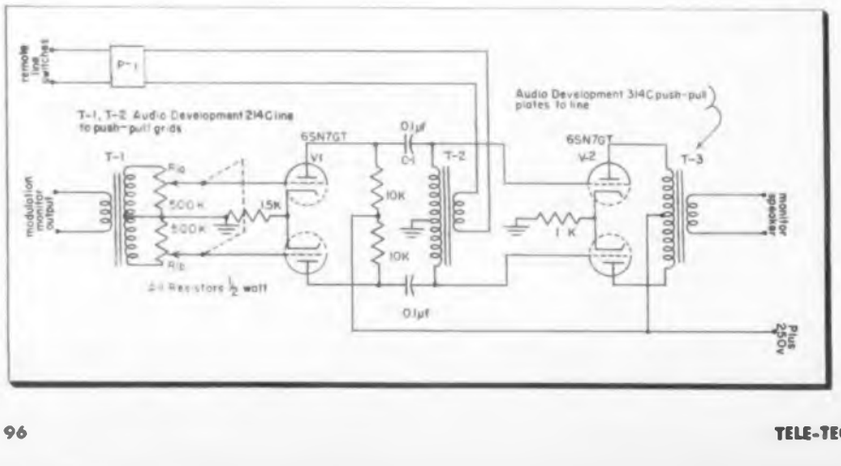
DURING the process of building new studios which included a new control board, a need was felt for a simple but effective monitor amplifier. The result was a very simple amplifier which included some novel features not found in most monitors.

This amplifier is fed from the station modulation monitor which has a fairly high level output, making high gain stages unnecessary. We wanted, through suitable switching, to be able to feed a program cue down any of our remote lines and, most of all, allow the remote operator to call into the control room at any time prior to a broadcast without any assistance from the studio operator. By using push-pull stages all the way and high quality transformers, a simple and efficient amplifier was constructed.

Transformer T-2 acts as a combination input, output and V-2 grid impedance. The remote lines, through their respective switches are connected to the 500 ohm side of T-2 through P-1, a 6 db pad. This pad may be changed to any value needed or a variable used. The program is amplified by V-1 and the output is sent down the remote line by T-2, giving the remote operator his cue. At any time he wishes to contact the studios, he merely opens his gain and talk into his microphone. This is fed back through T-2, into the grids of V-2, and is amplified with the program from V-1 overriding the program and calling the studio operators attention to the fact that the remote line is ready for a check.

Another feature is the simple and economical master gain control. This is the dual potentiometer R-1a and R-1b. This replaces the usual variable T or H pad in the input line and once set is left in that position. The speaker level in the control room is adjusted by means of an external line pad in the speaker line. The output is sufficient for all normal levels, and the quality leaves nothing to be desired.

Modulation monitor amplifier feeds remote cues and allows remote operator to call control room



Halo for the Tower

SAM LILES, Transmitter Supervisor, WPTF, Raleigh, N. C.

AN unusual type of TVI was experienced at WPTF when it was discovered that during periods of high humidity, corona discharge was taking place at the tops of our two directional towers. On modulation peaks in damp weather, TVI sufficient to cause vertical roll-over was noted at distances of *three or four miles.*

The cure was a ring of copper tubing supported on legs so that the copper ring just cleared the tops of the beacons. The halo ring also acts as a lightning protective device for the tower lighting system.

Conelrad Alarm

B. ALLEN, WINZ, Miami, Fla.

OPERATION of the Conelrad alarm system at WINZ is based on the principle that the receiver AVC is the triggering medium. Receiver sensitivity control (S-40B Hallicrafters) precedes the AVC, therefore it acts inversely on this alarm system; i.e. the lower the sensitivity setting, the more quickly the system reacts because the bias is correspondingly lower. The system may be adapted to perform satisfactorily with most receivers incorporating AVC.

Conelrad alarm triggered by receiver AVC

Fabricating Copper Line

L. B. DAY, JR., KVET, Austin, Tex.

A method for bending copper tubing was described in TELE-TECH (March '53, page 86) which advocated packing sand into the tubing. This is an excellent method but it also has several disadvantages. As the author mentioned, it is not successful with tubing over ¾ inch diameter. It is also inconvenient in that sand could be easily spilled into the equipment and it may be necessary to clean and dry tubing in which sand has been used.

Another method of preventing kinks while bending copper tubing is the use of inside or outside bending springs. While not very useful when bending steel tubing, or where heat must be applied, they can be used on practically all available sizes of soft, thin wall, annealed copper and aluminum tubing as well as bendable coax and "gas lines" to make extremely close neat bends.

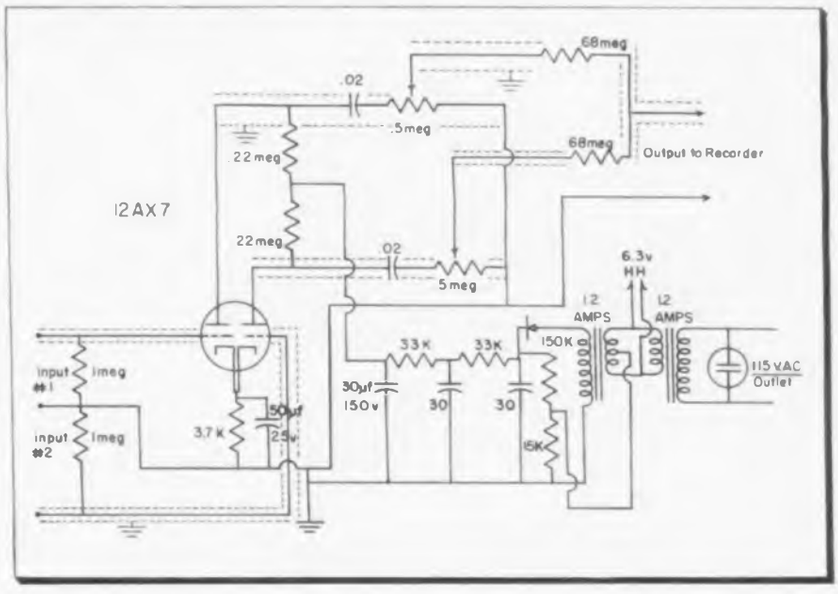
To obtain the necessary springs, determine the inside and outside diameter of the tubing or cable to be bent; then, determine the distance from the nearer end of any tube at which a bend will be made. For short pieces this will not matter, but on long lines it will indicate the need

for an outside spring since it would be impossible to retrieve an inside spring.

After the requirements of the job are determined, heavy close wound steel springs made especially for bending tubing may be obtained from practically any dealer in commercial refrigeration supplies and tools. Sometimes door springs may be used, but this will have to be determined experimentally. The proper spring should fit very closely, but slip freely in, or on, the tubing to be bent.

Actual bending is accomplished by placing the spring inside or outside of the tubing at the point at which the bend is to be made and bending to shape, the coils of the spring maintaining the round cross section of the tubing while it is bent. If there is a choice of springs, the inside spring should always be used as it provides more support, but this is not always possible.

After the tubing is bent, the spring must be removed and this is frequently difficult. Removal can be expedited by twisting the spring in a direction which increases or decreases its diameter. When this fails, a spring can usually be freed by bending the tubing more than desired and then straightening it to the desired shape.



Circuit of small mixing preamp for remote recordings. Isolation and filtering eliminates hum

Small Preamplifier for Remote Recordings

ELLIOTT FULL, Chief Engineer, KXIC, Iowa City, Iowa.

FOR several years, KXIC has recorded and rebroadcast portions of monthly city council meetings. These recordings, unfortunately, were seldom satisfactory as our reporter did not have adequate gain or the proper number of mike channels on his non-professional, portable recorder to do the job correctly. The problem was: How to get good recordings without loading him down with expensive and heavy professional equipment, mixer box, mike extension, etc.

We solved the problem by using a small mixing pre-amp permanently located in the city hall council chambers. The pre-amp is housed in a miniature utility cabinet with an attached chassis measuring 4" x 5" x 3".

The filament transformers are located on the back of the cabinet. The output cord is about eight feet long and is equipped with a plug that connects into the tape recorder microphone input.

Almost complete hum elimination is achieved by isolating the line, ample shielding, positive filaments, and adequate filtering. Separating the two transformers from the circuit by locating them outside the cabinet also helps.

The bad acoustics of the council chambers are still with us, but this little unit has completely overcome our earlier recording troubles.

Stand-by AC Power for Remote Amplifiers

EMANUEL FARBA, Chief Engineer, WNEX, Macon, Ga.

MOST of the smaller stations have little need for a remote amplifier that will automatically switch its operation to batteries should the AC power lines fail. However, sometimes an important remote is scheduled and such a power supply is needed in a hurry. Because we had a 6v. dc to 110v. ac vibrator in stock we used the circuit shown in the diagram. It is inexpensive and quite reliable. A car battery can be used for the 6v. supply. The vibrator which is very noisy should be placed a good distance from the microphone and amplifier.

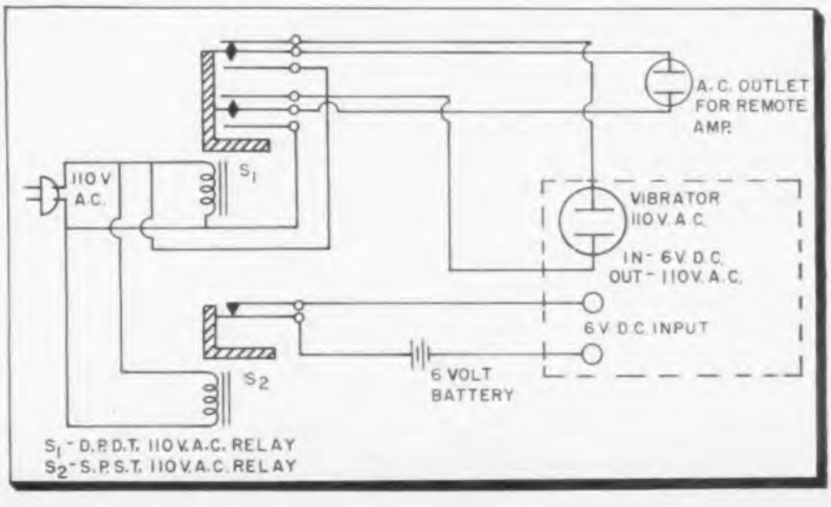
Locating DA Faults

RUSSEL GRAMBSCH, Chief Engineer, WOSA, Wausau, Wis.

ON a directional array it is sometimes difficult to locate the fault, when the system goes bad, because of mutual between towers. In fact it may be hard to decide which tower circuit is faulty. WOSA is a 5 KW, DA-2 with the antenna circuit as

(*Continued on page* 114)

Standby power for remote amplifiers obtained from vibrator operating from car battery



Electronic Power for

Fig. 1: R-F supply system can cover both proton and deuteron ranges with minor adjustments

By LESTER KORNBLITH, Jr., Chief Engineer, Institute for Nuclear Studies, University of Chicago, Chicago 37, Ill.

THE synchrocyclotron is a development by McMillan[1] of the original cyclotron of Lawrence and Livingston,[2] in which the energy attainable by the particles being accelerated is greatly extended.

In the cyclotron, ions are accelerated in an evacuated space between the poles of an electromagnet. They are constrained to move in circular orbits by the uniform magnetic field in which they find themselves and are accelerated by the electric fields which they encounter in the course of their motion. These electric fields are applied between two hollow semi-circular electrodes, called "dees," located in the pole gap. With proper adjustment of the frequency of the electric field the ions continue to gain energy and radius with each revolution and will spiral outward until their maximum energy is reached near the periphery.

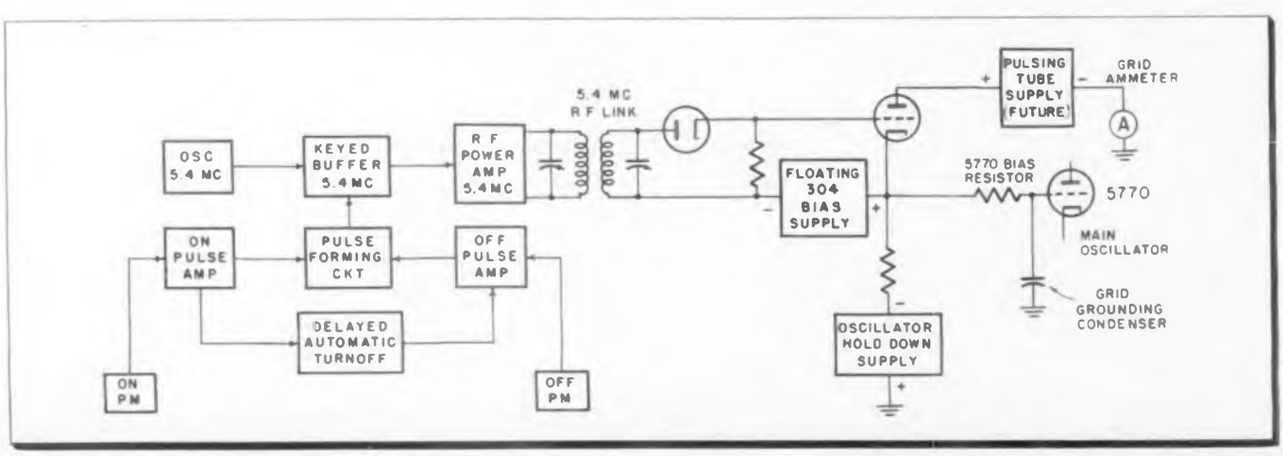
The operation of the conventional cyclotron depends upon the fact that, for nonrelativistic velocities, the time of flight of an ion around an orbit in a uniform magnetic field is independent of the energy of the ion and the frequency required for accelerating the ion is constant. This condition holds until the effect of the relativistic increase in mass becomes important. At this time the necessary synchronism between the frequency of rotation of the ions and the frequency of alternation of the electric field is lost. This condition occurs at about 25 million electron volts for protons.

McMillan's idea, which had been proposed independently by Veksler[3], was that synchronism could be maintained by decreasing the frequency as the particle was accelerated and was moving on orbits of increasing radii. The motion of the particles has the property of phase stability, which makes the idea a practical one. Because of this stability the rate at which the frequency is altered is not critical.

The synchrocyclotron which we are considering is the 170-inch machine of the Univ. of Chicago.[4] In this machine the central field is 18,600 gauss, and protons begin their acceleration when the frequency is 28.4 MC. As this frequency is decreased, the protons gain in energy and move outward in radius until the frequency reaches 18.2 MC. The protons then have an energy of 450 million electron volts and are at radius 76 in., magnetic field 17,600 gauss. The cycle is completed in about 3 milliseconds and is repeated 50 or 60 times a second. During this cycle the particle travels about 300 miles. The protons, at the end of their acceleration cycle are normally caused to strike some sort of target, causing nuclear transformations with their accompanying radioactivities.

The principal items which will be discussed are the r-f supply system providing the electric field for acceleration, the magnet current

Fig. 2: Pulser system turns oscillator on during those portions of the FM cycle which are actually required for particle acceleration



a Synchrocyclotron

Growing importance of electronic devices in nuclear field illustrated by detailed description of pulsed FM oscillator using rotating capacitor. Current regulator and remote servo indicator circuit design and performance discussed

regulator for providing constant magnetic field and equipment for monitoring the output of the machine.

R-F Supply System

The requirement on the r-f system (Fig. 1) is that it supply to the dee a voltage of the proper frequency and of as large a magnitude as possible. In the 170-inch machine a single dee is used, the other dee being represented by a grounded dummy dee. The dee, which is approximately semi-circular, is 164 in. in diameter and looks like a transmission line of about 6 ohms. The dee voltage is of the order of 10 to 15 kv, which is sufficient for a repetition rate of 60 per second.

The frequency range required for the acceleration of protons is 28.4 – 18.2 MC. The machine was originally designed so that with minor switching operations the frequency range of 14.2 – 11.8 MC could also be covered to allow acceleration of deuterons. Subsequent experience has shown that, by making certain internal readjustments in the system, better operation for protons could be attained at the sacrifice of the deuteron range. Since the demand for deuterons was small, these changes were made. The system can be changed back to deuteron operation in one or two weeks time. The actual frequency range covered is from about 28.8 to about 17 MC.

The basic design of the r-f system is identical with that developed by MacKenzie for the same use at the Univ. of Calif.[6,6,7] This system has several advantages over most of the many other possible systems: It is inherently capable of covering both the proton and deuteron ranges with minor adjustments; the rotary condenser is located at a point of low magnetic field; and dc bias for the dee to avoid ion loading is easily provided.

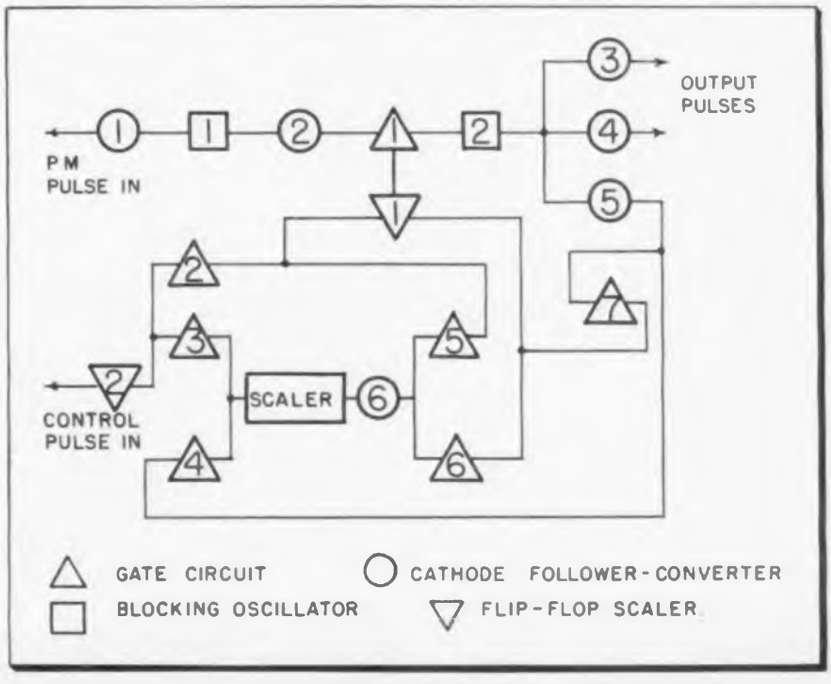
In this system the dee is connected to a rotating condenser through a section of transmission line. The other side of the condenser is connected to ground through a transmission line stub. It is possible to proportion the dimensions of the whole system so that it behaves like a uniform transmission line, shorted at one end and open at the other, with the rotating condenser inserted at a point about one-third of the way from the shorted end. This system will resonate at a frequency which depends upon the capacity of the condenser. The minimum frequency is approached as the capacity of the condenser becomes very large and the system behaves as a resonant quarter wave line. As the capacity approaches zero the system behaves as a three-quarter wave line with a 180° phase shift at the condenser. The theoretical ratio of maximum to minimum frequency thus is three.

In practice, the attainable ratio is appreciably less than three. This is mainly because of the finite capacity limits of the rotating condenser and the difficulty of arranging an efficient coupling to the oscillator tube over such a wide frequency range. The coupling for the tube is designed to avoid undesired modes of oscillation of the system. A particularly troublesome parasitic mode is a three-quarter wave mode which places no voltage across the condenser. In this mode the condenser has no control over the frequency at which the system resonates; since the condenser losses do not appear, this mode has a higher Q than the proper mode. If the condenser losses are excessive, the condenser can behave as a mode selector, tending to favor the incorrect mode. For this reason the condenser must be designed to have as small a loss as possible.

Oscillator Tube

The oscillator tube is coupled across the condenser through long high impedance lines, so designed that the excitation phase is incorrect for the ¾-wave untunable mode. The tube is operated grounded-grid, to take advantage of the inherent freedom from oscillator parasitics which this type of operation can afford. The oscillator excitation is thus supplied to the cathode, which must be driven in phase with the anode. The cathode is indirectly coupled by means of a loop suspended inside the dee to induce a voltage which, transformed through a long line, drives the cathode with enough amplitude in the proper phase. Because of the resistive component of the drive impedance, the actual phase must be corrected by capacity loading of the cathode. The anode is coupled directly by means of a long line which is connected in

Fig. 3: Pulser controller provides means for operating at other than normal 50 or 60 pps



SYNCHROCYCLOTRON (Continued)

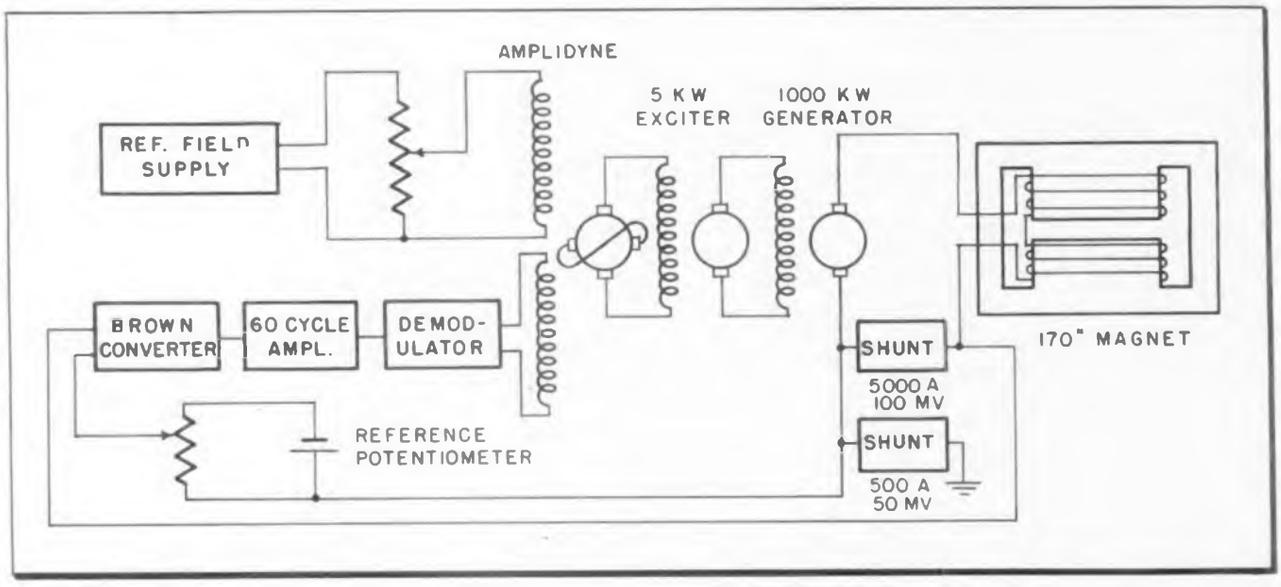


Fig. 4: Magnet current regulator employs voltage from shunt bucking against reference pot. Difference voltage is utilized to control current

parallel with the stub line. These arrangements are shown in Fig. 1.

The resonant system, consisting of the dee and its line and condenser stator, the rotor, and the grounded stub line and its stator, is all suspended and operated in vacuum. The dee is 164 in. across the tip, and it and its line are of such length that the rotary condenser shaft is 157 in. from the center of the magnet. The rotor of the condenser, which is 18½ in. in diameter and about 4 feet long, has 6 rows of blades with 85 blades in each row. It was machined out of a solid steel forging and then copper plated. The rotor blades mesh with stator blades to leave a minimum gap of 0.110 in. This gives a total design capacity of 3600 μμf. At the present time the machine is being operated with the stators retracted as far as possible, increasing the gap and decreasing the area, and thus decreasing the maximum capacity and increasing the amount of rotation required to cover the proton frequency range. The effect of this change is to increase the duty cycle for acceleration and thus allow increased repetition rates and substantially increased output from the machine. A spare set of stators is now being fabricated incorporating an adjustable number of smaller blades so that this effect can be fully exploited. The stub line is of the same width as the rotor and has a length determined by the position of two shorting bars.

The dee is an aluminum framework covered with water-cooled copper skins. This structure is cantilevered from its rear supports, which consist of one vertical rod pulling down and two rods pulling up and outward. Two additional rods pulling back (towards the condenser) and slightly downward provide stability against motion toward or from the magnet. These rods are necessary to resist eddy current forces produced when the magnet current is changed. Three rods support each of the two rotor bearing blocks.

(*Continued on page* 186)

Automatic Picture Tube Metallizing Unit

VIRTUALLY automatic production of the vacuum-metallized coating on the inner surface of TV picture tubes can be achieved with a new self-contained unit developed by the F. J. Stokes Machine Co. All valve, pump and switching functions are controlled by a standard sequence-type electrical timer.

In operation, a piece of aluminum ribbon is placed on the stranded tungsten filament spanning the gap between two electrodes (Fig. 1). The uncoated tube is automatically lowered into the unit, the operator pushes one button to start the timer (Fig. 2), and pays no further attention to it until the operation is finished.

(*Continued on page* 179)

Fig. 1: Aluminum strip is placed on tungsten filament before uncoated tube is positioned

Fig. 2: Pushing button starts automatic operation. Flashing current preset by rheostat

IRE Professional Engineering Groups

A capsule summary of the membership segments functioning in 21 specialized fields of electronic engineering.

AERONAUTICAL AND NAVIGATIONAL ELECTRONICS —1,411 members—Dr. K. C. Black, Chairman . . . next major meeting May 10-12 at National Airborne Electronics Conference in Dayton, Ohio . . . The application of electronics to operation and traffic control of aircraft and to navigation of all craft.

ANTENNAS AND PROPAGATION—1,221 Members —P. S. Carter, Chairman . . . next major meeting May 3-6 at URSI-IRE Spring Meeting, Washington, D. C. . . . Technical advances in antennas and wave propagation theory and the utilization of techniques or products of this field.

AUDIO — 2,164 Members — M. Camras, Chairman . . . next major meeting Oct. 4-6 at National Electronics Conference, Chicago, Ill. . . . Technology of communication at audio frequencies and of the audio portion of radio frequency systems.

BROADCAST AND TELEVISION RECEIVERS—1,124 Members—E. I. Anderson, Chairman . . . next major meeting April 24, 8th Annual Spring Technical Conference, Cincinnati, Ohio . . . The design and manufacture of broadcast and television receivers and components and related activities.

BROADCAST TRANSMISSION SYSTEMS—665 Members—L. Winner, Chairman . . . next major meeting October, Fourth Annual Broadcast Symposium, Philadelphia, Pa. . . . Broadcast transmission systems engineering, including the design and utilization of broadcast equipment.

CIRCUIT THEORY—2,187 Members—Dr. C. H. Page, Chairman . . . design and theory of operation of circuits for use in radio and electronic equipment.

COMMUNICATIONS SYSTEMS—738 Members—Col. John Hessel, Chairman . . . next major meeting April 28, IRE-AIEE Symposium on Military Communications Systems, New York, N. Y. . . . Radio and wire telephone, telegraph and facsimilie in marine, aeronautical, radio-relay, coaxial cable and fixed station services.

COMPONENT PARTS—394 Members—F. A. Paul, Chairman . . . next major meeting May 4-6, Electronic Components Symposium, Washington, D. C. The characteristics, limitations, applications, development, performance and reliability of component parts.

ELECTRON DEVICES — 1,097 Members — Dr. L. S. Nergaard, Chairman . . . next major meeting Oct. 18-20, IRE-RETMA Radio Fall Meeting, Syracuse, N. Y. . . . Electron devices, including particularly electron tubes and solid state devices.

ELECTRONIC COMPUTERS—2,267 Members—J. H. Howard, Chairman . . . next major meeting December, Eastern Computer Conference . . . Design and operation of electronic computers.

ENGINEERING MANAGEMENT—1,276 Members—Gen. T. C. Rives, Chairman . . . next major meeting Oct. 4-6 at National Electronics Conference, Chicago, Ill. . . . Engineering management and administration as applied to technical, industrial and educational activities in the field of electronics.

INDUSTRIAL ELECTRONICS—854 Members—Dr. E. Mittlemann, Chairman . . . next major meeting Annual Industrial Electronics Conference, Cleveland, Ohio . . . Electronics pertaining to control, treatment and measurement, specifically in industrial processes.

INFORMATION THEORY—1,166 Members—Dr. W. G. Tuller, Chairman . . . Information theory and its application in radio circuitry and systems.

INSTRUMENTATION—1,988 Members—I. G. Easton, Chairman . . . next major meeting September, 1st International Instrument Conference, Philadelphia, Pa. . . . Measurements and instrumentation utilizing electronic techniques.

MEDICAL ELECTRONICS — 702 Members — L. H. Montgomery, Jr., Chairman . . . The application of electronics engineering to the problems of the medical profession.

MICROWAVE THEORY AND TECHNIQUES — 1,184 Members—A. G. Clavier, Chairman . . . next major meeting May 3-6 IRE-URSI Spring Meeting Symposium on Millimeter Waves . . . Microwave theory, microwave circuitry and techniques, microwave measurements and the generation and amplification of microwaves.

NUCLEAR SCIENCE—236 Members—Dr. L. V. Berkner, Chairman . . . next major meeting Oct. 6-7, 1st Annual Conference, Chicago, Ill. . . . Application of electronic techniques and devices to the nuclear field.

QUALITY CONTROL—480 Members—L. Bass, Chairman . . . next major meeting Nov. 12-13 National Symposium on Quality Control, Hotel Statler, N. Y. Techniques of determining and controlling the quality of electronic parts and equipment during their manufacture.

RADIO TELEMETRY AND REMOTE CONTROL — 826 Members — M. V. Kiebert, Jr., Chairman . . . next major meeting May 24-26 National Telemetering Conference, Chicago, Ill. . . . The control of devices and the measurement and recording of data from a remote point by radio.

ULTRASONICS ENGINEERING—101 Members—A. L. Lane, Chairman . . . next major meeting Oct. 4-6 National Electronics Conference, Chicago, Ill. . . . Ultrasonic measurements and communications, including underwater sound, ultrasonic delay lines, and various chemical and industrial ultrasonic devices.

VEHICULAR COMMUNICATIONS—596 Members—W. A. Shipman, Chairman . . . next major meeting Sept. 30-Oct. 1, 5th Annual Meeting, Houston, Texas . . . Communications problems in the field of land and mobile radio services, such as public safety, public utilities, railroads, commercial land transportation, etc.

(See also "A Roster of Associations in the Electronic Industries," Section 2, this issue)

New Products at

Previews of new equipment and what

Booth 145 **Analyzer**

The Models MRFR 30-1 and MRFR 30-2 spectrum analyzer contains many narrow gates, or filters adjacent in frequency that cover any desired spectrum. The signal to be analyzed is fed to all the filters simultaneously, and each filter

output is applied to the stator of a capacitance communtator. When scanned by the rotor, this yields the output of all the filters in frequency sequence. Maximum sensitivity is attained by high-Q manetostriction rods as filters. **Raytheon Manufacturing Co., Equipment Engineering Div., 148 California St., Newton 58, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES.

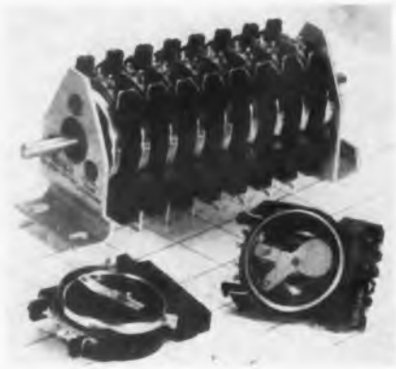
Booth 216 **Noise Figure Meter**

The Model NFT transistor noise figure meter eliminates manual step-by-step adjustment of noise reference sources, switching from internal to external source, and monitoring of output levels. Accomplishing this process automati-

cally many times per second obtains a continuous direct reading of noise figure which reduces measurement to a simple meter reading. Noise figure is measured in accordance with IRE standards, one cycle band width at 1,000 cps. **Electronic Research Associates, P.O. Box 29, N. Caldwell, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 226 **Potentiometer**

The RVBC 1⅝ in. plug-in potentiometer combines "unitized" construction with plug-in mountings. The entire plug-in ganged assembly or an individual section can be removed and replaced. Plug-in units are supported on



front and rear brackets, though units are also available in servo type mountings. Dual loaded ball bearings and the unique design of the crank-arm and coupling-pin assembly minimize torque and radial shaft play, and reduce backlash. **Technology Instrument Corp., 531 Main St., Acton 54, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 233 **Aluminizer**

The inline system of "aluminizing" TV picture tubes, called the "Aluminizer," consists of twenty self-contained vacuum pumping carts, each of which accommodates a picture tube and a single locomotive. A stationary type "Aluminizer," consisting of from one to four carts is used for pilot plant opera-

tions and can be converted to the inline system when additional capacity is needed. The stationary, or bench type unit is suited for color TV tube leak-checking without major alterations. Cycling is automatic. **Consolidated Vacuum Corp., 735 Ridge Road West, Rochester 3, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 248 **Amplifiers**

The hp-Models 490A and 491A traveling wave amplifiers provide complete "S" band frequency coverage, large power output, high gain, and μsec pulse modulation. Being broad band linear devices they can be connected to

the output of signal generators to provide signal and modulation information at a greatly increased power level. They are also suitable as a broad band r-f amplifiers for receiver and detector applications. **Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif.**—TELE-TECH & ELECTRONICS INDUSTRIES.

Booth 261 **TV Camera System**

The "Kay-Lab" TV camera system comprises the camera, camera control, and synchronizer monitor. The small, light, camera consists of a vidicon pick-up tube operated with an 8 MC bandwidth cascode pre-amplifier. Electrical adjustments can be made remotely at

the camera control which consists of an 8 MC video amplifier, horizontal and vertical deflection chassis, and a power supply. Up to 500 ft. of cable can be used between camera and control unit. **Kalbfell Laboratories, Inc., P. O. Box 1578, 1090 Morena Blvd., San Diego 10, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

the IRE Show

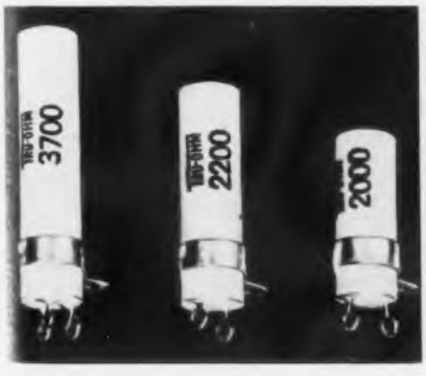
exhibits will display at the convention

Booth 323 **Pulse Height Analyzer**

The Model 520 twenty-channel differential pulse height analyzer was designed primarily to analyze the pulse-height spectrum obtained from nuclear particle detectors. It is useful, however, to study other phenomena where events can be expressed in terms of electrical pulses of various amplitudes. Basically, the unit consists of a linear amplifier, an "expander" or "window amplifier," a pulse lengthening circuit, and twenty-one pulse-height discriminators—twenty of which are followed by an anti-coincidence and scaler-drive circuit, a scale of sixteen, a register drive, and an electro-mechanical register. There are also two scales of 256 with registers to record the "total" and "surplus" count. All 22 scalers and registers are reset electrically from one push button control. **Atomic Instrument Co., 84 Massachusetts Ave., Cambridge 39, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 444 **Resistors**

The "Stand-Ohm" resistance units, made for top of chassis mounting to remove a high heat source from the critical components area, are integrally bracket-mounted to aid in heat conduction to the chassis. In turn, the chassis radiates the heat and affords cooler overall operation. Wound with high grade resistance wire on a flat ceramic core, heavier gauge wire can be used. The wound core is coated with silicone cement and inserted into a ceramic tube that is filled with silica and sealed with silicone cement to exclude moisture



from the winding. The units are supplied in 10, 15, 20, and 25 w. ratings in 1½, 2, 2½, and 3 in. heights, respectively. All are $1^{9}/_{32}$ in. in diameter and fit in a ⅝ in. chassis cutout. **Tru-Ohm Products, Div. of Model Engineering & Mfg. Inc., 2800 N. Milwaukee Ave., Chicago 18, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 445 **Connector**

The QWIK microphone connector is a bullet-shaped, streamlined unit that is smaller than other models and designed to be operated by one hand. The dielectric is the "Amphenol Blue 1-501 material approved under government specifications. Shell bodies are satin nickel finish zinc alloy. Buttons used to connect or disconnect mating parts are of "Tenite" and operate by thumb pressure. **American Phenolic Corporation, 1830 South 54 Ave., Chicago, Ill.**—TELE-TECH & ELECTRONICS INDUSTRIES.

Booth 574 **Switches**

The "17AS" series of subminiature rotary selector switches enable switching as many as eight different circuits with one compact assembly. With from two to eight switching units and from two to eight detent positions—with a 45° angle beween detents—virtually any switching sequence is possible. The eight-switch assembly requires only a $1\text{-}^{17}/_{64}$ in. diameter mounting surface. Overall length is less than four inches. In the eight-switch assembly, four switches can be wired normally-open and seven normally closed, etc. The switches are rated for an inductive load of 3 a. at 30 v. dc. and 10 a. at 125 or 250 v. ac. **Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 463 **Relay**

The "Series OCS" relay is an adaptation of the Automatic Electric Type 44 rotary stepping-switch mechanism that provides means for using every pulse,

every second pulse, or every *n*th pulse to perform a series of operations in a planned sequence. The unit can be used as a relay to replace latch-in type relays where shock and vibration requirements of MIL-R-6106 have to be met. **Automatic Electric Co., 1033 West Van Buren St., Chicago 7, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 532 **Plastics**

The Herbert oxy cold bar demonstrates how various grades of "Synthane" products are combined with entirely different materials. Used as an electrical static eliminator that supplies a safe source of high voltage electricity

to neutralize static charges during the processing of paper, plastics, paper, etc., the unit combines three grades of "Synthane" with a thermoplastic bar, an aluminum bar, and copper emitter points. The bar is made from Grade XXX tube stock; the brackets from Grade XX black sheet stock. The end connector is Grade C black, and the end plugs are Grade XX black. **Synthane Corp., Oaks, Pa.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 704 **Camera Chain**

The Model UK-1A photoconductive camera chain includes camera with cables, friction head and dolly, camera control monitor, and synchronizing generator. The camera employs elec-

tronic viewing and a 7-inch direct view screen. All controls except mechanical focus are located on the illuminated control panel below the screen. Can be mounted by one man on any standard tripod or dolly. **Electronics Division, Willys Motors, Inc., Benore Road, Toledo 1, Ohio.**—TELE-TECH & ELECTRONIC INDUSTRIES.

IRE Show Exhibits

Previews of the latest electronic equipment that

Booth 130 **Aircraft Electronics**

Complete line of receivers, transmitters, and mobile units, with accessories. Glide slope receiving antennas, omnimag indicator and distance-measuring equipment. **Bendix Radio.**

Booth 145-149 **Tubes and Radar Components**

Complete line of diffused junction transistors, subminiature tubes, and germanium diodes. Also miniature differential, servo motor, one-way transmission lines (gyrators), bridge rectifiers, miniature rate gyro and accelerometer, and radar altimeter. New products include spectrum analyzer, magnetrons, magnetic shift register and hydraulic servo valve. **Raytheon Mfg. Co.**

Booth 174-196 **Magnets**

Magnets for electronic and automotive industries, featuring application to suspension, driving, braking and torque control. Thermistor demonstration unit. Line of barium oxide magnets and aluminum-clad magnets. **Carboloy Dept. of G. E.**

Booth 185-187 **Graphic Recorders**

Electronic recording equipment for monitoring operations in industry. Three channel recorder plots time vs. occurrence on eight-day tape. **Alden Electron and Impulse Recording Equip. Co.**

Booth 191 **Recording Paper**

Electrosensitive, smudge-proof paper for use in Alden and similar recorders, with special application to facsimile techniques. **Alfax Paper and Engineering Co.**

Booth 193-195 **Antennas**

Microwave, UHF-TV, and communications antennas, featuring new passive reflector and mount for microwave relay systems. Also demonstrated—a simplified mount for 2000 MC offset parabolic feed. **Gabriel Electronics Div.**

Booth 204 **Microwave Meter**

Microwave multiplier measures and generates frequencies from 500 to 10,000 MC. This new device requires stable driving source. Also, VHF interpolator for 20 to 1000 MC, and VHF frequency meter with accuracy and stability of 0.001%, covering 20 to 640 MC. **Gertsch Products, Inc.**

Booth 210 **Meters**

Test instruments for magnetic measurements, featuring rotating coil gasmeters and fluxmeters. Line of precision laboratory ac and dc meters, and sine-cosine potentiometers for radar and computer design. **Rawson Electrical Instrument Co.**

Booth 216 **Test Equipment**

Line of transistor test equipment and miniaturized power packs. Audio frequency transistor amplifiers for PA and intercom use. **Electronic Research Associates.**

Booth 233-235 **Tube Mfg. Equip.**

New rotary tube exhaust machine for manufacture of miniature tubes and 4-unit stationary aluminizer for TV picture tubes. Complete line of vacuum gauges. **Consolidated Vacuum Corp.**

Booth 242-244-246 **Test Equipment**

Complete line of VHF and UHF signal generators for color and B&W. Also, crystal controlled decade-switched oscillator covering 100-500 MC, complete radar noise figure measuring equipment, and radar-type receiver with 30 MC i-f for low level microwave measurements. **Kay Electric Co.**

Booth 273-275 **Tubes**

Among tubes for communications uses are miniature twin tetrodes featuring low drain for mobile use, and ruggedized triode. Other features include point-contact transistors, power-frequency-application power tube chart, and rectifiers, thyratrons and ignitrons for control uses. **Amperex Electronic Corp.**

Booth 368 **Capacitors**

Line of bonded plastic capacitors and line of subminiature metallized paper capacitors designed for operation over temperature range —55° C. to 125° C. Also, miniaturized r-f noise suppression filters. **Astron Corp.**

Booth 373 **Microwave Accessories**

Samples of Mitered Elbows, waveguide switches, Hybrids and transitions. Features "Flexaguide" line of flexible waveguide and dummy loads, with demo model of complete waveguide section of radar system. **Airtron, Inc.**

Booth 374 **Static Alarms**

Industrial applications of static alarm and static control systems. High voltage dc insulation tester and Power supplies, with range of 5 kv to 75 kv. **The Hewson Co., Inc.**

Booth 376 **Microwave Equipment**

Microwave waveguide instruments for frequencies from 1,000 to 40,000 MC. Includes laboratory measuring devices, attenuators, power measuring equipment, waveguide tuners, frequency meters, and new standing wave detector and amplifier. **Waveline Inc.**

Booth 390 **Connectors**

British manufacturer. Line of unique subminiature connectors and high impedance precision connectors. **Transradio Ltd.**

Booth 394-396 **Connecting Devices**

Tube sockets, terminal strips, micro connectors, multi-plugs and sockets. Also, line of barrier terminal strips, fanning strips and tube shields, etc. **Howard B. Jones Div., Cinch Mfg.**

Booth 397, 494-495 **Delay Lines**

New developments in use of fused silica as delay medium at ultrasonic frequencies. Printed circuits, featuring photochemical glass—complete line of high-temp resistors, capacitors, and products of new research in high-frequency resistors. **Corning Glass Works.**

Booth 445-447 **Connectors**

Various types of connectors introducing new gold plated contacts and improved dielectric. Series of miniature connectors and new latched and keyed shell-type connectors. **American Phenolic Corp.**

Booth 458-460 **Tube Checkers**

Test instruments, including oscillographs and tube checkers. Free tube-testing service to exhibitors on Dynamic Mutual Conductance Tube Tester. **Hickok Electric Inst. Co.**

Booth 462-464 **Vibration Testers**

Complete line of electrodynamic shakers, force output from 25 to 2500 pounds, with electronic power supplies. Vibration measuring instruments and accelerometers. **The Calidyne Co.**

and New Products

will be on display during forthcoming convention.

Booth 471-473-475 — Waveguides
Waveguide switches and wavemeter or 6-60 cm. High power coaxial attenuator, rectangular recorder and polar recorder. **Thompson Products, Inc.**

Booth 538 — Resistors
Resistor and capacitor considerations in color TV design. Industrial uses for special carbon resistor products and new high-dielectric-constant material. **Erie Resistor Corp.**

Booth 567 — Transmitting Tubes
New kilowatt range triodes and tetrodes with coaxial terminal ring seals and thoriated tungsten filaments for industry and broadcasting. Heavy wall anode triodes for industrial service; broadcast types for AM, FM and TV. **Machlett Laboratories.**

Booth 603 — UHF-TV Sweep Generator
UHF sweep generator covering 450-900 MC. Other equipment: FM Signal generator, S-Band Microwave generator, square wave generator and broadband amplifier. **New London Instrument Co.**

Booth 604-605 — Tape
Complete line of pressure-sensitive tapes of plastic, acetate fibre, paper and cloth, with dispensing machines. **Permacel Tape Corp.**

Booth 678 — Filters
Newly developed single side band filters, and subminiature telemetering filters. Also, new plug-in decades and subminiature toroids designed for use in transistorized electronic equipment. **Burnell & Co.**

Booth 681 — Power Transistors
Transistors capable of 5 watts dissipation and output powers of over 20 watts, cofeatured with a line of gold bonded germanium diodes, and silicon diodes. **Transitron Electronic Corp.**

Booth 686 — TV Broadcast Equip.
New video distribution amplifier for small studio budget. Line of hermetically sealed precision resistors and miniature wirewound resistors measuring ¼ x ¼ in. **Eastern Precision Resistor Corp.**

Booth 703 — Mfg. Technique
Introducing equipment for conversion to the modular design in electronics manufacturing. **Sanders Associates, Inc.**

Booth 723 — X-Band Mixer
A compact X-band mixer for radar or link applications has been developed. Unit can be furnished completely wired and tested in brass, silver and rhodium plated, or aluminum. **Premier Instrument Corp., 52 West Houston St., New York 12, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 790 — Waveguides
Precision bending and forming of waveguides. **F. C. Kent Co.**

Booth 850 — Test Equipment
Ultra-sensitive, shock proof meters, with 1 μa movement and ultrasonic attenuation measuring set for 5 MC to 70 MC. Crystal dielectric memory cell for computer use, with line of temperature compensating capacitors, printed resistors, etc. **Gulton Mfg.**

Booth 882 — Microphones
New miniature, condenser-type microphone fits coat lapel. Extra sensitive medical microphone for detecting and registering heart beats. **Altec-Lansing Corp.**

Booth 719 — Deflection Yoke
A special type TV camera deflection yoke is used to control the electron scanning beam as it moves vertically or horizontally. Each raster is scanned at 525 lines/sec. the same as commercial broadcast TV camera and home receivers. Horizontal resistance is 3.59 ohms; vertical resistance, 161 ohms. Horizontal inductance is 0.92 mh; vertical inductance, 53.2 mh. Dimensions: 1⅝ in. in diameter by 4 in. in length. Weight, approximately 4 oz. **Resistor Div., I-T-E Circuit Breaker Co., 1924 Hamilton St., Philadelphia 30, Pa.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 807-809 — Tape Duplicator
The mass production of full-fidelity recorded tapes is the aim of a new high-speed tape duplicating system capable of reproducing 2400 hours of recorded material in eight hours. A half-hour program is copied in 3¾ minutes. System permits speed-ups as high as 320-to-1

in making multiple copies of recorded tapes. **Ampex Corp., 932 Charter St., Redwood City, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 840 — Oscilloscope
The Model 54 automatic oscilloscope sweep halves cathode-ray oscilloscope use time, it is said. The unit locks onto a signal of 0.1 to 50 v. in the frequency range of 20 to 30,000 cps. and automatically generates a sawtooth sweep voltage of perfectly synchronized constant amplitude. This voltage can be fed to the X axis amplifier of any oscilloscope. Positive and negative sweep polarities are available. Input impedance is 1 megohm. Sweep frequency is always one-half the signal frequency so that two cycles of the signal are displayed on the oscilloscope screen. **Audio Instrument Co., Inc., 133 West 14 St., New York 11, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Booth 869 — Oscillographs
The new Brush oscillographs are multi-channel instruments that are said to provide a new high in performance. The units are equipped with an electrically controlled chart-drive that provides multiple chart speeds and instantaneous switching; and, a choice of ink or electric writing. New accessories are, event and timing markers, dual motor drive to double the number of chart speeds, and a remote control unit. Mounting can be a standard rack or a bench-top console. **Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.**—TELE-TECH & ELECTRONIC INDUSTRIES.

New Test and

COLOR TV GENERATOR

Model 650 C incorporates a feature to provide accurate registration adjustment of the three color guns in the tube of new color TV receivers. It provides means for the accurate adjustment of

focus, convergence, centering of individual beams, purity yoke, dynamic convergence, linearity and aspect ratio. Operation requirements are a quick connection to antenna of color TV receiver and setting the 650 C to produce white dots on the receiver CRT. Then, color guns are adjusted until colored fringes disappear from around the dots. The equipment is also a device for black and white receiver trouble-shooting and identifying trouble in any section of a TV set. **The Hickok Electrical Instrument Co., 10606 Dupont Ave., Cleveland 8, Ohio**—TELE-TECH & ELECTRONIC INDUSTRIES.

TESTERS

Three new high-voltage, pocket volt-amp testers have been added to the "Amprobe Junior" line. Each has two voltage ranges; 0-150/600 v. ac and is available in ranges of 0-25, 0-50, or 0-

100 amps ac. The line also includes 0-125/150 v. models in 0-10, 0-25, 0-50, and 0-100 amp. current ranges. **Pyramid Instrument Corp., 630 Merrick Rd., Lynbrook, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

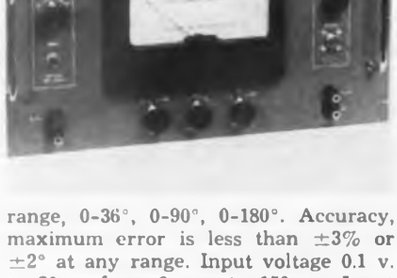
SIGNAL GENERATOR

The "Decalator" 100-1 signal generator provides decade selection of 9,000 predetermined crystal-controlled frequencies in 100 cps steps over the range 100 KC to 1 MC. Two banks of crystals,

having a short-term stability of 5 cps and overall accuracy within 0.025%, control the output of the device. Output voltage is 3 v. maximum into 600 ohms. Total harmonic content is less than 3% at any frequency. Signal generator output measurement characteristics are obtained through an output meter followed by a step-by-step attenuator calibrated in fractions of full-scale meter readings. An AGC circuit maintains the output level of the unit within 1 db. **Decade Instrument Co., Box 153, Caldwell, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

PHASE METER

Type 405 phase meter is a device for studying phase relationship between two signals, and presenting phase angle in degrees on an 8-in. panel meter. Frequency response, 8 cps to 150 kc. Phase



range, 0-36°, 0-90°, 0-180°. Accuracy, maximum error is less than ±3% or ±2° at any range. Input voltage 0.1 v. to 70 v. from 8 cps. to 150 kc. Input power, 115 v. or 230 v. rms, ±10%, 50-60 cps, 60 w. **Advance Electronics Co., Inc., 451 Highland Ave., Passaic, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

MONITORS

Types FTL-12B (VHF) and FTL-57A (UHF) are TV frequency and modulation monitors with the high order of crystal oscillator stability of ±½ part per million over a 7-day minimum period. The carrier frequency accuracy is ±200 cps for the visual monitor and ±500 cps for the aural monitor. Accurate crystal oscillators are incorporated in both monitors to enable rapidly checking zero carrier frequency readings and maximum frequency error indications. The r-f input level can be checked by the front panel meters. High quality, low impedance audio output is provided for monitoring purposes. Output of high impedance for distortion measurements is also incorporated. Distortion is less than 0.25%. Noise measures at least 70 db below output corresponding to 25 kc deviation with 50 cps modulation. **Federal Telecommunication Laboratories, Div. of I. T. & T., 500 Washington Ave., Nutley, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

"PULSESCOPE"

A new "Pulsescope" in "Pocketscope" size features instantaneous direct-reading dc. calibration of either positive or negative signals. The instrument has a vertical amplifier sensitivity of 0.2 v. rms/inch response from dc. to 5 MC within 3 db, or pulse rise of 0.1 μsec. and internal intensity modulated markers of 1, 10, 100, or 1,000 μsec.

Repetitive or trigger sweep is variable from 5 cps. to 500 kc with 5X sweep expansion. Sweep, marker, and dc. calibrating voltage is available externally. Operates from 50 to 400 cps. at 115 v. ac. Size, 8½ x 6¾ x 13¾ in. Weight, 22 lbs. **Waterman Products Co., 2445 Emerald St., Philadelphia 25, Pa.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Measuring Equipment

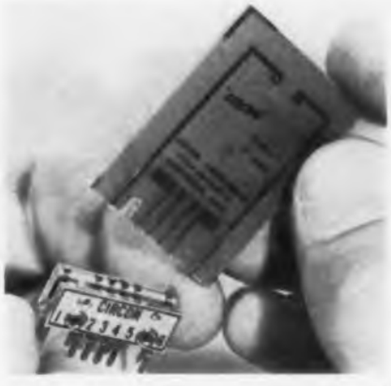
VOLTMETER

The Model 201 vacuum tube voltmeter is a general purpose laboratory or service unit for the measurement of ac or dc voltages and resistances. DC voltages are covered in seven full scale ranges of 1.5 to 1,500 volts at an impedance of 11 megohms. AC ranges are calibrated both

in RMS values of sine waves (1.5 to 1,500 v. full scale) and peak-to-peak values of 4 to 4,000 v. Separate scales are provided for the 0-4 peak-to-peak, and the 0-1.5 v RMS ranges for greater accuracy. Resistance values from 1,000 ohms to 1,000 megohms, full scale, are covered in seven ranges. Maximum accuracy is a mid-scale, which is calibrated in multiples of 10 ohms. Standard probes are included. **Shasta Div., Beckman Instrument, Inc., P.O. Box 296, Sta. A, Richmond, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

CONNECTORS

The "Circon" series of miniature and subminiature printed circuit connectors, now in limited production, consists of sixteen models in each of the miniature and subminiature basic modules of two, four, six, and twelve contacts at rated



maximum loads of one and two amps. contact. They are produced in three gauges to accommodate $\frac{1}{32}$ in., $\frac{3}{64}$ in., and $\frac{1}{16}$ in. printed circuits. **Circon Component Co., 17544 Raymer St., Northbridge, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

TEMPERATURE DETECTOR

The Model 221 N90A temperature detector is designed for use with temperature recording, indicating, and control equipment where fast response is a primary requirement, as the unit has an exponential time-constant of 0.8 seconds or better in an agitated water bath.

Its useful temperature range is from −70° C. to +200° C. Accuracy is ±1.0% or better in mid-scale region. The sensing element is a nickel winding having a basic resistance of 90.38 ohms at 0°C. The instrument is sealed in a stainless steel housing with a glass-to-metal sealed base through which the electrical connection is made. It is not affected by most forms of destructive radiation, and exerts maximum resistance to corrosion. **Thomas A. Edison, Inc., Instrument Div., 51 Lakeside Ave., West Orange, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

MAGNETRON

The 6444 CW magnetron resembles a standard receiving tube and operates from a plate supply of 450–500 v. and a heater supply of 6 v. and is designed for use in the range 9,800–10,000 MC. Originally developed by Signal Corps Engineering Laboratories as the

ESM-48, the 6444 is fixed-tuned, incorporates the Philips dispenser-type cathode, and delivers 1 w. of CW energy into a standard klystron type output. **Microwave Associates, Inc., 22 Cummington St., Boston 15, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES.

INSULATION TESTER

For use in the coating of magnetic wire and similar fine wires, a new continuous type of coating continuity tester counts and records pinholes automatically at speeds up to 600 feet per minute. The instrument consists of a continuously variable power supply with indicating

voltmeter, magnetic counter and felt cup electrode. A flashing lamp and bell indicates the frequency of the pinholes. In conjunction with the footage counter, the instrument produces a continuous display of total number of pin holes for a given footage. **Peschel Electronics, Inc., 13 Garden St., New Rochelle, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

TEST SET

A new test set provides rapid and reliable measurement of the voltage coefficient for composition resistors. It finds application in the study of resistor materials and geometry, contact behavior, and semi-conductor phenomena. Further, the unit can be used for inspection and quality control. The instrument operates on the principle that the nonohmic nature of a material or resistor results in the generation of current harmonics when an alternating

current is applied. These harmonics can be accurately interpreted in terms of v. coeff. Resistance range, 1,000 ohms to 1.1 megohms; test voltages, 0–500 v., power dissipation, 2 w. Supply, 105-135 v. ac., 60 cps. **Brunswick Instruments, P. O. Box 813, New Brunswick, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

New Lab and Plant Equipment

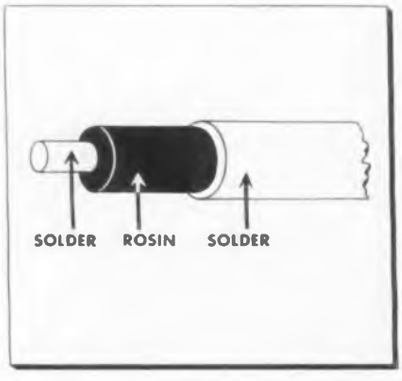
MIDGET PRESS

A precision-built, open-back, inclinable punch press has a solid, heat-treated alloyed steel crankshaft, a roller-bearing mounted flywheel, and a self-contained clutching mechanism that is independent of the crankshaft.

The drive collar is also of steel alloy, heat-treated and ground. Connecting rod and crankshaft bearings are of special bronze alloy. Ram and ram guides are of the over-size length 90° V type. The standard stroke is ¾ in., though a 1 in. stroke is optional at extra charge. **Kenco Manufacturing Co., 5211 Telegraph Road, Los Angeles 22, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

SOLDER

Alpha "Cen-Tri-Core" (sequence action) energized rosin-filled solder consists of a solder wire coated with rosin over which is formed the outer solder sleeve. This makes a rosin void impos-



sible, and, thereby, assures continuity of flux and reduction of cold joints and rejects. Despite the high activity of energized rosin, it is said that it is non-corrosive and electrically non-conductive. Conforms to Federal Specifications QQS-57 1b, Par. E-2a and has been tested in cycled humidity 250 v. dc. at high temperatures for 1,008 hrs. with no evidence of breakdown or corrosion. **Alpha Metals, Inc., 56 Water St., P.O. Box 34, Bergen Station, Jersey City 4, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

FOLDING TRUCKS

Several models of folding trucks originally designed for sales, service, and delivery of business machines, may interest manufacturers and sales-service organizations in the electronic industries. Collapsible for easy storage and transportation, they can be set up in a moment and wheeled to any location and serve as a table or stand. The "Regular" size is for 25 to 300 lb. loads; the

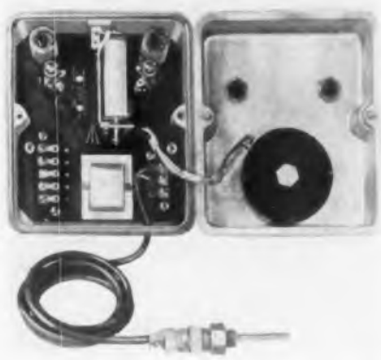
"Heavy Duty" for loads up to 500 lbs.; and the "Self-Balanced 2 Wheeler" is for almost any load that one can handle on a two-wheel truck. All sizes are designed to handle a 50% overload. One or more of the trucks will be shipped for examination without obligation to purchase. **The Federal Cash Register Co., P.O. Box 2265, Kansas City 6, Mo.**—TELE-TECH & ELECTRONIC INDUSTRIES.

SOLDERING IRONS

Two new electric soldering irons, Cat. Nos. 3118 and 3210 are small, light weight units that are adapted to conventional use or in the manner of the pencil-type soldering iron. Identical in shape, size, weight, construction, and wattage, they differ only in the size of the tip. No. 3118 has a ⅛ in. diameter tip, No. 3120 has a 3/16 in. tip. The elements of both irons are replaceable, the casing material is lifetime nickel stainless steel. Each has a light weight, ultra-flexible, special-size cord. The elements are wound on a single piece, solid brass spool. Input is 30 w. Weight, approximately 7 oz. Overall length, approximately 9¼ in. **American Electrical Heater Co., 6110 Cass Ave., Detroit 2, Mich.**—TELE-TECH & ELECTRONIC INDUSTRIES.

TEMPERATURE CONTROL

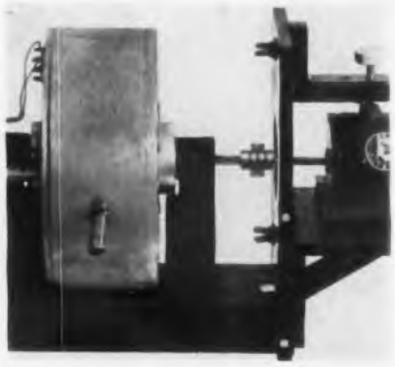
The Series 97 electronic temperature controller uses a resistance temperature detector element as a sensing device in a bridge circuit in conjunction with a high gain phase sensitive amplifier relay unit. A dial sets the temperature control point, and red and green lights indicate temperature above or below the set point. The single pole two-way control contact will handle 220 v. at



amps. Standard ranges are 0° to 100°, 300°, or 500° F. and C., but any range between the limits of 200° to 500° C. can be supplied in conjunction with an appropriate resistance bulb from the Fielden list. Sensitivity is 0.1° F. on all ranges. Only two vacuum tubes are employed. The unit is encased in a 6½ x 7½ x 4 in. cast aluminum housing. **Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 North 4th St., Philadelphia, Pa.**—TELE-TECH & ELECTRONIC INDUSTRIES.

DYNAMOMETER

The "Dyna-Chek" Model DM-3 measures the horsepower output of electric motors of 2 hp. and less. Model MDM tests motors of less than 1/10 hp. Two types of broad-range speed measuring equipment are available as extra acces-



sories. One provides accuracy to 2%, the other to 1/10 of 1%. Both models are supplied with a special dc power supply. **Mission-Western Engineers, Inc., affiliate of Western Gear Works, 132 West Colorado, Pasadena 1, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Cinch MICRO CONNECTORS

...THREE TO FIFTY CONTACTS

MINIATURIZED

Micro Connectors (shown here completely within color area) save space, weigh less, and are more efficient.

Cinch molded general purpose connectors are available with from three to fifty contacts in low loss material for chassis mounting or assembled with cap for cable applications, terminals gold or silver plated. Cinch experience indicated in the wide variety of designs and materials available, in service and consistent use, assures you the connector for your purpose.

Cinch electronic components are available at leading jobbers — everywhere.

CONSULT CINCH

Cinch ELECTRONIC COMPONENTS

CINCH MANUFACTURING CORPORATION

1026 South Homan Ave., Chicago 24, Illinois

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

POTENTIOMETERS

The new "J" series high-precision, single-turn, continuous-rotation potentiometer is designed for servo mounting and can provide resistances from 2 to 100,000 ohms with tolerances as close as ±1%. Linearity tolerance of ±0.25%

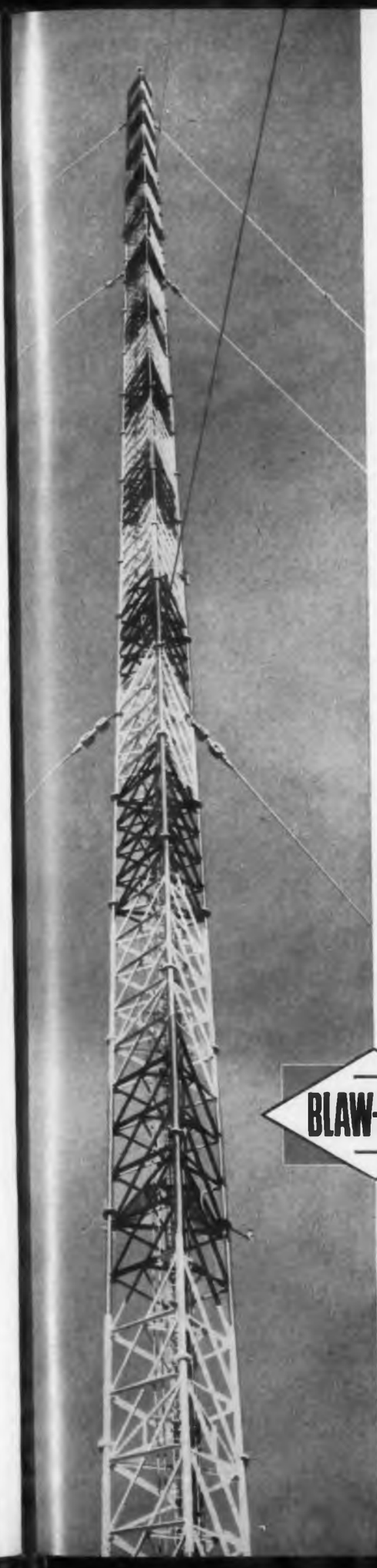
can be achieved in resistances below 10,000 ohms, and ±0.15% in resistances of 10,000 ohms and above. Power rating of the series is 4 watts ambient at 40° C. Derating is unnecessary at ambients up to 40° C. Up to 21 extra taps can be added to each unit. Each is spot-welded to a single turn of resistance wire without shorting out adjacent turns, and as many as six sections can be ganged on one shaft. Sections of the "J" series can be ganged with other series. Unit diameter is 2 in., overall section length, $1\frac{19}{32}$ in. Each ganged section adds $\frac{39}{64}$ in. **Helipot Corp., Div. of Beckman Instruments, Inc., 916 Meridian Ave., South Pasadena, Calif.** —TELE-TECH & ELECTRONIC INDUSTRIES.

I-F TRANSFORMER

The "K-Tran" 455 KC i-f transformer has been miniaturized. Only ½ in. square by 1½ in. high, with an overall length of $1\frac{15}{16}$ in., the unit provides the gain and bandwidth characteristics formerly obtained in larger i-f assemblies, and can be used with subminiature tubes where sockets are not required. A small non-metallic screw driver is used to adjust the transformer to resonance. **J. W. Miller Co., 5917 South Main St., Los Angeles 3, Calif.** —TELE-TECH & ELECTRONIC INDUSTRIES.

GE Curtails Color-TV

The General Electric Company has announced that it will curtail the production of 15-inch color television tubes. The company said "This change in the production schedule is a result of recent indications that the future trend is going to be toward the larger sizes of color tubes."



Tallest TV tower in the South . . . WMCT's new 1088 foot guyed tower

With their new Blaw-Knox tower, and operating on channel 5 to full maximum power of 100,000 watts, WMCT in Memphis, Tennessee, has increased their coverage 100%.

The 1088 foot tower is a triangular guyed type with insulated base and sectionalizing insulators at the 640 foot level.

Tower designed for triple service

This special design tower does triple duty. The lower portion is used as an AM radiator for WMC. In the portion above the insulator and just below the top is mounted an 8-bay FM antenna for WMCF. On top of the tower is a 6-bay super turnstile antenna for television station WMCT.

In addition to this main tower, they use three Blaw-Knox self-supporting 315 foot towers in night time directional operation . . . plus a 310 foot guyed tower for an auxiliary. So at this one station they have a total of five Blaw-Knox towers.

This unusual installation is typical of how we are prepared to cooperate with you on any antenna tower problem you may have.

For more information on the many types of Blaw-Knox Antenna Towers, simply write for your copy of Bulletin No. 2417. Or, for prompt service send us your inquiry, specifying height of tower and type of antenna.

BLAW-KNOX COMPANY
BLAW-KNOX EQUIPMENT DIVISION • TOWER DEPARTMENT
PITTSBURGH 38, PENNSYLVANIA

BLAW-KNOX **ANTENNA TOWERS**

Guyed and self-supporting types—for AM • FM • TV • microwave • communications • radar

Distributed by GraybaR

Looking skyward, note the solid round corner legs and the double laced structural angle bracing. Insert shows the triple unit compression cone base insulator.

COMPLETE CIVILIAN LINE

Exceptionally **good delivery cycle on civilian orders due to tremendous mass production facilities.**

TYPE C45-70

NEW HIGH QUALITY MINIATURIZED "DIME-SIZE" CIVILIAN CONTROL— ***Performance Fully Equals Larger Types.***

TYPE 70, 3/4" diameter metallized composition resistor. Wattage rating: .3 watt for resistances through 10,000 ohms, .2 watt with 350 volts maximum across end terminals for resistances over 10,000 ohms. Also available in concentric shaft tandem construction C45-70 as shown above.

TYPE C3-45

TYPE C3-35

TYPE C3-252

TYPE C3-25

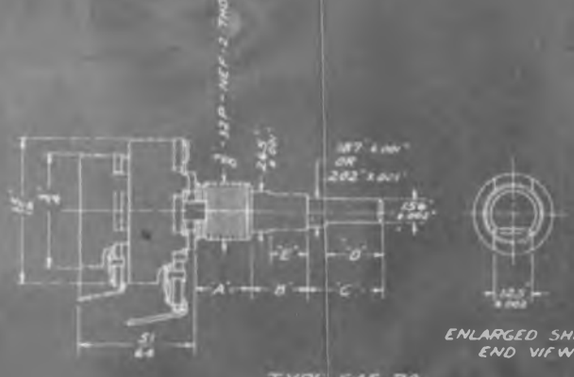
TYPE GC-45, 15/16" diameter variable composition resistor. Wattage rating: 1/2 watt for resistances through 10,000 ohms, 1/3 watt for resistances over 10,000 ohms through 100,000 ohms, 1/4 watt with 500 volts maximum across end terminals for resistances over 100,000 ohms. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-45 as shown above.

TYPE GC-35, 1 1/8" diameter variable composition resistor. Wattage rating: 3/4 watt for resistances through 10,000 ohms, 2/3 watt for resistances over 10,000 ohms through 25,000 ohms, 1/2 watt with 500 volts maximum across end terminals for resistances over 25,000 ohms. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-35 as shown above.

TYPE GC-252, 2 watt, 1 17/64" diameter variable wirewound resistor. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-252 as shown above.

TYPE GC-25, 4 watt, 1 17/32" diameter variable wirewound resistor. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-25 as shown above.

Typical concentric shaft tandem with panel and rear sections operating separately from concentric shafts (TYPE C45-70 ILLUSTRATED). Similar construction available for all military resistors.



ENLARGED SHAFT END VIEW

TYPE C45-70

REPRESENTATIVES

Henry E. Sanders
[illegible] Bldg
69th & Market St
Upper Darby Penna
Phone Flanders 2-4420

[illegible] Company
[illegible] Blvd
Los Angeles 35, California
Phone Bradshaw [illegible]

John A. Green Company
1611 Oriole Drive
Dallas 9, Texas

IN CANADA

C. L. Meredith & Co.
Streetsville, Ontario

SOUTH AMERICA

Jose Luis Pombal
Buenos Aires, Argentina
Montevideo, Uruguay
Rio de Janeiro, Brazil
Sao Paulo, Brazil

OTHER EXPORT

Sylvan Ginsbury
[illegible] West 40th Street
New York [illegible], N. Y.

Specialists in Pre

COMPLETE MILITARY LINE

Immediate delivery from stock on 189 types including JAN-R-94 and JAN-R-19 types of variable resistors.

NEW 38-PAGE ILLUSTRATED CATALOG—
Describes Electrical and Mechanical characteristics, Special Features and Constructions of a complete line of variable resistors for military and civilian use. Includes dimensional drawings of each resistor. Write today for your copy.

TYPE 45, (JAN-R-94, Type RV2)
1/4 watt, 15/16" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94 including concentric shaft tandem construction. Attached switch can be supplied.

TYPE 65, (Miniaturized)
1/2 watt 70°C, 3/4" diameter miniaturized variable composition resistor.

TYPE 35, (JAN-R-94, Type RV3)
1/2 watt, 11/8" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94 including concentric shaft tandem construction. Attached switch can be supplied.

TYPE 90
1 watt 70°C, 15/16" diameter variable composition resistor. Attached switch can be supplied. Also available in concentric shaft tandem construction.

TYPE 252, (JAN-R-19, Type RA20)
2 watt, 1 17/64" diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19 including concentric shaft tandem construction. Attached switch can be supplied.

UNPRECEDENTED PERFORMANCE CHARACTERISTICS

Specially designed for military communications equipment subject to extreme temperature and humidity ranges. −55°C to +150°C....aridity to saturation.

TYPE 95, (JAN-R-94, Type RV4)
2 watt 70°C, 11/8" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94 including concentric shaft tandem construction. Attached switch can be supplied.

TYPE 25, (JAN-R-19, Type RA30)
(May also be used as Type RA25)
4 watt, 1 17/32" diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19 including concentric shaft tandem construction. Attached switch can be supplied.

Burton Browne Advertising

CHICAGO TELEPHONE SUPPLY
Corporation
ELKHART • INDIANA

Precision Mass Production of Variable Resistors

CUES for BROADCASTERS

(*Continued from page 97*)

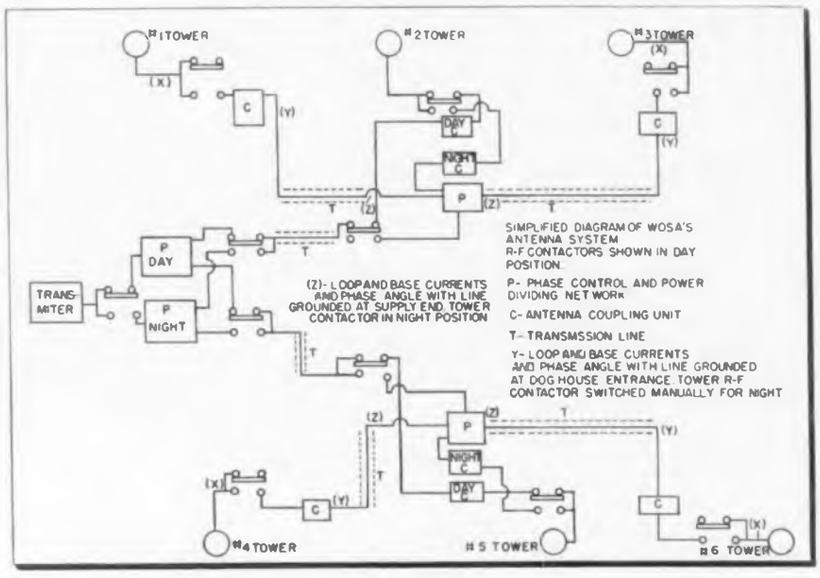


Diagram showing the antenna circuit of WOSA, a 5KW DA-2 station.

shown in the simplified diagram. The two center towers are used for day pattern at which time the end ones are floating. On the night pattern all *six* are used.

With the following method faults can be localized in the tower circuits not used in the day pattern. With the station operating on day pattern I went through the following procedure on each tower separately and logged the readings of the induced currents for future reference in case of difficulty. I would suggest a little caution as some set ups may change the loading on the transmitter considerably. Also another thing to watch is the base currents which in some set-ups may be considerably more than the normal base current reading for that tower.

1. I logged loop current and phase angle with tower grounded. (X)

2. Loop current, base current, and phase angle with transmission line grounded where it enters that towers dog house and the r-f contactor for that tower switched manually into its night position. (Y)

3. Loop current, base current, and phase angle with transmission line not grounded and r-f contactor of that tower in night position. Loop current, base current, and phase angle transmission line grounded at supply end and contactor for that tower in night position. (Z)

In case of difficulty all one has to do is take these measurements and see where they vary from those logged with system working properly.

Service Aid for Tape Recorder Take-Up Clutch

HAROLD I. PETERS, Chief Engineer, WOMI, Owensboro, Ky.

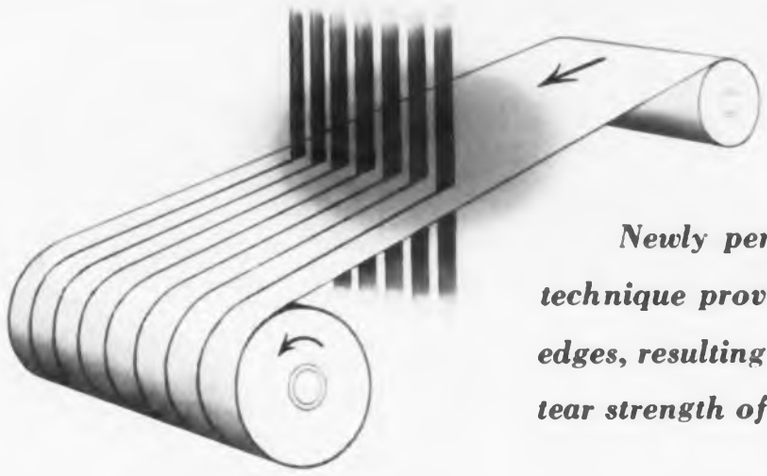
TROUBLE resulting from too much oil on clutch felts can be corrected by a simple modification. At fast rewind speeds and high ambient temperatures a small amount of lubricating oil in the clutch felts is released and travels up the walls of the large drive wheel to the driving surface. Here it is transferred to the motor shaft by the take-up puck wheel, and the oil eventually causes slippage in the capstan drive takeup puck with resultant errors in tape speed.

This oil can be trapped before it reaches the driving surface of the takeup friction assembly by turning two narrow grooves on each side of the exposed walls of the large wheel of this assembly. Oil trapped in the grooves can then be removed during regular maintenance inspection.

If there is no lathe readily available, a homemade tool, such as the sharpened end of a small rat-tail, or three-cornered, file can be used to turn the grooves while the wheel is still on the recorder, and the unit switched to "forward." The tool should be sharpened to cut a Vee-shaped groove for best results. A square-bottom groove is better if a lathe is available. The grooves need not be more than .020 to .030 in. deep.

NEW HOT-SLITTING PROCESS

GIVES audiotape EXTRA STRENGTH



Newly perfected thermal-slitting technique provides smoother, cleaner edges, resulting in increased break and tear strength of plastic base Audiotape

IN THE manufacture of Audiotape, particular care has always been given to the slitting operation, in which the processed tape is cut into reel-size widths. Precision straight-line slitting has been one of the reasons why Audiotape tracks and winds perfectly flat and has no fuzzy edges to impair frequency response.

Now, however, even this superior slitting operation has been still further improved by precisely controlled heat application. The result, though not visible to the naked eye, is a significant increase in tape *strength*. For thermal slitting avoids the formation of the microscopic cracks and irregularities which result, in varying degrees, from any cold slitting process. Each such defect is a source of weakness and a potential tape break.

The thermal treatment in no way alters Audiotape's *balanced performance*. Hence Audiotape not only offers you the most faithful reproduction of the original sound, but also assures the highest mechanical strength obtainable with cellulose acetate base material—all at *no extra cost.*

Audiotape is now available on this NEW 7" PLASTIC REEL

• 2¼ inch hub • more area for labeling • less chance of tape spillage • greater protection to tape • rugged, non-warping construction • distinctive, modern design

. . . and in colors, too!

Audiotape 7" reels can now be obtained, for special applications, in red, blue, green, yellow or clear plastic. And Audiotape is also being offered on either blue or green colored plastic base, in addition to standard red. These distinctively colored tapes offer interesting possibilities for specialized recording and filing applications. Write for further details.

AUDIO DEVICES, INC.

444 Madison Avenue, New York 22, N.Y.

Export Dept., 13 East 40th St., New York 16, N.Y., Cables "ARLAB"

audiodiscs • audiotape • audiofilm • audiopoints

New Technical Products for the Electronic

AMPLITUDE MODULATOR

The "Gyraline" microwave amplitude modulator is a section of cylindrical waveguide containing a ferromagnetic core. When external voltage is applied

to a coil that surrounds the waveguide, a magnetic field acts on the ferrite. This causes Faraday rotation of the transmitted microwave energy and degree of attenuation is a function of this rotation. The unit can be used to provide direct CW signal amplitude modulation from 0° to over 90°, or it can be used as a continuously variable microwave attenuator by varying the voltages applied to the input coil. VSWR is 1.4 to 1 (or less). Insertion loss is less than 1 db. Five models are available: 5900-6400, 6400-6900, 6900-7400, 8500-9900, and 9600-11,200 MC. **Cascade Research Corp., 53 Victory Lane, Los Gatos, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

CRYSTAL UNIT

The Bantam BX crystal is a hermetically sealed unit with wire leads and a 15 MC to 100 MC range. It has the same

performance characteristics as MIL types CR-23 or CR-32. It can be wired into a miniature socket or soldered to a printed circuit terminal board. Bulletin 46 contains additional technical information. **Bliley Electric Co., Union Station Building, Erie, Pa.**—TELE-TECH & ELECTRONIC INDUSTRIES.

VIBRATION MOUNT

The protection of directly read or remotely registered instruments used in airborne operations from vibration and shock is provided by model K130

mounting system. It is a center-of-gravity type that employs stainless steel resilient cushions that are corrosion-resistant and unaffected by extreme temperature exposure, oil, water, solvents, fungi, or dust. Multi-directional design is said to provide maximum stability and protection at any altitude under the most adverse flight and landing conditions. **Robinson Aviation, Inc., Teterboro, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

CONTACT PROTECTOR

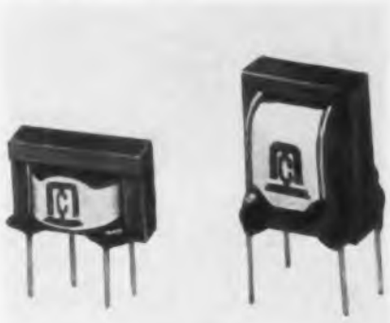
FTR 8A2PS1 contact protector is a unique application of selenium cells for eliminating the destructive effects of arcing at contact points. These tubular units have peak voltages and timing characteristics that make them applicable to all equipment that draws up to 600 ma operating current at voltages up

to 150 v., ac or dc. They connect into a circuit much in the same way as do resistors or capacitors. Technical information is available on request to the **Federal Telephone & Radio Co., Selenium-Intelin Dept., 100 Kingsland Road, Clifton, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Industries

TRANSFORMERS

Miniature transformers for use with printed circuits are now available with power handling capacities which range from 8 mw. to 2 w. The units have



special soldering tabs that can be inserted in a printed circuit terminal board and be mounted and connected by dip soldering. To assure strength characteristics, the units are resin impregnated. **Microtran Co., 2117 Mott Ave., Far Rockaway, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

SWITCH BUSHING

A $\frac{15}{32}$ in. diameter bushing with 32 threads/in. is designed for toggle switches, telephone switches, and circuit breakers that must be seal-proof mounted. A silicone rubber diaphragm, tested from −40° C. to 150° C. at 90 psi maximum pressure is bonded to the stainless steel handle and bushing. The diaphragm has been tested statically without failure at 240 psi ambient room temperature. At 90 psi, the unit has

been tested up to 150,000 cycles of handle throw without leakage. The maximum deflection angle is ±25° of arc. The key slot is on the outside for radial location. **Krautter-Weber Tool Co., 69-77 Twelfth Ave., Newark 3, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

PRESSURE PICKUP

Immediate response where pressure transients occur too rapidly for observation with conventional indicating devices is provided by type 4-312 pressure pickup. Absolute models are avail-

able in 10, 15, 25, 50, 100, and 150 PSIA ranges. Differential models are supplied with ranges ±5, ±7.5, ±12.5, ±25, ±50, and ±75 PSID, and are usable with maximum line pressures of 150 PSI. Upper limits of gauge pickups are 5, 10, 25, 50, 100, and 150 PSIG. Other ranges are available on special order. Pickup weight is 20 grams. Diameter and length, 0.5 in. and 0.75 in. Overloads to 250% of full scale can be tolerated without damage. Each pickup is individually calibrated and supplied with a calibration certificate. **Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

INDUCTORS

Type SL2 miniature inductors are random wound on plastic bobbins using coated wire. Wound cores are checked with their own pot cores for inductance and Q, and are adjusted to the specified value. The coils, Ferroxcube pot cores,

and leads are then assembled and vacuum-impregnated with tropicalized r-f wax. Values of inductance range from 2.2 to 220 mh. Nominal tolerance is ±10% ± one turn. Nominal Q tolerance is ±20%, Core material is Ferroxcube 3C. Curie temperature, 172° C. (342° F.) Weight, ½ oz. **Mico Instrument Co., 75 Trowbridge St., Cambridge 38, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES.

QUALITY IN MINIATURE!

Langevin PLUG-IN

AMPLIFIERS and POWER SUPPLIES

Langevin-engineered to IMPROVE PERFORMANCE!

Miniature-designed to SAVE PANEL SPACE!

MINIATURE PLUG-IN PRE-AMPLIFIER OR BOOSTER AMPLIFIER TYPE 5116

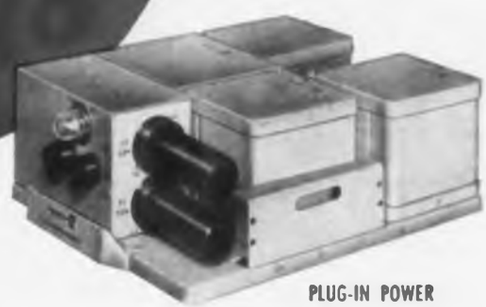
Miniature plug-in two stage, low noise pre-amplifier or booster amplifier. The smallest high performance amplifier of its type that exceeds FCC requirements. Small size, excellent design and plug-in features make type 5116 ideal for installation in consoles and equipment racks. Push button metering facilities and gold plated plugs are standard at no extra cost.

MINIATURE PROGRAM BOOSTER or MONITOR AMPLIFIER TYPE 5117

A plug-in two stage, push-pull, fixed gain audio amplifier. The most compact amplifier available for this service. Outstanding quality recommends type 5117 for applications requiring outstanding performance and maximum availability. Push button metering facilities and gold plated plugs are standard at no extra cost.

–for Radio and Television Broadcast, Recording Studios and Sound Systems

AVAILABLE IMMEDIATELY FROM STOCK



PLUG-IN POWER SUPPLY TYPE 5208

A miniaturized power supply of extremely compact design. Built of highest quality component parts throughout, type 5208 is designed for continuous service. Capable of supplying power for 10 Type 5116 pre-amplifiers or lesser combinations of types 5116 and 5117. Overall length 10¼"; width 2⅝"; height 3".

Langevin

PLUG-IN POWER SUPPLY TYPE 5206

Designed for use with Langevin Miniature Amplifiers. Provides AC for amplifier filaments and well filtered DC for amplifier plate. One unit provides adequate power to operate up to 22 Type 5116 Amplifiers or lesser combinations of Types 5116 and 5117 with separately fused filament and plate supplies.

–the name synonymous with quality in audio equipment and components since 1923

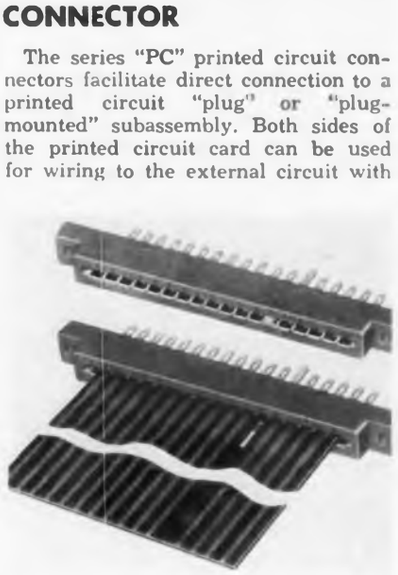
NEW! File Catalog for broadcast engineers and sound technicians available without obligation. Request your copy today—just call or write, on company letterhead, to:

LANGEVIN MANUFACTURING CORPORATION
37 WEST 65th STREET, NEW YORK 23, N. Y.
A SUBSIDIARY OF THE W. L. MAXSON CORPORATION

EXPORT DISTRIBUTORS: INTERNATIONAL STANDARD ELECTRIC CORPORATION, 50 CHURCH ST., NEW YORK CITY

CONNECTOR

The series "PC" printed circuit connectors facilitate direct connection to a printed circuit "plug" or "plug-mounted" subassembly. Both sides of the printed circuit card can be used for wiring to the external circuit with



the double-row contact construction of the unit. This provides up to 30, 36, and 44 contacts on the PC-15, PC-18, and PC-22, respectively. The connectors are also available in single-row construction, however. Multi-conductor, two-sided, pressure contacts of spring temper phosphor bronze are gold-plated over silver for low contact resistance. Terminal ends can be hot tinned for easy soldering. The low resistant contacts have a maximum voltage drop of 20 mv. Positive polarization is provided with polarizing stud that can be located at any contact. **DeJur Amsco Corp., 45-01 Northern Blvd., Long Island City, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

FOCUSING MAGNET

A single "Focomag" ferrite magnet will provide a uniform field and superior focusing for TV tubes up to 27 in. It also provides an extended focus

range with a very fine adjustment to exact focus and a built-in centering device. The entire unit is shielded, hence, there can be no harmful external field. A lever positions the TV picture and several mounting arrangements are available. **Heppner Manufacturing Co., Round Lake, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

CONNECTORS

The Series "B" bayonet-locking, miniature electrical connectors are completely weatherproof. Die cast aluminum shells assure maximum mechanical protection. Synthetic rubber seal rings offer resistance to moisture and dust. Keyways in the shells provide polarization. Contacts are precision-machined and gold-plated over silver. Molded insert bodies are melamine filled for dielectric strength, mechanical strength, and arc resistance. Voltage breakdown between contacts at sea level is 2,600 VDC; 1,100 VDC at 60,000 ft. Weight of panel-mounted receptacle is 0.60 oz. Weight of cable-mounted plug is 0.50 oz. **Winchester Electronics, Inc., 16 Crescent St., Glenbrook, Conn.**—TELE-TECH & ELECTRONIC INDUSTRIES.

VARISTOR KITS

Two new "Thyrite" varistor kits provide a variety of miniature disc-type and rod-type varistors for experimental applications in electronics, communications, power control, etc., Kit No. 1, Cat. No. 108L338G1, contains 12 miniature disc-type varistors, two each of six ratings, color-coded with connecting leads. Kit No. 2, Cat. No. 108L338G2, contains 10 rod-type varistors, two each of five ratings, color-coded with connecting leads. Both kits contain data tables of physical and electrical properties and log-log volt-ampere characteristics graphs. **General Electric Co., Dept. 42-211, Pittsfield, Mass**—TELE-TECH & ELECTRONIC INDUSTRIES.

COMPONENT GROUP

Model 1110A experimental mechanical component group is a set of standard precision mechanical parts comprising gears, shafts, bearings, hangers, and mounting plates. When coupled to necessary motors, tachometers, syncros, potentiometers, and amplifiers, the set facilitates the rapid build-up of a flexible experimental mechanical assembly of a servo-system, computer, or regulator. The set was developed to provide means for quickly synthesizing the electromechanical parts of the control system. **Servo Corporation of America, 20-20 Jericho Turnpike, New Hyde Park, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

PRINTED CIRCUITS

The flush switch plate shown is indicative of current production of printed circuits with continuous follow-through patterns for increased efficiency, faster and easier assembly, and the elimination of hardware for more usable space. In one square foot of printed circuit board 0.125 in. thick, 150 0.20 in. diameter holes can be plated through. **Insulated Circuits, Inc., 115 Roosevelt Ave., Belleville, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

WASHINGTON
News Letter

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

NEW CONQUESTS—Industrial and mobile radio communications, including microwave, intraplant, vehicular and remote control services, have taken away an important part of the spotlight of television both among the radio-electronic manufacturers and the present and potential users of these services, and both the latter groups are seeking to have speedy formulation of permanent rules and standards to get the microwave and intraplant services, particularly, on a "green light" speedway. It is known that the members of the Radio-Electronics-Television Manufacturers Association as well as the leading industries and services using these media of communications are greatly concerned with an expeditious decision by the FCC so they can be established on a regular service basis.

MICROWAVE GROUP—To promote orderly allocation of microwave frequencies and to demonstrate to the FCC the need for eliminating the present developmental status of microwave service, approximately 50 communications engineers and consultants from twelve major segments of users and representatives of manufacturers such as Motorola, RCA-Victor, General Electric, Westinghouse, Federal Telephone and Radio Corp., Collins Radio and the Canadian General Electric recently formed a Microwave Users Council. FCC Safety and Special Radio Services Bureau Chief Edwin L. White outlined the requirements of the FCC in the promulgation of a clear policy on the microwave spectrum and a delineation of the services to be furnished by the Bell System and the industries and state and local governmental organizations in the public safety field.

CONTROVERSY LOOMS—There is no question that the conflict of interests between the Bell System and the private users of microwave and mobile radio services—with the latter supported by the manufacturers cited above—will brew up into a heated controversy which will be carried to the FCC in the Commission's proceedings on the formulation of rules and standards for those radiocommunications services. At the recent microwave users council meeting this was under the surface but was not brought out in the statements at the sessions. The FCC was asked to hold up the finalization of the dockets' procedure blueprints on microwave until the Radio-Electronics-Television Manufacturers Association and the American Petroleum Institute's central committee on radio have completed surveys and studies requested by the Commission. To illustrate the scope of the users who formed the council they were the API committee, the railroads, national committee on utilities radio, forest industry, American Trucking Associations, National Bus Communications, forestry conservation departments of states, special industrial radio group, the Associated Police Communications Officers and the International Municipal Signal Association.

CALIFORNIA SYSTEM—Based on the views of FCC Commissioners in the hearing on the quarter-century-old Federal-State Marketing News Service's radiotelegraph network covering California, that state's plan for a statewide microwave system to handle all California state governmental communications, voice and telegraph, would receive a cool FCC reception when that plan comes before the Commission. The FSMNS is slated to relinquish its five frequencies under the provisions of the international frequency allocation agreement, first devised at Atlantic City and then implemented last year by the world nations at Geneva. A majority of the FCC Commissioners definitely indicated their feeling that the regular communications services of the telephone and telegraph companies could serve the needs of the state.

FCC CHAIRMAN—All indications, at TELE-TECH's press deadline, pointed to the reappointment of FCC Chairman Rosel H. Hyde as chieftain of the Commission when his one-year term in that post expires April 18. Chairman Hyde is supported for reappointment to the Chairmanship by most of his fellow-Commissioners. Mr. Hyde is well deserving of the continuance at the helm of the FCC in view of his career of more than a quarter century with the old Federal Radio Commission and the present FCC in their legal departments. He was named Commissioner after having served as General Counsel. In addition, as Chairman during the past year, he has directed the FCC's functioning so well that it is up-to-date in the processing of television station construction permit applications—a task which was slated to take up to five years has been cleared away in one year. The UHF television prospects, incidentally, have been dampened by the withdrawal of several score of applications for that service.

FM BAND—The FCC is endeavoring to bolster the sagging fortunes of FM broadcasting by allowing that service to furnish non-broadcast operations such as background music service, storecasting and transitcasting. Major industrial radiocommunications services, such as the petroleum and power utilities, have proposed that the FCC consider a reallocation of the FM frequencies to give their operations badly needed spectrum space.

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Editor

UPSET PINS

Improvement in automatic high-speed machines have made possible the production of precise upset pins in diameters from 0.010 to 0.090 in. on straight or formed wires in all workable metals. Heads and flanges are rounded, and can

be positioned to any specified distance from the wire end and held to closed tolerances. Head variation is possible within limits. **Art Wire & Stamping Co., 227 High St., Newark, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

SWITCH

The PM-901-A is a light-weight, manually-operated, broad-band, impedance-matched switch for X band in RG-52/U waveguide size. Input power may be diverted to either of two output channels. Maximum VSRW in switched positions is 1.10 over the band 8500 to

9600 MC. and isolation between output channels is nominally 30 db. **General Precision Laboratory Inc., 63 Bedford Road, Pleasantville, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

CAPACITORS

"Hy-Met" metallized paper capacitors are designed for operation over the temperature range from −55° to +125° C. They are available in metal, paper-tubular, and bathtub containers and include MIL-C-25A case styles and sizes. Metal cased capacitors are hermetically sealed with glass-to-metal terminals and ruggedized for shock and vibration resistance. All units are precision-tested individually before leaving the factory. **Astron Corp., 255 Grant Ave., East Newark, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

WASHINGTON
News Letter

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

NEW CONQUESTS—Industrial and mobile radio communications, including microwave, intraplant, vehicular and remote control services, have taken away an important part of the spotlight of television both among the radio-electronic manufacturers and the present and potential users of these services, and both the latter groups are seeking to have speedy formulation of permanent rules and standards to get the microwave and intraplant services, particularly, on a "green light" speedway. It is known that the members of the Radio-Electronics-Television Manufacturers Association as well as the leading industries and services using these media of communications are greatly concerned with an expeditious decision by the FCC so they can be established on a regular service basis.

MICROWAVE GROUP—To promote orderly allocation of microwave frequencies and to demonstrate to the FCC the need for eliminating the present developmental status of microwave service, approximately 50 communications engineers and consultants from twelve major segments of users and representatives of manufacturers such as Motorola, RCA-Victor, General Electric, Westinghouse, Federal Telephone and Radio Corp., Collins Radio and the Canadian General Electric recently formed a Microwave Users Council. FCC Safety and Special Radio Services Bureau Chief Edwin L. White outlined the requirements of the FCC in the promulgation of a clear policy on the microwave spectrum and a delineation of the services to be furnished by the Bell System and the industries and state and local governmental organizations in the public safety field.

CONTROVERSY LOOMS—There is no question that the conflict of interests between the Bell System and the private users of microwave and mobile radio services—with the latter supported by the manufacturers cited above—will brew up into a heated controversy which will be carried to the FCC in the Commission's proceedings on the formulation of rules and standards for those radiocommunications services. At the recent microwave users council meeting this was under the surface but was not brought out in the statements at the sessions. The FCC was asked to hold up the finalization of the dockets' procedure blueprints on microwave until the Radio-Electronics-Television Manufacturers Association and the American Petroleum Institute's central committee on radio have completed surveys and studies requested by the Commission. To illustrate the scope of the users who formed the council they were the API committee, the railroads, national committee on utilities radio, forest industry, American Trucking Associations, National Bus Communications, forestry conservation departments of states, special industrial radio group, the Associated Police Communications Officers and the International Municipal Signal Association.

CALIFORNIA SYSTEM—Based on the views of FCC Commissioners in the hearing on the quarter-century-old Federal-State Marketing News Service's radiotelegraph network covering California, that state's plan for a statewide microwave system to handle all California state governmental communications, voice and telegraph, would receive a cool FCC reception when that plan comes before the Commission. The FSMNS is slated to relinquish its five frequencies under the provisions of the international frequency allocation agreement, first devised at Atlantic City and then implemented last year by the world nations at Geneva. A majority of the FCC Commissioners definitely indicated their feeling that the regular communications services of the telephone and telegraph companies could serve the needs of the state.

FCC CHAIRMAN—All indications, at TELE-TECH's press deadline, pointed to the reappointment of FCC Chairman Rosel H. Hyde as chieftain of the Commission when his one-year term in that post expires April 18. Chairman Hyde is supported for reappointment to the Chairmanship by most of his fellow-Commissioners. Mr. Hyde is well deserving of the continuance at the helm of the FCC in view of his career of more than a quarter century with the old Federal Radio Commission and the present FCC in their legal departments. He was named Commissioner after having served as General Counsel. In addition, as Chairman during the past year, he has directed the FCC's functioning so well that it is up-to-date in the processing of television station construction permit applications—a task which was slated to take up to five years has been cleared away in one year. The UHF television prospects, incidentally, have been dampened by the withdrawal of several score of applications for that service.

FM BAND—The FCC is endeavoring to bolster the sagging fortunes of FM broadcasting by allowing that service to furnish non-broadcast operations such as background music service, storecasting and transitcasting. Major industrial radiocommunications services, such as the petroleum and power utilities, have proposed that the FCC consider a reallocation of the FM frequencies to give their operations badly needed spectrum space.

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Editor

TRANSDUCTORS

(*Continued from page 79*)

scheme must be coincident and lin ear for the desired range of opera tion. Since single-ended transducto operation is characterized by nonlin earity in the vicinity of zero contr they are not applicable to system which require full range totalizin However, there are systems whic require only limited range totalizin for which single-ended transductor are applicable. A typical example o this type system is an electro-chemi-

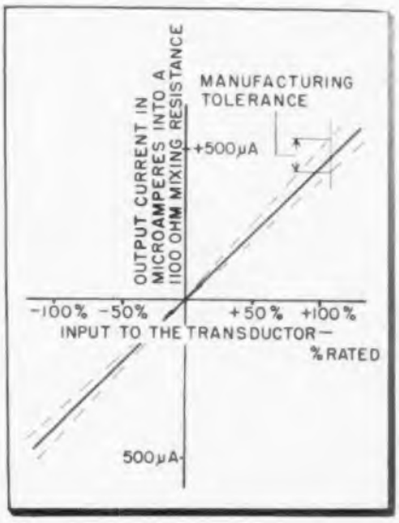
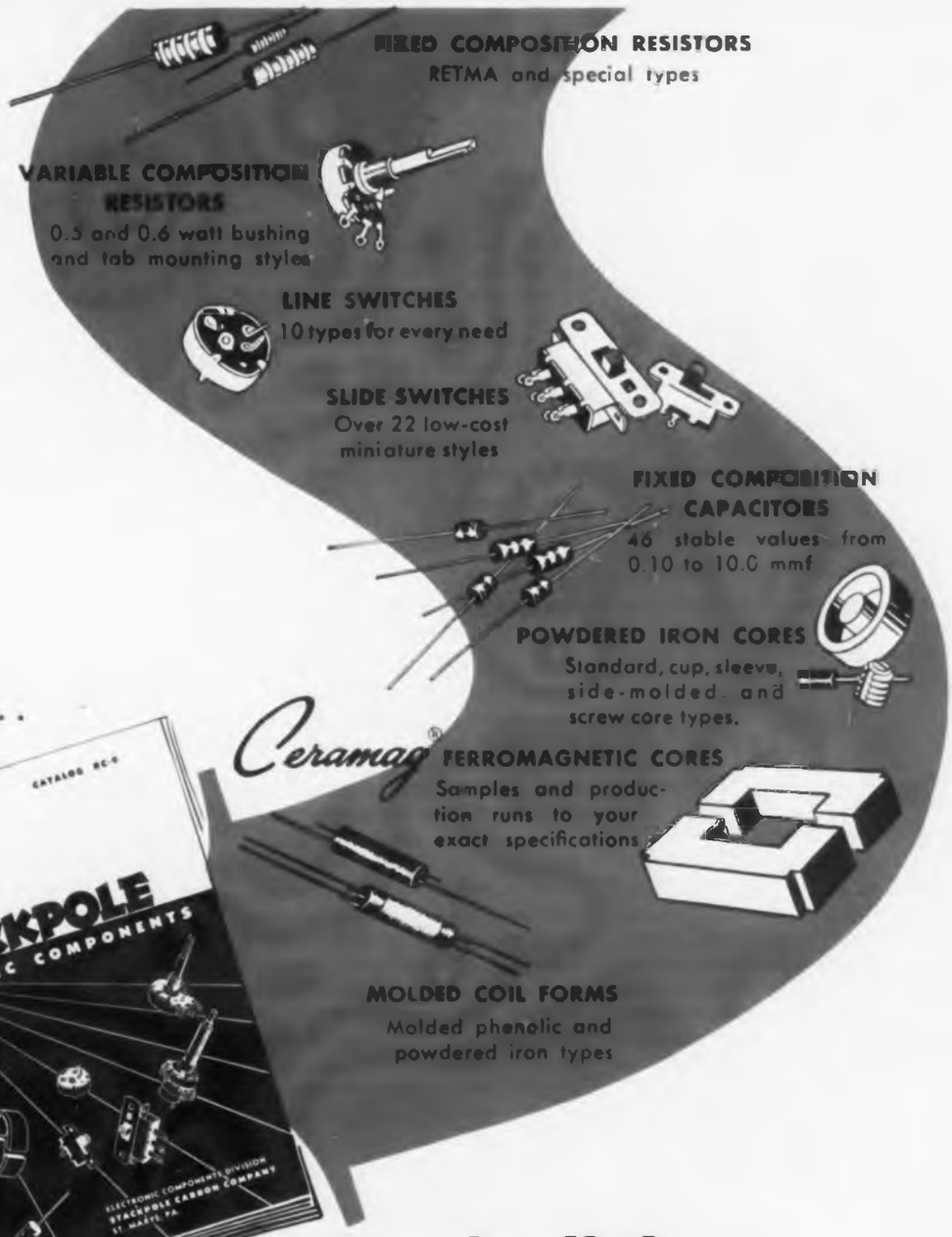


Fig. 7. Push-pull transductor characteristic

cal process line whose feeder buses operate at all times between 50% and 100% rated current. The mechanics of matching single-ended transductor outputs for totalizing are more easily explained if the characteristic curves are also expressed in terms of percent rated input to the transductor versus output voltage in millivolts developed across a selected portion of the load resistance. The first step in matching transductor outputs is to compensate for the gain tolerances of Fig. 4 by varying the load resistance until the linear sections of the curves are parallel. Although the single-ended transductor is essentially a constant current device, sufficient change in gain can be made to compensate for manufacturing tolerances. The second step is to select that portion of the load resistance which develops the desired voltage drop when rated input is fed to the transductor. Thus, all of the transductors can be calibrated for the same output to the totalizing meter per unit feeder bus current. When the selected portions of the load resistances are connected in series so that the voltage drops



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add, the reading on the totalizing instrument will represent the sum of the feeder bus currents.

Push-Pull

A typical application of push-pull circuitry as applied for metering individual unidirectional current is shown in Fig. 6. A push-pull potential transductor is applied for metering individual unidirectional voltage in the same way except that the control winding is connected between buses with an external series resistance as is shown for the single-ended transductor of Fig. 3. The operation of the push-pull circuit, applied as shown in Figure 6, is typified by the characteristic curve of

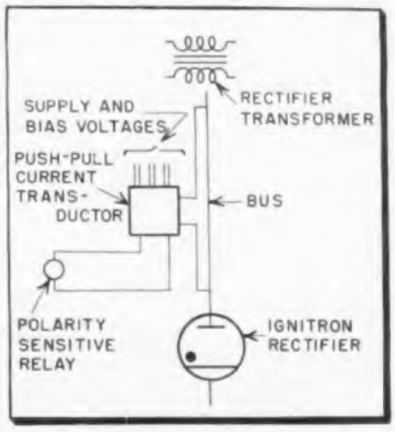

Fig. 8: Bus-tap current transductor used in detecting arc-backs in ignitron rectifiers

Fig. 7, when the relationship of input to output is expressed as percent rated input to the transductor versus output in microamperes of d-c current into a specified mixing resistance. The dotted lines of Fig. 7 indicate that manufacturing tolerances are to be expected in production units. The operating characteristics of push-pull circuitry can be interpreted for the instruments of Fig. 6 from the curve of Fig. 7.

Fig. 7 shows that the output of the push-pull transductor is zero at zero input and is linear for the full range of input (0 to 100% rated), hence the instruments of Fig. 6 which are activated by this output will have linear scales. The instrument in Fig. 6 can be either a dc microammeter or a null-balancing potentiometer type instrument or both. The dc microammeter is connected in series with the mixing resistance and is activated by the entire output current. The potentiometer-type in-

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strument is connected across a portion of the mixing resistance and is activated by the voltage developed in this selected resistance by the load current. The calibration of a dc microammeter is made by varying the mixing resistance to obtain full-scale deflection on the meter for 100% rated input to the transductor. The calibration of the potentiometer type instrument is made by selecting the portion of the mixing resistance which develops the full scale input voltage of the instrument for 100% rated input to the transductor.

The mechanics of matching push-pull transductor outputs for totalizing is less involved than matching single-ended transductor outputs, but it is still convenient to express the characteristic curves in terms of percent rated input to the transductor versus output voltage in millivolts developed across a selected portion of the mixing resistance. The characteristic curves for push-pull transductors can be made identical for totalizing simply by calibrating each transductor for the same output to the totalizing meter per unit feeder bus current. The outputs are connected together the same as for the single-ended units of Fig. 5 and again the reading on the totalizing instrument will represent the sum of the feeder bus currents.

The characteristic curve of Fig. 7 shows that the push-pull transductors will supply a change in the polarity of output for a change in polarity of input. As a bi-directional device, the push-pull transductor is directly applicable to the metering of bi-directional currents and volt-

(*Continued on page* 132)

EXAMINE CAMERA AT CLINIC

Foreign visitors discuss operation of RCA's Type TK-11 monochrome TV studio camera with E. T. Griffith (on platform), manager of RCA broadcast promotion. Visitors attended 19th television technical training course conducted by RCA Engineering Products Division.

98% of all U.S. TV stations use Houston-Fearless equipment

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TRANSDUCTORS (Cont.)

ages. It can also be used in control schemes to detect reverse currents or voltages. A typical application of a push-pull current transductor in a control scheme is shown in Fig. 8.[4] In this scheme the push-pull transductor is used to detect the reversal of current that occurs in an arc-back of an ignitron rectifier and the directional output can be used to activate a polarity sensitive relay in a fault clearing mechanism. For application to control schemes, such as given in Fig. 8, where accuracy is not of prime importance, a bus-tap transductor is used.[4] As shown in Fig. 8, this type unit eliminates the need for a shunt since it uses a section of the bus as a shunt. The operation of current transductors either single-ended or push-pull which use the bus-tap scheme for sensing the bus current is the same as the operation of current transductors which use shunts to sense the bus current.

Transductors are applicable to high-voltage dc systems as auxiliary metering and control devices. They can be applied to meter both unidirectional and bi-directional currents and voltages, and the outputs are suitable for use with standard switchboard instruments and null-balancing potentiometer type instruments. Their operation in industrial installations is compatible with industrial metering accuracies. The electrical isolation they maintain between the system potential and the metering and control circuits permits safe operation with standard instruments and control equipment and provides adequate safety to operating personnel.

1. J. R. Specht and R. N. Wagner, "The Theory of the Current Transductor and Its Application in the Aluminum Industry," *A.I.E.E. Trans.*, vol. 69, pp. 441-452; 1950
2. H. F. Storm, "Series-Connected Saturable Reactors with Control Source of Comparatively High Impedance," *A.I.E.E. Trans.*, vol. 69, Part II, pp. 1299-1309; 1950
3. W. F. Horton, "Isolation Metering of D-C Bus Currents," *Proc. N.E.C.*, vol. 8, pp. 260-262; 1950
4. W. A. Derr and E. J. Cham, "Magnetic Amplifier Applications in D-C Conversion Stations," Paper 53-26 presented at the A.I.E.E. Winter Meeting, New York; 1953

Electralab, Inc. A Farrington Subsidiary

The production facilities of the Farrington Mfg. Co., Jamaica Plain, Mass., entered the field of printed circuitry recently, with the acquisition of Electralab, Inc., of Cambridge, Mass. as a subsidiary. The merger is aimed at stepped-up production of quality printed circuits, with special application to the modular Design System.

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BULLETINS

Transistor Sockets

Bulletin No. 1954-1, covering subminiature tube and transistor sockets produced by Super Ear Products Co., 675 Merrick Road Lynbrook, N.Y., illustrates six units and gives code numbers, number of contacts, dimensions, and list prices.

Panel Visibility

Brochure "D", available on request to Universal Aviation Equipment, Inc., 36 Fifth Ave., New York 1, N.Y. describes "Universal" illuminated control panels, dials and knobs designed to produce maximum day and night visibility.

Vibration Isolator

Bulletin 537, available at the Barry Corp., 700 Pleasant St., Watertown 72, Mass. presents detailed application information on the Series 262 and 633 "Barrymounts" designed to isolate motor noise and vibration.

Wire and Cable

A new catalog recently released by Lenz Electric Mfg. Co., 1751 N. Western Ave., Chicago Ill. provides complete specifications of the company's line of hook-up and lead wires, and cables produced for the electronic industries.

Batteries

A technical information bulletin issued by P. R. Mallory & Co., Inc., Battery Division, North Tarrytown, N.Y., contains descriptive data covering the company's new transistor power supplies and its standard line of Mercury "A" batteries and multi-cell combination "A" and "B" packs and stacks that can be tailored for greater capacities or higher voltages.

"Crystal Handbook"

A handbook of crystal and oscillator theory has been compiled and published by James Knights Co., Sandwich, Ill. Intended for the design engineer using crystals. Price, $1.00.

Measurement Techniques

Vol. 5, No. 1-2 of the Hewlett-Packard Journal describes time interval techniques involving high-speed clutch systems, relay operating times, phase delay at low frequencies, etc. The publication may be obtained from Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif.

DB Meters

A newly revised engineering data sheet that gives complete information on 1½ in. db panel meters for commercial and military applications has been announced by International Instruments Inc., P. O. Box 2954, New Haven 15, Conn.

Counter Techniques

"The Application of Counter Techniques In Precision Frequency Measurements," presented at the WESCON, 1953, is available on request to Berkeley Division, Beckman Instruments, Inc., 2200 Wright Ave., Richmond, Calif.

Power Supplies

Power Designs Inc., 119-22 Atlantic Ave., Richmond Hill 19, N.Y. have released a 4-page brochure that describes and presents engineering data that covers the power supplies produced by the company.

Camera Accessories

The 96-page 55th annual camera, lens, and equipment catalog published by Burke and James, Inc., 317 South Wabash Ave., Chicago 4, Ill., is available free of charge.

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BULLETINS

Audio Systems

"Tools for Building Temples of Tone," a 16-page brochure, tells how to select components for a home audio system, including the cartridge, record player and changer, tape machine, tuner, amplifier, and loudspeaker system. Write for Bulletin No. 21 to Electro-Voice, Inc., Buchanan, Mich. Enclose 10¢ in coins or stamps.

Tube Selector

The "Picture Tube Selector," a pocket size, slide-rule device that solves most picture tube replacement problems has been made available by Allen B. Du Mont Laboratories, Inc., Cathode Tube Div., 750 Bloomfield Ave., Clifton, N.J. The selector may be obtained at all distributors of the company's replacement picture tubes.

Recording Systems

A new 38-page catalog by Sanborn Co., Industrial Div., 195 Massachusetts Ave., Cambridge 39, Mass. describes oscillographic recording systems and accessories.

Resistors-MIL Type

Catalog Data Bulletin D-1 released by International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. contains comprehensive engineering data, photos, charts, and graphs covering "IRC" precision wire wound resistors.

Electronic Equipment

Electro-Tech Equipment Co., 308 Canal St., New York 13, N.Y., have released Catalog No 54, an illustrated, indexed 189-page presentation of a wide variety of electronic meters, controls, and test equipment. Attached is a folder, "Off-The-Shelf-Service," that explains the policy and service of the company.

Coils and Meters

Catalog 102-A, a new 16-page publication, introduces a line of subminiature torodial coils and toroidial coil meters made by Burnell & Co., 45 Warburton Ave., Yonkers, N.Y. It includes descriptions, and attenuation and Q curves.

Terminal Boards

Bulletin "Terminal Boards", page 1, in color, presented by the Electronic Sales Division, DeJUR-AMSCO Corp., 45-01 Northern Blvd., Long Island City, N.Y. includes information concerning base materials and pin arrangements.

Monograph

"Electrical Noise in Wire-Wound Potentiometers," a 21-page illustrated technical paper that describes noises that originate in a precision potentiometer; discusses methods of observing and measuring noise, etc. The monograph, by Irving J. Hogan, is available at Technical Information Service, Helipot Corp., 916 Meridian Ave., South Pasadena, Calif.

Tape Recording

Audio & Video Products Corp., 730 Fifth Ave., New York 19, N.Y. have released their new 6-page tape recording accessories catalog. It contains specifications and descriptive material on recommended accessory items.

Microwave

"Microwave," a 10-page booklet illustrates and describes microwave communication equipment with block diagrams and pictorial applications. Collins Radio Co., 855 35 St., N.E., Cedar Rapids, Iowa.—TELE-TECH & ELECTRONIC INDUSTRIES

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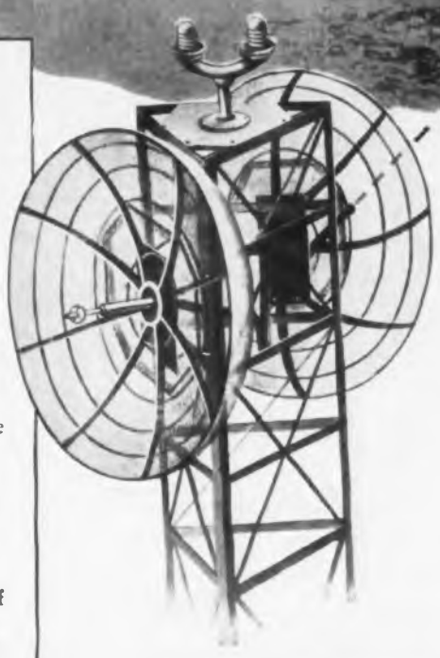

MICROWAVE MOVIES:

Be sure to see Federal's 16 mm. sound-and-color motion pictures: "Microwave Communications for Power Utilities"..."Pipeline Communications With Microwave"..."Microwave for Modern Telephony"..."Railroad Operation With Microwave"..."Modern Communications With Microwave." Prints shipped without charge for company showings. Write to: *Film Distributing Department.*

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IT'S A FACT...

ITaT scientists conducted the *first* successful demonstration of voice communication via *microwave*, March 31, 1931, across the English Channel.

TV Antenna Patterns

(*Continued from page 92*)

amount of downward beam tilt as well as null fill-in. The small amount of beam tilt resulting quite often is desirable in that the horizon may actually be this amount depressed because of the height of the antenna In fact, null fill-in usually is required only when these antennas are mounted at such heights as to result in a fair amount of horizon depression.

To provide phase deviations, the corresponding cables feeding the bay to be phased are modified slightly in length to result in proper phasing of these bays. This is the only thing necessary when accomplishing contouring by phasing. When amplitude distribution is used for contouring, or when used in addition to phasing, proper matchers are placed in the branches feeding the corresponding bays, to result in the current amplitude distribution desired. A contoured pattern is usually designed on a per-channel basis, since both the cable lengths and branching matchers are to some extent frequency sensitive. In some cases, broadband matchers may be applied to widen the band width for which the contoured pattern will exist.

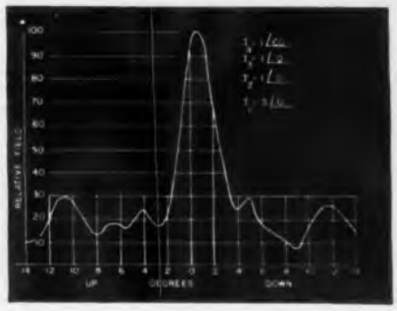

Fig. 13: UHF 4-bay helical contoured pattern

UHF Applications

The gains used in UHF are considerably higher than used in VHF. Some contouring is therefore more often required for UHF since the nulls now fall a considerable distance away from the transmitter. Here again, the two basic techniques of phase and amplitude deviation from standard are used for contouring solutions.

Fig. 14 illustrates the standard 4-bay UHF array factor, the angles marked on the locus again representing the angle below horizontal. Lead-phasing the top bay moves the locus outward from the reference. Further, by additionally reducing

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the amplitude and modifying the phase of the bottom bay, two powerful controls are obtained for contouring. The results of a typical case

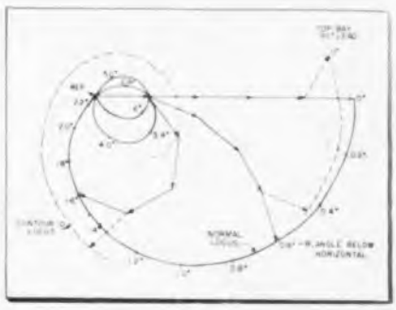

Fig. 16: UHF 5-bay antenna array factor

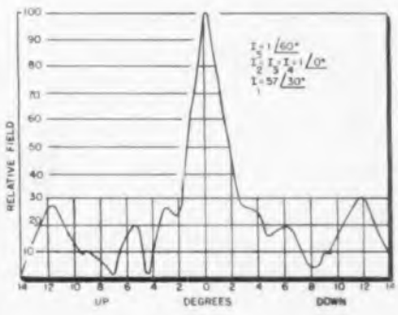

Fig. 17: UHF 5-bay helical contoured pattern

are shown in Fig. 15. The relative bay currents are as indicated. The phasing required is accomplished simply by relative bay rotation. The amplitude distribution is obtained by a variation in the matcher at the proper bay feed. Naturally, with the amount of contouring shown here, some gain reduction occurs. Also, the pattern shown included some beam tilt. The amount of actual beam tilt may additionally be controlled by reinserting the proper amount of progressive phase shift, over and above the deviations used to procure the original contouring. The amount of contouring and tilt may be modified after installation simply by rotating the top bay.

Such contouring of course is not limited only to the four-bay, similar basic methods being used for contouring the five-bay helical. The basic array factor is shown in Fig. 16. By operating on the top and bottom bays alone, a large amount of contouring can be provided. Actual pattern illustrations are shown in Fig. 17, illustrating a fair amount of contouring.

The author wishes to acknowledge the assistance of Mr. R. E. Fisk in preparing much of the pattern data.

This paper was presented at the NARTB Broadcast Engineering Conference, April 28-May 1, 1953, held in Los Angeles.

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Coupled Traps

(*Continued from page 85*)

assumptions of Q and attenuation, but as shown in Fig. 6 these errors become negligible when compared on an over-all basis.

Until now the amplitude characteristics of an inductively coupled trap circuit has been the main topic of discussion. However, the phase characteristics of a trap are of equal importance in so far as they have serious consequences on the "Electrical Fidelity" of a video i-f system. This fact will be borne out by a practical video i-f amplifier design illustrated in the following section, by determining the system's 250 kc transient response through analytical as well as experimental methods.

Practical Video I-F Amplifier Design

The evaluation of picture quality or "Electrical Fidelity" of a video i-f amplifier requires consideration of the phase as well as the amplitude characteristics. Mathematically the response of a video i-f amplifier to a unit voltage can be determined from the phase and amplitude characteristics. The idealized i-f standards of uniform amplitude response, sharp cut-off, and constant time delay are of little practical significance since the requirements of sharp cut-off and high rejection are contrary with constant time delay. On the other hand the simple video i-f response curves obtained by either stagger-tuned or double-tuned networks are not sufficient to prevent

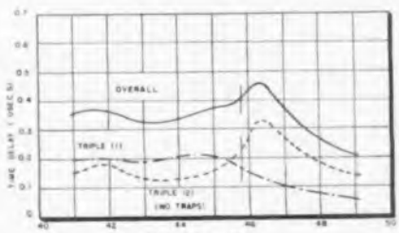

Fig. 11: Time delay of staggered-triples

interference from the adjacent channel sound and video carriers, and thus traps must be employed in the system. However, traps tend to distort the amplitude as well as the phase characteristics of an i-f system. Fortunately, however, the amplitude and phase characteristics are directly related to each other regardless of what circuit is used, provided it is a minimum phase shaft network. The transient response can be readily calculated from the effect of this relationship

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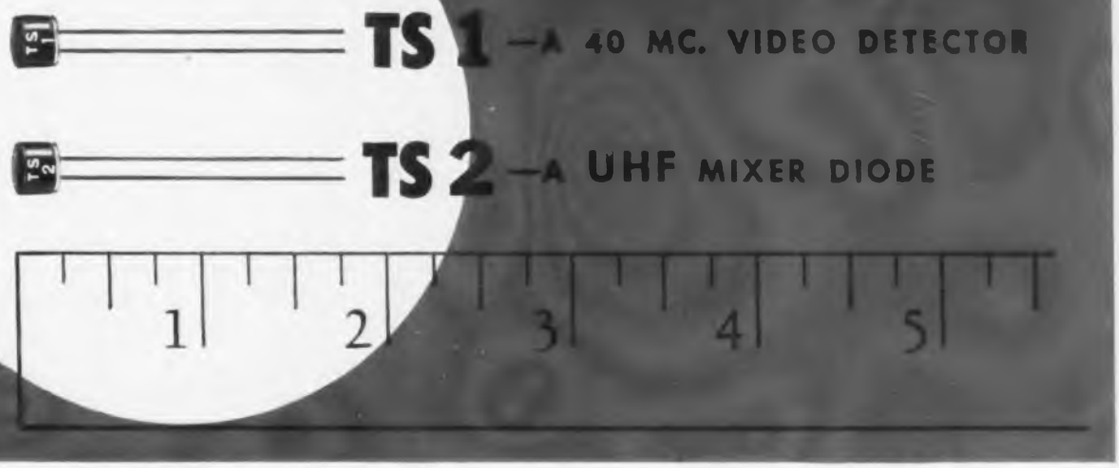

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COUPLED TRAPS (Cont.)

and it is the purpose of this bulletin to show how the inductively coupled trap affects this pertinent aspect of "Electrical Fidelity."

For reasons of simplicity, economy, gain, selectivity, stability, and ease of alignment, a four stage 41.25 MC stagger-tuned amplifier utilizing the 6CB6 vacuum tube was designed to have a 6 db bandwidth of approximately 3.5 to 4.0 MC, and an

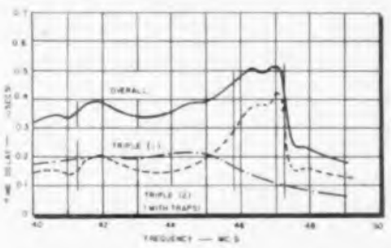

Fig. 12: Time delay characteristics with traps

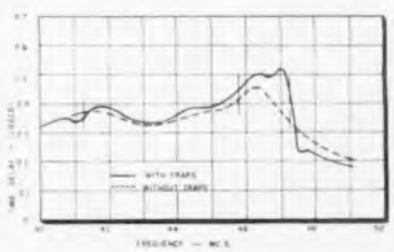

Fig. 13: Comparison of overall responses

adjacent channel sound carrier rejection of 30 db with reference to the picture carrier as well as an associated sound carrier rejection of 20 db min. with reference to the picture carrier.

The 3-stage stagger-tuned amplifier discussed in a previous section of this paper, as well as the response of another triple-tuned network, will serve as the networks depicting the overall response of the system to be analyzed. A comparison of the "Electrical Fidelity" of the system in terms of the 250 KC transient response, with and without the trap circuits, will be made in order to determine what effects traps incur on the picture quality of a video i-f system.

Since the amplitude and phase characteristics of stagger-tuned or any other multi-tuned network can be determined from methods explained in detail by publications dealing with the fundamentals of network theory, and since the introductory sections of this bulletin dealt with these characteristics for inductively coupled trap circuits,

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only the final theoretical computations will be illustrated. Fig. 8 contains the response curve of the triple tuned network (triple 2) explained in the introductory section of this paper as well as the triple tuned network (triple 1) comprising the remaining network of the over-all amplifier system. Fig. 9 shows the same response curves less the trap circuits in triple 2. Fig. 10 are over-all response curves of the video i-f system with and without traps. The results illustrated in this plot show how the associated sound carrier trap tends to reduce

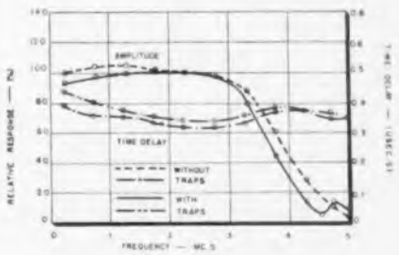

Fig. 14: Low pass amplitude and time delay

the bandwidth of the over-all system, while the adjacent channel trap on the other hand increases the rate of cut-off on the video carrier side. The effects of these aspects on the transient response will be shown later, but at this point the phase characteristics in terms of the time delay response will be illustrated.

Staggered-Triples

Fig. 11 contains plots of the individual time delay characteristics of the staggered-triples without traps, as well as their over-all response. Fig. 12 shows time delay curves of these same amplifiers, but with the addition from the trap circuits. Comparing the two over-all responses of the system in Fig. 13 shows that abrupt shifts in the time delay characteristics take place within the regions of the trap frequencies. The associated sound carrier side shows a relatively small shift in time delay whereas the adjacent channel sound carrier side shows abrupt changes especially within the region of the picture carrier frequency. The effects of these nonlinear transitions in time delay on picture quality is serious since they tend to shift the principle frequencies of the transient response.

In order to evaluate the transient response of the video i-f amplifiers presented as examples, they must

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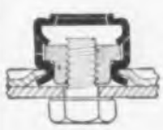
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COUPLED TRAPS (Cont.)

first be transformed into their equivalent low pass network. As a result of the demodulation process employed in a vestigual sideband transmission system, the energy present in the lower sideband must be added vectorially to that of the upper sideband. This addition may be accomplished by either graphical or analytical procedures. The analytical approach is the most preferable since accuracy is of importance in determining the exact amplitude and phase characteristics of the principal frequencies of the transient response.

Fig. 14 shows the demodulated or low pass equivalent amplitude and

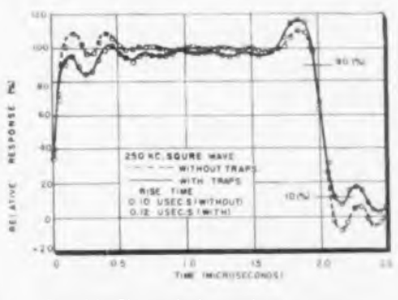


Fig. 15: Theoretical transient response

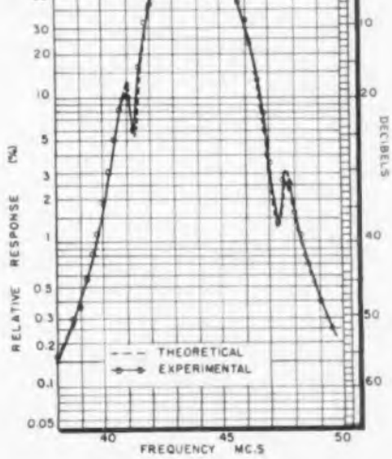


Fig. 16: Amplifier amplitude response

time delay characteristics of the amplifier with and without the trap circuits. From these curves two definite conclusions may be drawn, one being that the associated sound carrier trap tends to reduce the effective bandwidth of the system, and secondly that the adjacent channel sound carrier trap tends to advance the time delay characteristics of the network especially within the principle frequencies of the transient

esponse. Thus, the associated sound arrier trap will effect the rise-time f the transient response as well as he ring frequency. The adjacent hannel sound carrier trap, on the ther hand, will determine the de-ree of smear as well as the per-ntage anticipatory overshoot pres-t in the transient response. Fig. contains theoretical curves of the ansient response of the system, ith and without trap networks.

In order to bear out the validity these analytical computations, for Electrical Fidelity," experimental urves for the amplitude response the amplifier with and without aps are shown in Figs. 16 and 17. igs. 18 and 19 illustrate photo-graphic experimental confirmation the theoretical transient response alculations. The experimental re-ult obtained were well within the realm of experimental error.

General Practice

No theoretical approach to the design of a video i-f amplifier would be complete in its own right unless certain practical aspects were ful-filled. One such requisite is that the amplifier be free from regeneration since regeneration tends to alter the amplitude as well as the phase characteristics of the system. Again, the stagger-tuned networks should

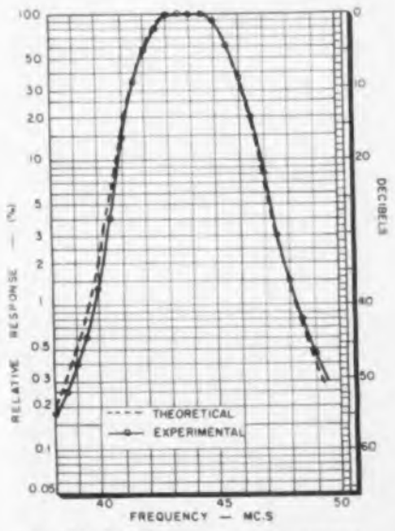


Fig. 17: Experimental amplifier response

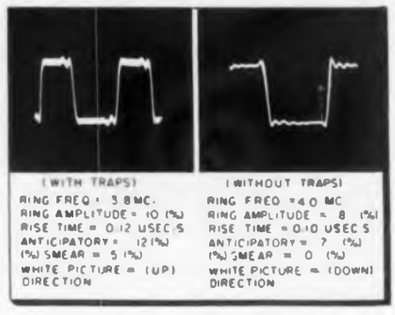
e arranged in accordance with ood engineering practices, and yet llow a fair degree of flexibility so s to meet changing production re-uirements. However, as further roof of the practical aspects of the nalysis presented in this bulletin, ig. 20 contains photographic evi-lence in the form of a representa-

tive production amplifier. Figs. 1[illegible] and 18 are experimental results depicting the "Electrical Fidelity" o[illegible] this particular amplifier which was one of many amplifiers having such a high degree of correlation existing between the theoretical and the practical design.

Video Transformer Test Jig

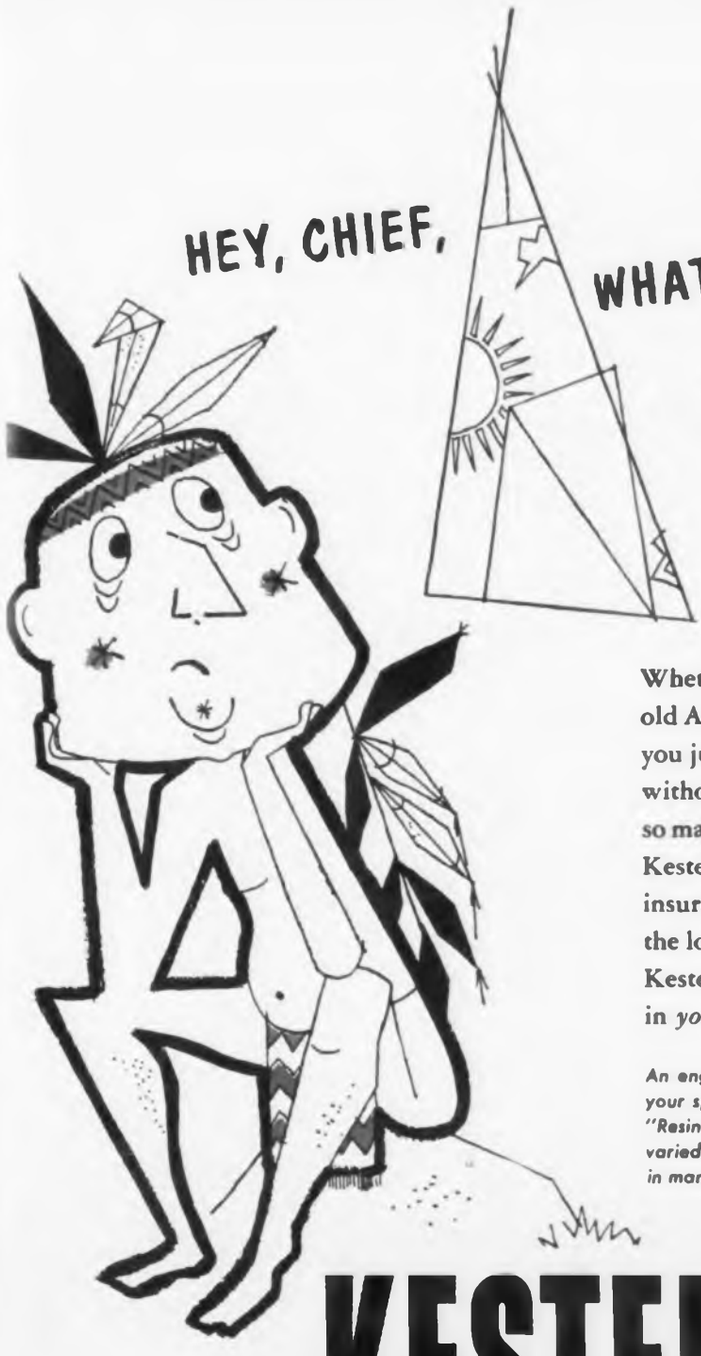
In checking the theoretical computations for the inductively coupled trap circuit, experimentally it became very desirable to have some means in which the electrical aspects of the circuit to which the trap was coupled could be checked rapidly as well as independently from the other networks of the amplifier. For this reason a test jig as shown in Fig. 21, was devised having a flat amplitude response from 35 MC to 55 MC, with a relative gain of approximately 30,000 μv for a 1 volt dc detector level. A three-stage stagger-tuned triple comprised the network used to obtain this desired response. A fourth stage was employed as a means for which the coil or transformer in question could be simulated to those operating conditions existing in the actual amplifier itself. In this way the characteristics of the coil or transformer could be investigated accurately as well as quickly with regard to such design constants as Q and tuning range. Thus the test jig allows one a means of measuring these coils or transformers on a semi-production basis by comparing their electrical characteristics to that of a standard.

On the other hand the test jig may serve the designer of a video i-f amplifier as a useful laboratory tool in so far as it allows him to



Figs. 18-19: Experimental transient response

check experimentally the networks he has computed theoretically. In this way the designer affords himself a means of working out his particular design problems with little or no loss of time and mate-



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COUPLED TRAPS (Cont.)

rial. In all, the jig serves a very useful purpose in the development of complex multi-tuned circuit constants, and for this reason should be considered as a possible tool in the design of video i-f amplifiers employing inductively coupled trap networks or similarly related networks.

The analytical analysis presented may be considered as nothing more than a simple modification of the familiar double-tuned network theory, the major difference being the reference network and the narrow bandwidth assumptions. Whether the network to which the trap is coupled be either a two-

Fig. 20: Representative production amplifier

terminal, four-terminal, or an n-terminal network, modification of the driving point impedance must be made before proceeding with the analysis. Again, the analysis may be applied to the top-capacity coupled trap network as well as the top-inductance coupled trap circuit.

It may be further concluded, that the "Electrical Fidelity" in terms of the 250 KC square wave response, of a video i-f amplifier employing inductively coupled traps, may be determined on the basis of the information presented in this bulletin. In this way the designer of such networks or similarly related networks may find this analysis of assistance to him by enabling him to direct his design constants to that condition wherein the predicted values depict the "Electrical Fidelity" of the system in terms of good transient response, high gain, adequate selectivity, stability, and ease of alignment.

In the stagger-tuned system, it is necessary to couple the trap circuit to that network in the system which is close in frequency so as to minimize the degree of in-band amplitude and phase distortion. The adjacent channel sound carrier trap tends to advance the time delay characteristics of a video i-f amplifier which invariably results in a smeared transient response as well

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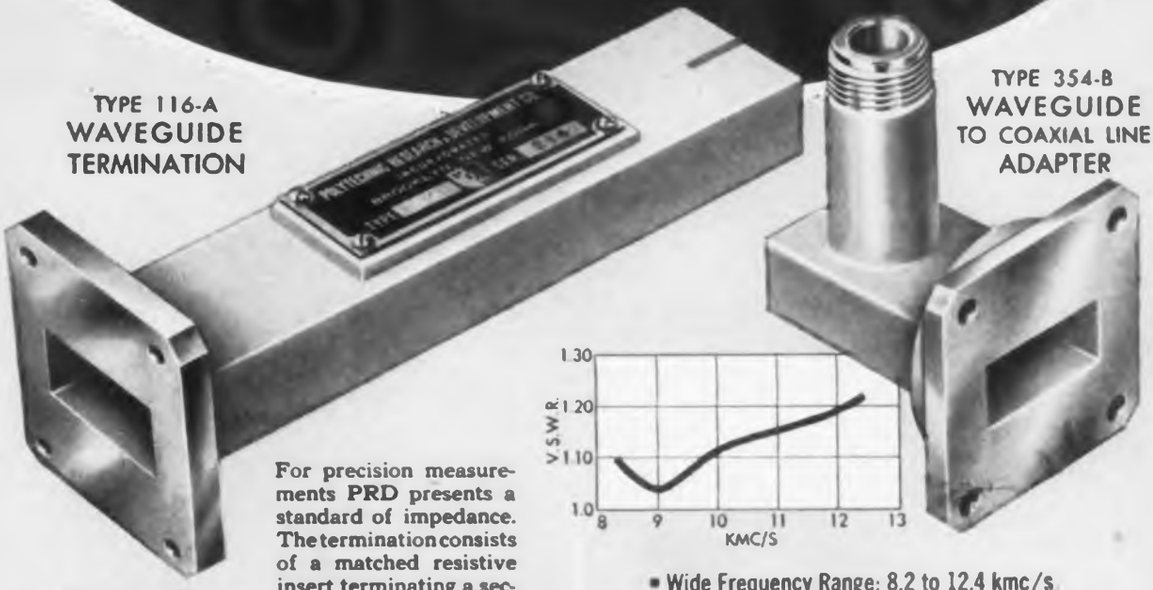

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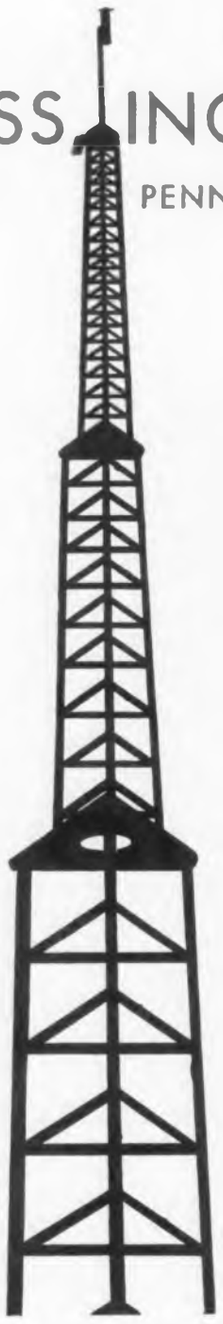

as an increase in the anticipatory over-shoot. On the other hand the associated sound carrier trap tends to reduce the over-all bandwidth of the system thus raising the rise-time as well as lowering the ring frequency of the transient response. However, this small amount of picture quality degradation may be considered acceptable, since the trap networks tend to alleviate a more pertinent problem, namely, the prevention of interference from the adjacent channel sound and video carriers.

Amount of Attenuation

On the other hand, the amount of attenuation that can be had from a single inductively coupled trap network is limited. It was apparent from both the theoretical as well as

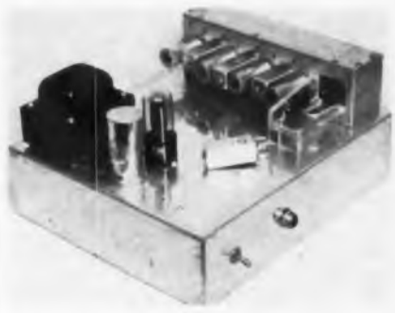

Fig. 21: Test jig with flat 35-55 mc response

the experimental standpoint, that attenuations greater than 10 db for an adjacent channel sound carrier trap produced a smear in the transient response of the video i-f system, that could not be compensated for by any simple alignment correction. However, higher Q traps improved the attenuation problem without further picture quality deterioration, but the stability and reliability of such a network is difficult to maintain at 40 MC.

Bandwidth Constant

In regard to the gain-bandwidth constant of a video i-f amplifier, if the designer wishes to maintain the same bandwidth conditions that existed without the trap networks, there then exists a corresponding reduction in amplifier gain. This factor may be of significant importance in the case of a low-cost receiver design, since the sensitivity and selectivity requirements may not be in line with the economic limitations of the receiver.

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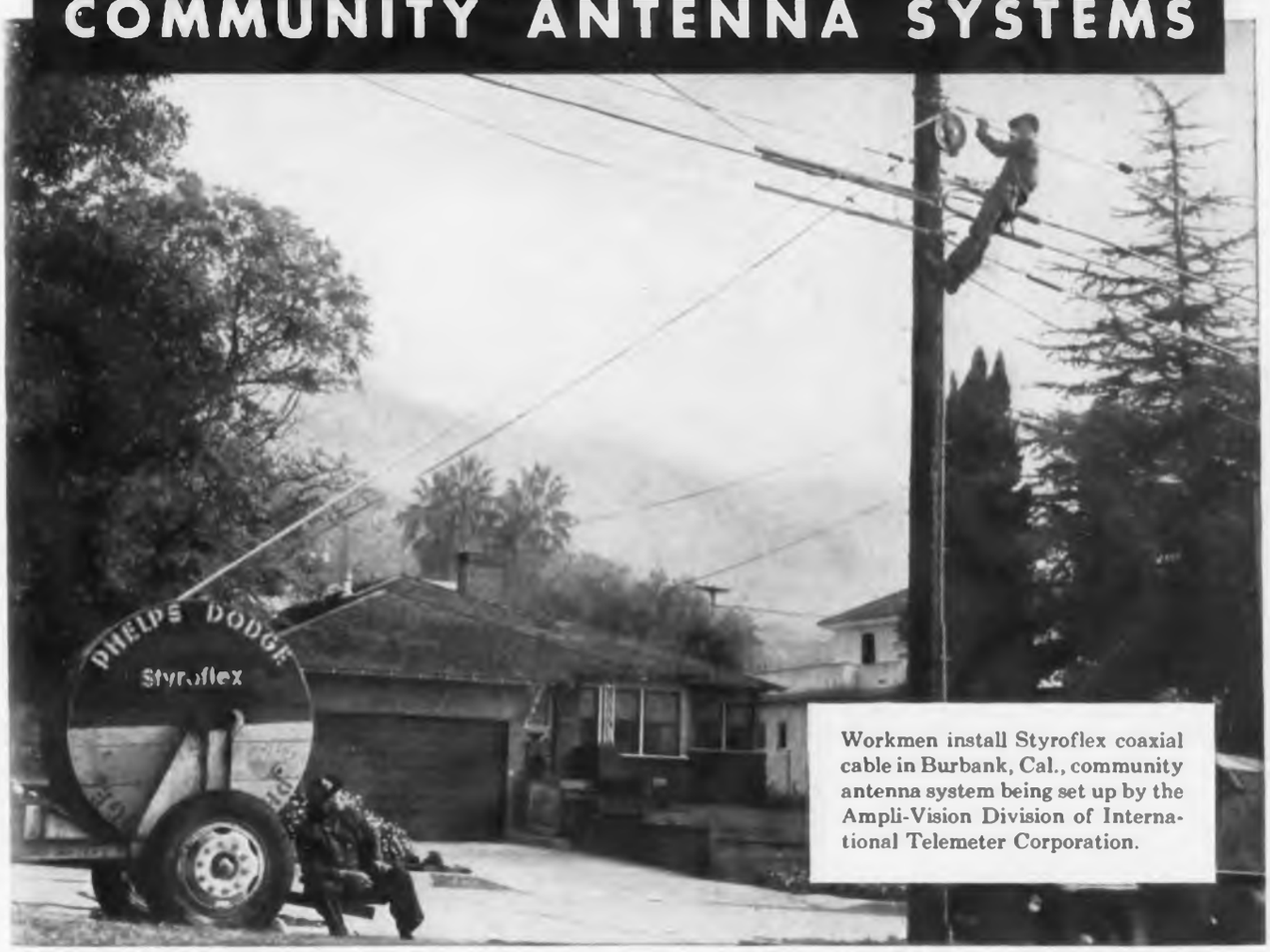

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PERSONAL

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Mr. Magnuski acts as techincal consultant on all products manufactured by the division. The company also announced the appointment of **Lloyd P. Morris** to the position of chief engineer of a new Motorola department—an engineering advisory service for 2-way radio and point-to-point VHF systems.

Richard P. Corporon, former development engineering head at Penn Controls, Inc., has joined the communications department of the N.Y. Central, at New York. Other N.Y. appointments were **Roy A. Calendine,** to general plant supervisor, and **William B. Anderson,** to communications traffic supervisor.

Edward C. Lloyd has been named chief of the mechanical instruments section of the NBS, following the retirement of Dr. W. G. Brombacher. **Dr. Robert D. Huntoon** was recently designated acting chief of the NBS electronics division and associate director for physics.

Dr. Frederick W. Brown has been appointed director of the new Boulder (Colorado) Laboratories of the National Bureau of Standards.

William C. Jenner has joined Houghton Laboratories, Inc., Olean, N.Y., as Chief Electrical Engineer. Mr. Jenner was formerly with Reliance Electric and Engineering Co. of Cleveland, Ohio.

John W. Christensen was recently promoted to vice-president and chief engineer of CBS laboratories.

Carmine Masucci, formerly of Sylvania Electrical Products, Inc., has been appointed as senior project engineer to the staff of CBS-Columbia.

PERSONAL

Dr. James B. Fisk, until recently the director of research in physical sciences at Bell Laboratories, has been elected vice president in charge of research,

R. Bown

J. Fisk

succeeding **Dr. Ralph Bown,** who continues as a vice-president, with a new assignment in planning laboratories programs.

John M. Del Vento has been made chief engineer in the current expansion of the engineering, research and testing facilities of Waveline, Inc., Caldwell, N.J. Following World War II service as an instructor in radar and other electronic navigation techniques, Mr. Del Vento specialized in microwave research and development with Federal Telecommunications Laboratories. Priorily, he established microwave tube production and testing techniques with National Union Tube Co.

Dr. John E. Barkley, former head of physical-chemistry research at the Armour Research Foundation, has been appointed manager of physics and

J. Barkley

T. Buchhold

chemistry research for the Mechanical Division of General Mills. Dr. Barkley will direct research in fields related to food and petroleum processes.

Dr. Theodor Buchhold has joined the Ford Instrument Co., Division of Sperry Corp., as staff consultant to the vice-president for engineering. Dr. Buchhold, who has been active for many years in rocket and guided missile experimentation, will specialize in research and development projects.

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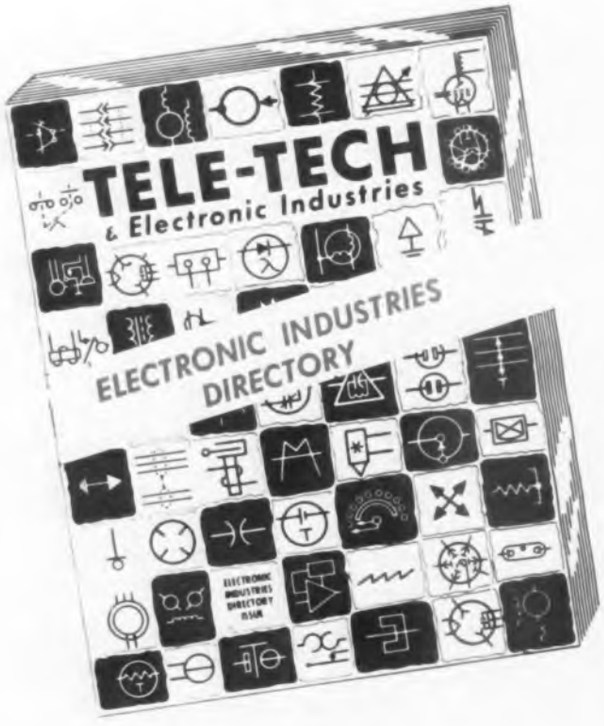

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INDUSTRY NEWS

Earl F. Sanderson, assistant general manager of Eitel-McCullough, Inc. since 1949, has retired on the advice of his physician. **John Stenson,** purchasing agent for the company since 1951, has been made administrative assistant to **George Wunderlich,** general manager of the San Bruno, Calif. firm.

Harold Jones, head of the technical information center of Motorola Communications & Electronics Inc., Chicago, Ill., has been promoted to the position of

Harold Jones

executive assistant to the national sales manager. In his new position Mr. Jones will assist with the sales and promotion of all communication products distributed through this wholly owned subsidiary of Motorola, Inc.

C. J. Harrison has been made sales manager of the Mobile Communications Department of the Communication Products Div., Allen B. Du Mont Laboratories, Inc. He will organize a national sales operation which will service representative distributors of mobile radio products. Previously, Mr. Harrison was marketing manager of the division's Transmitter Department. **Kenneth F. Petersen** has been named marketing manager of the TV Transmitter Department and will coordinate the activities of regional district managers and sales representatives from coast to coast, and aid in supervising distribution of telecasting equipment.

Joseph M. Coleman was recently appointed merchandising assistant for Sylvania Electric Products, Inc. Radio Tube and Television Picture Tube divisions. Formerly with the J. Walter Thompson advertising agency, Mr. Coleman will work on merchandising programs to support the company's distributor sales force.

W. F. Hoeppner has been appointed assistant to the president of Capehart-Farnsworth Co., Fort Wayne, Ind. Joining the predecessor company in 1941, Mr. Hoeppner became comptroller of the present company in 1949. **P. H. Hartmann** will assume the management of the comptroller's department.

(*Continued on page* 204)

FM TELEMETERING

(*Continued from page* 95)

plate voltages can be monitored. The only additional equipment needed is an audio signal generator and an instrument for checking distortion.

Reliability Program

A subject of prime concern at present is the reliability of the equipment that is designed. Reliability importance was first being recognized during the initial conception of this unit. A lot was said about designing reliable equipment but there existed few positive principles for guides, other than such time worn maxims as "don't overdrive" and "keep components within ratings." Since reliability was a prime requisite in the service this unit was to perform, steps were planned to minimize the basic causes for failures. In a reliability study conducted on military World War II equipment, five basic causes of failure were discovered.

These were:

1. Tubes
2. Poor engineering
3. Faulty components
4. Faulty installation, operation and maintenance procedure.
5. Manufacturing faults.

To reduce tube failures a tube test program was undertaken that was based on the fact that the rate of tube failures with life is highest during the first interval of life and follows thereafter a failure rate that is exponential in character. By burning in every tube under a vibration of 25 CPS and 0.01 in. amplitude and at an ambient temperature of 100°C for 100 hrs., the greater portion of potential failures were culled out. This burn-in period was followed by 100% inspection according to JAN specifications.

Forty percent of the failures in the study, excluding those due to tubes, had been traced to poor engineering. Development time was short and high performance was the primary goal in the design of this equipment. In order to obtain the high performance, circuits were unnecessarily complicated, newly designed non-standard components were used, and many components were misapplied and used above their rated values. Reliability was sacrificed for performance. To avoid repeating these mistakes, principles that were simple but effective were used to design dependability into the transmitter. First, reliability, simplicity, and the conditions of service were emphasized right from the beginning. The emphasis on reliability gave an added factor to be weighed in the design

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If your station plans to begin television service, or go to high power . . . Standard Electronics invites you to compare and decide on a basis of cold facts.

Compare circuitry . . . tube replacement costs . . . power consumption . . . ability to transmit color signals . . . operating simplicity . . . eye appeal . . . maintenance . . . deliveries . . . comparative factors that truly decide which transmitter best serves your needs.

Comparison Chart of VHF High Power Transmitters (50 K W)

	Transmitter B	Transmitter C	Transmitter D
AMPLIFIER DRIVES WITH 5 KW	NO	YES	YES
AMPLIFIER WILL OPERATE WITH ANY MAKE DRIVER	NO	NO	NO
TUBE COST { COMPLETE SET / FCC SPARES	$11,625 / $4,237	$13,230 (est) / $6,429 (est)	$9,250 (est) / $5,050 (est)
AIR COOLED	YES	NO	NO
POWER LINE REQUIREMENTS (at black level)	460 V 60 cy, 3 ϕ 193 KW	208/230 V 60 cy, 3 ϕ 150 KW (est)	208/230 V 60 cy, 3 ϕ 165 KW (est)
FLOOR AREA (including power equipment, blowers, etc.)	154 sq. ft.	160 sq. ft. (est)	———
ALL TUBES VISIBLE FROM FRONT	NO	NO	NO
SELF CONTAINED (no separate enclosures, vaults, pumps, etc.)	NO	NO	NO
INDIVIDUAL CHASSIS CONSTRUCTION	NO	NO	NO
INTERUNIT CABLING WITHOUT TRENCHES	NO	NO	NO

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and influenced many decisions which otherwise might have favored unnecessary performance characteristics. Second, the breadboard models of the transmitter were type tested as soon as possible. They were vibrated, shocked, accelerated, and heat tested. With the early type tests, shock resistance, thermal stability and vibration damping developed with the other characteristics and they were consequently not the cause of costly patchwork changes that usually result when type testing is delayed to the pilot model stage.

To reduce component failures standard components were used except in a few instances where none were available. Such was the case with the audio bypass capacitor. These new components were thoroughly life tested by the component engineers. All components were derated voltage- and temperature-wise to meet the existing conditions reliably.

Fig. 5: Telemetering transmitter test unit

Faulty installation, operation and maintenance procedures were prevented by adequately prepared specifications and instructions.

Minimizing Failures

To minimize failures due to manufacturing faults, it was necessary to add to the normal manufacturing procedures an additional emphasis of care. Assembly and inspection personnel understood the rugged conditions that were to be met and consequently units were assembled, inspected, and tested in rigid accordance with specifications. By having the engineers that designed the transmitter carry their responsibility through the manufacturing and test stages, production problems were solved more in accordance with the overall reliability and performance requirements of the unit rather than with production techniques and principles. In addition to frequent quality reviews of the product, several units

of a production run were assigned to the engineering labs for complete environmental and operational test.

Since reliability is the result of continuing and prolonged corrective measures and redesign, a special failure report system was instituted. This consisted of an orderly system of reporting failures that occurred at the various stages of manufacture and test and of those that occurred in the field. These failures were analysed by the engineer responsible. If they were design faults, they were corrected; if they were workmanship faults, better quality control was instituted. The majority of the failures reported by this program were still tubes. Most tube failures were due to the falling off of transconductance below specifications. No serious component failures outside of tubes occurred. Redesign was of a minor nature; for example, a coil that required sleeving or a terminal that needed clipping to prevent shorting under vibration.

Although security restrictions prevent the disclosure of exact results, this reliability program has shown two things. First, reliability is much more effective when it is used as a guiding principle right from the initial conception of the design. Second, tubes, even with careful application, are still the biggest problem in any reliability program. Most positive results can, however, be obtained if the other causes of failure, namely; engineering, manufacturing, and the installation and maintenance, are rigorously pursued.

In conclusion, this transmitter has proven itself hundreds of times on numerous types of duty. Its excellent frequency stability and attenuation of spurious sidebands have allowed it to work side by side with other radio equipment without interference. Its compact heavy-gage structure made it possible to gather data under rugged, high shock applications. It is a transmitter that can be relied upon to send the data back.

This paper was presented at the 1953 National Telemetering Conference held in Chicago.

New Bedford Gets New TV Station

Southern Massachusetts and Providence, R.I., will be served by WTEV, now under construction. Transmitter and studios will be located in Freetown, Mass., 8 miles from New Bedford, Mass. Operation is slated to begin within six months.

G-Curves

(*Continued from page 87*)

as a load, a transconductance as high as 7000 micromhos with a plate conductance of the order of 54 micromhos may be obtained.

Assume that a 300 ohm input impedance push-pull grounded grid TV booster is required which can be built as an ac-dc unit. The use of the 12BZ7 tube is desired. Examination of the vertical 125 v. load supply load line indicates that the use of about a half volt bias on the tube should be satisfactory. The ac-dc requirement makes necessary blocking capacitors in the input and the output twinleads. Shunt cathode feed through a center-tapped r-f choke and common cathode bias resistor may be chosen. Choosing a plate current of 5 ma. per tube and a bias of 0.35 v., the cathode resistor should have 35 ohms resistance. Plate dissipation, 0.6 watt, is less than half that allowed. Transconductances of the tubes are about 6200 micromhos and plate conductances are about 54 micromhos.

The value of resonant resistance chosen for the output tuned circuit depends upon bandwidth requirements for the plate circuit. If no increasing of bandwidth is required, one chooses a tuned impedance satisfying $G_P R_L = 1$. If increase of bandwidth is required, then $G_P R_L$ may be made greater than one. With $G_P R_L = 1$, one obtains the booster input to plate amplification equal to 41.3 nominal. The input to output amplification at three hundred ohm impedance level then is approximately 3.7 to one. The plate tuned impedance is about 18,500 ohms including the loading of the output circuit.

Electronic Voltmeter

An electronic voltmeter having low input loading and comparatively high output is frequently needed. Since the 12BZ7 tube makes an excellent cathode follower for voltmeter use, a sample design using this tube follows.

The cathode follower is a combination of an impedance changer and a voltage repeater. A voltage applied to the cathode follower grid at very high impedance is repeated in the cathode circuit with a small voltage loss, but greatly reduced effective impedance. The equation for the cathode follower is

$$VA = G_M R_K/[1 + (G_M + G_P) R_K] \quad (9)$$

Effective cathode follower action requires that $G_M R_K$ be large compared to one. Then the efficiency of

the cathode follower depends on $G_M/(G_M + G_P)$. As in the grounded grid amplifier, a high transconductance and a low plate conductance is needed in a tube to be used as a cathode follower.

Assume that the voltmeter design is as shown in Fig. 4. The unit is to use regulated voltage from an OA2 tube or an OD3 tube. The components values shown in Fig. 4 develop a bias of approximately 0.5 v. on each tube. The heater voltage of the input tube is reduced by 0.5 v. to improve the tube input impedance. Voltages are indicated to permit the reader to check the design on Fig. 2. The overall voltage efficiency of the two tubes in series is 95.7%.

Series Tube Voltage Regulator

As a final example of degenerative amplifier design, consider the two-stage amplifier and series tube regulator shown in Fig. 5. The triode V_1 acts as a grounded grid triode, and V_2 as a degenerative amplifier. The series tube, V_3, acts as a special cathode follower. The grounded grid amplifier, V_1, since its applied input signal appears both at the plate and the cathode obeys

$$i_{p1} R_{L1}/\Delta E_1 = (G_{M1} - 2G_{P1}) R_{L1}/ [3 + 2G_{M1} R_{K1} + G_{P1}(3R_{L1} + 2R_{K1})] \quad (10)$$

The total voltage applied to the grid of V_2 is the sum of $i_{p1}R_{L1}$ and the input voltage ΔE_1. Call this sum ΔE_2. Then the amplification for the second tube is

$$-i_{p2} R_{L2} = \frac{\Delta E_2}{-G_{M2} R_{L2} - G_{P2} R_{L2} (\Delta E_1/\Delta E_2) = \Delta E_2} \quad (11)$$

$$1 + G_{M2} R_{K2} + G_{P2} R_{L2} \qquad \Delta E_2$$

The loop amplification of the regulator may be calculated by the use of Eqs. 10 and 11. If the bias of V_1 is taken as -0.9 v., the amplification of the input tube is 10, and $\Delta E_2 = 11\Delta E_1$. The amplification of V_2, with a -0.9 v. bias, is 23.4, giving an over-

COLOR CAMERAS TESTED

Color television cameras enter final test stage at RCA's Camden, N. J. plant. These initial commercial models are being shipped to networks and independent TV stations throughout the country

G-CURVES (Cont.)

all feedback path amplification of 258. If, on the other hand, R_{K2} were zero, the overall amplification would be 625.

The control tube itself behaves as a cathode follower with the load serving as the cathode impedance. If the regulator source voltage changes, the regulator action of the amplifier corrects the change. The regulator tube plate current change equation takes the form

$$i_{pc} = G_{Mc}\,[(\Delta E_3/\Delta E_1)\, i_{pc}\, R_{Kc}] + G_{Pc}\,(i_{pc}\, R_{Kc} + \Delta E_p) \qquad (12)$$

where ΔE_p is the plate supply voltage change. The overall load voltage change, $i_{pc}\, R_{Kc}$, is

$$i_{pc}\, R_{Kc} = G_{Pc}\, R_{Kc}\, \Delta E_p / [1 + (\Delta E_3/\Delta E_1)\, G_{Mc}\, R_{Kc} + G_{Pc}\, R_{Kc}] \qquad (13)$$

For a voltage change E_k in the cathode circuit, resulting from any cause, the resulting voltage change produces a compensating change in voltage loss given by

$$\frac{i_{pc}\, R_{Kc}}{\Delta E_k} = \frac{-(\Delta E_3/\Delta E_1)\, G_{Mc}\, R_{Kc} - G_{Pc}\, R_{Kc}}{1 + (\Delta E_3/\Delta E_1)\, G_{Mc}\, R_{Kc} + G_{Pc}\, R_{Kc}} \qquad (14)$$

Choice of a 6AS7 as the regulator tube permits determination of the overall regulation characteristics. The curves on the 6AS7 tube are shown in Fig. 6. If the total cathode current of the 6AS7 tube is taken as 100 ma., with a bias of 30 v. developed by V_2, the required supply voltage is 347 v. for 250 v. output. The effective load impedance is 2500 ohms. Assuming R_{K2} is zero, the cathode load voltage change resulting from a source voltage change of 10 v. is 0.0097 volts. If the voltage change were in the cathode circuit, the compensating change would be approximately 9.999 v., leaving only 1 mv. uncompensated.

If, on the other hand, the load current drops to 50 ma. in the regulator cathode, a regulator bias change of 10.5 v. is required to compensate for the current change if the souce supply voltage does not change. The bias change is read by reading down the 97 plate voltage line of the 6AS7 from 100 ma. to 50 ma. The change in bias is 10.5 v. This 10.5 v. bias change requires a load voltage change of 105 625 or a 17 mv. change in the load voltage.

Normally the regulation of the source supplying the control tube is not ideal, as has been assumed above. The effect of the source supply regulation may be compensated if the voltage against load current characteristic is known. The voltage variation resulting from the

source causes the voltage loss across the control tube to vary. Consequently, a load line on the regulator tube characteristics may be plotted showing he tube voltage loss against tube current. The required bias is determined on the regulator tube load line.

In the problem just considered, assume that the source voltage increased 10 v. when the load current was changed from 100 to 50 ma required to produce constant output. The output voltage change then Eighteen volts change in bias is now is 0.029 v.

Choice of the tube to be used in degenerative amplifier should be made carefully. As can be seen from the examples, the 12BZ7 tube should be one of the tubes considered in the design of triode degenerative amplifiers. High values of transconductance and small values of plate conductance are the preferred parameters for efficient degenerative amplifier and cathode follower design. Degeneration improves the amplifier linearity by limiting the effective transconductance of the tube. The amplification then becomes more dependent on circuit component values than on moderate variations of the tube parameters. The result, where tube ratings are used conservatively, is improved circuit reliability.

The next article in the series takes up the effect of degeneration on the operation of pentode amplifiers. The presence of the screen grid and the resulting current division causes the pentode degenerative amplifier to behave differently in several respects than the triode degenerative amplifier.

Design calculations indicated in the examples in this and other articles of this series assume that, except where noted, uncontrolled parameters (such as stray capacitances or cathode to grid contact potential) may be neglected. If one's design, using the described techniques, appears not to function properly after a careful check of tubes and wiring, one would check for possible interference by these uncontrolled parameters. The contact potential for the 12BZ7 tube, for example, is nearly 1v. Consequently, the minimum grid to cathode bias for the vacuum tube voltmeter input tube would actually have to be approximately 1v. Oscillation may occur in almost any of the circuits having as much complexity as the regulated power supply or the vacuum tube voltmeter.

Manufacturer Offers Custom Facilities

Hi-Spex Manufacturing Co., Inc., 319 Schuyler Ave., Kearney, N.J., announces the availability of custom facilities for the production of precision coils for field windings, filament, solenoids, toroidal, bobbin and electrical assemblies, and transformers, power, audio, choke and specialty from multi-watt up to 5 KVA. Facilities are also available for the manufacture of precision armatures for electronic equipment.

RCA's New 19-inch Color Tube

The recent RCA development of a tricolor kinescope using a 19-in. envelope is scheduled for production in the very near future. A comparison of this new tube's design features with those of the 15GP22, the 15-in. type made available earlier, will highlight modifications required to achieve a large color picture.

The overall length of the 19-in. tube is $26^{15}/_{16}$ in., which is about the same as that of the 15GP22. The larger picture size is obtained by increasing the deflection angle from 45° to 59°. The new picture area, $15^{5}/_{16}$ x $11^{7}/_{8}$ in., is close to 162 sq. in., or almost double that of the 15GP22. Three major features contributed considerably to the good results obtained. These include: A new electron-gun and convergence system, a modified shadow mask design, and improved phosphors.

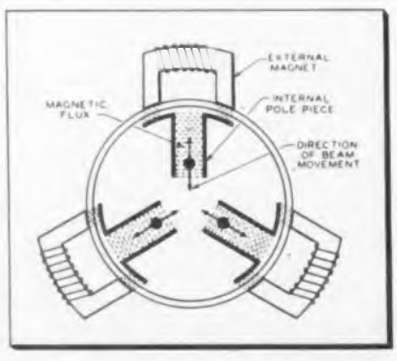
Convergence

Convergence, or the coincidence of the three electron-gun beams at the phosphor dot trio, became increasingly difficult in the 19-in. tube because of the larger deflection angle. As in all three-beam color tubes, to prevent color fringing, the relative angles of the beams must be altered in synchronism with the scanning. This is called dynamic convergence. Unlike the 15-in. tube, special deflection yoke design can no longer adequately reduce the effect of varying convergence displacements, particularly toward the screen edges.

The solution of the convergence problem was obtained by designing a gun which provides for individual convergence control of each beam. The new gun has the same delta-type arrangement of three closely spaced guns as the 15GP22. A major difference is the fact that the 15-in. tube has an electrostatic converging electrode consisting of a 9-kv No. 4 grid is used. It also has a 3-kv grid No. 3.

However, in the 19-in. tube, control of convergence is obtained by magnetic fields formed between each of the three pairs of pole pieces mounted above the ultor 27-kv No. 4 grid. See Fig. 1. The magnetic fields are induced in the pole pieces by three external electromagnets coupled through the glass tube neck. For example, the change in the convergence angle of the green beam is a function only of the current through the corresponding external magnet. For convergence stability at the center of the screen, each of the three guns is tilted slightly over 1°.

Fig. 1: Individual dynamic convergence control



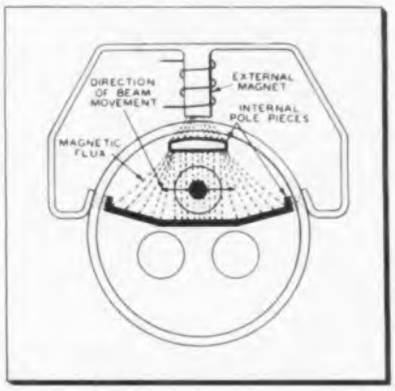


Fig. 2: Blue center convergence corrector

To compensate for small deviations in center convergence due to manufacturing variations, a small dc field is provided by blue corrector poles mounted on the No. 3 grid of the blue gun. See Fig. 2. The resulting tangential movement of the blue beam permits exact center convergence. Because the magnetic convergence is independent of the focusing system in the 19-in. tube, it is no longer necessary to use dynamic focusing. In the 15GP22, the No. 4 grid carried the dynamic focusing and convergence voltages.

Screen Assembly

In the center of the screen, each beam is smaller than the phosphor dot, and lands in the center of the appropriate dot. Toward the edge of the screen, the radial separation of the beams is increased, and the portion of each beam landing on the phosphor dot moves radially outward. If the beam shift is sufficiently great, part of it will fall on an adjacent dot, producing an unwanted color. To prevent this latter effect, the diameter of the apertures in the shadow mask is gradually reduced from the center to the edge, reducing the landing diameter of the beam, and preventing fringing. The resulting increased color purity is accompanied by decreased light output (2:1) toward the edge, but this is not objectionable.

Phosphors

Three improved phosphors are used in the 19-in. tube. The short-persistence

red phosphor (zinc selenide) of improved efficiency results in double the light output of former red phosphors. A more saturated blue phosphor (zinc sulfide) having short persistence is used, as well as a short-persistence green (activated willemite) of good efficiency. This new group of phosphors provides improved efficiency and balance.

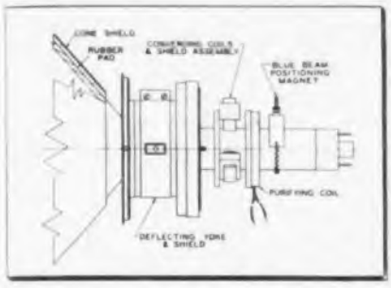


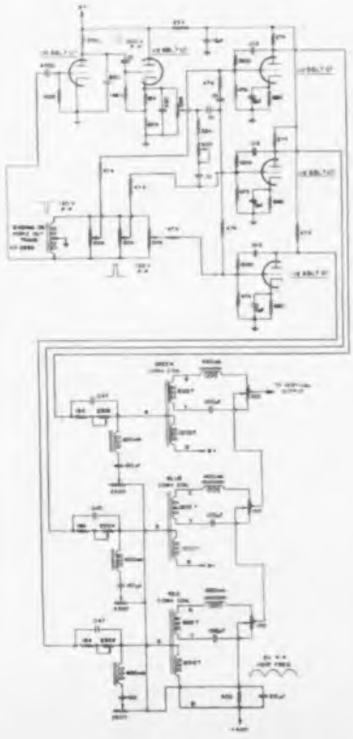
Fig. 3: Components on color picture tube neck

Associated Components

A number of circuit changes have resulted from the increased ultor voltage requirements (27 kv, 700 μa) of the 19-in. electrostatic focus tube, but the deflection circuitry is essentially similar to that used with the 15GP22. The convergence circuit, however, requires more careful attention. See Fig. 4.

The various deflection and convergence components discussed are shown in their final mounting position in Fig. 3. Initially, the same deflection yoke as used on the 15GP22 is employed on the 19-in. kinescope, except that a copper shield is added to keep the magnetic field of the yoke out of the pole-piece region of the gun.

Fig. 4: Experimental convergence circuit



THERMISTORS (*Continued from page 74*)

CPS to develop an input signal. See Fig. 10.

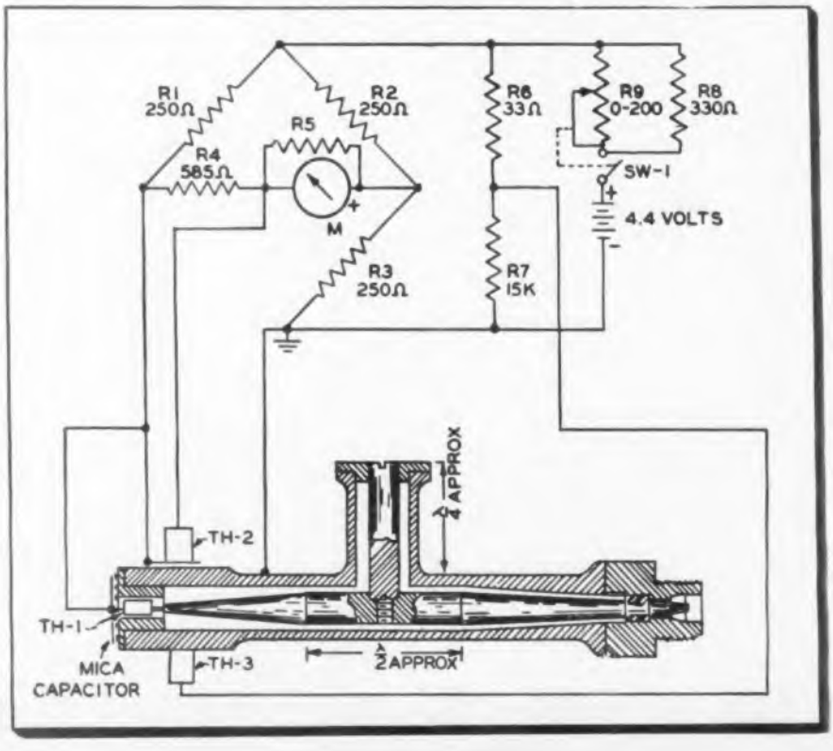
Bead thermistors are a means of measuring microwave power. These stable units are employed in balanced or unbalanced bridges, the latter providing more rapid readings, and terminate the transmission line. After being calibrated for power characteristics with dc or low-frequency power, they are inserted in the coax or waveguide. The currents induced in the thermistor by the r-f causes the resistance to drop, and the resulting meter deflection caused by bridge unbalance is read in terms of power. Such a thermistor, rated say at 20 mw, may be overloaded for a considerable time without affecting calibration.

As with some other thermistor systems, the r-f measuring bridge must be compensated with a second thermistor which maintains the zero point by compensating for changes in ambient temperature. For fine accuracy, a third thermistor may be incorporated to maintain constant sensitivity by offsetting the increased sensitivity which could result at low temperatures. See Fig. 11.

By passing a current through a thermistor sufficient above ambient to heat it, its resistance change will be dependent on how rapidly heat is removed by the environment. In this we have the means for measuring and controlling liquid level humidity, air flow, thermal conductivity, vacuum, and other conditions which can affect the rate of heat transfer to the surrounding medium. In the simplest case, a series of thermistors may be mounted along the wall of a tank and connected in series with a voltage source and meter or control valve actuator (Fig 12). When the liquid in the tank rises, one thermistor after another is immersed, and thereby cooled. The cooling makes the resistance rise, and if the meter is properly calibrated, the lower current reading due to the thermistor's increased resistance will be a measure of the liquid's height.

For the other quantities mentioned, i.e., humidity, thermal conductivity, air flow and vacuum, two heated thermistors in a bridge are used for the instrumentation. (See Fig. 13.) One unit in one arm is sealed in a reference chamber. The thermistor in the adjacent arm is exposed to the open air for an anemometer, in a pipeline for a flow meter, in a gas chamber for a thermal conductivity analyzer, and in a vacuum system for a vacuum gage. These devices utilize both the volt-amp and temperature-resistance characteristic of the thermistor.

Fig. 11: Microwave power measuring system uses three thermistors: TH-1 is r-f sensitive, TH-2 maintains constant sensitivity, and TH-3 compensates for ambient temperature changes



In certain respects, thermistors have properties similar to vacuum tubes in that they can alter the intensity of electrical energy passing through them. The nonlinear volt-amp characteristic may be put to good use to stabilize high and low frequency oscillator amplitude. These oscillators operate on the basis of positive feedback around the vacuum tube. By inserting a thermistor of selected resistance in the feedback circuit, the phase and magnitude of the feedback may be

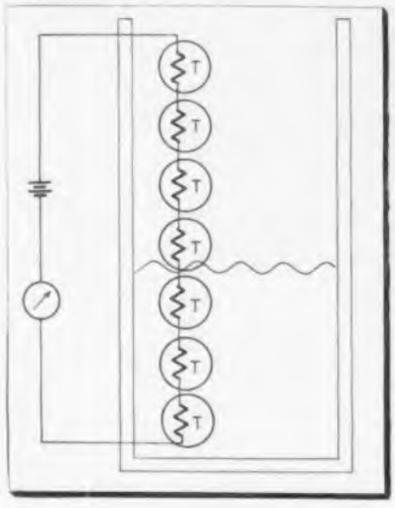


Fig. 12: Liquid level measurement accomplished by series of thermistors. Rising liquid cools thermistors, increasing circuit resistance

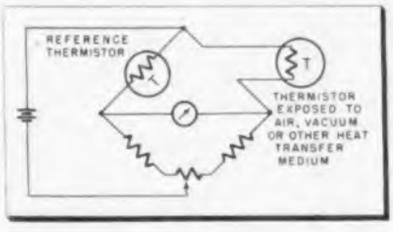


Fig. 13: Humidity, air flow, gas conductivity or vacuum may be measured with bridge containing reference thermistor and similar unit in medium to be measured. Heat transfer is directly related to condition of the medium

controlled. Besides exacting a cost saving, thermistor-controlled oscillators have several advantages over those whose amplitude is limited by vacuum tube nonlinearity. Harmonic content in the output is smaller, and operation is less dependent on variations in individual tube construction and supply voltages. The thermal inertia of the thermistor will easily prevent it from varying at the oscillation frequency for all frequencies down to a fraction of a CPS.

As has been suggested previously, the main point of caution for such

THERMISTORS (Cont.)

an application is to compensate the control thermistor with a second thermistor when ambient temperature may be expected to affect operation. If the control thermistor is a heater type, the compensating unit may be a disc type which controls the heater current from an auxiliary source, keeping the control unit at constant temperature.

Thermal feedback is also useful for amplifier automatic gain control. One method of accomplishing this is to shunt a thermistor across the input, and its heating element across the amplifier output. (See Fig. 14.) If the output power rises to a high level, the heater current will increase, raising the thermistor's temperature. The resulting lower shunt resistance will lower the amplifier input.

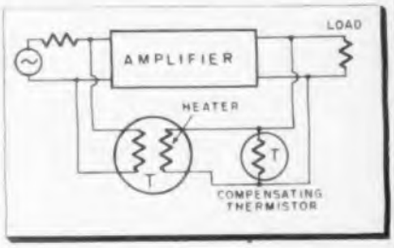


Fig. 14: Thermal feedback applied to amplifier AGC. Increased output causes heater to reduce resistance of thermistor shunted across input. Similar circuit provides overload protection

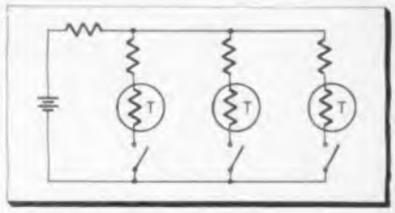


Fig. 15: Thermistor as a lock-out switch

In similar fashion, thermistors may be employed in speech volume limiters, automatic level regulators, expanders and compressors.

The flake type thermistor described previously may be applied to communication and navigation systems. A strong light or infrared signaling source can be read at a considerable distance. For navigation, thermistors can sight the sun through clouds, locate ships, or detect icebergs.

The voltage across a thermistor rises to a peak, and then drops rapidly with an increase in current. This permits applications analagous to those of gas-filled tubes possessing the breakdown voltage charac-

(*Continued on page 175*)

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teristic, making thermistors successful substitutes for lock-in or lock-out switches.

As a lock-in switch, the thermistor is connected in a circuit with normal voltage less than breakdown. By briefly applying a breakdown voltage, a large current is passed, effectively locking in the low voltage circuit until it is opened.

As a lock-out switch, several thermistors may be connected in parallel to a voltage source (Fig. 15). An open key is in series with

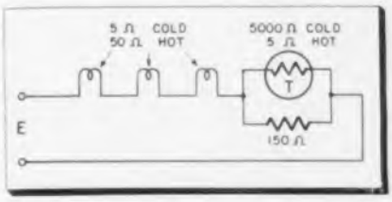

Fig. 16: Thermistor surge protection reduces failures in series tube and lamp filaments

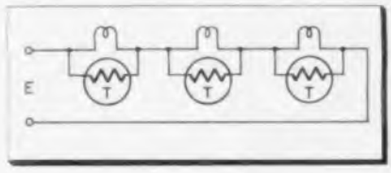

Fig. 17: Shunting thermistors across series lamps permits uninterrupted operation of remaining lamps if one or more units blow out

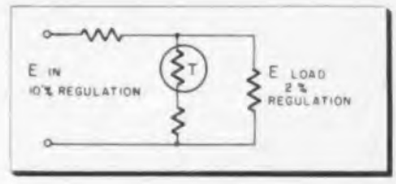

Fig. 18: Voltage regulation effected by thermistor which draws more current if V rises

each unit. As soon as one key is closed, the corresponding thermistor breaks down, causing a large current flow and increased voltage drop across the series source resistor. The voltage is reduced sufficiently so that no other thermistor will break down if their keys are closed until the circuit has been returned to normal voltage. A modification of this arrangement makes possible a voltage selective system.

Protection and Regulation

The same circuit which was described for automatic gain control (Fig. 14) may be applied to overload protection. For such protection, the time constant must be long enough to pass pulses of short duration, and prevent the passage of continuous high level signals.

A simple method of protecting

series lamp indicators or tube heater strings from voltage surges when power is being applied is to connect a parallel thermistor-resistor combination in series with the lamps or filaments. (See Fig. 16.) For illustrative purposes, assume three lamps are in series, each with a cold resistance of 5 ohms and a hot resistance of 50 ohms. If the thermistor cold resistance is 500 ohms and hot resistance 5 ohms, and if the parallel resistor is 150 ohms there will be no initial current peak because total circuit resistance will always be about the same. At the moment the current surge starts, total resistance is 15 ohms for the lamps and almost 150 ohms for the parallel combination, or 165 ohms. After the lamps and thermistor have heated, the resistance is 150 ohms for the lamps and about 5 ohms for the combination, or 155 ohms.

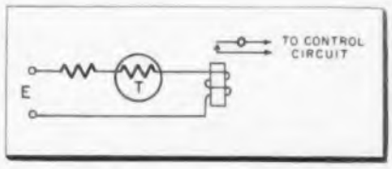

Fig. 19: Thermistor as a time delay control

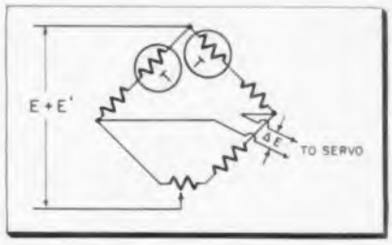

Fig. 20: Servo control with thermistor bridge

Series Lamps

A different approach to series lamps ensures continuous operation even if one or more blow out. In this case a small disc thermistor is connected in parallel across each lamp. (See Fig. 17.) When the lamps are operating normally, the voltage across each thermistor is low and the resistance remains high, having no effect on the lamp. However, if a bulb burns out, the complete line voltage appears across the thermistor, causing it to break down to a resistance as small as that of the lamp, and restoring operation of the other bulbs until the one burned out is replaced.

Thermistors make useful, yet inexpensive, voltage regulators. By

placing one in series with the output resistor, an increase in voltage will make the resistance decrease, maintaining a near constant output voltage across the combined output resistor-thermistor series (Fig. 18).

Timing

Just as the thermistor's thermal inertia and high initial resistance prevent destructive current surges in series tube filaments, these properties may be exploited to delay operation of a circuit. Current rise sufficient to actuate a relay may be delayed from a few milliseconds to several minutes. (See Fig. 19.) The

Fig. 21: Thermistor manufacture at GE

absence of moving parts, coupled with long life and small size have made this thermistor application a very popular one.

The time delay thermistor should be allowed to cool before a second operation, otherwise the second timing interval will be shorter than the first. This may be accomplished by having the working relay short circuit the thermistor when it closes. If the closed relay time is sufficiently great, the thermistor will be available for use as soon as the relay drops out.

To avoid long cooling periods, a cooling time delay method using two relays is also available. Here the thermistor is heated by a large current for a short interval compared to the desired time delay. The current is reduced, and when the thermistor's resistance increases sufficiently it trips the working relay. With this arrangement, the thermistor may be used again immediately.

Servo Control

Two thermistors in opposite arms of a bridge circuit will provide a simple means of detecting voltage changes, and applying a corresponding differential voltage to a remote servo indicator or control. With the bridge balanced at a speci-

fied input voltage, no output will occur. A change in voltage will unbalance the bridge by reducing the thermistor resistances, and produce an output voltage to feed the servo. (See Fig. 20.)

Special thermistors have been made, having extremely short thermal time constants, which may be used as an oscillator, modulator or amplifier, with proper biasing on the negative slope of the volt-amp characteristic. These units are still developmental. Production methods (Fig. 21) of standard types (Fig.22) are gradually being improved.

Applications

The number of possible applications for thermistors is extremely great, and to some extent limited only by the imagination. Thermistors provide one of the simplest means for providing various control and measurement functions. Of course, they may not be used indiscriminately, and care must be taken to account for ambient temperature

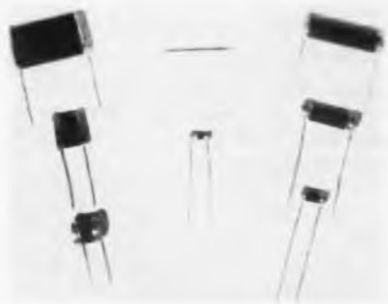

Fig. 22: Thermally sensitive resistors made by Stupakoff are of varied shapes and sizes

changes, self-heating, and other environmental conditions. As engineers become increasingly familiar with thermistor capabilities, we can look forward to very extensive application throughout the electronic industries.

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Dowell, K. P., Thermistors as Components Open Product Design Horizons," *Electrical Manufacturing*, Aug. 1948.

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Metallizing Unit

(*Continued from page 100*)

The rough pumping stage of the cycle automatically begins. A continuously running rotary mechanical pump reduces the pressure to about 200 microns in 2.5 minutes. At this preset time, the oil diffusion pump cuts in automatically to reduce the pressure in the tube to that desired for vaporizing the aluminum to be deposited. This takes four or five minutes.

Next the preset timer trips a switch which passes 25 amps through the filament which extends up through the tube neck. The resulting

Fig. 3: Micrometer setting on sequence timer is adjusted to control duration of flashing

heat melts and vaporizes the short bent strips of aluminum ribbon. At the low pressure now in the chamber, the aluminum takes flight in molecular form, depositing as a thin coating over all of the inner surface of the tube. The duration of the flash is adjustable to give the desired thickness. This coating will provide a brighter picture and prevent phosphor burns.

After flashing the filaments, the timer closes all vacuum valves, breaks the vacuum, and releases the tube, which is lifted by the automatic lowering device. Average length of the complete cycle is about 8 minutes. The overall dimensions of the "package" (see Fig. 3) is 30 x 24 x 33 in.

"Stabilized Germanium"

Sylvania has announced the development of "stabilized germanium" transistors and high temperature germanium-silicon alloys.

Test Tape

(*Continued from page 89*)

total harmonic distortion, which enables the user to determine if the recording level indicated as proper by the recorder's VU meter or glow lamp is in fact the correct volume setting.

To use this test, the tape is played back at a normal volume, and the playback volume control setting at which this is done is carefully marked as zero level. Note the output for this zero level. Then some fresh tape is inserted in the machine, and a 400-cycle tone from a second tape recorder or signal generator is recorded on it at the level indicated as proper by the recorder's meter or lamp. Note that this "proper" level may not yet be the truly correct one.

Level Too High

After the 400-cycle signal is recorded, it must be played back at the volume control setting which was marked zero level during the playing of the test tape. The output should be at the same zero level noted before, if the recording level was correctly adjusted. If it is higher, it means that the recording level was too high, and that 3% distortion has probably been exceeded.

Again a 400-cycle tone is recorded on the fresh tape, only this time at a lower recording level. If the playback output is now zero level, using the playback volume setting first marked zero level, the level at which the fresh tape was recorded is the maximum that all future tapes should be recorded to limit distortion. If the output is still above zero level, the 400-cycle tone is recorded on the fresh tape again, using a still lower than "proper" level, until the output is also zero level.

For those machines which have a VU meter, another 400-cycle tone is provided at exactly 10 db below maximum or zero level to check for proper recording level. This is the correct level at which this test should be made since the tone is virtually undistorted.

Tape Speed

The stretch-proof characteristics of the mylar tape make it possible to space timing beeps accurately at 0, 5 and 10 minutes, and to have them retain their accuracy for measuring tape speed for unlimited replays. With watch in hand, the user simply observes if the second and third beeps come at the correct time after the first. For example, if it took

longer than 5 minutes for the second beep to sound, it means that the tape speed is too slow.

An excellent professional machine should come as close as ±1 second in a 15 minute reel. Some of the cheaper recorders made for the home market have shown speed variations as great as 2 minutes during 10 minutes of play.

Other Audio Test Methods

Historically, it is worth noting that the D-111 is the outgrowth of two similar test discs produced by Dubbings: The D-100 for measuring frequency response, tracking, noise and wow; and the D-101 for measuring and adjusting a phonograph system's equalization, including frequency runs based on Columbia LP, AES, NARTB and RCA's "New Orthophonic."

Another test tape is made as a 7½ ips companion for the D-111. It is the D-110, made of the same Reeves Soundcraft "Lifetime" tape on a 5 inch reel. Besides the different tape speed, the main difference in the tests recorded is the limited frequency response run, which is in keeping with the capabilities of recording at 7½ ips. This test run contains the frequency steps: 30, 50, 100, 200, 400, and 700 cps, and 1, 2, 3, 4, 5, 6, 7.5 kc.

The above tests offer the audio and broadcast engineer a most convenient and accurate means of checking sound equipment and obtaining and maintaining peak perormance.

"EMMY" for NTSC

Dr. W. R. G. Baker, Chairman of the National Television System Committee, (right) receiving the award presented by the Academy of Television Arts And Sciences for the color television work of NTSC. RETMA Director H. L. Hoffman accepted the "Emmy" in Los Angeles in the absence of Dr. Baker. The above presentation took place in New York City at a recent meeting of the RETMA Board of Directors

FM Altimeter

(*Continued from page* 93)

higher altitudes, but it does not provide accurate values of very low altitudes.

The NBS altimeter (Fig. 1) employs a 10,000 MC FM generator and conventional microwave equipment to amplify and radiate the high-frequency energy. A small portion of the transmitted signal is fed through a frequency shifter and is then combined with the signal received from the ground. The frequency shifter may be either an electrical or mechanical device designed to produce a new signal with a frequency displaced by a constant amount (about 100 cycles) from the frequency of the transmitted signal. The combined signals—from the frequency shifter and the ground—are rectified, amplified, and then fed into a counting-averaging mechanism.

Use of Vectors

The operation of the NBS altimeter may be best explained by using vectors. See Fig 2. Consider the maximum amplitude of the carrier signal to be represented by a vector directed vertically (Fig. 3). The received signal becomes an oscillating vector at the tip of the carrier vector. It swings back and forth with an angle wholly dependent upon the distance between the transmitter and the reflecting surface, and at a fixed rate determined by the repetition frequency, f_r, of the transmitter. For short distances this phase excursion through which the vector moves is quite small; for larger distances, the angle increases accordingly. At even larger distances the phase angle may be several multiples of 2π or 360°. The base line around which the vector oscillates is determined by the phase of the carrier wave which strikes the ground. For example, if the phase of the wave at the ground is 45°, 90° or 180° respectively, the vector assumes corresponding base-line positions—the 90-, 180-, or 360-degree axis of the conventional quadrant system.

Oscillating Vector

Besides being controlled by the altitude of the transmitter, the oscillating vector is also affected by the output signal from the frequency shifter in the NBS altimeter. This very low frequency, denoted by f_d, makes the phase vector rotate around the tip of the carrier vector. The signal resulting from the combination and rectification of the carrier vector and the phase vector,

which has both a rapid oscillation and a slow rotation, may be represented by a projection of the phase vector on the carrier vector. The number of oscillations within one period of the recurrence or repetition rate is entirely dependent upon the altitude of the transmitter. If the altitude is low, the phase excursion will also be small, and the projection plotted against time may be but one wave in a period $1/f_r$. For larger distances, the phase excursion will be correspondingly larger, and the number of waves within the same period will be increased.

The major difficulty in using a conventional altimeter occurs at the

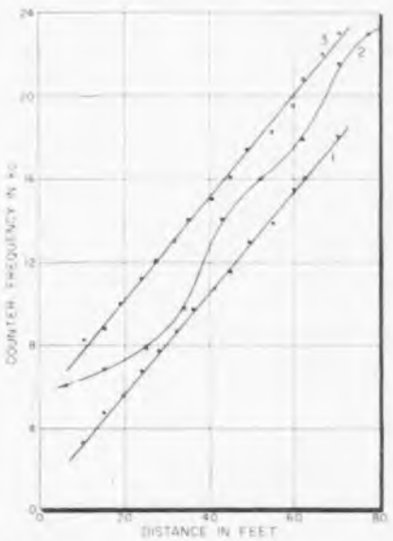


Fig. 5: Output vs distance for (1) amplifier with uniform frequency characteristic (2) amplifier with fd filter (3) amplifier with peaked frequency characteristic

very short distances. If the carrier wave strikes the ground at a point of zero phase, the phase vector will then swing back and forth around what corresponds to the zero-degree position in the quadrant system. The projection of the vector on a time base may be one complete wave in the period $1/f_r$. However, if the altitude is increased by ⅛ wavelength the carrier wave will strike the ground at a 45-degree phase point. The phase vector would then oscillate around the 90-degree position of the quadrant system. The projection of this motion on the time base would be two complete waves. The method for determining altitude is to count the number of waves produced by the projection of the phase vector. Thus, for essentially the same distance as in the first example above there is an ambiguity. Furthermore, at very short distances, for a fixed phase position (for example, zero degrees) the altitude

FM ALTIMETER (Cont.)

may be increased while the number of waves will remain the same. Thus a count of one may correspond to any altitude from 0 to 10 feet or more. At larger distances, a particular count will have this indeterminateness of ten feet; for example, a count of 5 may correspond to any distance between 40 and 50 feet.

Error Correction

The NBS altimeter overcomes these errors by superimposing a slow continuous rotation of the frequency-shifted signal vector, f_d. This causes the phase vector to rotate slowly at an angular velocity $2\pi f_d$ and gives it an average position that is time-dependent. While the phase vector is rotating at a rate f_d it also swings back and forth at a rate f_r. For each oscillation, the phase vector will produce one or two waves as previously. Now, however, in each period of $1/f_d$ second both will occur. The NBS altimeter uses the *average* number of waves to obtain the altitude. The greater the ratio f_r/f_d, the larger the number of counts per $1/f_d$ period. Since many waves are counted the average value can be changed by small fractional increments. In contrast, the count of conventional altimeters can change only by integers.

As the altitude is increased the phase excursion increases. Hence, it is evident that a larger proportion of two counts will be obtained. This increases the average number of counts per $1/f_d$ period. Thus the average count provides a continuous nonquantized indication of altitude.

Three Altimeter Systems

The utilization of frequency shifting and the slow, continuous rotation of the phase vector has led to the development of three altimeter systems. The first employs an amplifier with a uniform frequency characteristic. The detected signal appears as a sine wave of period $1/f_d$ having a train of waves superimposed. The number of waves in the train are dependent upon the altitude. The counter indicating altitude counts the waves having zero-crossings, which is obtained whenever the detected signal voltage becomes zero. Such a value is a function of the angular excursion of the phase vector and the long-time rotation of the frequency-shifted signal f_d. In the NBS system, a linear relationship exists between distance and counting rate, which would be continuously maintained if the fre-

quency shifter produces energy only at a frequency dependent on the *sum* of the carrier and shifted frequencies. However, practical frequency shifters also pass a small amount of energy at the *difference* frequency. This corresponds to a carrier with one or two sidebands separated by the shifted frequency. If this mixture is fed into a rectifier, a signal at the shifted frequency is obtained as long as the amplitude of the desired signal does not exceed the amplitude of the envelope of the undesired mixture. This is similar to the capturing effect in conventional FM receivers and is due to the action of the limiter which is incorporated in the counter.

Low Level Signals

The second system is designed for low signal levels. Here the frequency characteristic of the amplifier must be shaped to eliminate the frequency f_d from the counter. Thus, one would obtain the same series of voltage fluctuations that were previously superimposed on the wave of period $1/f_d$, but with the f_d component filtered out and the voltage axis being the average of all the fluctuations in a period $1/f_r$. The phase vector may be considered as being periodically arrested (Fig. 4) so that it swings back and forth through an angle dependent upon the distance between the transmitter and the ground. The number of counts per repetition period is determined by the crossings between the curve (cyclic fluctuations) and its average value (over each variation per repetition-rate cycle). The height-indicator of an altimeter using this system must be equipped with a dial calibrated according to a nonlinear curve which deviates from linearity only by a small degree and only at the very low altitudes. As compared with standard altimeters, the only additional components are the frequency shifter, which is inserted between the power oscillator and the mixer, and the recalibrated dial-indicator.

Interference Suppression

The third system suppresses interference from the leakage signals at frequency f_d by using an amplifier whose gain is proportional to frequency. The output caused by the low frequency, f_d, is very small while the high-frequency fluctuations are accentuated. Because every wave can now be counted, a linear relationship between distance and counting rate is obtained. See Fig. 5 for output curves for various systems.

Synchrocyclotron

(*Continued from page* 100)

The rotor and dee must be supported by insulators since there are no possible support points which are always at radiofrequency ground potential. The insulators are all exposed on one side to the atmosphere to dissipate the radiofrequency heating, necessitating the use of long support rods to reach from the dee and rotor to the insulator caps. The insulators are made of low loss steatite and are designed for operation, with convection air cooling, to 40 kv of dee voltage and, with forced air cooling, to 60 kv.

The support rods enter into the resonant standing wave pattern and thus have currents flowing into them from the rotor and dee. In all cases provisions have been made for a good current path into the support rods. Closed loops at the base of support rods have been studiously avoided. Brushes have been provided to shunt r-f around the rotor bearings to prevent damaging arcs in the bearings and so to assure reasonable bearing live.

Tank Interiors

The interiors of all vacuum tanks are lined with copper sheet where they face the dee, rotor, or stub line, providing a continuous current path. Above and below the rotary condenser a set of copper skins is placed considerably closer to the condenser than the copper liners on the tank wall. This reduces the inductance which appears in series with the condenser and allows the line to resonate at frequencies high enough to start the proton range. In order to cover the deuteron range, the skin below the condenser is lowered and a gap is opened in the skin above the condenser. These changes were made from outside without breaking the vacuum.

Water cooling is provided for all support rods and tank liners, and the stub line, rotor, and dee. Water for those parts not at radiofrequency ground potential is brought in through the hollow support rods. This water cooling contributes to the stability of the machine by keeping small the mechanical distortions which even moderate temperature changes can induce. In addition, it holds down the temperature of the r-f system so that operation is not often interrupted by gas bursts and discharges.

The oscillator tube is operated with the grid grounded. Its housing is divided into an upper or cathode

section, and a lower or anode section to guarantee minimum coupling between these electrodes. The cathode drive is supplied by a coaxial line coming through the top of the house, and the plate load is driven by a coaxial line coming out of one side. The box is mounted on wheels and tracks in order to move it to facilitate servicing other parts of the machine. Water, high voltage, and control wiring connections are easily removable.

Air-cooled Triode

The tube used is an RCA type 5770 thoriated-tungsten filament water-and air-cooled triode especially designed for grounded grid operation. This tube has a plate dissipation rating of 40 kw at 30 mc. It is mounted in a ½-inch thick mild steel jacket to provide magnetic shielding against the stray field of the cyclotron magnet which is about 300 gauss at this point. Cooling is provided through a water coil made of two 20-foot lengths of 1-inch nylon jacketed Tygon tubing wound on an insulating support. Air blowers are provided to cool the plate, filament, and grid seals.

Vacuum condensers were originally used for plate blocking, grid grounding and cathode phasing purposes, as they would be expected to provide the high current, high voltage, and low inductance characteristics which these services require. When trouble was experienced with voltage breakdown of the plate blocking condenser, the vacuum condensers were replaced with ceramic condensers. Eight 500-μμf, 15,000-volt, units are used in parallel. The vacuum condensers used for grid-grounding were replaced by a homemade parallel plate condenser using Teflon insulation in order to eliminate resonances in the old arrangement. The photograph of Figure 3 was taken before these changes were made.

Oscillator Power Supply

The oscillator power supply is rated at 200 kw and can deliver 11.5 amperes at 17.4 kv. The voltage is continuously variable from about 1 kv to maximum at rated current. The rectifier output is filtered through a choke input filter with 58 μf of output capacity to reduce supply droop during pulsed operation. A 70-ohm resistor is placed in series with the output, in order to protect the 5770 oscillator tube from flash-arc damage by limiting the arc current until the supply breaker

trips and thus limiting the energy dissipated in the tube.

The plate coupling line of 42-ohm characteristic impedance is built from 4-inch circular copper tubing inside an 8-inch circular tube and includes a replaceable strap in the plate line box, where the plate line enters the stub tank. This box amounts to a non-uniform section of line which may be adjusted to give roughly the same effect as changing the line length. The cathode coupling line consists, outside the vacuum tank, of 6-inch circular conductor inside an 8-inch square box. Inside the vacuum tank, it is a 4-inch in 6-inch coaxial line. It has sufficient cross-section to handle the 300-ampere filament current for the oscillator tube, allowing the elimination of one filament choke.

Oscillator Pulser

A number of factors make it desirable to turn on the oscillator only during those portions of the frequency modulation cycle which are actually required for acceleration. The most important of these is that during certain parts of the condenser cycle the system tends to go into undesired modes of oscillation outside the useful frequency range, frequently failing to return to the proper mode in time to start ion acceleration at the high frequency end of the range. An additional result of these parasitic modes is the heating of parts of the system in the vacuum and the consequent evolution of gas. A pulser has therefore been provided to turn the oscillator on and off at appropriate times.

Timing signals for operating the pulser are obtained from two photomultipliers which look at a mirror mounted on the rotary condenser shaft. The mirror has six sides, corresponding to the six sets of blades on the rotor, and is fixed with respect to the blades. The photomultiplier housings are mounted on carriages which move on a semicircular track concentric with the rotor shaft. The carriages are driven by selsyns operated from the control room and their position is indicated by a device to be described later. Cathode followers are built into the photomultiplier housings and the output sent through coaxial cable to the control room. There the two pulses are used, after amplification and shaping, to start and end a control multivibrator pulse. An additional multivibrator is provided

which puts out a pulse an adjustable time after the "on" photomultiplier pulse. This pulse will turn off the control multivibrator in the absence of a pulse from the "off" photomultiplier. The output of the control multivibrator is fed through a cathode follower to the pulser cabinet in the cyclotron pit. In this cabinet is located a 5.4 MC oscillator using a 6V6 which feeds a keyed buffer using a 6L6 which in turn feeds an 807 power amplifier. The control multivibrator pulse is fed through a 6V6 amplifier to the cathode of the keyed buffer, allowing it to amplify the 5.4 MC signal and drive the power amplifier. A switch is provided to ground the buffer cathode, permitting it to operate continuously.

The grid of the oscillator tube is

(*Continued on page* 190)

E. P. Gertsch Named President of WCEMA

E. P. Gertsch, owner and president of Gertsch Products, Inc., 11846 Mississippi Avenue, Los Angeles, Calif., has been selected president of

E. P. Gertsch

WCEMA (West Coast Electronic Manufacturers' Association) for 1954. He is one of the founders of WCEMA and has been an active leader in the association since its birth eleven years ago. He has served on the Board of Directors as Vice-Chairman of the Los Angeles Council in 1952, and as chairman of the first WCEMA Scholarship Committee. He was recently elected chairman of the 1954 Executive Committee for the Los Angeles Council.

Prior to organizing his own company, Mr. Gertsch had a long record of experience in the electronic field, having held management posts with Hoffman Radio Corp., Air Associates, and Radio Corporation of America.

normally held at about minus 1200 volts by a separate bias supply. During the pulse, this bias is overcome by the voltage developed across the cathode resistor of the pulsing tube. The pulsing tube, for which three 304TL's in parallel are used, is driven by the rectified voltage from a tuned circuit inductively coupled to the 807 power amplifier. This arrangement is used so that the low level stages are not required to operate at oscillator bias potential. Suitably insulated power supplies are of course required and interlocks are provided to insure that plate voltage cannot be supplied to the cyclotron oscillator unless all required voltages are present in the pulser. A block diagram of the pulser system is shown in Fig. 2.

Pulser Controller

After the cyclotron has been in operation for some time, it became apparent that it would be desirable to provide means for operating under conditions other than the normal 50 or 60 pulses per second. A circuit was therefore designed which could be inserted between the "on" photomultiplier and the pulser to provide several modes of operation. The modes selected were the following: 1) normal continuous operation 2) n pulses per control pulse, and 3) 1 pulse each n control pulses, where n is any power of two from zero to five. In addition, a time clock was provided which could be used to determine the length of operating time under the first and third modes. The control pulses referred to may be supplied from an external source, for example a piece of experimental apparatus, or from a one-second pulser which was already available in the machine. The cyclotron cannot of course be pulsed directly by the control pulses because of the requirement that it come on at the proper part of the condenser rotation cycle. It is however pulsed at the proper time in the first cycle following the control pulse. Two output channels are provided, one for triggering the cyclotron and one for triggering experimental apparatus, if desired. A block diagram of this unit is shown in Fig. 3.

The "on" photomultiplier pulse is amplified and inverted in cathode follower-inverter 1 and used to trigger blocking oscillator 1. The blocking oscillator pulse is fed through cathode follower 2 to the main gate 1. Pulses passed by the

main gate trigger blocking oscillator 2 which drives the output cathode followers 3 and 4. Control pulses are formed in a one-shot multivibrator 2 and applied to gates 2 and 3. For continuous operation gate 2 is opened, turning on control flip-flop 1. For the second type of operation, n pulses per control pulse, gate 2 is again opened. Gates 4 and 6 are also opened. Pulses from blocking oscillator 2 are now fed through cathode follower 5 and gate 4 into the scaler unit. The scaler counts to n and then sends a pulse through inverter 6 and gate 6 to turn off control flip-flop 1. This cycle is repeated for each control pulse. For the third mode of operation, one pulse each n control pulses, gates 3, 5 and 7 are opened. Control pulses go through gate 3 to the scaler which counts n of them and then sends a pulse through gate 5 to turn on the control flip-flop. The output pulse from blocking oscillator 2 is then fed through cathode follower 5 and gate 7 back to the control flip-flop to turn it off.

This circuit was built using standardized single-stage plug-in units. These units have proven very satisfactory from a maintenance point of view and are designed in such a way that they should be useful in future circuits.

Operating Characteristics

It has been known for some time that r-f systems of this sort have operating difficulties at practical vacuums due to ion loading. These troubles are caused by ions that find themselves between the high voltage components and grounded surfaces and oscillate under the influence of the electric field. During the course of their oscillations they ionize additional gas molecules until the loading on the oscillator is so severe that it refuses to continue in oscillation. The remedy for this condition is to bias the components of the system and thereby get rid of the ions. This is done in the case of the dee and the condenser rotor. The grounded stub line cannot be biased, however, so an arrangement of so-called clearing wires and skins is provided in the region between the stub line and the ground skin. These clearing wires are isolated from both stub and ground and are biased. Care must be exercised to avoid resonances in the clearing wires at frequencies covered by the oscillator as such a resonance could easily destroy a set of mounting insulators. The biases for the rotor, dee, and clearing wires are supplied from 300 ma

rectifiers adjustable from 0-3 kv negative, and are applied through 7000-ohm resistors. In addition, each clearing wire is decoupled from the set of clearing wires by an individual 5000-ohm resistor. This serves to leave some voltage on the rest of the wires if one is shorted or grounded through a gas-arc. Bias voltages are supplied to the rotor and dee through choke coils which are grounded to r-f by large condensers.

Once the clearing system for the stub was adequately worked out, operation of the oscillator followed directly. The oscillator normally operates with an anode voltage of about 10 kv. At this voltage there is an average plate current of about 1.5 amperes and about a half ampere of grid current. The input to the oscillator during the pulse is approximately 40 kw. About 5% of the power appears in the ions which strike the target.

Parasitic Modes

There are still indications of parasitic modes which are capable of destroying associated equipment, though no serious trouble has ever been encountered. All parasitics which have been observed are at frequencies higher than the usable range, so techniques which discourage higher frequency modes are useful. No wave traps are required.

The operation of the oscillator is quite stable, none of the adjustments being very critical. This is probably due in large part to the high impedance into which it operates. A consequence of this is that although the oscillator operates at high efficiency, it does not deliver as much power to the dee as it might.

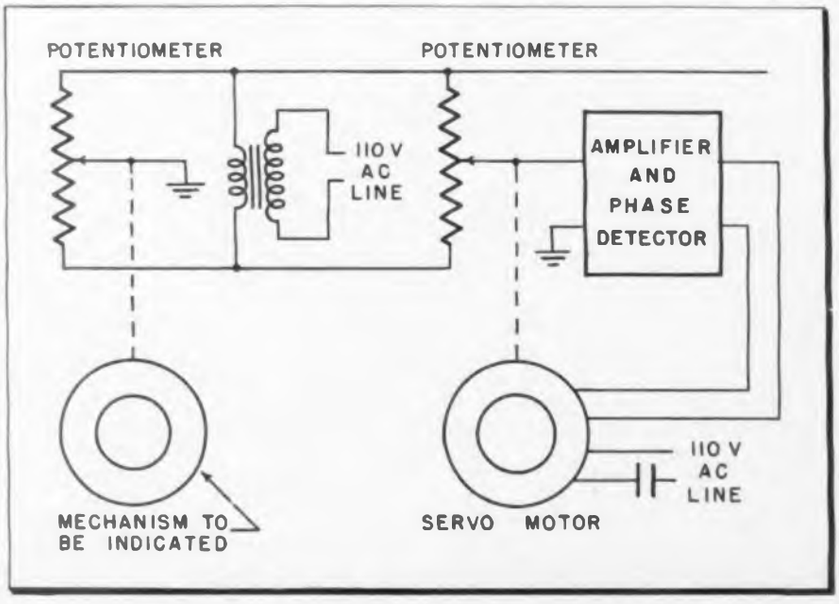
Magnet Current Regulator

The energy of the protons at any radius and frequency is directly related to the magnetic field. Close regulation of the field is therefore essential. At the time work was started on this machine, the necessary degree of current regulation required was not known, and 0.1% was arbitrarily adopted as a design value. Subsequent experience has shown that somewhat poorer regulation can be tolerated.

The magnet is powered by a 1000 kw motor generator set rated at 275 volts, 3636 amperes with an overload rating of 25%. The regulator was designed to provide a direct-reading setting at any value from zero to 5000 amperes, positive or negative. Tests indicated that the control was capable of maintaining an accuracy of one or two amperes over extremely long periods of time.

A block diagram of the regulator is shown in Fig. 4. A voltage corresponding to the magnet current is obtained from a 100-mv shunt in the magnet circuit. This voltage is bucked against the voltage from a reference potentiometer on the control console. The difference voltage, which is proportional to the error in magnet current, is chopped by a 60 cycle Brown Converter, ampli-

Fig. 5: One of two channels in position indicator. Only two leads are required to remote unit



fied, demodulated, and applied to one control field of a 150-watt amplidyne. A second control field on the amplidyne is supplied by an adjustable reference field voltage and the amplidyne output fed to the field of the generator exciter. The amplidyne used was selected because it was readily available at low cost from surplus dealers. A better arrangement would have been to use a larger amplidyne and eliminate the exciter.

Reference Potentiometer

The reference potentiometer utilizes a 10-turn Helipot as the continuously variable element with ranges selected by a 6-point switch. By proper selection of constants the interval between successive ranges is 20 mv, which is the voltage produced across the shunt by 1000 amperes. The Helipot also covers a range of 20 mv and is provided with a 1000-division Duodial so that any current may be selected by adding the Helipot reading to the range switch setting. The potentiometer draws 0.2 milliamperes and is powered by a dry cell. A Weston standard cell and a galvanometer are included for standardizing. The battery current is left on at all times. As a result of this precaution and of the fact that the control room temperature is kept fairly constant, standardizing is required at very infrequent intervals, perhaps weekly, or even less often.

Electrostatic Shield

The potentiometer output is connected in series opposition with the voltage from the shunt. This shunt is connected to the control room by a long shielded lead (200 feet) with the shield grounded at the shunt. The error voltage is connected to one contact of the Brown Converter and the other contact is grounded. An input transformer is connected between the leaf of the Brown Converter and ground. In order to avoid difficulty with noise pick-up, the shield of the shunt lead is used as the ground for the entire input circuit. As a result, very little voltage is picked up between input leads (about 10 μv) although the whole input circuit goes up and down about 0.1 volt with respect to ground. Disturbance because of this effect is avoided by an electrostatic shield in the input transformer.

The amplifier proper consists of two pentode stages and a high gain triode directly coupled to a cathode follower which drives a push-pull

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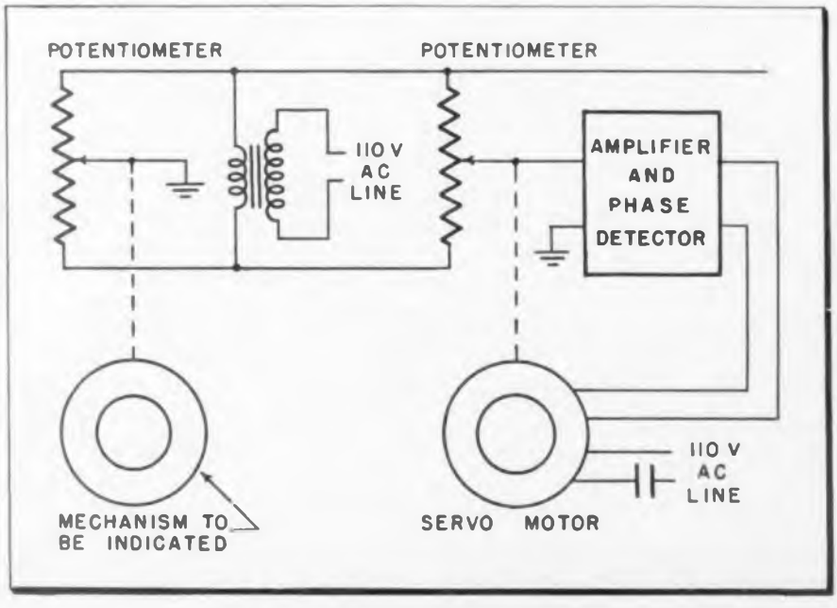

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The amplifier proper consists of two pentode stages and a high gain triode directly coupled to a cathode follower which drives a push-pull

output stage through an interstage transformer. The output is then transformer coupled to the demodulator. The demodulator is a ring type demodulator with input and output impedances of 500 ohms. It is supplied with 60-cycle switching voltage through a transformer and variable phase shifting network. The galvanometer used for standardizing the reference potentiometer is also used, through a suitable series resistor, to measure the demodulator output voltage which is applied to the amplidyne field. The reference field voltage is supplied by a separate rectifier and is adjusted by a voltage divider consisting of a potentiometer and a set of resistors selected by a switch ganged with the current selecting range switch. The procedure on operating is to adjust the reference field potentiometer so that the amplifier output, as shown on the galvanometer, is approximately zero. Coarse adjustment of this is done automatically by the range switch. Under this condition the regulator operates essentially as a null device. No trouble has been experienced with this unit in almost four years of operation.

Position Indicator

It was apparent early in the design of the cyclotron that a device would be required to indicate in the control room the position of certain remotely controlled components. Such a device has been built and installed and consists of two separate channels each of which has a ten position switch for selecting the component to be indicated.

A block diagram of one channel is shown in Fig. 5. The system is a null type servo system employing two Helipots, one mechanically driven by the component to be indicated and one driven by a servomotor. Both Helipots are energized through a transformer from the 110-volt 60-cycle line. The moveable arm of the remote Helipot is grounded and an amplifier is connected between that of the local Helipot and ground. The amplifier output is fed to a phase-sensitive power amplifier and then to the control field of the servo motor. The Helipots are all 10,000 ohm units, one of the local ones having 10 turns and the other 25. The remote Helipot would normally have the same number of turns as the local one, but this is not a necessary condition. Neither is it necessary that they have the same resistance. The

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- An attenuator whose performance is free of frequency distortion, providing an output Envelope flat to within ± 1 db over the maximum sweep range.
- Separate examination of either the positive or negative envelope by front panel control.
- Durable, compact, lightweight Output and Detector Probes.

Descriptive Specifications

MODEL	FREQUENCY MARKER RANGE	SWEEPWIDTH CONTINUOUS ADJUSTMENT	RF OUTPUT 50 OHM * TERMINATION
SM I	100 KC to 11 MC	150 KC to 14 MC	1 Volt RMS
SM II	500 KC to 50 MC	150 KC to 20 MC	0.1 Volt RMS
SM III	500 KC to 75 MC	150 KC to 20 MC	0.1 Volt RMS

*75 ohm available when specified

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To meet the needs of electronic equipment manufacturers for rugged, reliable, and accurate solid ultrasonic delay lines, we can now supply Corning Fused Silica Delay Lines designed and manufactured to your own specifications within the following ranges.

Delay Time	100 to 3000 microseconds within very close limits
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Bandwidths	Greater than 50% of carrier frequency are possible
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For further details, write to Department TT-4.

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SYNCHROCYCLOTRON (Cont.)

local Helipot has double shaft extensions, coupling on one end to the motor and on the other end to a suitable Duodial which is used as an indicator. The position is therefore readable to one part in 1000 or 2500, depending upon the channel, and may be estimated to twice this accuracy. The sensitivity of the system is great enough that the reproducibility is limited primarily by the number of turns of wire on the Helipot (about 10,000). The absolute accuracy is limited by the linearity of the Helipots, which is 1% for two Helipots, but this is not an important limitation since most of the units to be monitored are non-linear functions of the angle of rotation. A great advantage of this system is that only two leads are required to the remote unit and noise pickup is non-existent.

Beam Monitoring

Two means are provided for routine beam monitoring. The first is a large high pressure ionization chamber having a volume of about 1.9 cu. ft. and operating at 30 atmospheres. This chamber is placed well out of the ion beam, but in such a position as to monitor the general background radiation. The ion chamber current is measured by a balanced cathode follower electrometer feeding a 100-mv circular chart recorder. Relay switching of the electrometer grid resistor provides three ranges of sensitivity. Quite high sensitivity is possible with this arrangement and for preliminary adjustment of the machine a full scale range of about 10^{-10} amperes was used. Present ranges are 10^{-8}, 10^{-6} and 10^{-5} amperes full scale. This unit is battery operated, except for the recorder, and is very stable. The monitor reading is, however, sensitive to direction of beam rotation and target arrangements.

Second Monitoring System

The second monitoring system is useful only with a target such as is used for production of mesons or neutrons, but under these conditions measures a quantity directly proportional to beam intensity. In this system the target is mounted on a small heat leak which is attached to a large thermal radiator. Temperature differences across the heat leak are measured by a thermocouple and recorded on a strip-chart recorder. Since the energy loss in the target can be computed and the target thermally calibrated, a fairly

good measurement of beam current can be obtained. Outputs from the thermocouple are of the order of 10 mv which can be easily measured.

Since the thermal system has a time constant of the order of 2-10 minutes, depending on the construction, the response of the monitoring system is very slow. This difficulty has been overcome by the construction of a computing circuit which adds to the thermocouple voltage a voltage proportional to its derivative. This circuit has been described elsewhere.[8]

Many other items of electronics equipment of a fairly standard nature are used for a particle accelerator. Among these might be included power supplies, vacuum measuring equipment, portable radiation monitoring equipment and test equipment. Experimental apparatus, which is beyond the scope of this paper, uses a great deal of electronics, some of standard design but most quite novel and interesting. Several of these items are described in the subsequent papers.

Acknowledgment

Most of the equipment described in this paper is not the work of any one person but is the result of the cooperation of a group too numerous to mention individually working under the direction and guidance of Professor H. L. Anderson. The project has been supported in large part by the Office of Naval Research and the Atomic Energy Commission and has had the very substantial backing of the facilities and personnel of The University of Chicago.

This paper was presented at the 1953 National Electronics Conference held in Chicago.

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Compatible Color Signal

(*Continued from page 82*)

mer, as in Fig. 3, should be equal. Solving,

$$E'_Q \cos 33^\circ - E'_I \cos 57^\circ = 0.49 (E'_B - E'_Y)$$

$$E'_Q \cos 57^\circ + E'_I \cos 33^\circ = 0.88 (E'_B - E'_Y)$$

and,

$$E'_Q = 0.48 (E'_B - E'_Y) + 0.41 (E'_B - E'_Y) \quad (6)$$

Similarly,

$$E'_I = 0.74 (E'_B - E'_Y - 0.27 (E'_B - E'_Y) \quad (7)$$

Therefore, as long as operation is below 0.5 mc, where both E'_I and E'_Q are present, the chrominance portion of the video signal is alike, whether mathematically expressed in terms of E'_I and E'_Q or in terms of $(E'_B - E'_Y$ and $(E'_B - E'_Y)$.

The three independent signals E'_Y, E'_I, and E'_Q are sent through a phase correction network which provides NTSC specified compensation in the video signal for errors which will be produced by the transmitter and receiver. These departures from constancy of time delay arise from vestigial sideband operation and from the high frequency cut-off characteristics in typical receivers. As is to be expected, uniform time delay of picture display information is of even greater importance in color receivers than it is in black and white.

Complete Video Signal

The complete video signal may be expressed in the form:

$$E_M = E'_Y + [E'_Q \sin (\omega t + 33^\circ) + E'_I \cos (\omega t + 33^\circ)] \quad (8)$$

where the reference vector, sine wt, is taken as 180° rotated away from the reference burst. Fig. 3 illustrates this relationship. As has been shown, below 0.5 mc, the video signal may also be represented in the form,

$$E_M = E'_Y + \left[\frac{1}{2.03}(E'_B - E'_Y) \sin \omega t + \frac{1}{1.14}(E'_R - E'_Y) \cos \omega t\right] \quad (9)$$

This video signal is then fed to the transmitter where it modulates the r-f carrier in the normal manner and is eventually radiated through the antenna.

Some mention should be made of the choice of frequencies for the color subcarrier, and the horizontal and vertical scanning circuits. It is desired to have the color subcarrier

COMPATIBLE COLOR SIGNAL (Cont.)

frequency a high odd harmonic (455) of half the horizontal scanning frequency.

$$f_{cs} = 455\ f_H/2 \qquad (10)$$

To minimize the appearance on the receiver kinescope of the beat frequency (approximately 920 kc) between the color subcarrier and the 4.5 mc intercarrier sound frequencies, use is again made of the low visibility principle:

$$4.5\text{ mc} - f_{cs} = (2n + 1)\, f_H/2 \qquad (11)$$

Substituting Eq. (10) in (11),

$$f_H = \frac{9\text{ mc}}{(2\,n + 1) + 455} \qquad (12)$$

By arithmetic inspection of (12), when $n = 58$, f_H is closest to its 15,750 cps value in black-and-white TV. When $n = 58$,

$$f_H = 15{,}734^{+}\text{ cps} \qquad (13)$$

Since

$$f_H = \frac{525}{2} f_v \qquad (14)$$

From Eq. (13) and (10),

$$f_v = 59.9\text{ cps} \qquad (15)$$

$$f_{cs} = 3.579545\text{ mc} \qquad (16)$$

Human Engineering Institute Course

Dunlap and Associates will offer another Human Engineering Course during week of May 10, 1954, in Stamford, Conn. Course will deal with equipment and product design in connection with human limitations. Enrollment deadline is April 15, and is limited to approximately 16 people. Tuition fee is $300. For further information contact: Dr. Bernard J. Covner, Director, Human Engineering Institute, 429 Atlantic St., Stamford, Conn.

Librascope Acquires Minnesota Electronics

Librascope, Inc. of Glendale, Calif., a subsidiary of General Precision Equipment Corp., has acquired Minnesota Electronics Corp. of St. Paul, Minn., manufacturers of digital computers and components.

Minnesota Electronics has recently developed "sub-miniature magnetic decision elements" which will be used in combination with Librascope's computer techniques.

Minnesota Electronics will continue to operate with its present management and personnel.

INDUSTRY NEWS

(*Continued from page* 158)

Bert Rice has been promoted to district manager in the CBS-Columbia national sales organization. Formerly, he was sales manager for CBS-Columbia Distributors, Inc., New York City distributor. In his new post, he will cover distributors in Newark, Philadelphia, Baltimore, Washington, Norfolk, and Roanoke.

Leroy L. Emmel, Christian J. Goodman, and **Jon B. Jolly** have been appointed to the new field sales engineering staff covering the germanium products of General Electric Electronics Div. They will make their headquarters at 200 Main Ave., Clifton, N. J. **Harvey F. Hodsdon, Vincent J. Huntoon,** and **Albert C. Oeinck,** also appointed to the germanium products staff, will make their headquarters at 3800 North Milwaukee Ave., Chicago, Ill.

Leo Kagan has been elected vice-president in charge of sales of Elco Corporation, Philadelphia, Pa. Prior to his association with Elco in 1952, Mr. Kagan

Leo Kagan

had been assistant New York sales manager of Zenith Corp., district manager of Bendix Home Appliance Department for Bruno of New York, and divisional sales manager for Woodstock typewriters.

Robert L. Unger was recently made director of industrial relations for Hoffman Radio Corporation's TV division. He will maintain headquarters in Los Angeles and has appointed **William Cecil** of Kansas City as personnel manager of the company's new factory in that city.

Seymour Mintz, former vice-president of the Admiral Corp., Chicago, Ill., has been appointed president of CBS-Columbia, TV and radio receiver manufacturing division of Columbia Broadcasting System Inc. Mr. Mintz has also been elected member of the CBS Board of Directors, and vice-president of the parent company.

TELE-TECH ADVERTISERS — APRIL, 1954

INDUSTRY NEWS

(Continued from page 204)

C. H. Hartley has been appointed sales director of Servomechanisms, Inc. Mr. Hartley is now located at the company's corporate offices in Garden City, New York. In his new capacity he will co-

C. H. Hartley

ordinate the overall sales and promotional efforts of the company's three United States divisions and its Canadian subsidiary, Industrial Electronics of Canada, Ltd.

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HYDROGEN THYRATRONS — Bomac offers a complete line for use as switch tubes in line type modulators for pulsing magnetrons in radar equipment. Also used for precise triggering at high power levels.

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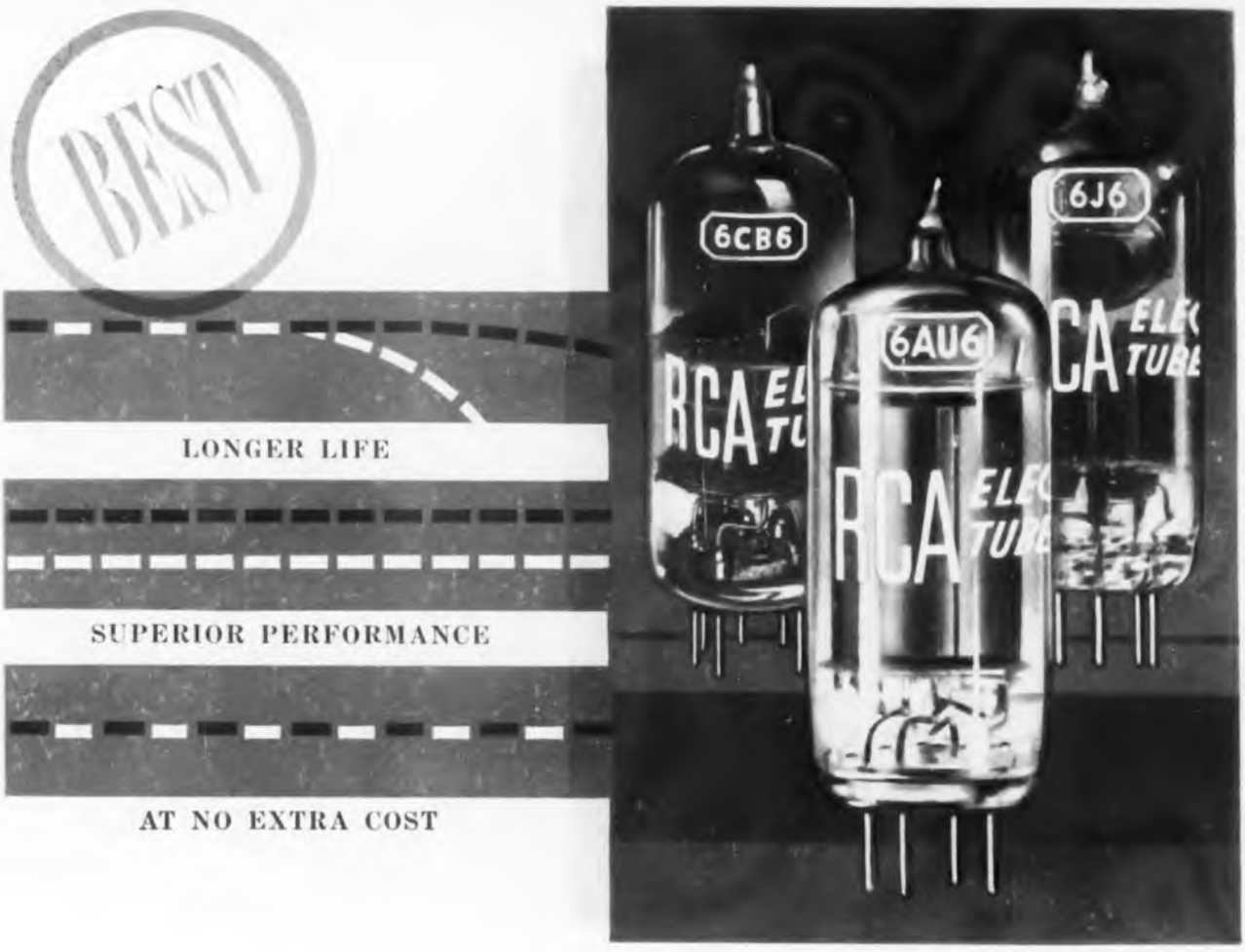

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TELE-TECH
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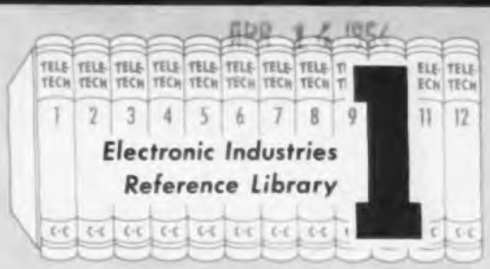

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A ROSTER OF ASSOCIATIONS IN THE ELECTRONIC INDUSTRIES

The lasting impact of the vacuum tube on modern industry is second only to that of the introduction of the wheel, in its influence on man's welfare. Today, electronic apparatus bisects every industry. Primary and marginal engineering associations are blazing new trails in electronics. This review of important associations in or allied to the electronic industries is another of TELE-TECH's many "Firsts" in subjects of major interest to the field.

ACOUSTICAL SOCIETY OF AMERICA — 1800 Members — 57 E. 55th St., New York, N. Y. EL 5-5850 . . . Hallowell Davis, Pres; Wallace Waterfall, Secy . . . Annual Conv. June 23-26; No exhibits . . . Conv. location: Statler Hotel, New York City . . . To disseminate information on the subject of acoustics and to promote practical applications.

AMERICAN ASSOCIATION OF ENGINEERS — 6000 Members — 8 S. Michigan Ave., Chicago 3, Ill. RA 6-9085 . . . P. J. Lucey, Pres; M. E. McIver, Secy . . . Annual Conv. November; No exhibits . . . Conv. location: Undetermined . . . Promote social and economic welfare of the engineering profession and the professional engineer.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS — 46,906 Members—33 W. 39th St., New York, N. Y. PE 6-9220 . . . E. B. Robertson, Pres; H. H. Henline, Secy . . . Regional meetings: May 5-7 Van Curler Hotel, Schenectady, N. Y.; June 21-25 Hotel Biltmore, Los Angeles, Calif.; Oct. 5-7 Abraham Lincoln Hotel, Reading, Pa.; Oct. 11-15 Hotel Morrison, Chicago, Ill. Advancement of theory and practice of electrical engineering and of allied arts and sciences.

AMERICAN PHYSICAL SOCIETY — 11,200 Members — Columbia University, Broadway & 116th St., New York, N. Y. UN 5-4000 . . . H. A. Bethe, Pres; K. K. Darrow, Secy . . . Annual Conv. January 1955; Exhibits: Undetermined . . . Conv. location: Statler Hotel . . . Advancement and diffusion of the knowledge of physics.

AMERICAN RADIO RELAY LEAGUE — 60,000 Members — 38 LaSalle Rd., W. Hartford 7, Conn. Adams 3-6268 . . . G. L. Dosland, Pres; A. L. Budlong, Secy . . . Annual Conv. Undetermined . . . Association of amateur radio operators.

AMERICAN SOCIETY FOR QUALITY CONTROL—7,500 Members — 70 E. 45th St., New York 17, N. Y. ORegon 9-2784 . . . A. L. Davis, Pres; D. Shainin, Secy . . . Annual Conv. June 9-11; Exhibits . . . Conv. location: St. Louis, Mo. . . . Advancement and diffusion of knowledge of the science of quality control and its application to industrial processes.

AMERICAN SOCIETY FOR TESTING MATERIALS — 10,000 Members — 1916 Race St., Philadelphia 3, Pa. RI 6-5315 . . . L. C. Beard, Jr., Pres; R. J. Painter, Exec. Secy . . . Annual Conv. June 13-18; Exhibits . . . Conv. location: Sherman Hotel and Morrison Hotel, Chicago, Ill. . . . To disseminate information on engineering materials, standardization of specifications, and methods of testing.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS — 39,133 Members — 29 W. 39th St., New York 18, N. Y. PE 6-9220 . . . Dr. L. K. Sillcox, Pres; C. E. Davies, Secy . . . Annual Conv. Nov. 27-31; No exhibits . . . Conv. location: New York City . . . An educational professional body concerned with mechanical engineering and allied arts.

AMERICAN SOCIETY OF TOOL ENGINEERS — 28,000 Members — 10700 Puritan Ave., Detroit 38, Mich. UN 4-7300 . . . R. F. Waindle, Pres; H. E. Conrad, Secy . . . Annual Conv. April 26-30; Exhibits . . . Conv. location: Convention Hall, Philadelphia, Penna. . . . Dissemination of knowledge of tool engineering.

AMERICAN STANDARDS ASSOCIATION—2,400 Members—70 E. 45th St., New York 17, N. Y. MU 3-3058 . . . R. E. Gay, Pres; Vice Admiral G. F. Hussey, Jr., (USN Ret.) Secy . . . Annual Conv. Nov. 15-17; No exhibits . . . Conv. location: Hotel Roosevelt, New York . . . To provide an orderly set of voluntary coordinated standards and to promote the knowledge and use thereof.

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NTENNA MANUFACTURERS ASSOCIATION — 12 Members—c/o Wm. J. Parker Co., 366 Madison Ave., New York, Murray Hill 2-2925 . . . Martin Bettan, Pres.; David Laine, Exec. Secy. . . . Annual Conv. May 17; Exhibits . . . Conv. location: Conrad Hilton Hotel, Chicago, Ill. . . . To solve mutual problems relating to the availability of antenna materials and to the distribution of finished products.

RMED FORCES ELECTRONICS COMMUNICATIONS ASSOCIATION — 7,500 Members—1624 Eye St., N. W., Washington 6, D. C. EX 3-3033 . . . Rear Admiral Joseph, Pres.; George P. Dixon Col. (Ret.), Exec. Vice Pres. . . . Annual Conv. May 6-8; No Exhibits . . . Conv. location: Hotel Shoreham, Washington, D. C. . . . A patriotic educational and nonprofit communication and electronic society dedicated to military, scientific and industrial preparedness.

ASSOCIATED POLICE COMMUNICATION OFFICERS, INC. — 1,650 Members — 18108 Strasburg Ave., Detroit 5, Mich. Lakeview 6-4751 . . . Brower McMurphy, Pres.; W. H. Durham, Secy. . . . Annual Conv. Aug. 10-13 Exhibits . . . Conv. location: William Penn Hotel, Pittsburgh, Pa. . . . For the improvement of all forms of police communications and to coordinate efforts over any frequency conflicts.

ASSOCIATION FOR COMPUTING MACHINERY—1,500 Members — 2 E. 63rd St., New York 21, N. Y. TE 2-8665 . . . Samuel Williams, Pres; Dr. E. Bromberg, Secy . . . Annual Conv. June 23-25; No exhibits . . . Conv. location: Ann Arbor, Mich. . . . Advancement, design and development of modern mathematical machinery for logic, statistics and kindred fields.

ASSOCIATION OF ELECTRONIC PARTS AND EQUIPMENT MFRS — 125 Members — 11 S. LaSalle St., Suite 1500, Chicago 3, Ill. Dearborn 2-4217 . . . K. W. Jensen, Chmn; K. C. Prince, Exec. Secy . . . No annual conv. . . . To treat with all problems relating to the sale and distribution of electronic items through electronic distributors.

ASSOCIATION OF FEDERAL COMMUNICATIONS CONSULTING ENGINEERS—44 Members—1242 Munsey Bldg., Washington 4, D. C. DI 7-8215 . . . F. G. Kear, Pres.; T. A. M. Craven, Secy. . . . Annual Conv. April 30th; No exhibits . . . Conv. location: Atlantic City, N. J. . . . To provide for mutual improvement of consulting engineers before the FCC and to promote the proper application of radio communication regulations emanating from the proper federal agencies.

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ELECTROCHEMICAL SOCIETY — 3,141 Members — 216 W. 102nd St., New York 25, N. Y. RI 9-0602 . . . M. J. McKay, Pres; Dr. H. B. Linford, Secy . . . Annual conv. May 2-6; No exhibits . . . Conv. location: Chicago, Ill. . . . Advancement of science and technology of electrochemistry, electronics, electrothermics, electrometallurgy and allied subjects.

ELECTRONICS MANUFACTURERS ASSOCIATION — 25 Members — 598 Madison Ave., New York 2, N. Y. MUrray Hill 8-3200 . . . David Wald, Pres; J. W. Martindale, Exec. Secy . . . No annual Conv. . . . To review and study the labor relations problems of its membership.

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FEDERAL COMMUNICATIONS BAR ASSOCIATION, 600 Munsey Bldg., Washington, D. C., Sterling 3-1000 . . . V. B. Welch, Pres.; T. H. Wall, Secy . . . Annual Conv. dates undetermined; no exhibits . . . Conv. location: Washington, D. C. . . . To maintain the standards and ethics of lawyers practicing before the FCC.

HIGH FIDELITY INSTITUTE OF THE ELECTRONICS INDUSTRIES—1 N. LaSalle, Chicago 2, Ill. J. J. Kahn, Commissioner . . . Annual Conv. May 15; No exhibits . . . Conv. location: Chicago, Ill. . . . To dispel public confusion on "high fidelity" and to promote buyer confidence in high fidelity equipment.

INSTITUTE OF RADIO ENGINEERS — 37,134 Members — 1 E. 79th St., New York 21, N. Y. RE 7-9600 . . . W. R. Hewlett, Pres; G. W. Bailey, Exec. Secy . . . Annual Conv. March 22-25; Exhibits . . . Conv. location: Waldorf-Astoria Hotel and Kingsbridge Armory . . . To advance the art and science of radio communication and to promote professional welfare of engineers engaged therein.

INSTITUTE OF THE AERONAUTICAL SCIENCES—12,000 Members — 2 E. 64th St., New York 21, N. Y. TE 8-3800 . . . J. L. Atwood, Pres; R. R. Dexter, Secy . . . Annual Conv. Jan. 1955; No exhibits . . . Conv. location: Hotel Astor, New York . . . To facilitate the interchange of technical information relating to the engineering design and development of airborne craft.

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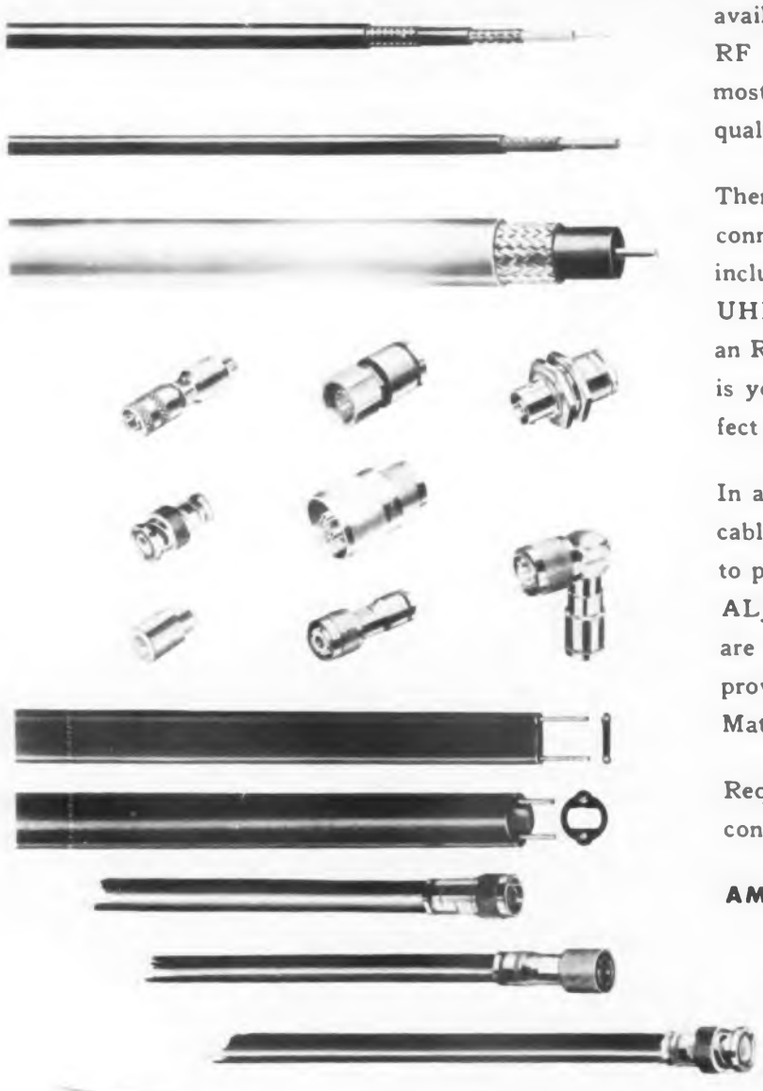

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OINT COMMITTEE ON EDUCATION TELEVISION — 1785 Massachusetts Ave., N.W., Washington 6, D.C. Hudson 3-6620 . . . Ralph Steetle, Exec. Director; Blanche Crippen, Asst. Director . . . No convention . . . To present the case for educational television to the FCC in the interests of seven educational organizations.

OINT ELECTRON TUBE ENG'G COUNCIL OF RETMA AND NEMA — 6 Council Members — 500 5th Ave., New York, N. Y. LO 5-3450 . . . V. M. Graham, Chmn; F. J. Martin, Secy . . . Conference: Sept. 16-18; No exhibits . . . Conference location: Chalfonte Haddon Hall, Atlantic City, N. J. . . . To develop standards, proposals, and data dealing with electron tubes and allied sealed devices.

JOINT TECHNICAL ADVISORY COMMITTEE — 8 Members — 1 E. 79th St., New York 21, N. Y. RE 7-9600 . . . A. V. Loughren, Chmn; L. G. Cumming, Secy . . . Annual Conv. April 22; Conv. location: Undetermined . . . To assist the Federal Government on electronic engineering matters impartially and on an engineering basis.

MAGNETIC RECORDING INDUSTRY ASSOCIATION — 25 Members — Room 1011, 444 Madison Ave., New York 22, N. Y. PLaza 3-0973 . . . J. F. Hards, Pres; Herman Kornbrodt, Secy . . . Annual Conv. May 1954; No exhibits . . . Conv. location: Conrad Hilton Hotel, Chicago, Ill. . . . To further the uses of magnetic recording and to bring about a better understanding among the dealers, distributors and manufacturers in the industry.

NATIONAL ALLIANCE OF TV & ELECTRONIC SERVICE ASSNS.—36 Members—5908 S. Troy Ave., Chicago 29, Ill. Grovehill 6-6363 . . . F. J. Moch, Pres.; J. B. McDowell, Secy. . . . Annual Conv. Sept. 24-26; Exhibits . . . Conv. location: Morrison Hotel, Chicago, Ill. . . . To unite ethical local and regional associations into a national organization working cooperatively for the best interest of independent service.

NATIONAL APPLIANCE AND RADIO-TV DEALERS ASSOCIATION — 1141 Merchandise Mart, Chicago 54, Ill. Michigan 2-5505 . . . Vergal Bourland, Pres; A. W. Bernsohn, Managing Dir. . . . Annual Conv. Jan. 1955; No exhibits . . . Conv. location: Chicago, Ill. . . . Promote and establish high ideals in the merchandising of appliances, radios and television.

NATIONAL ASSOCIATION OF ELECTRICAL DISTRIBUTORS — 1,100 Members — 290 Madison Ave., New York 17, N. Y. MUrray Hill 6-4633 . . . R. M. Johannesen, Pres; C. G. Pyle, Exec. Dir. . . . Annual Conv. June 6-11; No exhibits . . . Conv. location: Convention Hall, Atlantic City, N. J. . . . To disseminate information on industry matters and to promote beneficial relationships among electrical distributors.

NATIONAL ASSOCIATION OF MUSIC MERCHANTS — 1,500 Members — 28 E. Jackson Blvd., Chicago 4, Ill. Harrison 7-2150 . . . R. B. Wells, Pres; W. R. Gard, Exec. Secy . . . Annual Conv. July 12-15; Exhibits . . . Conv. location: Palmer House, Chicago, Ill. . . . For the mutual advancement of individuals and organizations selling at retail, musical instruments, radios, television, phonographs and kindred articles.

NATIONAL ASSOCIATION OF RADIO AND TELEVISION BROADCASTERS — 1,803 Members — 1771 N St., N.W., Washington 6, D. C. Decatur 2-9300 . . . H. E. Fellows, Pres; C. E. Arney, Jr., Secy . . . Annual conv. May 23-28; Exhibits . . . Conv. location: Palmer House, Chicago, Ill. . . . Advancement of aural and visual broadcasting arts.

NATIONAL AUDIO-VISUAL ASSOCIATION—400 Members — 2540 Eastwood Ave., Evanston, Ill. Davis 8-3376 . . . Don White, Exec. Vice Pres . . . Annual Conv. Aug. 1-4; Exhibits . . . Conv. location; Conrad Hilton, Chicago, Ill. . . . Trade assocation of audio-visual dealers.

NATIONAL CITIZENS COMMITTEE FOR EDUCATIONAL TELEVISION—20 Members—1200 18th St., Washington, D. C. Metropolitan 8-2526 . . . R. R. Mullen, Exec. Director . . . No annual convention . . . To aid civic and citizen groups in construction and operation of non-commercial educational television stations.

NATIONAL COMMUNITY TELEVISION ASSOCIATION—82 Members — P. O. Box 71, Palmerton, Pa. 6435 . . . M. F. Malarkey, Jr., Pres; C. E. Reinhard, Secy . . . Annual Conv. June 14-16; Exhibits . . . Conv. location: Park Sheraton Hotel, New York . . . To standardize community TV antenna system operations.

NATIONAL CONFERENCE ON AIRBORNE ELECTRONICS, Wright Patterson Air Force Base, Dayton, Ohio . . . R. J. Doran, Pres.; Monroe Baran, Secy. . . . Annual Conv. May 10-12; Exhibits . . . Conv. location: Dayton, Ohio . . . To disseminate regularly the latest technological developments in electronic equipment for aircraft.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION—547 Members—155 E. 44th St., New York 17, N. Y. Murray Hill 2-1500 . . . J. H. Jewell, Vice Pres; W. J. Donald, Managing Dir. . . . Annual Conv.

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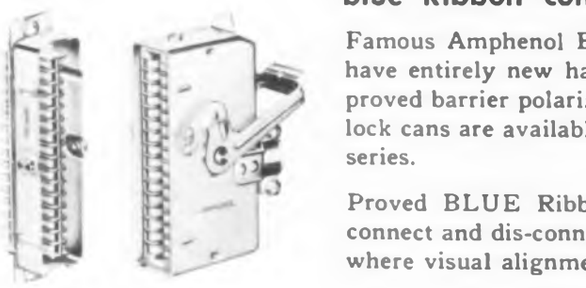

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Nov. 8-12; No exhibits . . . Conv. location: Haddon Hall Hotel, Atlantic City, N. J. . . . To disseminate technical and sales information and to develop industry standards.

ATIONAL ELECTRONIC DISTRIBUTORS ASSOCIATION — 375 Members — 228 N. LaSalle St., Chicago 1, Ill. Financial 6-5570 . . . D. W. Mack, Pres; L. B. Calameras, Exec. Vice Pres. . . . No annual convention . . . The dissemination of information concerning the electronics industry of interest to the distributors of radio, television and industrial electronic equipment.

ATIONAL ELECTRONICS CONFERENCE — 84 E. Randolph, Chicago 1, Ill. FR 2-1211 . . . Dr. R. M. Soria, Pres; G. I. Cohn, Secy . . . Annual Conv. Oct. 4-6; Exhibits . . . Conv. location: Hotel Sherman, Chicago, Ill. . . . A national forum on electronic research, development and application.

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS — 32,000 Members — 1121 15th St., N.W., Washington 5, D. C. Adams 4-1622 . . . T. C. Forrest, Jr., Pres; P. H. Robbins, Exec. Director . . . Annual Conv. June 10-12; Exhibits . . . Conv. location: Milwaukee, Wisc. . . . For the advancement of public welfare and promotion of professional, social and economic interests of the Professional Engineer.

PHONOGRAPH MANUFACTURERS ASSOCIATION — 14 members — 277 Broadway, New York 7, N. Y. RE 2-6980 . . . Joseph Dworken, Pres; A. D. Adams, Secy . . . No annual convention . . . Advancement of quality manufacturing procedures and operation of phonograph reproduction equipment.

RADIO CLUB OF AMERICA—340 Members—11 W. 42 St., New York 36, N. Y. LOngacre 5-6622 . . . F. H. Shepard Jr., Pres.; O. James Morelock, Secy. . . . Annual Dinner December 3. Location: undetermined . . . To interchange ideas among all radio enthusiasts.

RADAR-RADIO INDUSTRIES OF CHICAGO, INC. — 61 Members—1 N. LaSalle St., Chicago 2, Ill. CE 6-0077 . . . L. F. Muter, Pres.; S. I. Neiman, Exec. Secy. . . . Annual Conv. none . . . A liaison organization with government agencies for Chicago electronic equipment manufacturers.

RADIO - ELECTRONICS - TELEVISION MANUFACTURERS ASSOCIATION — 372 Members — 777 14th St., N.W., Washington 5, D. C. National 8-3902 . . . Glen McDaniel, Pres; J. D. Secrest, Secy . . . Annual Conv. June 15-17; No exhibits . . . Conv. location: Palmer House, Chicago, Ill. . . . Non-profit trade association of the radio-electronics-television industry.

RADIO PIONEERS — 900 Members — 580 5th Ave., New York 36, N. Y. PLaza 7-1800 . . . P. W. Morency, Pres; John Patt, Vice Pres. . . . Annual Conv. May 26; No exhibits . . . Conv. location: Palmer House, Chicago, Ill. . . . A fraternal and educational society in radio and television.

RADIO AND TELEVISION EXECUTIVES SOCIETY—1,000 Members — 420 Lexington Ave., New York 17, N. Y. LE 2-3988 . . . G. T. Shupert, Pres; Elizabeth Clarkson, Exec. Secy . . . Annual Meeting May 12; No exhibits . . . Meeting location: New York City . . . A fraternity of persons professionally interested in radio and television broadcasting and allied fields.

RECORD INDUSTRY ASSOCIATION OF AMERICA — 50 Members — 1 E. 57th St., New York 22, N. Y. MUrray Hill 8-3778 . . . J. B. Conkling, Pres; J. W. Griffin, Exec. Secy . . . No annual convention . . . To disseminate information to the industry and to promote beneficial relations among interested persons such as authors, artists, dealers, distributors, etc.

REPRESENTATIVES OF ELECTRONICS PRODUCTS MANUFACTURERS — 640 Members — 600 S. Michigan Ave., Chicago 5, Ill. Harrison 7-2402 . . . Russ Diethert, Pres; Elvera Bendt, Secy . . . Annual meeting of national delegates: March 23; No exhibits . . . Conv. location: Waldorf-Astoria Hotel, New York . . . Independent sale representatives for electronic product manufacturers, subscribing to a National Creed of Sales Ethics.

SCIENTIFIC APPARATUS MAKERS ASSOCIATION—208 Members — 20 N. Wacker Drive, Chicago 6, Ill. State 2-0277 . . . E. J. Albert, Pres; Kenneth Andersen, Exec. Vice Pres. . . . Annual Meeting: May 2-7; No exhibits . . . Conv. location: Broadmoor, Colorado Springs, Colo. . . . An association of companies manufacturing and distributing laboratory and industrial instruments, apparatus and supplies.

SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS — 4,600 Members — 40 W. 40th St., New York 18, N. Y. LO 5-0172 . . . Herbert Barnett, Pres; Boyce Nemec, Secy . . . Annual Conv. May 3-7; No exhibits . . . Conv. location: Washington, D. C. . . . Advancement of theory and practice of engineering in motion pictures, television and allied arts and sciences.

ULTRA HIGH FREQUENCY TV ASSOCIATION — 400 DeSales Bldg., Washington 6, D. C. NAtional 8-0032 —Lou Poller, Pres.; W. A. Roberts, General Counsel . . . Annual Conv. Feb. 1, 1955, exhibits undecided; Conv. location: Washington, D. C. . . . To promote and foster use of ultra high frequencies for television broadcasts.

WEST COAST ELECTRONIC MANUFACTURERS ASSOCIATION — 172 Members — 370 Fair Oaks Ave., Pasadena 1, Calif. . . . E. Gertsch, Pres.; G. Yarbrough, Secy. . . . Annual Conv. August 25-27 at WESCON, Pan-Pacific Auditorium, Los Angeles; Exhibits . . . To advance electronic industries in the west.

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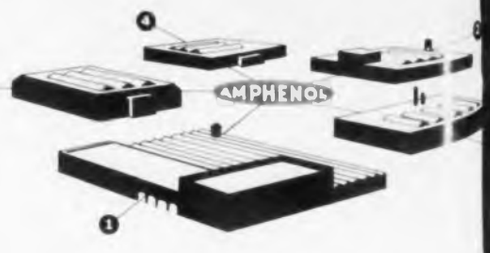

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