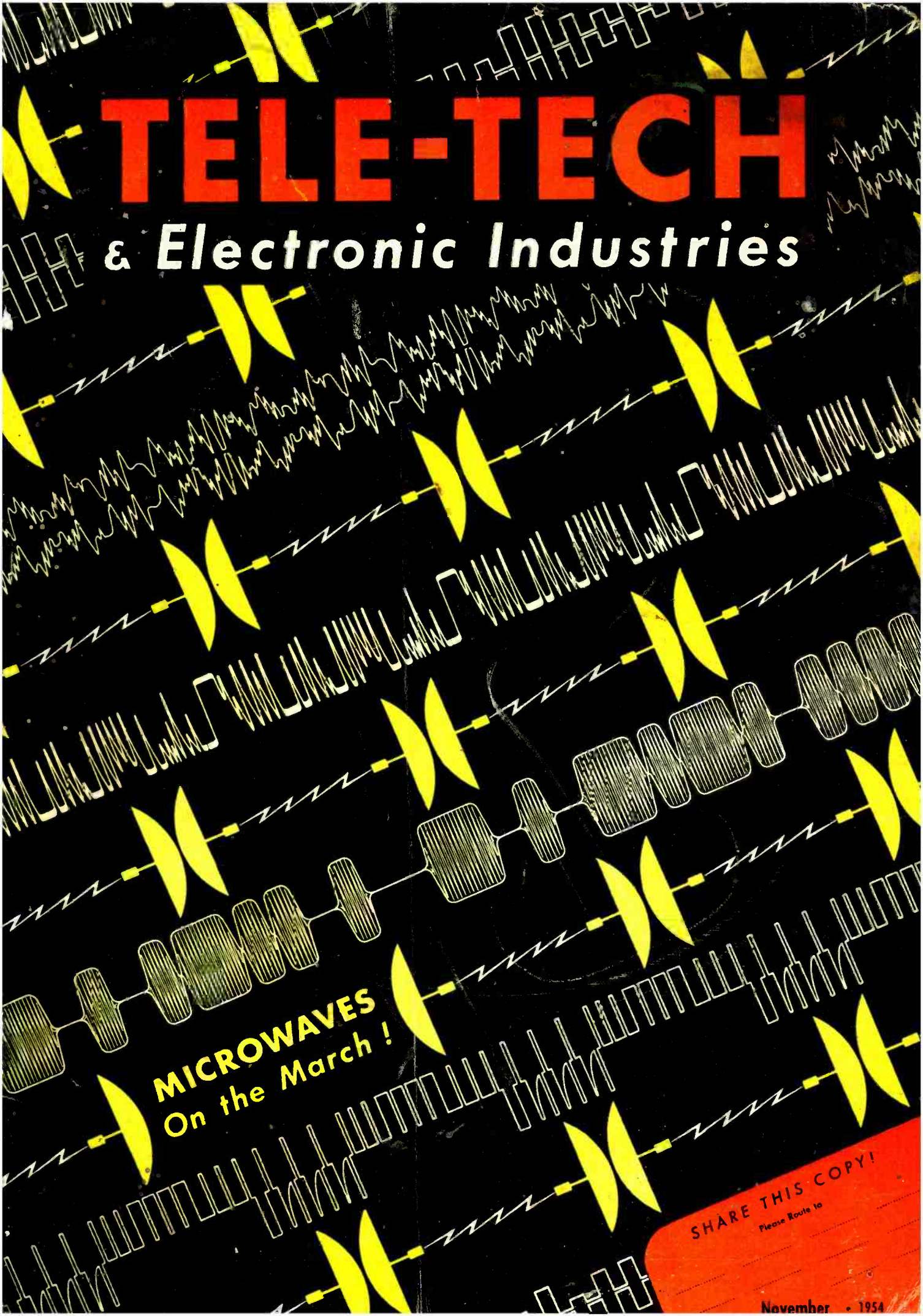
TELE-TECH

& Electronic Industries



MICROWAVES
On the March !

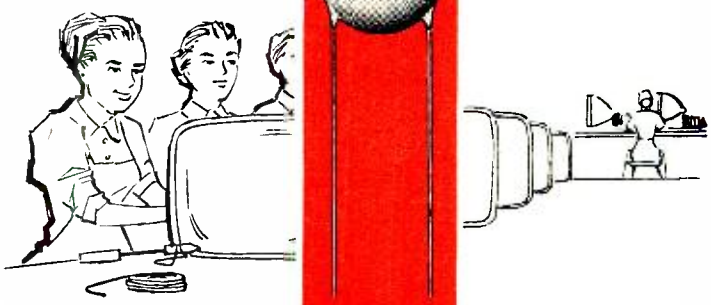
SHARE THIS COPY!
Please Route to

November • 1954

WHY

do leading TV makers specify RMC DISCAPS

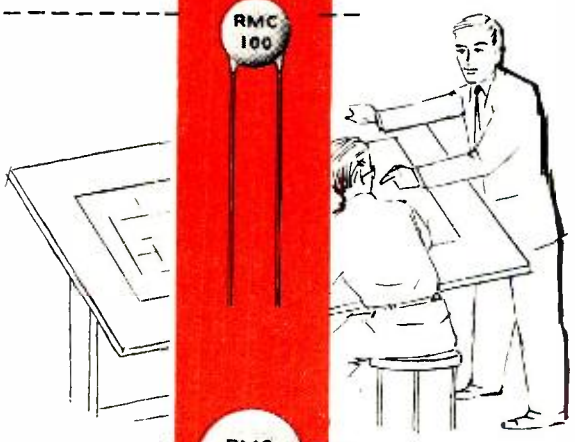
Manufacturers specify DISCAPS because they provide faster assembly line production and lower over-all costs.



WHY

do engineers specify RMC DISCAPS

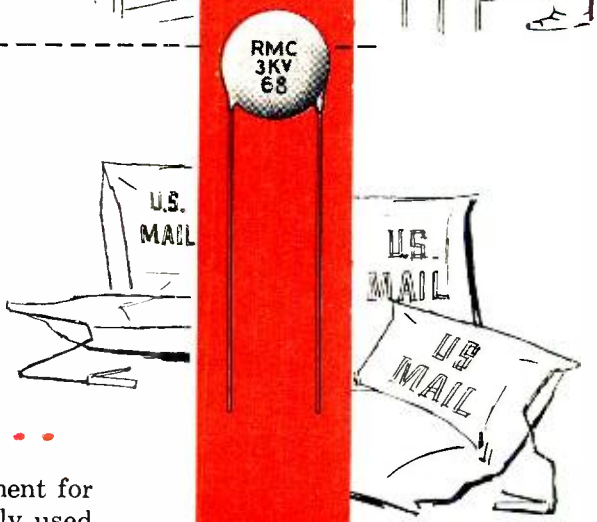
Engineers specify DISCAPS for their uniform quality, low inherent inductance, high working voltage and greater mechanical strength.



WHY

do purchasing agents specify RMC DISCAPS

Purchasing agents specify DISCAPS because they can depend on RMC to make delivery when scheduled.



Why don't you specify...

RMC DISCAPS, the proved money saving replacement for mica and ceramic tubular capacitors. They are widely used by leading manufacturers of TV sets and tuners, radio receivers and high frequency electronic equipment. RMC offers a full line of by-pass, high voltage, and temperature compensating DISCAPS. If you are interested in improving the quality and uniformity of your products you will be interested in RMC DISCAPS.

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS CORPORATION

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

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Two RMC Plants Devoted Exclusively to Ceramic Capacitors

TELE-TECH & Electronic Industries

NOVEMBER, 1954

FRONT COVER: MICROWAVE ON THE MARCH—An artistic design portrayal of microwave relay system antennas and reflectors together with waveform representations of the various types of signals commonly transmitted along microwave relay routes. Such signals include radar, industrial control signals, voice or audio, r-f code, telemetering, television and many others.

DEPARTMENTS

TELE-TECH & ELECTRONIC INDUSTRIES*, Vol. 13, No. 11. Published monthly by Caldwell-Clements, Inc. M. Clements, President; M. H. Newton, Assistant to President; John J. Borghi, Vice President and Secretary; M. B. Clements, Treasurer. Acceptance under section 34.64 Postal Laws and Regulations authorized at Bristol, Conn., June 9, 1954. Additional acceptance at New York, N. Y. 75¢ a copy. Subscription Rates: United States and U. S. Possessions: 1 year, $5.00; 2 years $8.00; 3 years $10.00. Canada: 1 year $7.00; 2 years $11.00; 3 years $14.00. All other countries: 1 year $10.00; 2 years $16.00. Please give title, position and company connections when subscribing.

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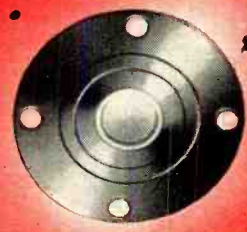
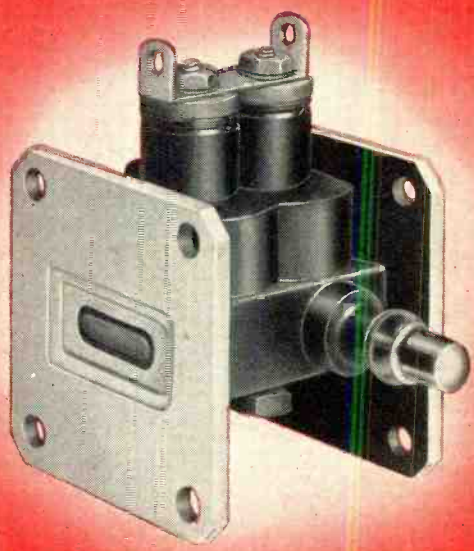
Bomac

...THE MOST COMPLETE LINE...





microwave tubes and components

GAS SWITCHING TUBES — Bomac carries the most extensive line of TR, ATR, Pre TR and attenuator tubes available for all frequency bands and power levels.

SHUTTER TUBES — Bomac has introduced a new concept in TR switching, offering continuous crystal protection through wave guide shorting plus TR tube action.

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.

PRESSURIZING WINDOWS — Bomac has windows available for all wave guide sizes, broad band characteristics with low insertion loss, temperature range — 55°C to 100°C and 30 lb./sq. in. pressure differential either direction.

SILICON AND GERMANIUM DIODES — Bomac diodes are manufactured to high standards to assure electrical uniformity, high burnout and humidity resistance.

DUPLEXERS — Bomac's line of dual TR tubes can be supplied with hybrids to make a complete duplexer to customer specifications.

MAGNETRONS — Bomac has available tunable and fixed tuned magnetrons with high peak RF powers for pulsed service in the higher frequency bands.

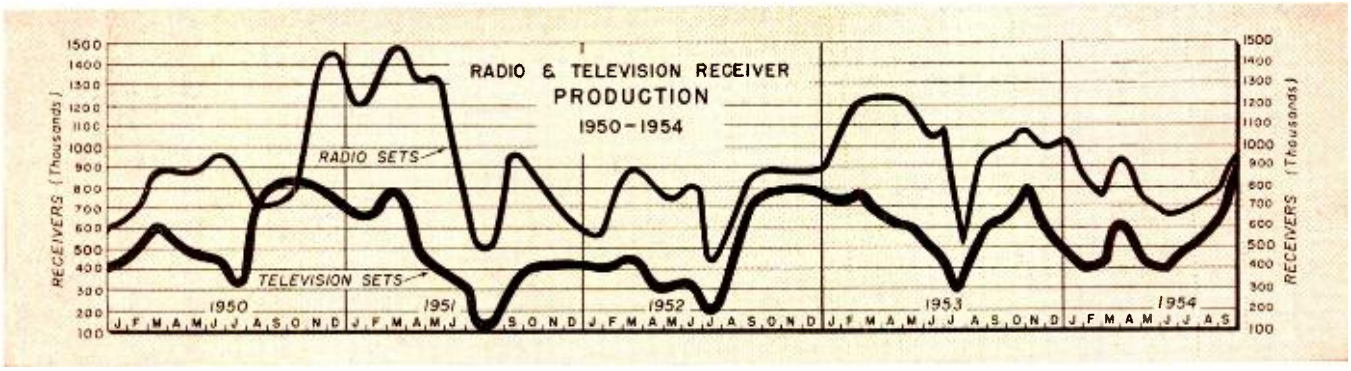
We invite your inquiries regarding
- ENGINEERING
- DEVELOPMENT
- PRODUCTION

Bomac Laboratories, Inc.

BEVERLY, MASSACHUSETTS

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

Catalog on request. Write (on your company letterhead) Dept. I-11 BOMAC Laboratories, Inc. Beverly, Mass.



BROADCAST STATIONS IN U. S.

	AM	FM	TV	
Stations on Air	2592	539	282 VHF	Comml.
			119 UHF	Comml.
			4 VHF	Educ.
			3 UHF	Educ.
Under Construction (CPs)	143	58	65 VHF	Comml.
			111 UHF	Comml.
			11 VHF	Educ.
			15 UHF	Educ.
Applications Pending	187	7	166 VHF	Comml.
			19 UHF	Comml.

GERMANIUM DIODES

Approximately 7,500,000 point-contact germanium diodes valued at $5,250,000 have been sold in the first three quarters of 1954. Of this number there were about 500,000 sold for renewal purposes, the remainder being for initial equipment.

EDUCATIONAL TV

The National Citizen's Committee for Educational Television reports that educational television is now a reality for 15,000,000 viewers with seven stations now on the air.

PHONOGRAPH RECORDS

About 50% of the records now purchased by the public are reported to be 45 rpm types. 25% are LP's and about 25% are 78's.

Magnetic Tape and Recorder Data

Magnetic Tape News Letter recently reported the following interesting figures on magnetic tape recording:

Item	1952	1953	1954 (Est.)
		20,000	23,000 professional
Tape Recorders Sold ($ Millions)	49.7	76.8	111.0
Tape Recorders Sold (No.)		275,000	450,000 home
Magnetic Tape Sold ($ Millions)	1.6	8.0	9.6

In past year number of tape recorder manufacturers and retailers is estimated to have doubled or even trebled over September 1953 figures which were 40 manufacturers and 13,000 retailers.

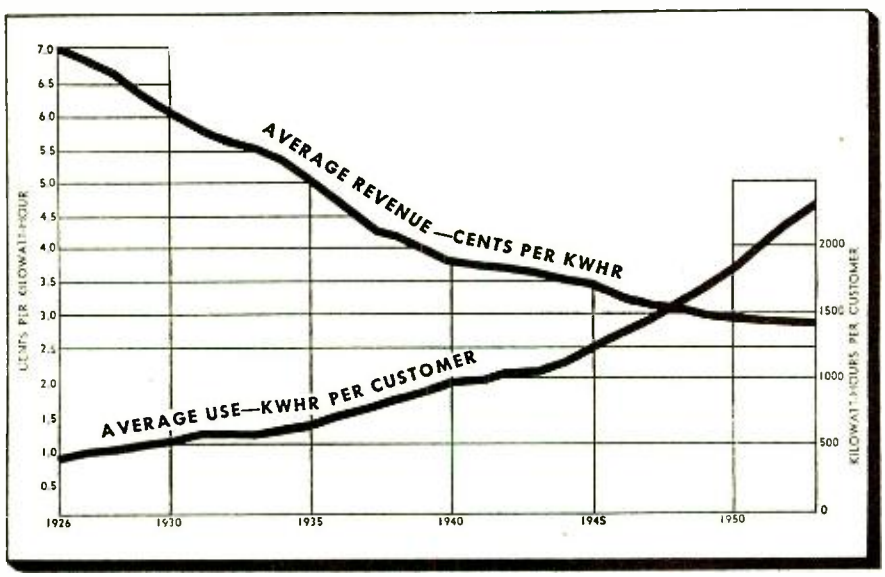


Chart showing average use per customer and average revenue per kilowatt hour in period 1926-1953 for residential service. This represents total electric utility industry in the U.S. (From Edison Electric Institute's Statistical Bulletin No. 21)

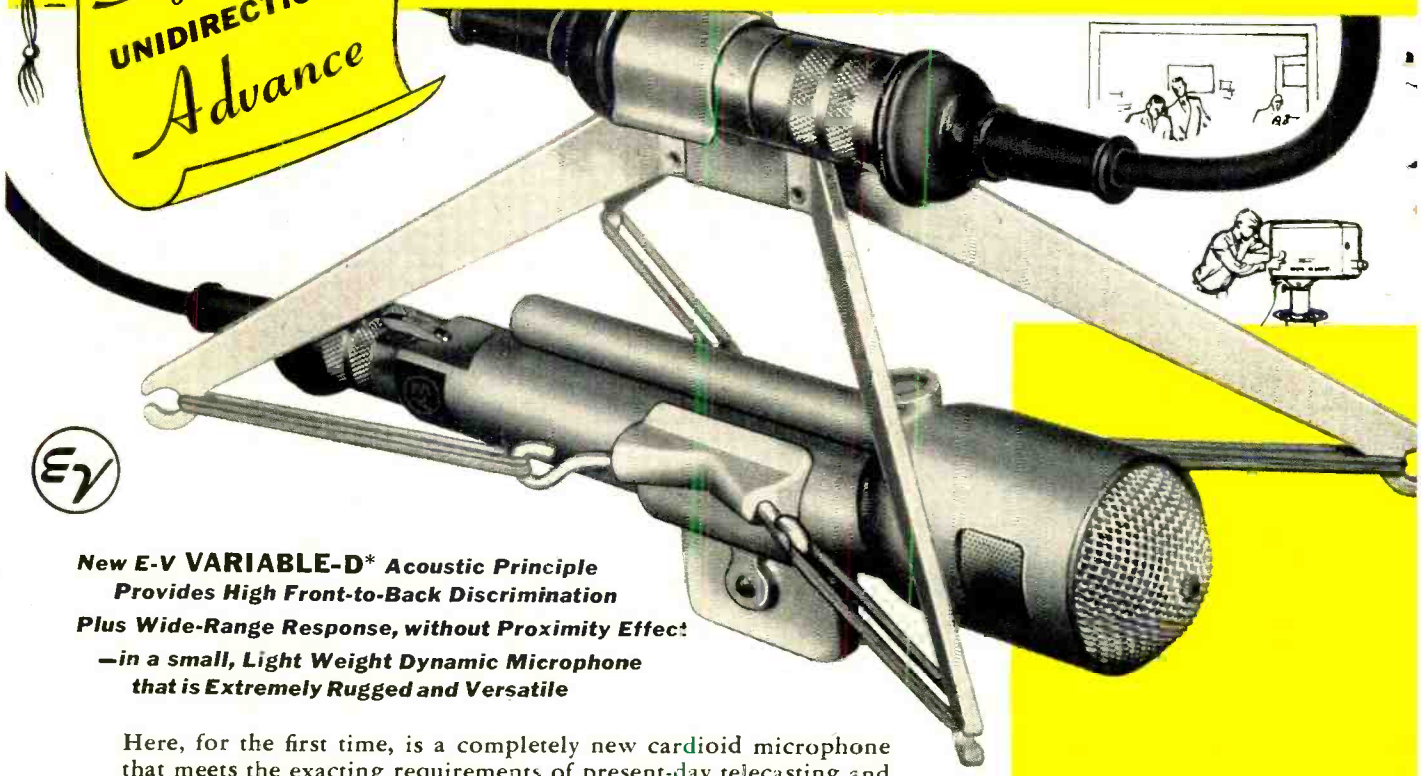
GOVERNMENT ELECTRONIC CONTRACT AWARDS

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

Actuator	$ 38,174	Generators, aircraft	93,427	Receivers, infrared	98,061
Actuator and Spare Parts	64,664	Generator Sets	38,574	Recorders, frequency	45,600
Amplifiers, junction	3,189,341	Generators, pulse	451,996	Regulators, magnetic amplifier	493,130
Antennas, reflector	36,162	Generators, tachometer	64,864	Scanning Head, miniature facsimile	41,667
Batteries, dry	598,845	Gyros	71,846	Sets, receiving and transmitting	377,101
Cable Assys	48,235	Indicators, tachometer	257,665	Switches, control stick	504,812
Calibrators	52,604	Klystron Amplifiers	55,634	Systems, digital recording	167,000
Communications Stations, aircraft	61,669	Line Section, r-f transmission	29,400	Tape, magnetic sound recording	44,613
Components, radio beacon	6,515,910	Master Controls	126,358	Terminal Boxes	26,948
Controllers and Servomotors	26,060	Oscillographs	28,825	Test Sets	25,446
Controls, radio set	44,200	Parts and Materials, electronic	613,261	Transmitter, aerohead	33,085
Electrodes	43,065	Playback Equipment, magnetic	71,846	Transmitter, rate of flow	833,720
Electrodes, welding	47,770	Plugs	43,046	Tubes, electronic	552,090
Enlarger, "ElectroFax"	68,372	Radar Sets, spare	6,614,076	Wattmeter, r-f	26,812
		Radio Sets	240,702	Wire	8,304,016

NEW 666 VARIABLE-D* CARDIOID
OUTPERFORMS ALL OTHERS

Significant UNIDIRECTIONAL *Advance*



New E-V* VARIABLE-D ***Acoustic Principle Provides High Front-to-Back Discrimination Plus Wide-Range Response, without Proximity Effect —in a small, Light Weight Dynamic Microphone that is Extremely Rugged and Versatile***

Here, for the first time, is a completely new cardioid microphone that meets the exacting requirements of present-day telecasting and broadcasting . . . a microphone that readily solves the many vexing problems of daily operation.

Designed in cooperation with network engineers, the E-V "666" combines the ruggedness of a single dynamic element with a new acoustic principle that assures smooth, extended wide-range response . . . and high, uniform discrimination against sound impinging on the back hemisphere . . . with virtually no proximity effect.

The new E-V "666" is especially useful in eliminating pick-up of ambient noise, unwanted reverberation, and movement of equipment. Closely matches existing high quality pressure microphones, such as the famous E-V "655", and thus permits easy fading from one microphone to another.

***PRINCIPLE OF OPERATION**

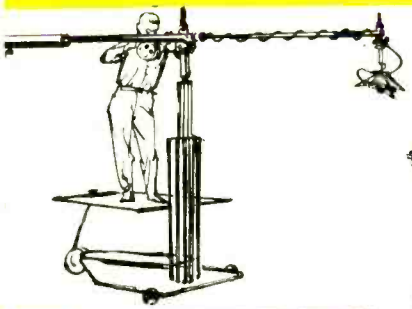
Exclusive E-V VARIABLE-D (for variable distance) provides three back sound entrances at different fixed distances. These entrances each possesses a phasing network which operates with the other entrances to provide effective front-to-back spacing which varies inversely with frequency. As a result, optimum front-to-back discrimination is obtained at all frequencies.

*E-V Pat. Pend.

VERSATILE DESK OR TABLE USE

Model 420 stable desk mount and clamp permits easy use for quiz shows or fixed position emceeing. Microphone simply slides out of clamp for other use in hand, on stand or boom.

DYNAMIC
FOR TV and BC



IDEAL FOR BOOM WORK

Small size, light weight, high resistance to shock, and consistent performance greatly simplify boom or fish-pole operation... allow fast pans on boom shots, without worry about mike shadows. Unique E-V Model 366 Boom Shock Mount is optional (extra).

EASY STAND OPERATION

Spring-type, cushioned-slide, stud-clamp permits instant stand mounting or removal (without marring surface). Smooth swivel allows proper placement and firmly holds microphone in desired position.

THESE E-V FEATURES MAKE THE BIG DIFFERENCE

Frequency Response: Uniform response 30-15,000 cps. Individual laboratory control insures conformity to the highest fidelity standards.

Polar Pattern: Average front-to-back discrimination 24 db.

Power Rating: Output level -57 db. Provides excellent signal-to-thermal noise ratio.

Magnet Structure: Alnico V and Armco magnetic iron. Provides flux density and signal sensitivity previously found only in microphone heads many times the size of the "666".

Impedance Adjustment: Supplied wired for 50 ohms. Can readily be changed to 150 or 250 ohms on terminal board inside case.

Acoustalloy Diaphragm: Exclusive E-V formulation provides the proper elasticity to complement the acoustical requirements of the "666". Promotes smooth, wide range response. Practically indestructible under all types of operating conditions.

Blast Filter: Acoustical screen protector minimizes wind and breath blasts, and traps iron filings.

Microphone Case: Made of aluminum and finished in durable TV gray. 7½" long x 1½" diam. Weighs only 11 ozs. Uses detachable clamp-on stand adapter for ⅝"-27 or ½" pipe thread. Swivel provides for tilt up to 90°.

Cable and Connector: Comes with 20 feet of 2-conductor broadcast-type cable, and Cannon UA-3-11 connector on microphone end.

Try the E-V "666" Now

Prove to yourself the superiority of the "666". No obligation. Normal trade discount applies.

Model 666 Microphone.....List $245
Includes Model 300 Stand Coupler.

Model 366 Boom Shock Mount. List $40
For easy attachment to standard booms. Weighs only 6 ozs. Has adjustable rubber band shock absorbers.

Model 300 Stand Coupler.....List $10

Model 420 Desk Stand.....List $20
Heavy cast base finished in matching TV gray. With microphone clamp.

Available at Authorized E-V Distributors

Write for Technical Data Sheet No. 39

Electro-Voice

ELECTRO-VOICE, INC. • BUCHANAN, MICHIGAN

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TELE-TECH* & ELECTRONIC INDUSTRIES is edited for top-level engineers and executives throughout the electronic industries. It gives the busy engineering executive authoritative information and interpretation of the latest developments and new products, with emphasis on subjects of engineering import and timeliness. Special attention is given to:

MANUFACTURING

—Electronic equipment, communications, broadcasting, microwave relay, instrumentation, telemetering, computing.
—Military equipment including radar, sonar, guided missiles, fire controls.
—TV-FM-AM receivers, phonographs, recorders, reproducers.

OPERATION

—Fixed, mobile and airborne communications in commercial, municipal, aviation and government services.
—Broadcasting, Color TV, video and audio recording, records, audio and sound systems, motion picture production.
—Military, civilian and scientific electronic computing and control systems.
—*Reg. U. S. Pat. Off.

THE ELECTRONIC INDUSTRIES DIRECTORY

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

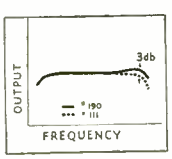
50% more tape on same size reel!

New, thinner magnetic tape cuts time-wasting reel changes!

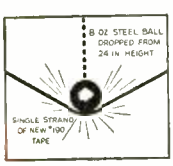
No more stopping for reel change when you're recording longer sports and news events, dramatic productions and musical works. New "Scotch" Brand Extra-Play Magnetic Tape No. 190A reduces time-consuming change-over breaks by giving you 50% more recording time on each reel.

Secret of new "Scotch" Brand's extra playing time is a more potent oxide coating which offers improved frequency response, yet is 50% thinner than many standard tape coatings. A thinner tape backing produces more uniform output — cleaner, crisper tones — while retaining critical strength factors to meet the demands of all professional recording machines.

EXTRA-THIN. 50% thinner, more potent oxide coating, 30% thinner backing permit more 190A tape to be wound on standard reel. One roll of new tape does job of 1½ reels of ordinary tape.



INCREASED FREQUENCY range of new Extra-play tape enables home machines to produce recordings with greater hi fi response than formerly possible with most conventional magnetic tapes.



STRENGTH TO SPARE. New 190A tape stands up under even grueling steel ball drop test. Naturally it's tough enough to withstand severe stresses of sudden machine stops, starts and reverses.

NEW! REG U.S. PAT. OFF. SCOTCH BRAND Extra Play Magnetic Tape 190A

At your tape dealer's now!

3M

The term "SCOTCH" and the plaid design are registered trademarks for Magnetic Tape made in U.S.A. by MINNESOTA MINING AND MFG. CO., St. Paul 6, Minn. General Export: 122 E. 42nd St., New York 17, N. Y. In Canada: London, Ontario, Canada.

HERE'S WHY . . .

The Magnetics, Inc. "Performance-Guarantee" on molybdenum permalloy Powder Cores is a revolutionary concept in the communications and electronics industries, and opens the way to substantial savings in your production and assembly operations. The guarantee of performance *to your specifications* is your assurance that these Powder Cores are standardized to meet your circuit requirements.

These Performance-Guaranteed Powder Cores cost no more—indeed, despite the fact that you have a guarantee of performance, they are sold at prices standard in the industry. You can't afford not to investigate Magnetics, Inc. molybdenum permalloy Powder Cores.

Keep in Mind These Advantages of Powder Cores . . .

1. Low hysteresis and eddy current losses;
2. High electrical resistivity;
3. Constant permeability over widely varying flux densities;
4. Magnetic stability with dc magnetization.

WANT THE COMPLETE STORY? . . .

Write us . . . on your company letterhead . . . we'll be delighted to send you literature, delighted to answer specific questions. No obligation, of course. . . .

*Manufactured under a license agreement with Western Electric Co.

MAGNETICS inc.

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COVERS the WORLD!

618S TRANCEIVER
for WORLD-WIDE Airborne Communications

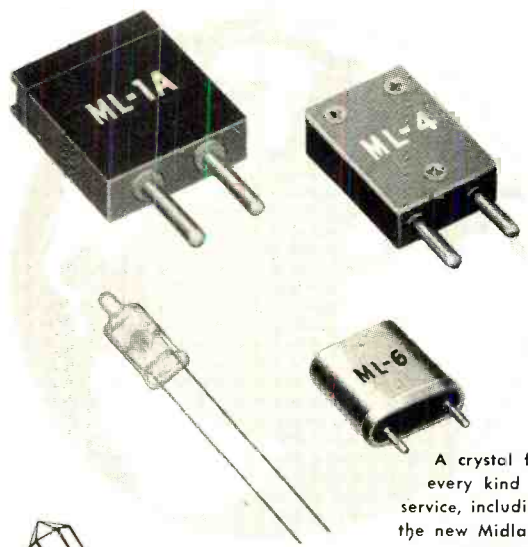
...and of course it uses Midland CRYSTALS

100-WATT POWER ON 144 CHANNELS gives the Collins 618S Tranceiver truly world-wide operation. Collins airborne HF communications equipment is *first choice of most U. S. trans-oceanic airlines,* and of many foreign and domestic carriers, as well as private and military aviation.

Midland crystals do the key job of frequency control in the 618S Tranceiver as in all Collins aviation equipment. In this critical service, there can't be any question of stability, precision, and sure-fire performance under toughest conditions.

Midland Crystals measure up to Collins' strict standards because every one of the millions of these crystals in use today is a product of Midland Quality Control. This is the system that constantly checks every crystal at every step in processing.

Midland employs the finest technical skill and production facilities in the industry to make sure you'll get completely dependable crystal quality and performance.



A crystal for every kind of service, including the new Midland Miniatures

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

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

WORLD'S LARGEST PRODUCERS OF QUARTZ CRYSTALS

"7:00 P.M. On the air..."

"Delayed broadcast going out from playback head in Position 1. Show being erased on head at Position 2. Recording incoming network signal on head in Position 3. Monitoring incoming signal on playback head in Position 4."

This is an actual case history. Operating engineer in this test was Bert Berlant, designer-manufacturer of the equipment used.

The Berlant Broadcast Recorder, BR-1, actually has provision for 5 heads, (3 heads are standard) and with a simple switching arrangement allows both single and dual track operation.

Research and development on this professional tape recorder took three years. 382 engineers wrote the specs from a detailed questionnaire sent them before work was started. *Every important feature* they requested is incorporated. The one described in the test is an example.

Other exclusive features are: UNISYNC DRIVE: a completely new hysteresis synchronous direct drive with 99.8% timing accuracy and total temperature rise of 30 degrees. UNIFIED CONTROL: one simple convenient error-proof lever system. A-B TEST FADER: fades from incoming signal to playback without transients or clicks.

And these additional requested features: Fast forward and reverse at any speed. Instantaneous *Reeloks*. Automatic cut-off. Tape tension arms. Adjustable bias... and three motors.

All of the above is what *you*, the engineer, wanted. The man in the "figure" department wanted dependability and low maintenance cost... at the right price! We listened to him, too.

$545 IS THE PROFESSIONAL USERS NET FAIR TRADED PRICE.

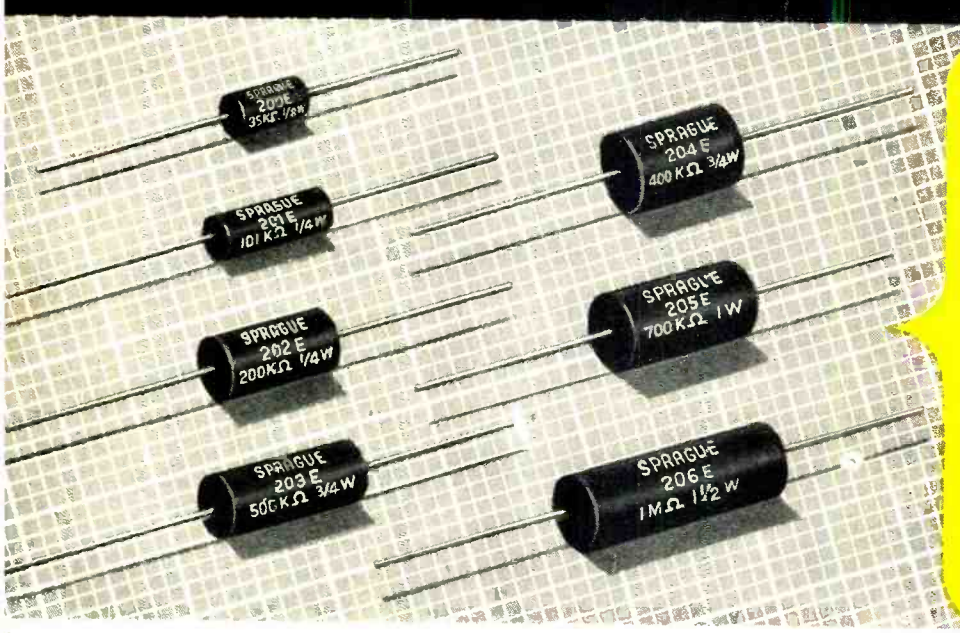
You'll want to test it yourself, we know. For a distributor close to you, for more complete technical brochure, write: Berlant Concertone 4917 West Jefferson Boulevard, Dept. N13 Los Angeles 16, California

THIS IS REPORT NO. 1 IN A SERIES OF FIELD TESTS.

Manufacturers of Concertone... world's foremost high fidelity recorders and accessories.

PERMASEAL®
PRECISION RESISTORS

NOW! ENCAPSULATED AXIAL LEAD STYLES FOR 85°C, 125°C and 150° AMBIENTS



85°C PERMASEAL® RESISTORS

SPRAGUE TYPE	SIZE D	SIZE L	LEADS	RATED WATTS	MAX. OHMS
200E	1/4	1/2	No. 22 AWG	.20	140,000
201E	1/4	3/4	No. 22 AWG	.33	225,000
202E	3/8	3/4	No. 20 AWG	.50	500,000
203E	3/8	1	No. 20 AWG	.75	700,000
204E	1/2	3/4	No. 20 AWG	.75	1.2 MΩ
205E	1/2	1	No. 20 AWG	1.00	1.7 MΩ
206E	1/2	1½	No. 20 AWG	1.50	2.8 MΩ

125°C PERMASEAL® RESISTORS

SPRAGUE TYPE	SIZE D	SIZE L	LEADS	RATED WATTS	MAX. OHMS
300E	1/4	1/2	No. 22 AWG	.10	140,000
301E	1/4	3/4	No. 22 AWG	.15	225,000
302E	3/8	3/4	No. 20 AWG	.25	500,000
303E	3/8	1	No. 20 AWG	.30	700,000
304E	1/2	3/4	No. 20 AWG	.30	1.2 MΩ
305E	1/2	1	No. 20 AWG	.40	1.7 MΩ
306E	1/2	1½	No. 20 AWG	.60	2.8 MΩ

PERMASEAL accurate wire-wound resistors are ideal for point-to-point wiring, for terminal board mounting and for use on processed wiring chassis.

Encapsulated for protection against high humidity, these resistors will stand up in military and industrial electronic service. The protective housing also guards against physical damage during installation and during equipment maintenance.

Standard designs are available in seven different physical sizes for operation at full rated wattage at ambient temperatures of 85°C and 125°C. Special units can be made for operation at 150°C ambient with full rated wattage dissipation.

Unusual long-term stability of resistance is another plus feature of Sprague Permaseal Resistors —as the result of careful matching of winding forms, resistance wire and encapsulating material —together with a thoroughly controlled aging process during manufacture. Permaseal Resistors are available in resistance tolerances down to 0.1%, when necessary.

SPRAGUE

FOR COMPLETE DATA, WRITE FOR COPY OF SPRAGUE ENGINEERING BULLETIN NO. 122, WITHOUT DELAY.

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

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

NORTH ADAMS, MASSACHUSETTS

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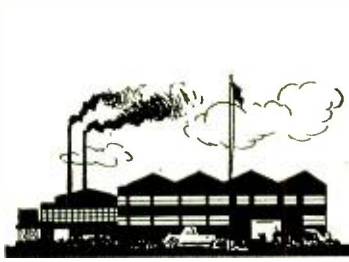


As We Go To Press...

RETMA to Renew Tax Drive

The Board of Directors of the Radio-Electronic-Television Manufacturers Association has authorized RETMA President Glen McDaniel to carry out a three point tax legislative program when Congress reconvenes. The first point is the removal of the 10% excise tax on all color TV receivers. Second is the reduction of the tax on monochrome receivers from 10% to 5%. Third, RETMA will cooperate with other trade associations in seeking administrative tax reforms involving TV-electronic products.

7-Station TV Ownership Limit

Effective Oct. 22, FCC incorporated an amendment of Section 3.636 of its Rules, increasing the ownership limit of TV stations to seven, with no more than five in the VHF band.

SBA Releases New Government Directory

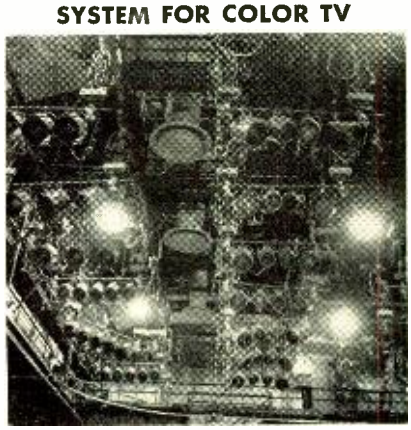
The first complete guide to reference sources of the specifications and standards, used by the government in its purchasing, was announced by the Small Business Administration in publication of the "U. S. Government Specifications Directory." The new directory discusses in detail the purchasing specifications used by the military and civilian agencies of the government; tells how the businessman may obtain copies of particular specifications or specifications indexes for continuing use, and lists more than 500 government activities or depository libraries for government publications where specifications and indexes to them are available for reference purposes. A major portion of the directory is devoted to the listing of the many points, in or near their own communities, where small business owners may locate specifications and indexes. The Specifications Directory is on sale by the Superintendent of Documents, Washington 25, D. C. for 25 cents.

Atomic Instruments for Diamond Prospecting

Atomic instruments are now pointing the way to a new and exciting era of geologic exploration. Diamond prospecting is the most recent field to which the use of atomic instruments has been applied. The Radiac Co., Inc., 489 Fifth Ave., New York City, has been supplying gem explorers in South Africa with airborne Geiger and Scintillation Counters.

It is now possible to locate diamond bearing "kimberlite pipes" by making Scintillometer aerial surveys. The Scintillometer is more efficient than standard Geiger counters, and is an extremely sensitive gamma ray detector. A plane equipped with an airborne Scintillometer would fly a grid pattern 50 to 200 feet above the ground. The gamma radiation picked up by the Scintillometer would be continuously recorded on a chart. If the chart shows a sudden drop in the radioactive level and then returns to normal, further investigation of the area should definitely be made with a Geiger or Scintillation Counter on foot. This would pinpoint the area of low radioactivity. By taking readings at fifty foot intervals, the outline of the kimberlite pipe could be mapped out.

900-CIRCUIT LIGHTING SYSTEM FOR COLOR TV



Maze of overhead lights is part of 900-circuit system, arranged in 63 groups, installed by NBC in converting huge TV studio for color. Each group can be lowered by remotely controlled hoists. Note vents of 250-ton air conditioning

TV Price Downtrend Levels Off

The industry-wide trend toward lower and lower TV receiver prices shows definite signs of leveling off. CBS-Columbia, DuMont, Emerson, Philco, Stewart-Warner, and Sylvania have already announced price increases on medium and high priced models, and other manufacturers are known to be considering similar moves. For the most part, the cheapest price leaders in each line, where the profit margin is very small, are expected to be retained for competitive reasons.

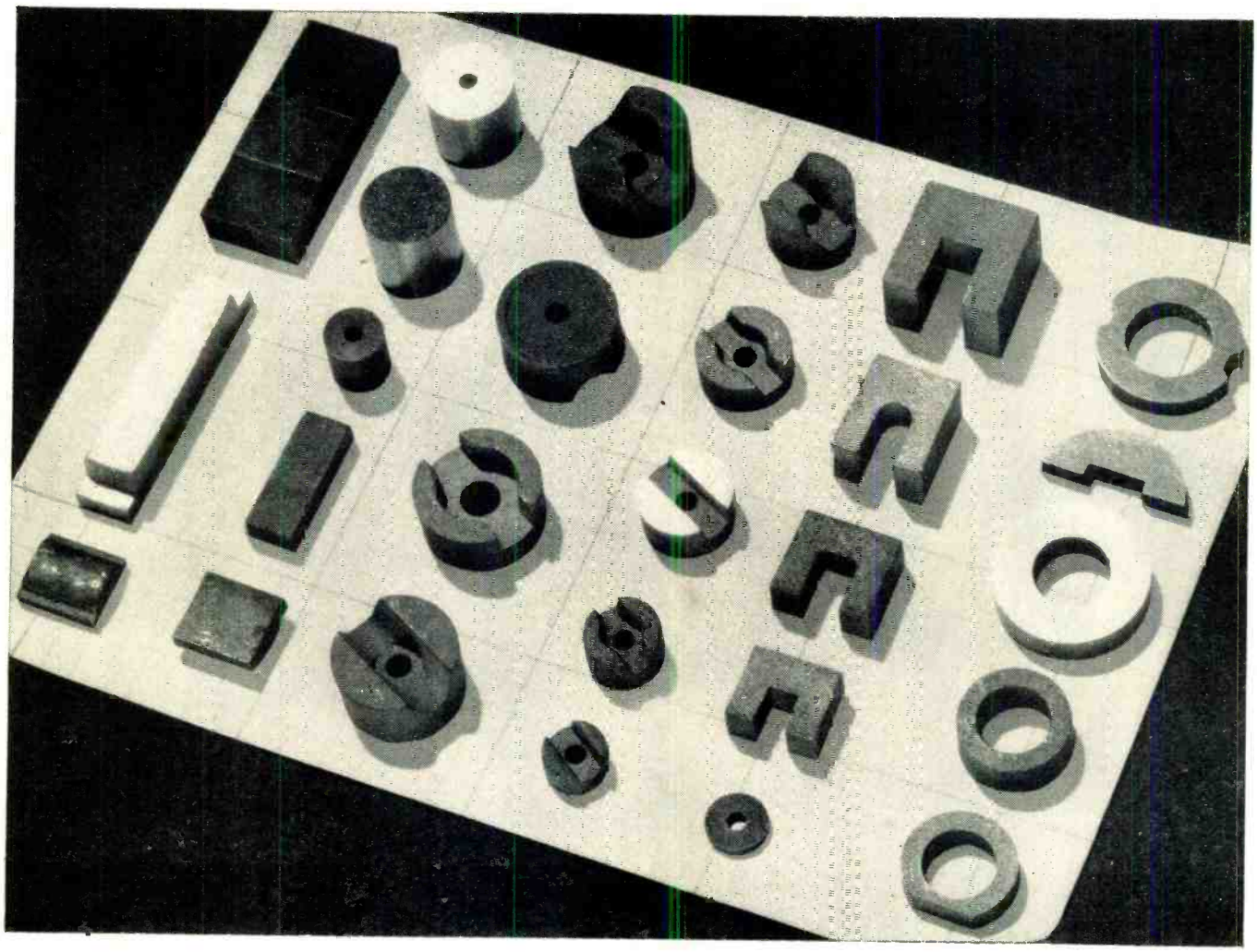
TV Excellent for Instruction

New impetus was given to the use of TV for instructional purposes as the result of tests conducted recently by the Educational Testing Service of Princeton, N. J., for the American Red Cross. The Univ. of Houston TV station KUHT was used as a laboratory for the tests. Conclusions released in a preliminary report prepared by Dr. Benjamin Shimberg of the testing service indicated that TV can be just as effective as classroom instruction in imparting knowledge of facts, and almost as effective in teaching certain skills. In certain situations, the report concluded that TV may enable students to learn the same amount of material in less time and possibly to master more material in the same amount of instructional time.

Voluntary Conelrad Plan

A temporary Conelrad plan calling for voluntary compliance by all stations, except AM, FM, TV, amateur and aviation, has been approved by FCC. The interim plan, applicable to communications and similar services operating up to 890 MC, will be furnished upon individual request to the Commission's Washington office.

MORE NEWS on page 16



Page-full of ideas for you on *Sintered Magnets*

"MAGNETIC MATERIALS CATALOG"

Write for your copy

Contains handy data on various types of Alnico Magnets, partial lists of stock items, and information on other permanent magnet materials. Also includes valuable technical data on Arnold tape-wound cores, powder cores, and types "C" and "E" split cores in various tape gauges and core sizes.

ADDRESS DEPT. T-11

"OFF-THE-SHELF" ITEMS or SPECIAL SHAPES to suit your needs

Magnets of sintered Alnico offer endless opportunities to designers who need their useful combination of self-contained power and small bulk. A wide range of sintered Alnico shapes are carried in stock for quick shipment. Special shapes to meet an individual design need can be developed, where the quantity required is large enough to justify the tooling costs. Arnold sintered permanent magnets are fully quality-controlled and accurately held to specified tolerances. ● *We'll welcome your inquiries.*

W&D 5280

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

DISTRICT SALES OFFICES . . . New York: 350 Fifth Ave.

Los Angeles: 3450 Wilshire Blvd. Boston: 200 Berkeley St.

NOW KTR-100A

Color TV microwave relay

ONE BASIC SYSTEM FOR ALL BANDS

BROADCAST
6875-7050
12800-13200

COMMON CARRIER
5925-6425
7050-7125
12800-13200

GOVERNMENT
7125-7200

ONE BASIC SYSTEM

with all these extra features

AT NO EXTRA COST!

- Complete Multiband Frequency Coverage
- Easily Interchangeable RF Plumbing Units
- Tunable Calibrated Reference Cavity
- Differential Gain and Differential Phase Controls
- Built-in Multiplexed Audio

The new KTR-100A microwave relay meets or exceeds all FCC and RETMA color specifications for multiplexed video and audio signals with a differential phase of less than ±2° and a differential gain of less than 1 db maximum.

It provides in a single, basic system complete equipment to cover all broadcast and common carrier bands and the adjoining government band . . . combines multiplexed video and audio . . . and is designed for the widest possible flexibility in application.

Not only are these features available *at no extra cost* but the new KTR-100A still remains *the lowest cost microwave in the industry.*

Write for complete information. Address Dept. 6130 TL

The advanced design of the new KTR-100A offers simplicity and accessibility with proven reliability . . . providing greater flexibility with maximum tube efficiency, power and long life. Easily interchangeable RF units (as shown above) provide for band changes and a referenced calibrated cavity makes possible frequency changes in the field within allocated bands. One basic system for color and monochrome and for all present and future frequencies protects your equipment investment.

RAYTHEON

Specialists in Microwave for Television

RAYTHEON MANUFACTURING COMPANY

Equipment Sales Division

WALTHAM 54, MASSACHUSETTS

As We Go To Press . . . (Continued)

Magnetic Heads Easily Modified

Changing many commercial magnetic recording heads to function as modulator playback heads is now possible by a simple operation developed recently at Armour Research Foundation of Illinois Institute of Technology, Chicago. The commercially available heads are adapted by drilling suitable openings in the core and adding simple excitation windings. The adapted head is not meant to replace original magnetic recording heads in all cases, but for non-critical applications not requiring an excellent signal to noise ratio, such as in digital computers, the method is expected to be valuable.

New FCC Chairman

George C. McConnaughey has been sworn in as chairman of the Federal Communications Commission. He stepped into a vacancy on the seven-member board created by the retirement of George E. Sterling, whose seven-year term expires June 30, 1957.

Copper Shortage Near

A copper shortage which is developing into the most serious materials problem since the Korean war may have a severe impact on communications manufacturing activities within a short time if a solution is not found, an informal survey of several leading manufacturers indicated. Although the communications equipment producers said that no curtailment of production activities has yet resulted from the copper scarcity, they forecast a severe squeeze—and in one case, a blow to the national economy—if copper supply pipelines are not filled again in the near future. Government sources said that although most of the miners' strikes in the United States and Chile have been settled, supplies have been pretty well exhausted during the walkouts and "filling the pipelines" will require some time. Aggravating the problem is the price factor. European bidding has driven the world price beyond 34 cents a pound, although thus far US producers have held the 30-cent "peg" price generally applied in the US for established customers. One report said that scrap copper is "drying up" at around 32 cents a pound, and that unless some stockpiles are soon released, the world price may move back to the 36-cent level. At the same time, it was said that there have been indications that Russia may soon contribute substantially to the shortage by increased buying of copper from sources outside its usual sphere of control.

NEW TRANSISTOR MIKE

Exploded view of new Remler A-258 magnetic microphone containing a two-stage built-in transistor amplifier. Designed to plug into existing carbon microphone circuits, this handheld design has response of 500-6000 cps ± 6 db.

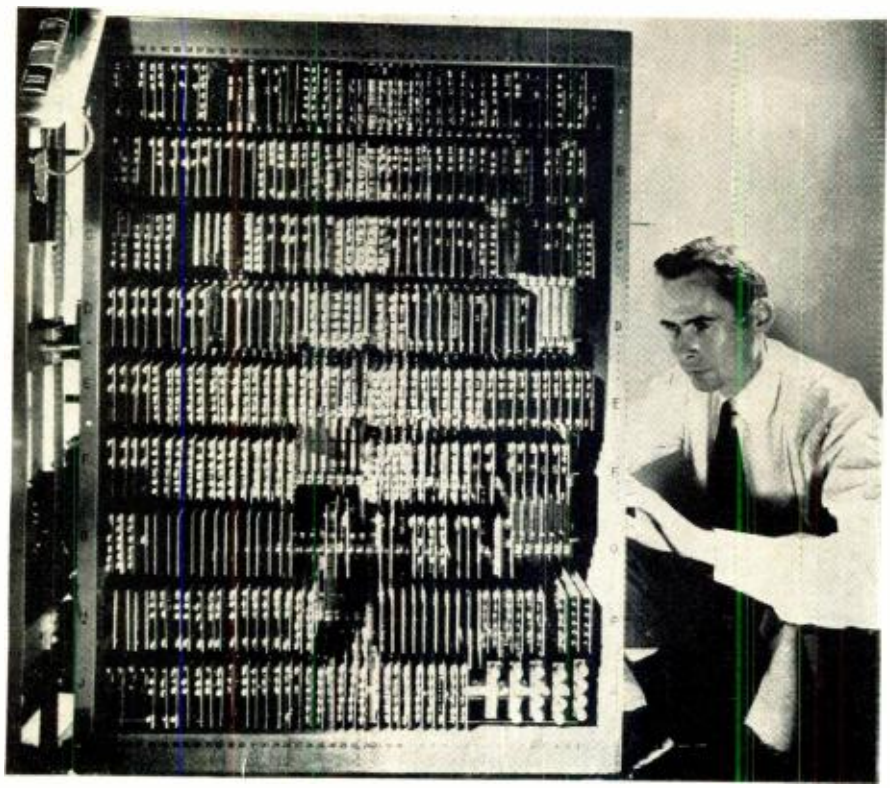
Color TV Controls

Chicago Telephone Supply Corp., Elkhart, Ind. has made a new line of controls available recently that are especially designed for color TV applications. The new line includes controls ranging from ¾-in. in diameter to 2.5 in. with wattages ranging between 0.2 to 4 watts. Both carbon and wirewound types are available, with and without attached switch. Mountings are conventional bushing, twist ear and snap-in bracket for printed circuits. Terminal styles are for conventional soldering, printed circuits and wire wrap. An endless combination of tandems with both single and dual shafts is possible.

New Signal Corps Res. & Dev. Chief

Edward L. Nelson, Technical Director of the Signal Corps Engineering Labs., Ft. Monmouth, N. J., has been appointed Scientific Chief of Research and Development for the Army Signal Corps. In his new assignment, Mr. Nelson will be responsible to the Chief Signal Officer, Maj. Gen. George I. Back, for the technical direction of the research and development mission of the Army Signal Corps. Prior to his appointment as Technical Director of SCEL in 1951, Mr. Nelson was with the Bell Telephone Labs.

NEW TRANSISTORIZED COMPUTER USES PRINTED CIRCUITS

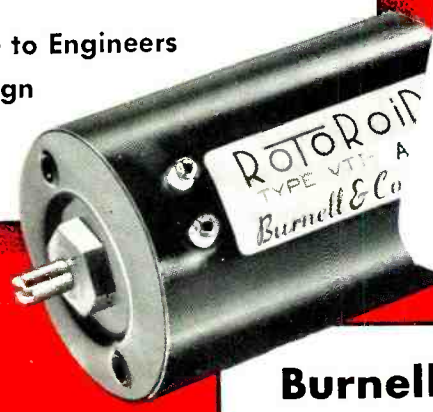


595 printed wiring panels containing 2250 transistors make up IBM's new all-transistor computer. The unit is about one-half the size of a comparable vacuum tube system, and requires only 5% as much power. The new calculator is reported by the company as being the first fully operative transistorized computer complete with automatic input and output. More details on page 117

MORE NEWS on page 19

An Announcement

of the Utmost Importance to Engineers Doing Research and Design Work in the Entire Audio Frequency Range.



BURNELL

Burnell and Co., Inc.

is proud to announce the development of *an entirely new product*—

ROTOROID®

a Variable Toroidal Inductor (patent applied for)

ROTOROID will prove to be a valuable aid in the solution of many engineering problems—in research and design—and opens new possibilities for production which were previously impractical or impossible.

ROTOROID

- . . . is a continuously variable, stepless toroidal inductor which can provide a 3:1 range of maximum to minimum inductance in 180° rotation of a shaft.
- . . . employs no mechanical resistance contacts and is therefore free of noise and wear.
- . . . requires no DC saturating currents and thereby eliminates the need for circuitry.
- . . . is applicable over the entire audio range (from approximately 300 cps). ROTOROID is not limited to any stock value of nominal inductance. It is available in any value of inductance now available in regular toroids.
- . . . is hermetically sealed and is virtually vibration and shock-proof, can be chassis or panel mounted.

Write Department G for further information.

Burnell & Co., Inc.
Yonkers 2, New York

PACIFIC DIVISION: 720 Mission Street, South Pasadena, California

An outstanding feature of ROTOROID is that, at maximum inductance, it provides the full Q of the toroid it contains. Thus, the user is at once able to take advantage of the high Q characteristics of toroids while at the same time having available a variable inductor not previously available in a toroid.

Applications: Virtually unlimited. Just a few of the many possible uses of ROTOROID are:

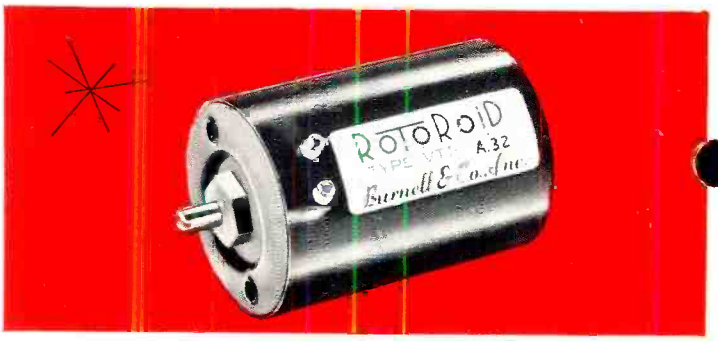
- **Tunable Audio Oscillators**
- **Variable Z Devices**
- **Servo Systems**
- **Telemetering**
- **Adjustable Selective Networks**
- **Variable Phase Shift Networks**
- **Variable Filters**
- **Electro-Mechanical Control Systems**

Availability: Immediately available: ROTOROIDS VTI-A and VTI-B which are equivalent in electrical characteristics to Burnell toroids TC-16 and TC-3 in cases 2¼" in diameter, 3-1/16" long. Soon to be available: two miniature types, VTI-C and VTI-D, equivalent to Burnell toroids TCO and TC-6.

FIRST IN TOROIDS AND RELATED NETWORKS

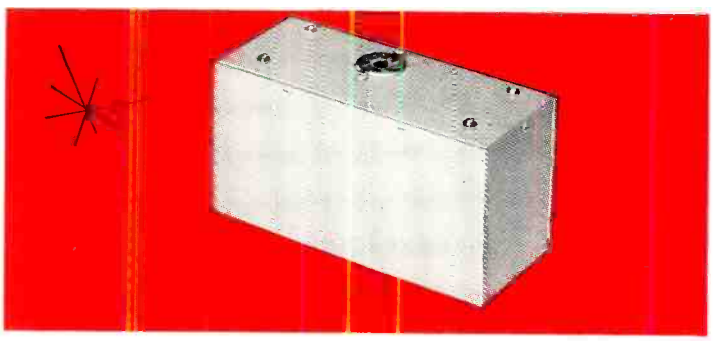
3 BIG REASONS

to check BURNELL first!



ROTOROIDS® A continuously variable, stepless toroidal inductor which can provide a 3:1 range of maximum to minimum inductance in 180° rotation of a shaft. Write for new brochure which gives complete technical data.

TOROIDS Combining the advantages of toroidal type winding with the molybdenum permalloy dust core and other specially selected materials, these toroids provide higher Q than any other structure. They also provide greater stability of inductance vs. temperature and level in a smaller space. Their self-shielding properties permit compact assemblies of coils with a minimum of deleterious effects. Supplied to an inductance accuracy of 1%. Available in standard, miniature and sub-miniature sizes. Also in a wide variety of finishes, including ***for the first time toroids molded in a new special material.***



TELEMETERING FILTERS

Band pass filters available for every channel ranging from 400 to 70,000 cycles for band width between 15 - 40%. Low pass filters available for operation in either unbalanced or balanced line, and range in cut off frequency from 6 up to 10,500 cycles. Also, miniaturized filters that do not sacrifice attenuation characteristics, save up to 80% space.

3 EXTRA REASONS TO CHECK BURNELL FIRST!

- Proven Top Quality
- Competitive Prices
- Prompt Deliveries

Write Department G for Catalog 102A

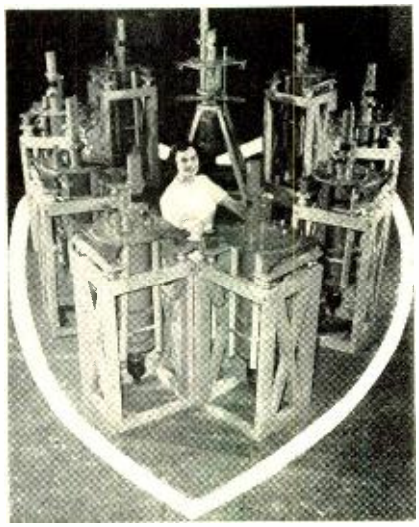
BURNELL & CO., INC.
Yonkers 2, New York

PACIFIC DIVISION: 720 Mission Street, South Pasadena, California

FIRST IN TOROIDS AND RELATED NETWORKS

As We Go To Press . . .

ELECTRONIC HEART

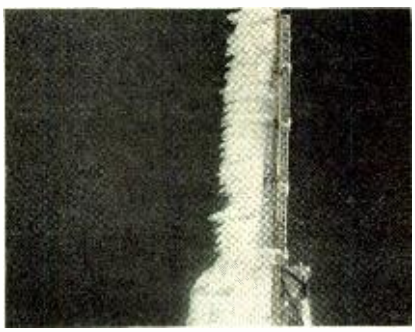


Nine huge klystrons enroute to GE's Electronics Park in Syracuse, N.Y. for installation in first million watt UHF station's transmitter. Destined for WILK-TV, Wilkes-Barre, Pa., each tube is over 4 feet high and weighs over 200 lbs. Four are used for video, two in audio. The three others are spares

"Ferrosheen" Recording Tape

ORRadio Industries Inc., T-120 Marvyn Road, Opelika, Ala. are introducing a completely new tape for magnetic recording that involves a new base material, formulation, coating technique and "ferro-sheening." The latter is their own new tape treatment manufacturing technique. "Ferro-Sheen" tapes are reported to offer the following advantages: (1) Extended frequency response, (2) Drastic reduction in head wear (40-100%), (3) reduced drop outs, (4) Unexcelled adhesion, (5) No embrittlement with age. The new tape will be marketed as IRISH Sound-Plate Mylar #220; IRISH LP-6:00 (long playing); and IRISH Shamrock #300.

"COLD IN THEM HILLS"



Recent sleet storm built up a 4-ft. thick layer of ice on WMTW's mast and tower. Station's channel 8 antenna array, manufactured by Alford Mfg. Co., Boston, is located atop 6288-ft. Mt. Washington, N.H. Deicing apparatus, used for the antenna only, kept elements ice-free using 1/16 of the maximum deicing power available

COMMON CHARACTERISTICS OF ALL
TYPE 2028B MOTOR GENERATOR UNITS

Pinion Data	10T.96P. 20° P.A.
O.D. of Case	1.000 inch
Overall Length	2 37/64 inches
Weight	5 ounces
Frequency	400 cycles
No. of Poles (Motor)	6
No Load Speed (Min.)	6500 rpm
Rotor Inertia	1.1 gram-cm²

ELECTRICAL CHARACTERISTICS
OF TYPICAL TYPE 2028B MOTOR GENERATORS

TYPE NO.	MOTOR					GENERATOR		
2028B —	EXCITATION		INPUT PER PHASE	STALL TORQUE	Theoretical Acceleration AT STALL	EXCITATION FIXED	INPUT	OUTPUT PER 1000 rpm
	FIXED	CONTROL						
0411110	26	26	2.3	0.4	25600	26	1.8	.51
0412120	26	26	4.0	0.6	38500	26	2.2	.68
0413120	26	26	1.8	0.3	19200	26	2.2	.68
0460600	115	115	4.0	0.6	38500	115	2.5	1.00
0470600	115	P-P	4.0	0.6	38500	115	2.6	1.00
	volts	volts	watts	Oz-n	rad/sec²	volts	watts	volts

OUTSTANDING FEATURES OF TYPE 2028B MOTOR GENERATOR

- New methods of manufacture result in high efficiency
- High torque to inertia ratio to give fast response
- Available for 115 volt -115 volt two phase or single ended tube operation
- High impedance winding for direct plate to plate operation available
- High generator output voltage with excellent signal to noise ratio
- Zero degree phase shift in generator
- All metal parts corrosion resistant
- Extremely wide operating temperature range

a new peak of efficiency in small servo motors

Input per phase only 1.8 watts

A new line of units has been added to the Kollsman "Special Purpose Motors" family combining precision machining, advanced electrical design and the latest in new materials. This new line consists of Induction Motors and Induction Generators supplied separately or combined in a single case one-inch in diameter. The new motors have been designed to give the maximum torque per watt ratio with the minimum rotor inertia. The generators have been designed to give the maximum output voltage with the minimum residual voltage and phase shift.

One of the principal features of the Kollsman "Special Purpose Motors" is the interchangeability of parts which permits numerous electrically different combinations of motor and generator windings within the same case.

Another unusual feature of the new line is the integral gear head unit. Contained within a single case is the gear train and motor; or gear train, motor and generator. Gear ratios as high as 300:1 can be supplied.

Other models of one inch O.D. units

TYPE NO.	DESCRIPTION
2103	Induction Motor
2101	Geared Induction Motor
2131	Geared Motor Generator

kollsman INSTRUMENT CORP.

Latest catalog and/or complete specification drawings will be sent upon request.

80-12 45th AVE., ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF *Standard* COIL PRODUCTS CO. INC.

In a nutshell HERE'S THE G-E PICTURE ON—

JUNCTION TRANSISTORS

TOP QUALITY UNITS ARE NOW BEING SHIPPED

G-E engineering consistently aimed for and *achieved* second-to-none quality in this transistor product. During the past year we refused time after time, to sacrifice quality to the urgency of orders on hand. The thousands of hours invested in development and test laboratories, in field testing and application, earned this most heartening response—every one of our customers has applauded the extreme reliability, the over-all superb quality of these General Electric transistors.

The facts on delivery today are as follows: We're swamped with orders. We can only handle your minimum requirements. Larger orders will be filled as promptly as General Electric's greatly-expanded production lines swing into "high". So place your order promptly. A shipment of G-E junction transistors applied in *your circuits* will save space and power, and reduce weight . . . as they deliver the important design advantages listed at the right.

DESIGN FEATURES:

SEALED JUNCTION...contaminating gases permanently eliminated!

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

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

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

HERMETIC SEAL...unaffected by moisture.

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

LONG LIFE...designed for long-term, stable performance.

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

G-E recommends these germanium-fused junction transistor triodes (P-N-P units) for low-to-medium power applications, for gains as follows:

2N43...HIGH **2N45**...MEDIUM
2N44...INTERMEDIATE

We can't tell all in a nutshell—so write today for complete specifications and delivery details. *Section X48114, General Electric Company, Electronics Park, Syracuse, N.Y.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

COMING EVENTS

Nov. 1-5—National Metal Exposition. International Amphitheater, Chicago, Ill.

Nov. 4-5—East Coast Conference on Airborne and Navigational Electronics, sponsored by the Baltimore section of IRE and IRE Professional Group on Aeronautical and Navigational Electronics. Sheraton-Belvedere Hotel, Baltimore, Md.

Nov. 10-11—AIEE Conference on Electronic Instrumentation and Nucleonics in Medicine, Morrison Hotel, Chicago, Ill.

Nov. 10-12—18th Annual Time and Motion Study and Management Clinic, sponsored by the Industrial Manage- Society. Sherman Hotel, Chicago, Ill.

Nov. 12-13—National Symposium on Quality Control Methods in Electronics, sponsored by the Professional Group on Quality Control of IRE and Electronic Technical Comm. of the American Soc. for Quality Control. Hotel Statler, New York.

Nov. 17—Western Area Development Conference sponsored by Stanford Research Institute, Nat'l. Assoc. of Mfrs., Calif. Mfrs. Assn., Soc. of Industrial Realtors, and Chamber of Commerce of Hawaii, Mark Hopkins Hotel, San Francisco, Calif.

Nov. 18-19—6th Annual Electronics Conference, sponsored by the Kansas City Section of IRE, Hotel President, Kansas City, Mo.

Nov. 21-22—Automatic Control Equipment Exhibition. Waldorf-Astoria Hotel, N. Y. C.

Nov. 29-Dec. 4—First International Automation Exposition, 242nd Coast Artillery Armory, New York, N. Y.

Dec. 8-10—4th Annual Eastern Joint Computer Conference and Exhibition, jointly sponsored by the AIEE, IRE, and ACM. Bellevue-Stratford Hotel, Phila. Pa.

1955

Jan. 20-21—Symposium on Printed Circuits, sponsored by RETMA, Univ. of Pa., auditorium, Philadelphia, Pa.

Jan. 26-28—10th Symposium on Instrumentation for the Process Industries, sponsored by School of Engineering, Chemical Engineering Dept., Agricultural & Mechanical College of Texas, College Station, Texas.

Feb. 10-12—Audio Fair-Los Angeles, sponsored by Los Angeles Section of AES, Alexandria Hotel, Los Angeles, Calif.

March 21-24—1955 IRE National Convention, Kingsbridge Armory, New York, N.Y.

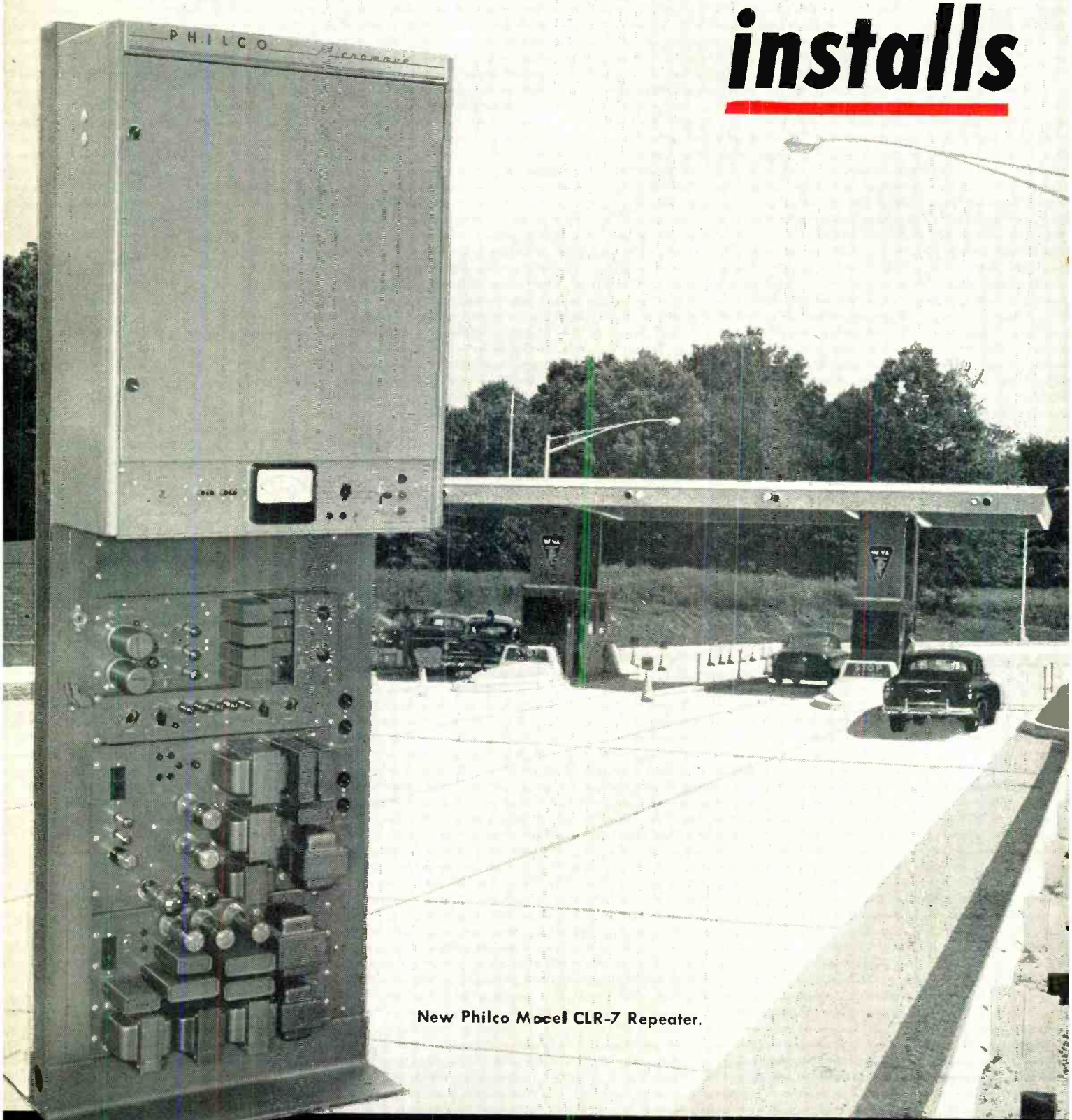
Apr. 18-22—National Convention of Dept. of Audio-Visual Instruction of Nat'l. Education Assn., Hotel Biltmore, Los Angeles, Calif.

Aug. 24-26—Western Electronic Show & Convention, San Francisco Civic Auditorium, San Francisco, Calif.

Nov. 2-5—World Symposium on Applied Solar Energy, conducted under leadership of Stanford Research Institute, Phoenix, Arizona.

(*Continued on page* 132)

THE NEW WEST VIRGINIA installs



New Philco Model CLR-7 Repeater.

PHILCO CORPORATION

TURNPIKE

PHILCO MICROWAVE!

A Great New Superhighway—with the Most Modern Communications

Now open to traffic, the West Virginia Turnpike marks completion of one of the most difficult road-building projects in the nation's history. In the words of C. H. Peterson, Project Engineer for Howard, Needles, Tammen & Bergendoff, Consulting Engineers: "Mountains had to be literally moved into valleys, before paving could begin on sections of the 88-mile throughway" which extends from Charleston to Princeton, West Virginia.

For greatest safety and efficiency in traffic control, the turnpike is equipped with the new Philco Model CLR-7 microwave communication system, which features simplicity, economy and continuous unattended operation—*it virtually runs itself, 24 hours-a-day!*

The complete communication system consists of a multi-hop microwave system integrated with VHF two-way radio installed in 10 base stations and 24 mobile police, fire protection and highway maintenance vehicles. The range of these VHF units is extended to the entire length of the turnpike by the microwave system.

Philco maintains a staff of experienced field and system engineers, to help you plan your communication system . . . to install and maintain it—*at surprisingly low cost.* Phone or write Philco, Dept. T today for information without cost or obligation.

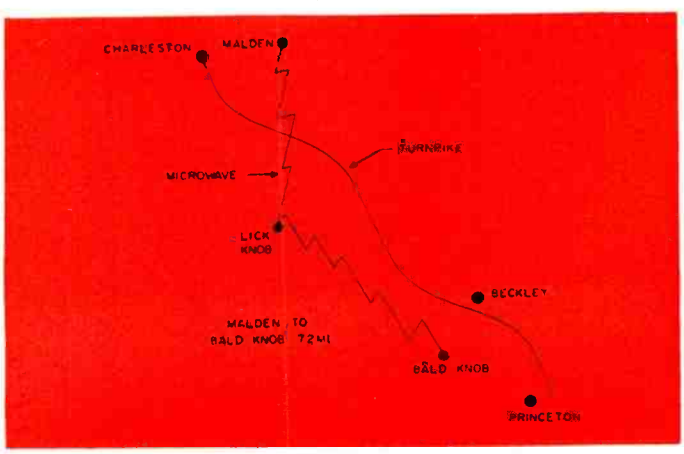
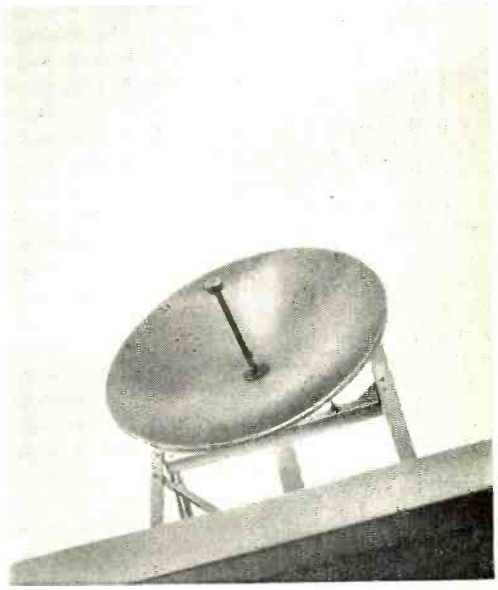
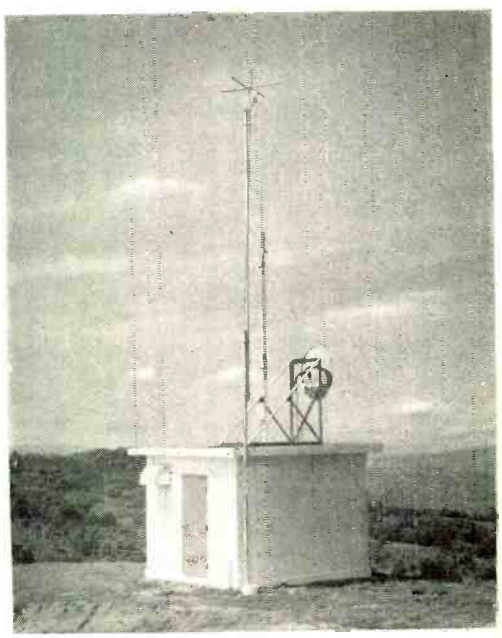


Diagram of Turnpike and Microwave Routes.



Microwave dish at Malden Terminal Station.



Microwave Terminal Station at Bald Knob.

GOVERNMENT AND INDUSTRIAL DIVISION • **PHILADELPHIA 44, PENNSYLVANIA**

IN CANADA: PHILCO CORPORATION OF CANADA LIMITED, DON MILLS, ONTARIO

Messages to the IEC Delegates

Shown below are two messages of interest that were addressed to the recent International Electrotechnical Commission meet in Phila. See page 61 "A Salute to International Standardization" for additional information on this activity.

Harold Osborne, President
Electrotechnical Commission
Houston Hall,
3417 Spruce Street
Philadelphia, Pennsylvania

Please extend my warm greetings to all the delegates to the Golden Jubilee of the International Electrotechnical Commission. It is my hope that all of you have had a pleasant and profitable session and that our international visitors will have many occasions to visit us again. The fifty-year record of the I.E.C. shows clearly the mutual benefits which come when nations and men of good will can share their problems in friendly and equal partnership.

Dwight D. Eisenhower

To Delegates to the IEC

Gentlemen:

First I want to express my extreme regret for my inability to be with you tonight due to completely unforeseen circumstances. It would have been a great privilege and pleasure to meet you all in person and to talk to you about the wonderful job that I know that you have accomplished in these two weeks of sessions.

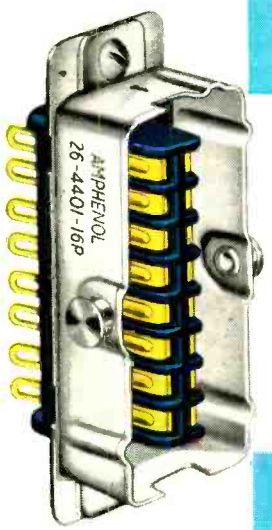
As you know, I am primarily interested in the electronics industry and have for many years been concerned with the development of standards in that industry both as Director of the Engineering Department of the Radio-Electronics-Television Manufacturers Association and as Director of the Joint Electron Tube Engineering Council of RETMA and NEMA. Naturally, I am much interested in the extension of our national and industry electronics standardization work to the international activities of the IEC. In the work of the professional societies, particularly the Institute of Radio Engineers, much of the work on standardization in that province is essentially international in character from the start and thus flows easily into IEC channels. In the case of the "trade association" type of standardization more directly related to products, I realize that there are many more facets of consideration between countries and there is where the really hard work of the IEC comes in. However, I do know that you have engaged in this work whole-heartedly and seriously and that you have made great accomplishments in this year's sessions. I want to congratulate you on these accomplishments and tell you that American industry has been most happy to have you here.

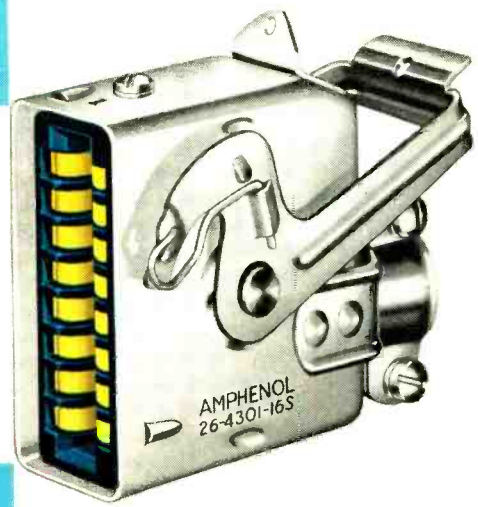
We hope that you have enjoyed your stay in this country and that you will visit us again soon.

Sincerely,
W. R. G. Baker
Director,
RETMA Engineering Dept.

AMPHENOL

the famous BLUE RIBBON CONNECTORS





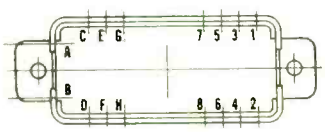
now available with Panel & Latch-Lock shells!

AMPHENOL's crack engineering team have completely redesigned the famous *Blue* RIBBON connectors and the results will be of interest every company engaged in electronics.

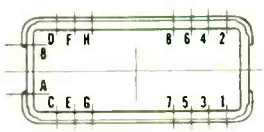
The basic improvement has been the design of a new method of polarization. Instead of conventional guide pin and bushing polarizatic male and female *Blue* RIBBON connectors are now mated by means of proper matching of the barrier heights betwen the contacts. Following this first important improvement AMPHENOL's engineers designed a complete line of front panel shells and cable-clamp latch-lock cans to the connectors—a step forward that makes the versatile *Blue* RIBBONs even more useful to the electronics industry.

What are the advantages of these design changes to you? Barrier polarization allows increased contact spacing without extendi the overall length of the connector—mismating is impossible. Front panel shells and latch-lock cans are available for *Blue* RIBBONs in a wide variety of keying arrangements, making possible the mounting of large numbers of connectors side by side without the possibility of connector mismating by untrained personnel. Latch-lock types may be safety-wired and the cans are available with either end or side cable outlets.

Alternate Keying Positions



Receptacle Front Shell



Plug Front Shell

Alternate keying on BLUE *RIBBON shells provide positive insurance against mismating in side-by-side connector mountings.*

Complete details on all AMPHENOL Blue RIBBON connectors in CATALOG R1

AMPHENOL

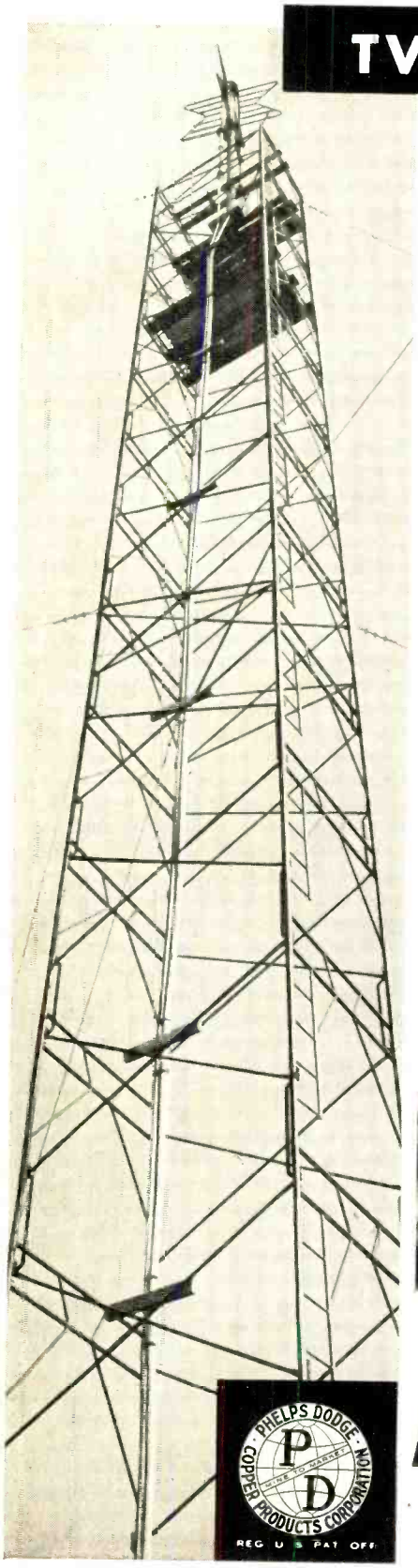
AMERICAN PHENOLIC CORPORATION *chicago 50, illinois*

In Canada: AMPHENOL CANADA LIMITED, Toronto

Styroflex Coaxial Cable

FIRST CHOICE OF STATION WDSM-TV FOR

TV TRANSMISSION!



WDSM TV Channel 6 CBS
DULUTH and SUPERIOR
MINNESOTA 7-4375 WISCONSIN 2-7234

May 24, 1954

RECEIVED MAY 25 8 AM 1954 P.D.C.P. CORP. NEW YORK OFFICE

Phelps Dodge Copper Products Corp.
40 Wall Street
New York 5, New York

Attention: Mr. Fred B. Turk

Gentlemen:

Styroflex cable with its easy and rapid installation helped immensely in allowing WDSM-TV to meet its target date of March 1, 1954. While construction of our transmitter building was still in progress, WDSM-TV installed its studio equipment, transmitter, antenna, and Styroflex transmission line in less than one month to meet this target date. Styroflex cable was a major factor in making us feel proud of this achievement.

Styroflex cable proved its worth to us when time was of an essence under the adverse weather conditions which prevail during the winter months in this area.

An overall standing wave ratio of 1.02 has been obtained since we have been on the air.

We are using 1-5/8" Styroflex line with our temporary single bay antenna on an interim power of 5,000 watts that will be increased to 26,000 watts within one week. Within the next few weeks, shipment will be released for 3-1/8" Styroflex transmission line that will be installed with our 6 bay antenna and 500 ft. permanent tower for an ERP of 100,000 watts.

We are indeed pleased with this product, and we are positive that the Styroflex line will give us many years of service with little maintenance cost. It is my opinion that Styroflex cable with its many uses has an important future.

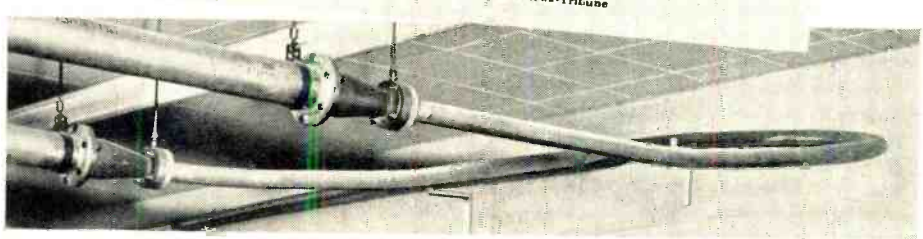
Sincerely yours,

G. M. Baumann

G. M. Baumann
Chief Engineer

GMB:D

Affiliated with WDSM Radio and Duluth Herald & News-Tribune



Interior installation above illustrates practical application of the remarkable bending properties of aluminum-sheathed Styroflex cable.

PHELPS DODGE COPPER PRODUCTS CORPORATION
REG U S PAT OFF

PHELPS DODGE COPPER PRODUCTS CORPORATION

40 WALL STREET, NEW YORK 5, N. Y.

STANDARD S-E ELECTRONICS

invites you to COMPARE ... BENEFIT ... SAVE!

COMPARATIVE REPORT PROVES S-E's LOWER OPERATING COSTS and TOP PERFORMANCE . . .

as compared to competitive transmitter "B"

Side-by-side comparison again spotlights the superior features and economy of Standard Electronics equipment. Compare for yourself how and why a S-E TH-654 50 KW VHF TV transmitter ranks well above equipment of equal power produced by another leading manufacturer.

(Based and computed from information published by both companies. ALL FIGURES ACCURATE TO THE BEST OF OUR KNOWLEDGE.)

1. INVESTMENT SAVINGS $8,844

	10 KW Driver—High Band			50 KW Amplifier—High Band			Total Initial Savings
	Trans. "B"	S-E TH-614	Savings With S-E Equip.	Trans. "B"	S-E TH-654	Savings With S-E Equip.	
Initial Investment	$89,000.	$85,000.	$4,000	$135,000.	$136,000.	(—$1,000.)	$3,000.
Replacement or Spare Tube Cost*	$ 2,817.	$ 2,605.	$ 212.	$ 10,361.	$ 4,729.	$5,632.	$5,844.*

*Not included in summary total.

2. OPERATIONAL SAVINGS (5-year basis) $145,200

		Transmitter "B"—High Band		S-E TH-654—High Band	Net Savings With S-E Equipment
		"Ideal" Life, 5,000 Hours	Est. Field Life, 2,500 Hours	Proven Life, 5,000 Hours †	
Tube Costs	Tube Cost Per Hour	$2.60/hr.	$5.20/hr.	$0.95/hr.	$4.24/hr.
	5-Year Tube Cost ††	$78,000.	$156,000.	$28,800.	$127,200.
Power Costs	Power Consumption Black Picture	235 KW		178 KW	app. 25%
	Average Picture	189.5 KW		143.5 KW	app. 25%
	5-Year Average Power Cost†††	$72,180		$54,180.	$18,000.

† Actual proven life in excess of 7500 hours.
†† Based on 18 hours per day, 6000 hours per year.
††† Computed on rate data furnished by a leading Power Co. (name on request).

3. SPACE SAVINGS and DESIGN ADVANTAGES with S-E equipment

	Transmitter "B"—High Band	S-E TH-654—High Band	Benefit and/or savings With S-E Equipment
Approx. Floor Area Required	852 sq. ft.	702 sq. ft.	150 sq. ft.
Self-Contained	No	Yes	Quick, convenient accessibility to all components; no units away from main cabinet.
Air Cooling	External	Integral	Valuable space saver; keeps construction cost low.
Loading Door Requirements	84" x 32-9/16"	81¾" x 33"	Simplified installation; no door removal problem.
Accessibility of Tubes and Meters	Hidden	Visible and accessible from front.	Easy maintenance and checking.
Equipment Weight	23,000 lbs.	27,000 lbs.	Additional weight of S-E equipment from extra heavy frame and components . . . helps insure more dependable service.
Power Supply	460 V, 3 ø	208/230 V, 3 ø	Requires no special wiring or transformers.

SUMMARY:

In your first five years of operation . . . Standard Electronics equipment saves you $148,200

PLUS THE ADDITIONAL SAVINGS YOU DERIVE FROM S-E SPACE SAVING AND DESIGN ADVANTAGES (CHART #3).

Get all the facts on the advantages of S-E equipment over Transmitter "B" from your Standard Electronics Sales Engineer. Write to S-E today!

The Most Adaptable Line of Add-A-Unit Amplifiers!

- Puts You On The Air Fast With High Power
- Makes Maximum Use of Your Present Equipment

Start With Any 2 KW Transmitter	Step Up To 10* Or 20 KW With S-E Add-A-Unit Amplifiers
Start With Any 5 KW Transmitter	Step Up To 25 Or 40 KW With S-E Add-A-Unit Amplifiers
Start With Any 10 KW Transmitter	Step Up To 40 Or 50 KW With S-E Add-A-Unit Amplifiers

*Only S-E has a separate 10 KW amplifier

★ **FIRST WITH HIGH POWER**

standard electronics corporation

A SUBSIDIARY OF CLAUDE NEON, INC.

285-289 EMMETT STREET • NEWARK 5, NEW JERSEY

devoted exclusively to the engineering, manufacturing, and servicing of equipment for the broadcast and television industry

SIMPLER

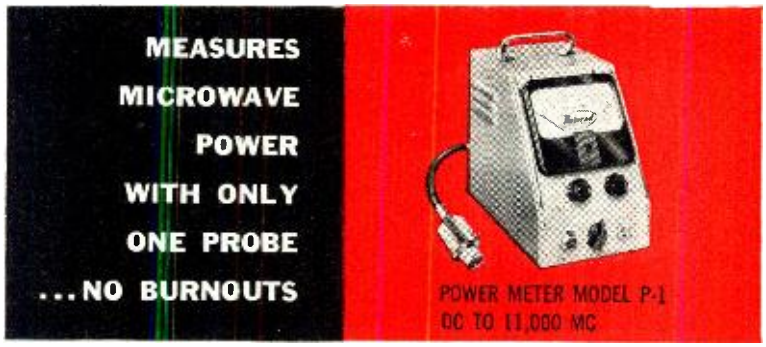
MICROWAVE

MEASUREMENTS

TO SAVE

ENGINEERING

MANHOURS



Over the entire frequency range DC to 11,000 MC, Polarad's new Micro Power Meter utilizes only **one** power probe, supplied as an integral part of the instrument. This unique power probe will sustain severe overloads without burnout since it does not contain hot wire barreters or other delicate components.

This new rugged and stable instrument reduces microwave power readings to the simplicity of everyday low frequency measurements. It is a true rms milliwatt indicating meter accurately measuring CW and pulse power.

Because of its wide band coverage, the Polarad Model P-1 is outstanding as a general lab and field instrument, available for power measurements at all commonly used frequencies.

Features and Specifications:

- Single power probe for all frequencies.
- 150% overload without burnout.
- Direct reading.
- Broadband Coverage ..... DC to 11,000 mc continuous in single mount.
- Dual Power Range ..... 0-20 mw and 0-100 mw.
- Impedance ..... 50 ohms coaxial.
- VSWR ..... Less than 1.4:1 from 0 to 5000 mc.
  Less than 2:1 from 5000 to 11,000 mc.
- ACCURACY
  - Indicating Unit ..... ± 0.5 db.
  - RF Mount ..... ± 1.0 db.
- Connector ..... Type N plug.
- Input Power Required ..... 115v ±10%, 60 cps.
- Dimensions ..... 5½" x 8½" x 7½".
- Weight ..... 8 lbs.

Now, for the first time, you can test all commercially available klystron tubes, built-in cavity types as well as those requiring external cavities, just as easily as you make tests on vacuum tubes.

Polarad's new Model K-100 Klystron Tube Tester provides complete metering facilities and control adjustments with a tube data chart to determine settings. Safety features protect personnel at all times when testing tubes requiring high voltages.

Features:

- Performs the following basic tests:
  - **a.** Filament continuity.
  - **b.** Short circuit tests between all elements.
  - **c.** Static d-c tests—measurement of rated d-c currents and voltages.
  - **d.** Life test—relation of cathode current versus reduced filament voltages.
  - **e.** Dynamic test—provision is made for external modulation so that klystrone tubes may be dynamically tested with external r-f measuring equipment.
- Special adapter mount for all commercial types of klystrons.
- Safety features protect personnel during tests.
- Protective devices prevent misadjustment and save tubes from accidental burnout.
- Built-in heavy duty blower provides forced air cooling of the klystron tubes.
- Tester designed to be adapted for future tubes.
- Built-in Universal Power Supply may be used for klystron testing purposes outside the instrument.

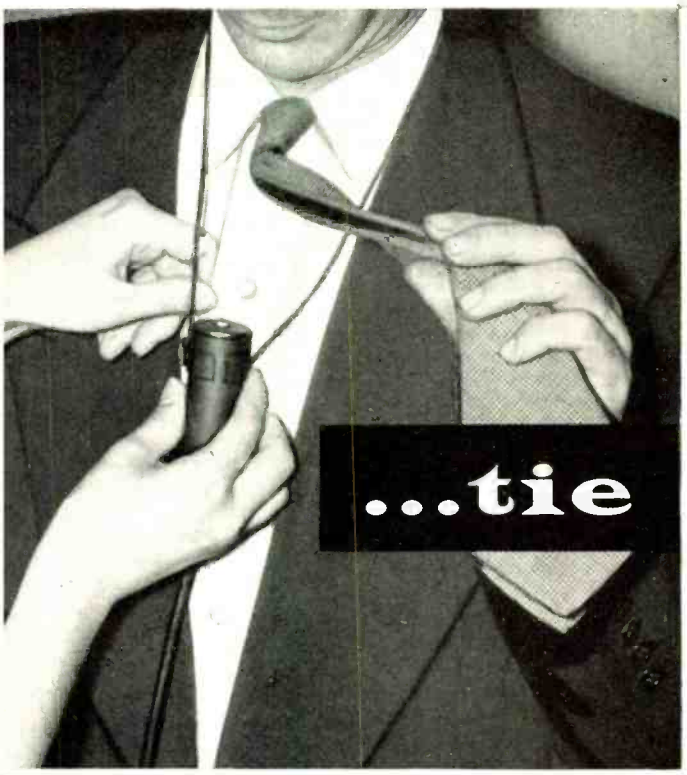
Polarad

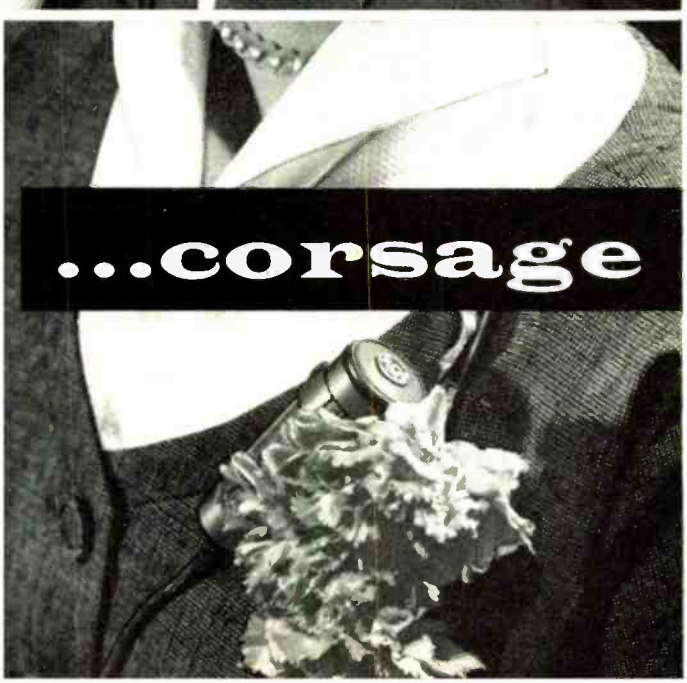
ELECTRONICS CORPORATION

100 METROPOLITAN AVENUE, BROOKLYN 11, N. Y.

REPRESENTATIVES Albuquerque • Arnprior, Canada • Atlanta • Boston • Chicago • Cleveland • Fort Worth • Kansas City • Los Angeles • New York • Philadelphia • San Francisco • Seattle • St. Paul • Syracuse • Washington, D. C.

"hides" *behind a...*





...*the new* **BK-6A** **RCA** *dynamic miniature microphone*

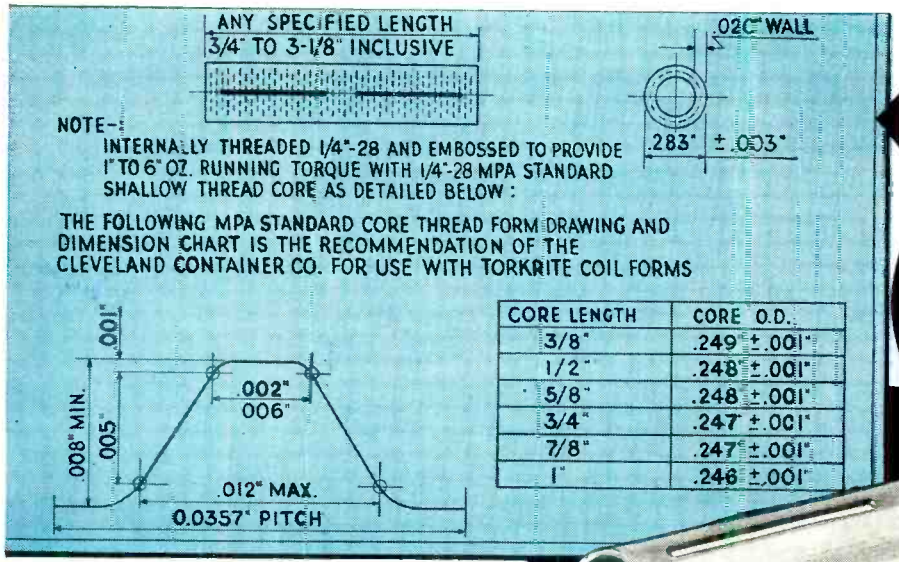
Here's a miniature mike that does a man-size job . . . This RCA Dynamic Microphone is small enough to conceal in a man's hand or under his necktie. Ladies can hide it behind a corsage. Or, you can put it behind a table decoration. In any setting, it's an amazing help in keeping the informal atmosphere so many television shows, interviews and public occasions require.

However you use it, you can be sure of correct speech quality. Low-pitched chest sounds, sibilants and high-pitched sounds are all reproduced in proper balance.

Just three inches long, weighing only 5½ ounces and neutral in color, this RCA Miniature is as inconspicuous as modern microphone design can make it. A small and very flexible cable allows free, easy movement by anyone using it. And in spite of its unusual compactness, the BK-6A is a high quality microphone and has very durable construction.

This RCA Miniature Dynamic Microphone can increase *your* staging and production flexibility in many ways. For information on *all* of its advantages . . . contact your RCA Broadcast Sales Representative, or write Dept. K-119, RCA Engineering Products Division. In Canada, write RCA Victor Ltd., Montreal.

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



DESIGN

PRODUCT

APPLICATION

TORKRITE

BY THE MAKERS OF CLEVELITE* PHENOLIC TUBING.

Torkrite coil forms eliminate torque and stripping problems and are rapidly replacing other coil forms because Torkrite:

- withstands more than required stripping pressure.
- requires no revision other than reduced winding arbor diameter.
- is round and concentric; winds coils at higher speed without wire breakage or fallen turns.
- permits use of lower torque since it is completely independent of stripping pressure.
- recycling ability is unmatched.
- is stronger mechanically because of heavier wall.
- provides 1—6" oz. running torque when used with MPA standard shallow thread core.
- has no holes or perforations thru tube wall which eliminates cement leakage locking cores.
- has smooth adjustment of core without lubricant.
- torque increases less after winding as heavier wall reduces any tendency to collapse and bind core.
- maximum stability results as core cannot move in relation to winding after peaking as it is engaged in internal threads.
- embossings are evenly spaced, with a lead at each end of the form to permit easy insertion of core.

INVESTIGATE this outstanding coil form.

Why pay more? For good Quality . . . Call CLEVELAND!

* Reg. U. S. Pat. Off.

★ ★ ★

Improved new Torkrite is now available in various diameter tubes. Lengths from 3/4" to 3-1/8" are made to fit 8-32, 10-32, 1/4-28 and 5/16-24 cores.

★ ★ ★

The CLEVELAND CONTAINER Co.

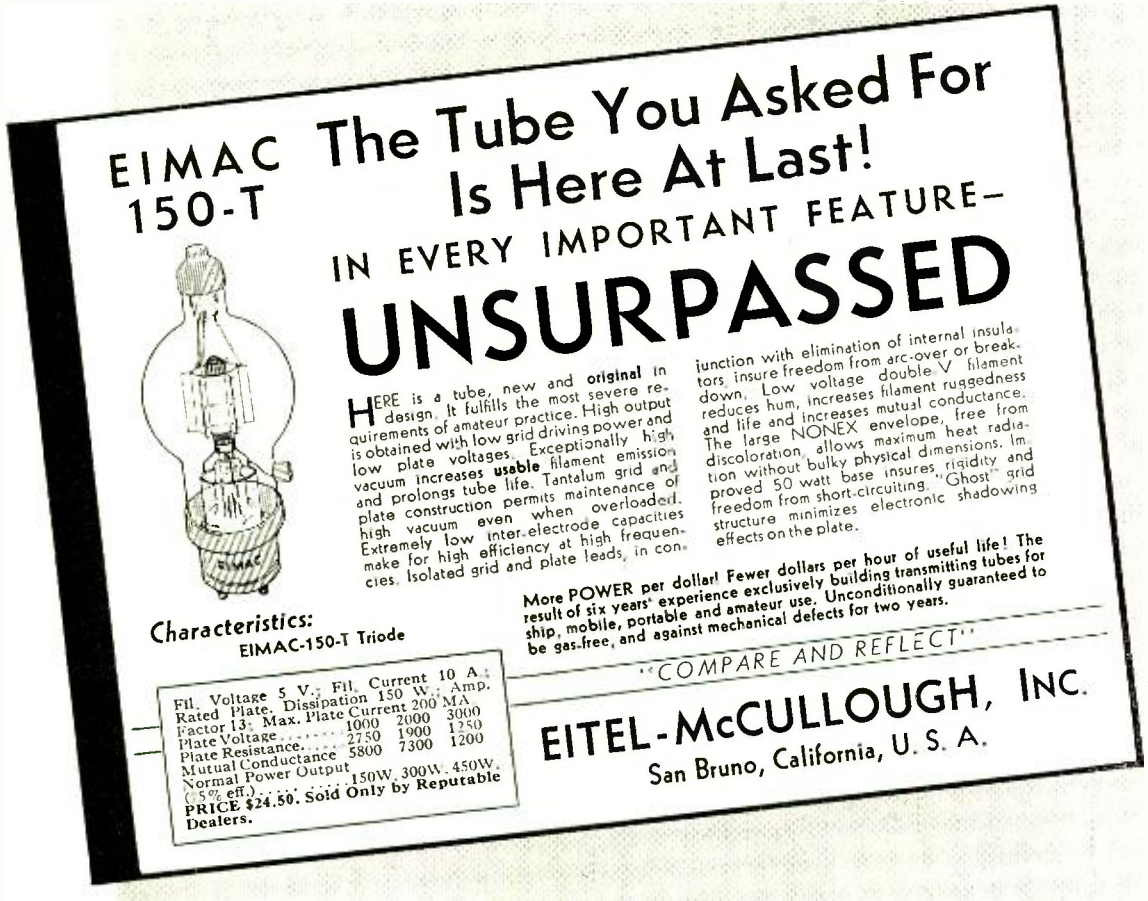
6201 BARBERTON AVE. CLEVELAND 2, OHIO

PLANTS AND SALES OFFICES at Chicago, Detroit, Memphis, Plymouth, Wisc., Ogdensburg, N. Y., Jamesburg, N. J.
ABRASIVE DIVISION at Cleveland, Ohio
CANADIAN PLANT: The Cleveland Container, Canada, Ltd., Prescott, Ontario

REPRESENTATIVES

NEW YORK AREA R. T. MURRAY, 604 CENTRAL AVE., EAST ORANGE, N. J.
NEW ENGLAND R. S. PITTSFORD & CO., 62 LA SALLE RD., WEST HARTFORD, CONN.
CHICAGO AREA PLASTIC TUBING SALES, 5215 N. RAVENSWOOD AVE., CHICAGO
WEST COAST IRV. M. COCHRANE CO., 408 S. ALVARADO ST., LOS ANGELES

AD #1: NOVEMBER 1934



The above advertisement introduced Eimac tubes 20 years ago this month, November 1934. Since then the reliability, performance and quality of Eimac triodes, tetrodes, pentodes and klystrons have made Eitel-McCullough, Inc., the largest manufacturer of transmitting tubes in the world.

Eimac

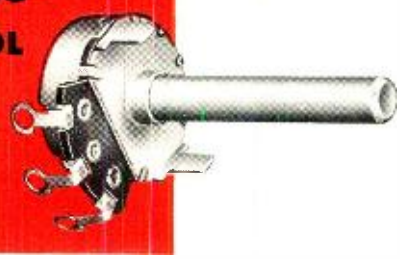
EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

The World's Largest Manufacturer of Transmitting Tubes

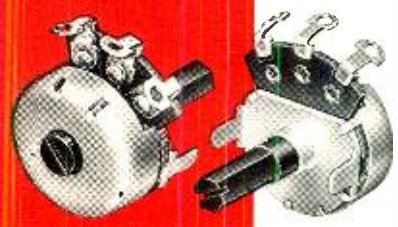
3 Low Cost VARIABLE RESISTORS for COMPACT CIRCUITS

COST-CUTTING TAB-MOUNTING CONTROL



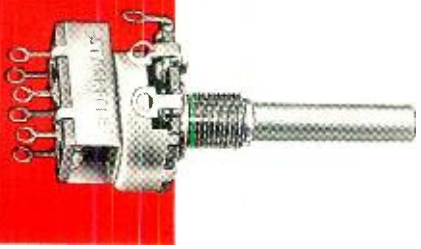
0.5 watt metal shaft type for TV picture adjustment, pre-set gain controls, etc. Tab-mounting cuts mounting time, eliminates hardware. Nine different Stackpole line switches available for this control. *Send for specifications on Type LR-5.*

TAB-MOUNTING "DOUBLE-ENDER"



Just right for rear-of-chassis or concealed front panel controls in TV receivers . . . especially in high voltage circuits. Bakelite shaft can easily be adjusted from either side of control. Measures only .894" in diameter, yet handles a full .5-watt. *Write for data on Stackpole Type LR-6.*

MINIATURE TONE CONTROL with SPECIAL DP-DT SWITCH



A really versatile space-saver for midget radios, combination receivers, or amplifiers. Helps reduce the number of controls on complicated sets. U.L. Approved .5 amp., switch throws at opposite ends of control rotation—maintains full 270° shaft motion in either position. Ideal for band changing, input or bandwidth switching. *Write for details on Stackpole Type LRSS-150.*

Electronic Components Division
STACKPOLE CARBON COMPANY
St. Marys, Pa.

STACKPOLE

In Canada: Canadian Stackpole Ltd., 550 Evans Avenue, Etobicoke, Toronto 14, Ontario

two towers designed by BLAW-KNOX provide three-way service

To gain maximum coverage within the FCC grant for television channel 9, as well as AM and FM radio, WSTV Steubenville, Ohio, required two radically different types of towers. So they came to Blaw-Knox.

The massive 800-foot Blaw-Knox TG type tower serves a dual purpose—as it rigidly supports a twelve bay, 8500-pound TV antenna and an FM radio antenna. Any interference with the AM signal transmitted from a nearby smaller tower is eliminated by base and guy insulators. Of triangular cross-section, 8-foot to a side, this large guyed tower has solid round rods with welded connections, double-laced angle bracing, heavy connecting flanges . . . and weighs 192,000 pounds.

By contrast, the comparatively slender but sturdy 275-foot Blaw-Knox type LT tower is the insulated vertical radiator for AM radio. This 3-foot triangular, guyed tower, double-laced for the full height, has specially formed corner legs for extra strength . . . yet weighs only 11,000 pounds.

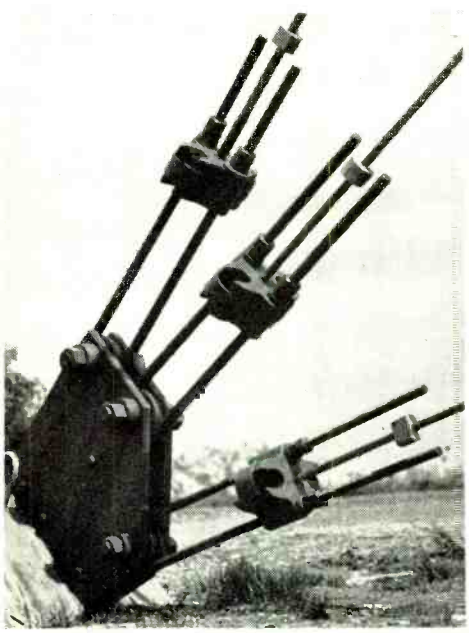
Designed and constructed to meet definite operating requirements . . . these towers typify the flexibility of our research, engineering, testing and fabricating services. And demonstrate our ability to provide towers to meet *your* specific conditions.

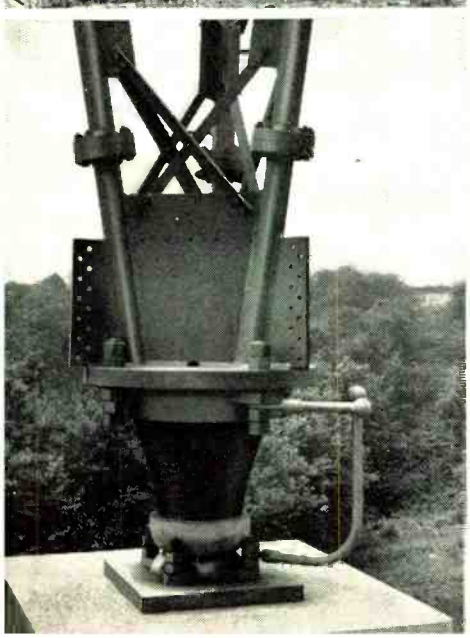
For more information about the many types of Blaw-Knox Antenna Towers, write for your copy of Bulletin No. 2417.

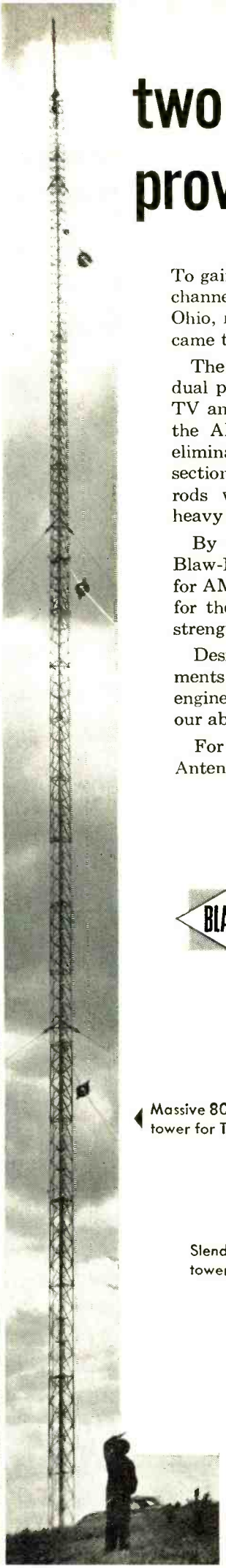
BLAW-KNOX COMPANY
BLAW-KNOX EQUIPMENT DIVISION • TOWER DEPARTMENT
PITTSBURGH 38, PENNSYLVANIA

BLAW-KNOX **ANTENNA TOWERS**

Guyed and self-supporting—for AM • FM
TV • radar • microwave • communications

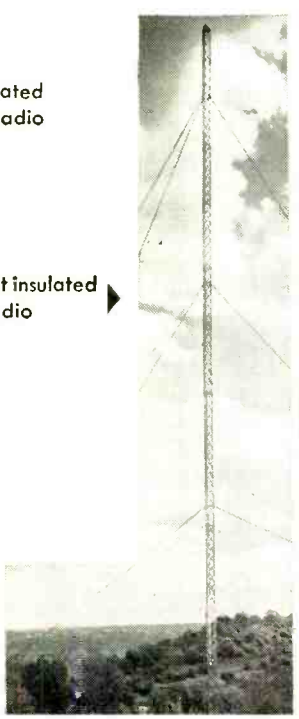






Massive 800-foot insulated tower for TV and FM radio

Slender 275-foot insulated tower for AM radio



TELE-TIPS

FIRST CONELRAD CITATION—The first citation by FCC to a radio station has been issued for failure to have a suitable receiver for Conelrad alerts. All stations must be equipped to receive these alerts even though they may be connected to Conelrad key station by wire lines.

RADIO HARVESTING—Two way Bendix radio in Quarryville, Pa., has proven invaluable to a food processor in an agricultural "checker game." In a matter of a few hours peas, for example, can turn from 100% to 80% fancy. Radio trucks now move harvesters from field to field over a 30-mile area with split-second timing.

HIGH INTENSITY NOISE can cause malfunctioning of avionic equipment. Armour Research Foundation engineers warn that ordinary shock and vibration isolation of components in aircraft is not effective acoustically. In a recent "sound-box" test involving guided missiles, jets and rockets, jet noises of 120 db and higher, fed into the reverberant chamber, caused tubes to fail electrically.

MACHINERY FOR INDUSTRY can be obtained through one of five ways according to S. D. Maddock, president of C.I.T. Corp. The management may (1) pay cash (2) get a short-term bank loan (3) make capital issues (4) get limited credit from the machinery manufacturers (5) use a term-loan from an industrial financing company. Aside from monthly repayment feature, latter plan also enables borrower to lump purchases from different sources into one overall loan.

RADIOACTIVE DIRT is now being used routinely by a number of companies to determine the amount of soil or dirt removed from fabrics under various cleaning conditions. According to Nuclear of Chicago, three standard test swatches are available. Geiger counter measurements before and after gives relative indication of the effectiveness of cleaning technique.

(*Continued on page 38*)

NEW

HUGHES MINIATURE GOLD JUNCTION* GERMANIUM DIODES

High Forward Conductance

High Back Resistance

Excellent Transient Response

Stable Characteristics

Actual size, diode body: 0.265 by 0.130 inches, maximum.

Developmental gold junction diodes have been made at Hughes for some time. Their commercial introduction, however, has been withheld until stability equal to that of the reliable Hughes Point-Contact devices was firmly established. Now, these superior diodes, in a variety of types, are available to meet your particular requirements. They combine high forward conductance with high back resistance—characteristics necessary for many circuit applications—yet offer the *assured* reliability that has made Hughes Diodes the standard. Like the *original* Fusion-Sealed Germanium Diodes, the new line of Miniature Gold Junction Diodes is housed in the famous Hughes one-piece glass body—impervious to moisture, fumes, and external contaminating agents. This means that you can specify—and confidently use—these Gold Junction Diodes in applications such as magnetic amplifier circuits . . . clamps . . . d-c restorers . . . logical gate circuits.

The ORIGINAL Glass-Body, Fusion-Sealed Germanium Diodes.

* *These are true junction diodes, with the miniature junction being formed by manufacturing processes at the end of the catwhisker. The envelope is the same sub-miniature package used in Hughes Point-Contact Diodes.*

Hughes SEMICONDUCTOR SALES DEPARTMENT

Aircraft Company, Culver City, Calif. *New York Chicago*

TELE-TIPS

(*Continued from page 36*)

NO REDHEADS NEED APPLY . . . or brunettes either for that matter. Blonde hair, because of its graining and fineness, is most sensitive to changes in relative humidity. These hairs are used in the new Bendix-Friez Automatic Humidistat Control now being marketed by the Abeon Supply Co., 179-15 Jamaica Ave., Jamaica 32, N. Y.

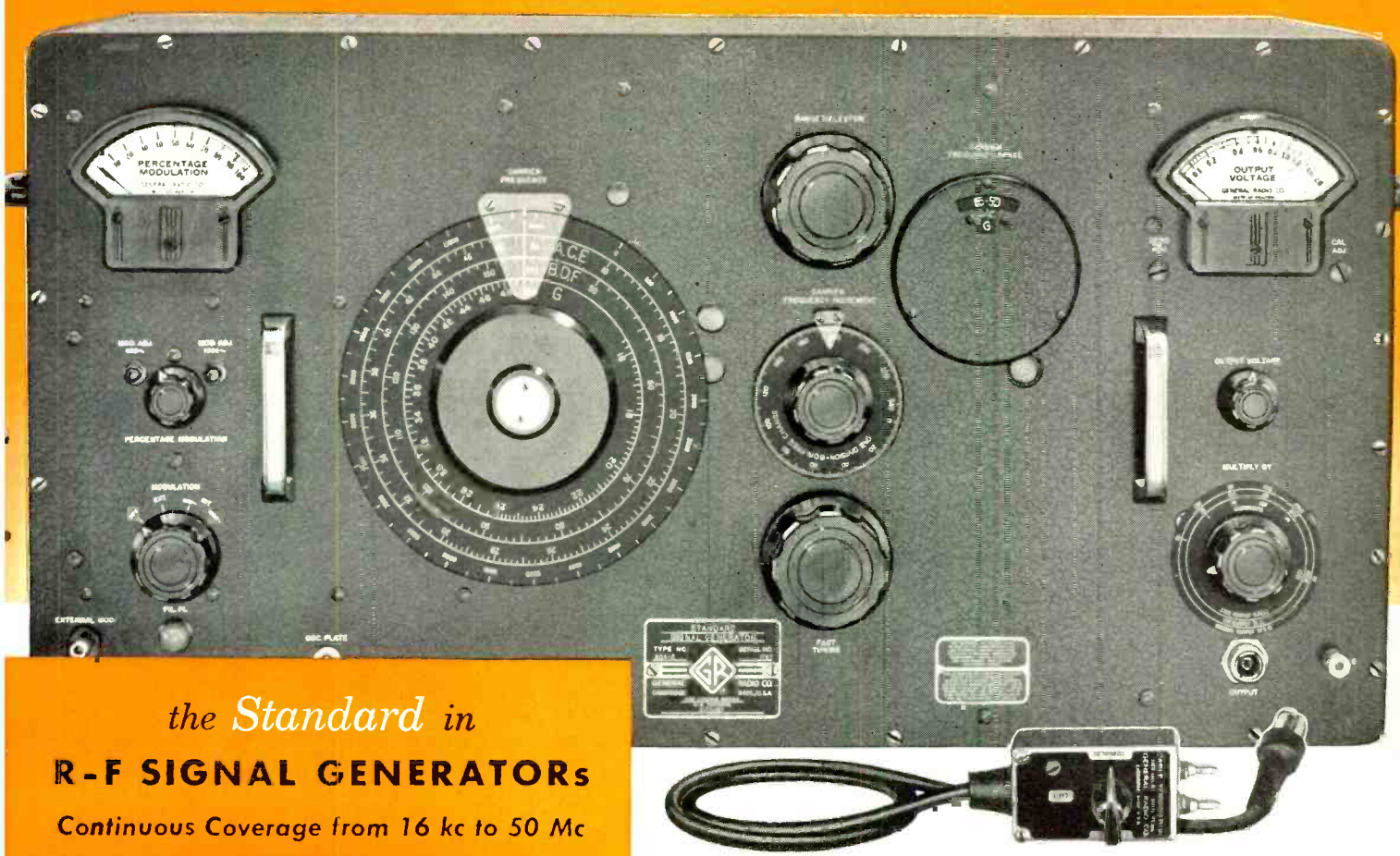
COLOR NOTES FOR ENGINEERING EXECUTIVES are valuable ally in daily work, according to Dr. Daniel Bower, New York psychologist. Study sponsored by Norma Pencil Corp. suggests that "stop (red) and go (green)" signals be used as marginal markers for reports and surveys. In a first draft red checks indicate need for additions or clarifications. Subsequent green check indicates "all-clear." Don't underline! This takes time, leads to eyestrain and is a poor memory device. Use marginal marks or circle entire paragraph.

ULTRAVIOLET LIGHT AND HEAT, through their effect on the molecular structure of cable cover plastic materials, are the principal factors causing their deterioration. This fact resulted from a study in the paper "The Natural and Artificial Aging of Nylon," which was conducted at Battelle Institute, Columbus, Ohio, under sponsorship of Coles Signal Laboratory. Latter branch of U.S. Army Signal Corps is seeking to improve durability of nylon and other plastic materials for communication cable covers.

COLOR TV reviews by newspaper critics are, at times, colored by how well the receiver is adjusted. For example, the TV reviewer for a large Chicago daily recently panned a big color production because the hues didn't come in right. It wasn't until he read favorable reports from other sources that he realized his set was out of kilter.

UHF TUNERS will be included in virtually all color television receivers by major set manufacturers, according to a recent survey published by the National Citizen's Committee for Educational TV. Two thirds of reserved educational channels are in the UHF band.

(*Continued on page 46*)



the Standard in
R-F SIGNAL GENERATORS
Continuous Coverage from 16 kc to 50 Mc

The Type 805-C Standard-Signal Generator is an industry-wide laboratory reference standard. It provides a signal whose frequency is directly indicated on a large 8-inch dial, and whose output level can be set over a 0.1-μv to 2-volt range. The usual difficulties due to frequency modulation, cable errors, excessive harmonic distortion, and leakage are absent. A precision output attenuator in combination with a logarithmically-calibrated voltmeter provides a means for accurately setting small increments in output voltage. Power-line fluctuations have no effect on operation, both percentage-modulation and output-voltage are continuously displayed, and attenuator impedance does not change with setting.

The Type 805-C Signal Generator is ruggedly built and will withstand the rigors of continuous use in production. This instrument is truly a *standard* among radio-frequency signal generators.

Wide Frequency Range — complete coverage from 16 kc to 50 Mc in seven ranges — spare position for extra set of coils permits choice of optional frequency range

Frequency Calibration — direct reading to accuracy of ±1%

Incremental Frequency Dial — permits accurate selectivity tests — frequency increments as small as 0.01% obtained with vernier

High Output Voltage — continuously adjustable from 0.1 μv to 2 volts — panel meter and multiplier give continuous indication

Constant Output Impedance — 75 Ω at panel jack; output cable and termination unit furnish output impedance at 37.5, 7.1, and 0.75 ohms — standard dummy-antenna included

Attenuator Accuracy — below 3 Mc, error is less than ±(3% + 0.1 μv); from 3 to 10 Mc, ±(5% + 0.2 μv); 10 to 30 Mc, ±(10% + 0.4 μv); 30 to 50 Mc, ±(15% + 0.8 μv)

Modulation at High Level — 400 and 1000 cycles internal modulation — for external modulation, 10-volts across 0.5 MΩ gives 80% modulation — panel control makes modulation continuously variable from 0 to 100% — meter indicates modulation with 10% to 15% accuracy

Negligible Incidental F-M — less than 0.05% on highest carrier-frequency range for full 100% modulation; 0.02% for 30% modulation — appreciable less at lower carrier frequencies

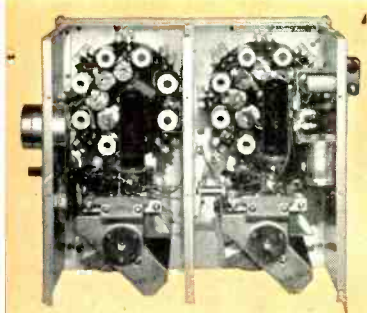
Distortion and Noise Level — envelope distortion less than 5% at 1 Mc and 80% modulation — noise level at least 40 db below 80% modulation

Minimum Leakage — magnetic field less than 5 μv per meter — negligible radiation

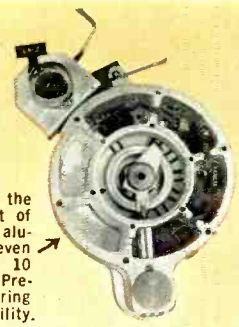
Complete Power Supply Regulation — line voltage variations, including transients from 105 to 125 volts (or 210 to 230 v) have no effect on performance

Size - 16 x 33 x 12 in. **Net Wt.** - 117½ lbs.

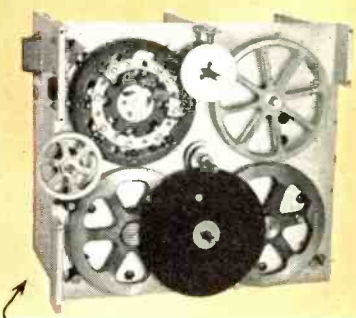
Type 805-C Standard-Signal Generator **$1495.00**



Back view of oscillator and amplifier sections with aluminum cabinet and shields removed. Both sections are mechanically identical. Each uses a precision main-tuning capacitor mounted with ball bearings in a cast-aluminum frame, and a series of 7 coils which cover the 16 kc to 50 Mc range. Each coil consists of a high-grade ceramic form which is wound and impregnated to prevent moisture absorption, providing maximum stability. Coils are individually adjusted so that each range will track the pre-engraved frequency scale. Heavy silver overlay is used for all switch contacts.



The precision attenuator is another example of the care taken in designing a superior instrument of this type. The attenuator, enclosed in a cast aluminum housing for thorough shielding, has seven steps providing successive dividing factors of 10 in output voltage for all frequency settings. Precision wire wound G-R resistors are used, insuring maximum accuracy and long-term stability.



The condensers are driven through 10:1 heavy-cast gear trains which are precision ground. They may be operated by either of two knobs. One is used to change quickly from one point on the dial to another; the other provides a slow motion drive of 100:1, providing frequency increments of 0.01% per dial division.

GENERAL RADIO Company

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

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8055 13th St., Silver Spring, Md. WASHINGTON, D.C.
920 S. Michigan Avenue CHICAGO 5
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POLARISCOPES
PRECISION CAPACITORS
PULSE GENERATORS
R-L-C DECADES
R-L-C STANDARDS
SIGNAL GENERATORS
SOUND & VIBRATION METERS
STROBOSCOPES
TV & BROADCAST MONITORS
U-H-F MEASURING EQUIPMENT
UNIT INSTRUMENTS
VARIACS
V-T VOLTMETERS
WAVE ANALYZERS
WAVE FILTERS

REMEMBER, MERLIN, WAND WAVING IS STRICTLY HOCUS-POCUS!

Pulling a rabbit out of a hat is fine for entertainment, we agree. But not even a magician can make good on the fantastic claims attributed to cheaper solders, *the mystery alloys with a secret ingredient,* that are supposed to equal the performance of higher tin content solders. Today, as always, Kester believes, the quality of the soldered connection is what counts . . . *not* an infinitesimal saving. That's why Kester Solder has been a "star performer" for more than 50 years!

For your specific solder requirements, remember Kester "44" Resin, "Resin-Five" or Plastic Rosin-Core Solder . . . with exact core size or flux-content "tailored" to every job.

KESTER

SOLDER COMPANY

4210 WRIGHTWOOD AVENUE, CHICAGO 39, ILLINOIS
NEWARK 5, NEW JERSEY • BRANTFORD, CANADA

For Fuses of *Unquestioned* High Quality

Standardize on BUSS FUSES

BUSS fuses can be relied on for dependable electrical protection, elimination of needless blows and top quality in every detail because . . . every BUSS fuse normally used by the Electronic Industries is electronically tested. A sensitive testing device rejects any fuse that is not correctly calibrated, properly constructed and right in all physical dimensions.

And there is a BUSS fuse to meet your most exacting needs. The complete line includes: dual-element (slow blowing), renewable and one-time types . . . in sizes from 1/500 amperes up — plus a companion line of fuse clips, blocks and holders.

It is just good business to rely on fuses that protect both the product and your reputation. So why not standardize your buying and stock records on genuine BUSS fuses . . . today!

Put the BUSS Engineers on your payroll

Many manufacturers save engineering time when they have special problems in electrical protection by turning to the BUSS engineers. Our engineers are full-time fuse specialists, working in the world's largest fuse research laboratory, well qualified to help determine the right fuse or fuse mounting for the job. If BUSS can be of service to you too, just tell us the problem.

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

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BUSS

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Please send me bulletin SFB containing facts on BUSS small dimension fuses and fuse holders.

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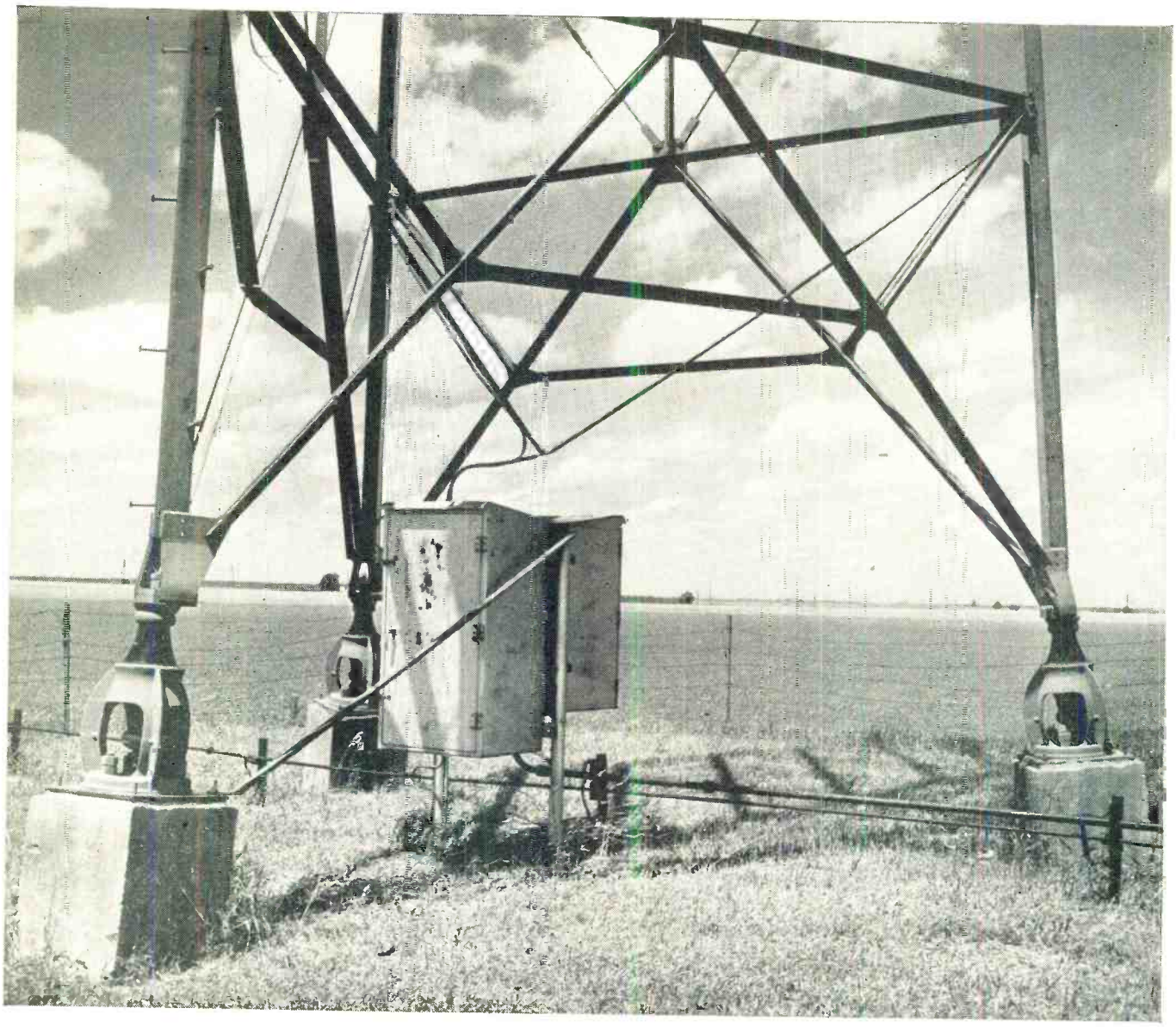

Base for Broadcasting

This is the base of a Truscon Self-Supporting Steel Tower. Standing sturdy and staunch astride the heart of the wheat country, it helps broadcast the AM signal of KFRM, Concordia, Kansas.

This picture of a firm, solid base, securely anchored, is but part of the story of Truscon "towers of strength." From this base rises a beautifully engineered, precision-manufactured steel spire that stands strong and steadfast against wind and weather.

Truscon knows towers. Truscon builds them for you tall or small . . . tapered or uniform in cross section . . . guyed or self-supporting . . . for AM, FM, TV, and Microwave broadcasting. Your phone call or letter to any Truscon district office, or to "tower headquarters" in Youngstown, will get your tower program under way without delay. Truscon® is a name you can build on.

TRUSCON MARK OF MERIT PRODUCTS

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REPUBLIC STEEL
1092 Albert St., Youngstown 1, Ohio
Export Department: Chrysler Building, New York 17, N. Y.

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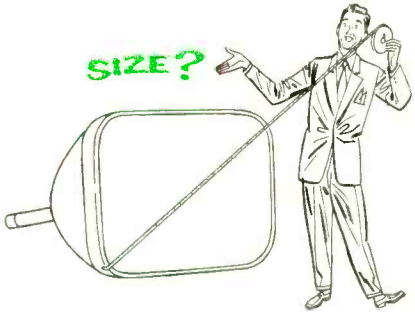
TRUSCON STEEL TOWERS • AM • FM • TV • MICROWAVE

What are your Aluminized Picture Tube Problems?

Now Sylvania offers a full line!

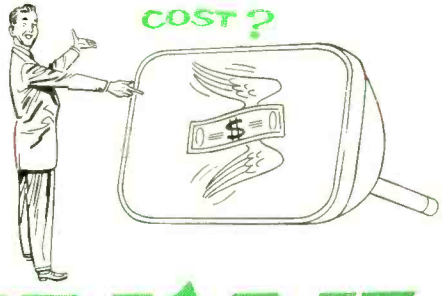


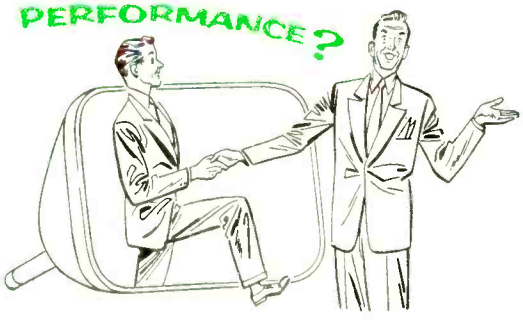
TODAY, because of greatly increased facilities and improved manufacturing techniques, Sylvania is in a position to offer you perfect answers to your aluminized picture tube problems.

And, much more than your physical spec requirements, Sylvania Aluminized Tubes also offer the finest *performance!* These tubes give whiter whites and blacker blacks . . . a 6-times better picture contrast.

This means Sylvania's new aluminized tubes make your sets stand out ahead of competition. The improvement is obvious . . . and immediate. And the low prices will amaze you!

For the full story concerning Sylvania's complete aluminized tube line, and how they can help your future sales, write a note on your letterhead to Dept. 4R-4411 at Sylvania TODAY!





SYLVANIA

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

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

LIGHTING • RADIO • ELECTRONICS • TELEVISION

THIS 980 LINE COMBINATION can save up to 50% of your time

Here are the two famous 980 Line instruments that form the basis of the new Weston simplified method of TV receiver alignment . . . eliminating the troublesome, time-wasting procedures heretofore involved, and enabling servicemen to cut alignment time almost in half. This new method is possible when these two instruments are used with the Weston scope, or scopes with provisions for Z-axis intensity modulation. They also can be used with available test equipment in the conventional method of alignment. For the complete story, write . . . WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N. J.

WESTON MODEL 985 *CALIBRATOR*

FEATURES

SCALE CALIBRATION: Crystal calibrating points are available at 1.5 and 4.5 megacycles throughout the entire scale. A scale shift knob is provided to align the scale with the crystal calibrating dots.

SCALE PRESENTATION: Slide rule type in which one scale is visible at a time. Ten scale range bands available . . . total scale length of 8¾ ft.

DUAL MARKERS: 4.5 mc side band markers permit simultaneous observation of video and sound carrier.

INTERNAL MARKERS: Special circuitry provides an internal marker of either a positive or negative pulse suitable for Z-axis intensity modulation of the scope pattern. Marker is visible even at the sound trap frequencies.

HETERODYNE DETECTION: With an input sensitivity of 500 microvolts, the local TV receiver-tuner channel oscillator frequency can be determined without tuner disassembly.

BAR PATTERN GENERATOR: Amplitude modulated signals of the band oscillator at 400 cycles and 300 KC are available for linearity checks.

SPECIFICATIONS

Frequency Range (with Variable Frequency Oscillator): 4-110 megacycles in 7 bands. 170-260 megacycles in 3 bands.

Output Attenuator Range: 100% to 1%

Crystal Marker Accuracy: 1.5 mc position ± 0.01%; 4.5 mc position ± 0.01%

Internal Modulation Frequencies: 400 cps, 300 KC, 4.5 mc

Heterodyne Input Sensitivity: 500 microvolts (VFO)

Linearity Adjustment: Horizontal—400 cycles, Vertical—300 KC

Dual Markers: video and scund . . . available for either Z-axis intensity modulation of scope or conventional marker pip display.

WESTON MODEL 984 *SWEEP GENERATOR*

FEATURES

BLANKING: Special circuitry produces a zero output reference base which is essential for relative gain measurements.

RF OUTPUT: Frequency modulated signal, TV channels 2 to 13 inclusive, complete FM coverage available by means of two preset selector positions. *Frequencies are fundamentals of the oscillator frequency.*

IF/VIDEO OUTPUT: Frequency modulated signals ranging to 50 megacycles, continuous tuning, signals free from harmonics.

SWEEP WIDTH: Full 10 megacycles on all channels.

Z-AXIS TERMINAL: For use with the Model 985 Calibrator.

SPECIFICATIONS

Sweep Width: 0-10 Megacycles (continuously variable for both IF and RF)

Output Voltage (RMS): 0.1 Volt . . . sweep is linear

RF Output: TV channels 2 to 13 preset. Complete FM coverage available by means of two additional preset selector positions.

IF/Video Output: 50 Megacycles (continuous tuning)

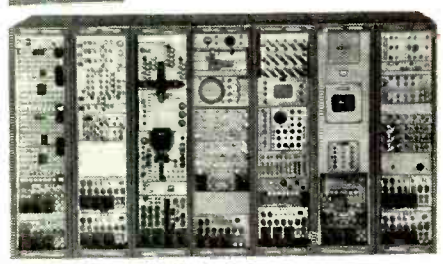
Horizontal Sweep for Oscilloscope: Phase adjustment range . . . 165° Frequency . . . Power Line 60 cycles per second.

WESTON 980 LINE | TV TEST EQUIPMENT

THE ONLY COMPLETE LINE OF TELECHROME COLOR TV BROADCASTING EQUIPMENT

Chromascope (Signal Certification)

Phase Slope (Envelope Delay) Curve Tracer



Full facilities — Transmits, receives, monitors, analyzes composite color pictures

In Color TV broadcasting, no other name means as much as Telechrome . . . because no organization can match Telechrome's 3 years of experience in providing color TV generating, testing and broadcasting equipment to these and other prominent manufacturers, laboratories and broadcasters.

Complete equipment for generating color bars; creating encoded and composite pictures from transparencies; color signal certification; transmission, reception, monitoring, and analysis of color pictures — literature on these and more than 100 additional instruments for color TV by TELECHROME are available on request.

DELIVERY 30 DAYS

TELECHROME INCORPORATED

The Nation's Leading Supplier of Color TV Equipment

88 Merrick Road Amityville, N. Y.

AMityville 4-4446

TELE-TIPS

(*Continued from page* 38)

NEW TAX code is estimated to have cut $1,363,000,000 from business and personal taxes this fiscal year.

INTEREST IN BOOKS is increasing among children. Libraries attribute this in part to TV, according to an NARTB report.

ATOMIC BEER was the subject of a report at the International Convention of the Master Brewers Association of America. The ultimate object is to pasteurize the brew by atomic radiation on the assembly line.

ELECTRONIC AIR CLEANERS are a necessary element in the defense against the kind of atomic dust which affected Japanese fishermen some 70 miles from the Bikini hydrogen bomb explosion early this year, according to a report made to the Air Filter Institute. Units to be used would be the type presently employed to clean air by electrostatic precipitation in commercial installations and homes.

REFRESHINGLY HONEST approach to record sales promotion is being practiced by Cook Laboratories. Each record in the company's "Road Recording" series is frankly labelled HF, MF or LF—meaning high-fidelity, medium-fidelity or low-fidelity.

RATHER UNUSUAL approach to sound quality nomenclature was suggested by one audio engineer who insisted that a reproduction was either true or not. Therefore the terms would be fidelity or infidelity. With more sober reflection he agreed that latter term might be misinterpreted.

OPERATIONAL RELIABILITY of color receivers is the goal of design engineers. Need for this is pointed up in recent estimates that color sets will require twice as many servicing calls, each one taking twice as long, as monochrome TV receivers.

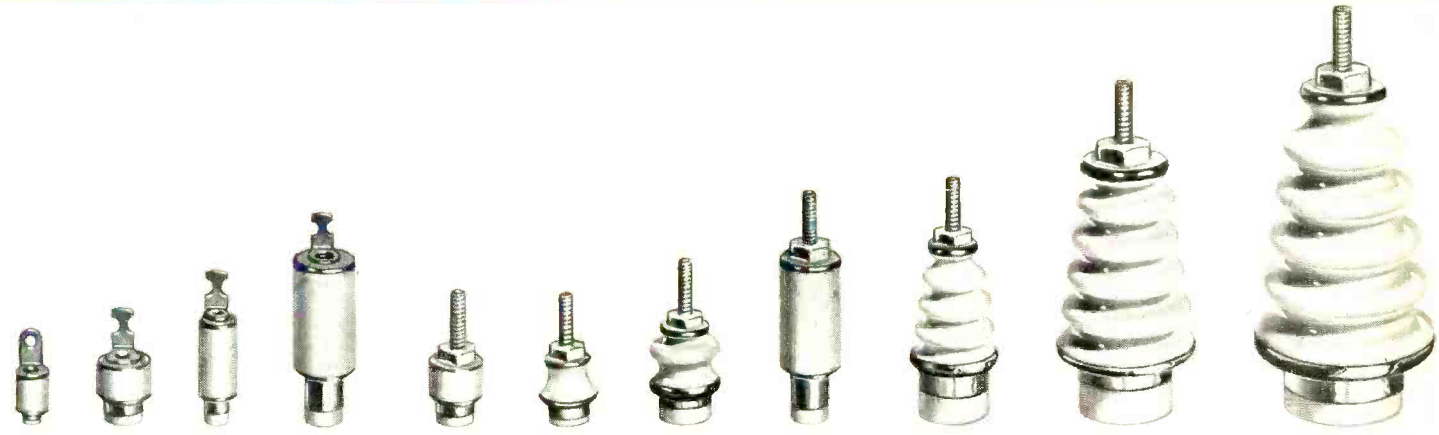
SHAKESPEARIAN quotations applied to modern-day subjects provoked some wry smiles when they appeared in these columns last month. Here are more of same:

TIME SALESMEN: *Are you good men and true?*

IMPREGNATING COMPOUNDS: *Comparisons are odorous.*

(*Continued on page* 50)

AlSiMag® metalized hermetic terminals



Y-26546 Y-26547 Y-26548 Y-26549 Y-33172 Y-33173 Y-33174 Y-33175 Y-33176 Y-33177 Y-33178

- High strength Alumina ceramic
- Superior electrical properties at high frequencies
- Excellent solder characteristics
- Will not deteriorate with time
- Withstand extreme temperature variations
- Metal permanently bonded to ceramic
- Reduce "leaker" troubles

Y-33171

Y-25707 Y-26541 Y-26542 Y-26543 Y-26544 Y-26545

The standard terminals shown here are in stock for immediate shipment. Bulletin No. 5410, sent on request, gives complete data. If you cannot use one of our many standards, special sizes or types can be custom made to your drawing. (Delivery on specials will take longer, of course.) Send sample or sketch for price and delivery information.

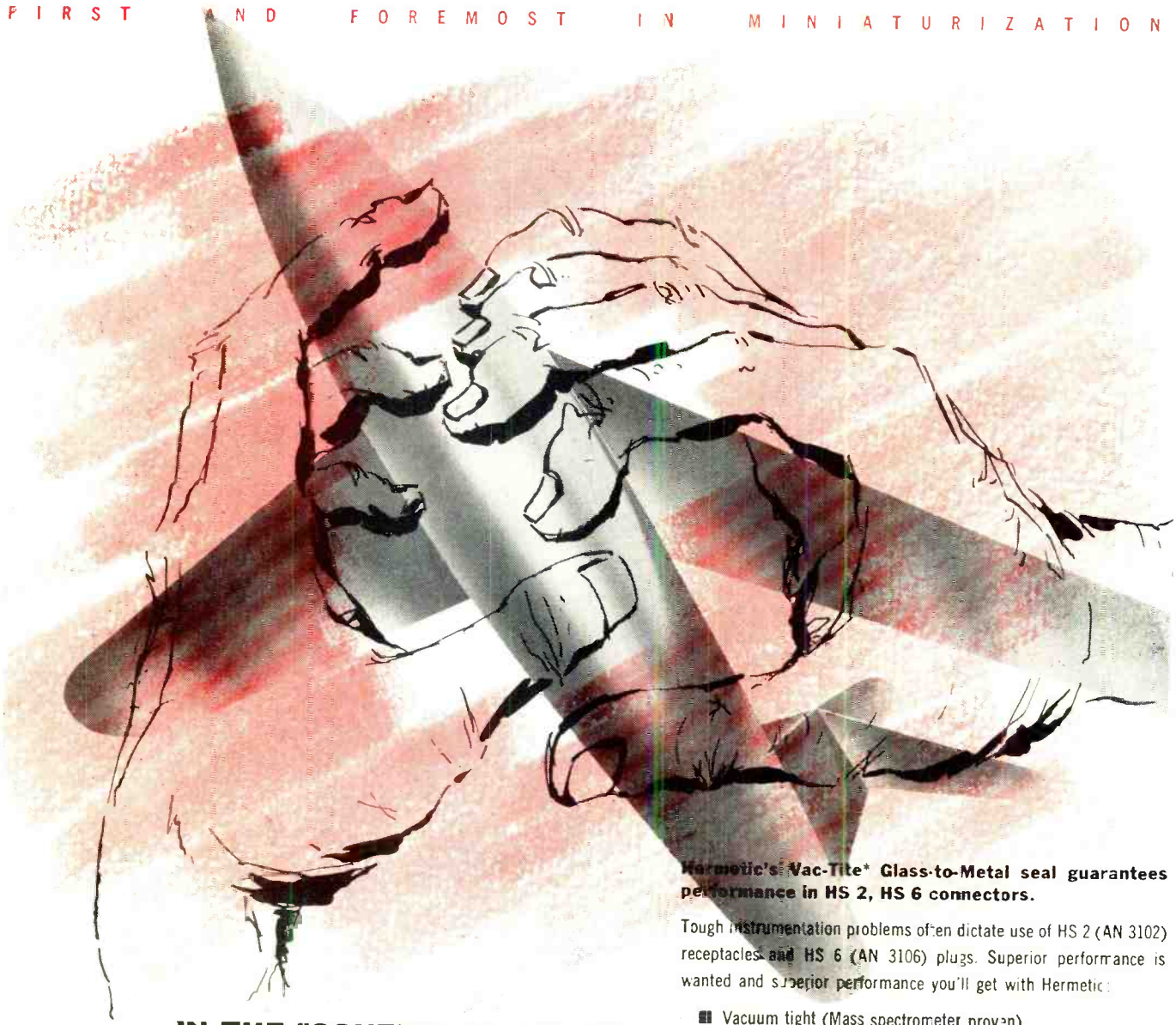
53RD YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE

A SUBSIDIARY OF MINNESOTA MINING AND MANUFACTURING COMPANY

Branch offices in these cities (see your local telephone directory): Cambridge, Mass. • Chicago, Ill. • Cleveland, Ohio • Dallas-Houston, Texas • Indianapolis, Ind. • Los Angeles, Calif. • Newark, N. J. • Philadelphia-Pittsburgh, Pa. • St. Louis, Mo. • South San Francisco, Calif. • Syracuse, N. Y. • Tulsa, Okla.



IN THE "SQUEEZE-PLAY" OF HEAT & PRESSURE— HERMETIC'S A-N CONNECTORS WON'T LEAK!

Hermetic's Vac-Tite* Glass-to-Metal seal guarantees performance in HS 2, HS 6 connectors.

Tough instrumentation problems often dictate use of HS 2 (AN 3102) receptacles and HS 6 (AN 3106) plugs. Superior performance is wanted and superior performance you'll get with Hermetic:

- Vacuum tight (Mass spectrometer proven)
- Arc-resistance of glass
- High-temperature operation
- Corrosion resistance
- 100% moisture and pressure resistant
- Shock and vibration proof
- Equivalent to MIL-C-5015

In addition to our standard line of HS 2 and HS 6 connectors, special units with particular plating requirements, varied flange style, and extra-high pressure resistance, etc., are being designed and manufactured to meet the most specialized needs.

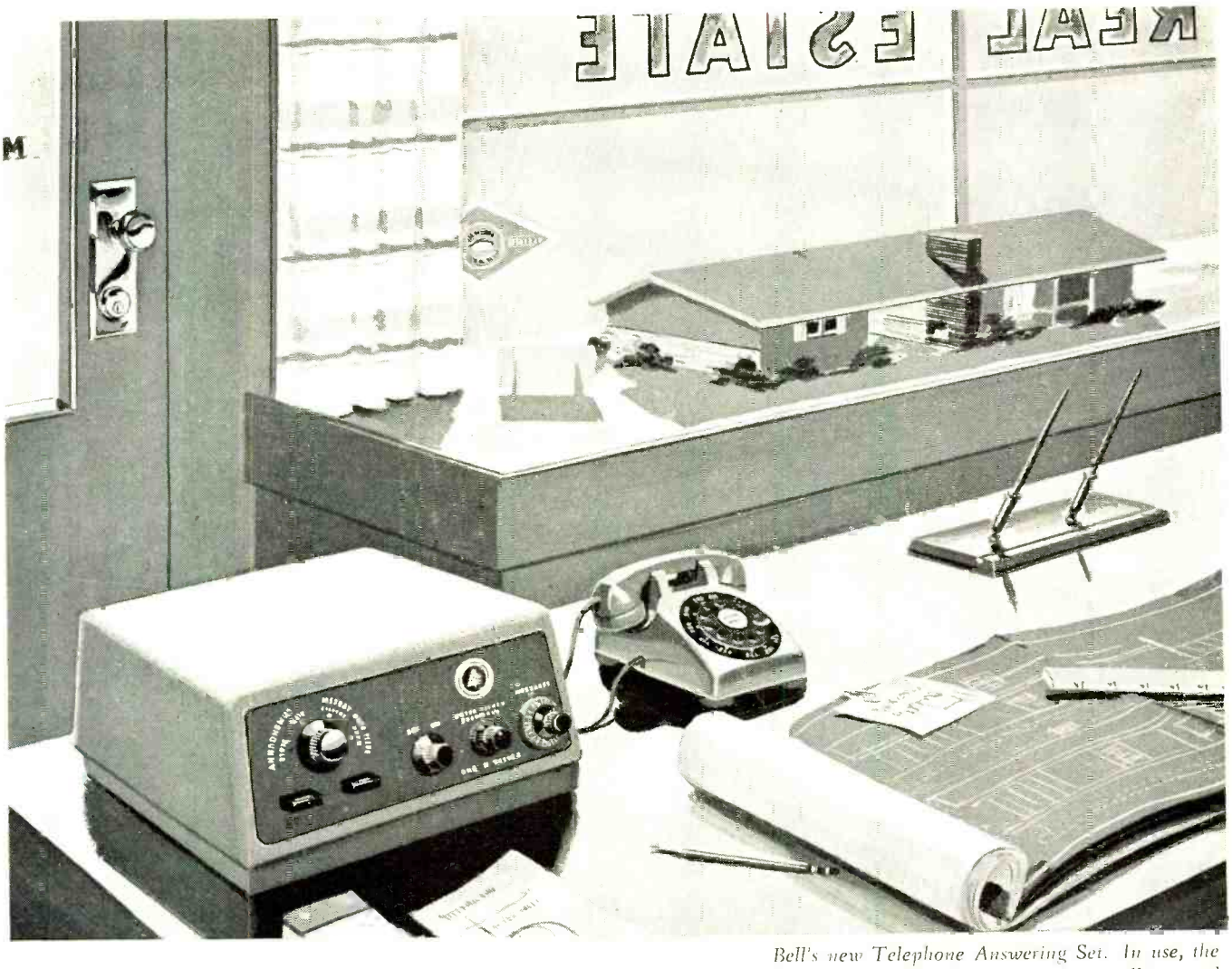
Let us serve you . . . Write for drawings, engineering data and Hermetic's new catalog.

***Vac-Tite is HERMETIC'S new, vacuum-proof, compression-construction, glass-to-metal seal.**

In standard A-N sizes and pin layouts

SEALED IN HERMETIC HEADERS

HERMETIC SEAL PRODUCTS CO.
33 South Sixth St., Newark 7, New Jersey



Bell's new Telephone Answering Set. In use, the machine tells the caller when to start talking, and when his time—thirty seconds—is up.

He's out . . . but he's answering his telephone!

This newly designed Bell Telephone Answering Set makes it possible for you to go out—but leave your voice behind.

Before you leave you twist a knob, dictate a message into your telephone, then switch the machine to "Automatic Answer." When somebody calls, the machine starts up and the caller hears your voice telling who you are, requesting his name and telephone number, repeating whatever you have said. The reply is recorded too. On your return you play back all the calls that have come in, as often as you please.

The new machine features "talking rubber," a Laboratories-developed recording medium made of rubber-like plastic and iron oxide which can be used over and over again millions of times. It is another example of how Bell Laboratories research works to help your local Bell Telephone Company serve you.

Bell Telephone Laboratories

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

TELE-TIPS

(*Continued from page 46*)

COLOR TV: *It adds a precious seeing to the eye.*

EMPLOYMENT INTERVIEW: *Eat no onions nor garlic, for we are to utter sweet breath.*

CONTRACT CANCELLATION: *Here are a few of the unpleasant'st words that ever blotted paper.*

REORGANIZATION: *This house is turned upside down.*

BUSINESS TRIP: *'Tis ever common that men are merriest when they are from home.*

PAY-AS-YOU-SEE-TV: *I see you stand like greyhounds in the slips, straining upon the start.*

STANDARDIZATION: *Delays have dangerous ends.*

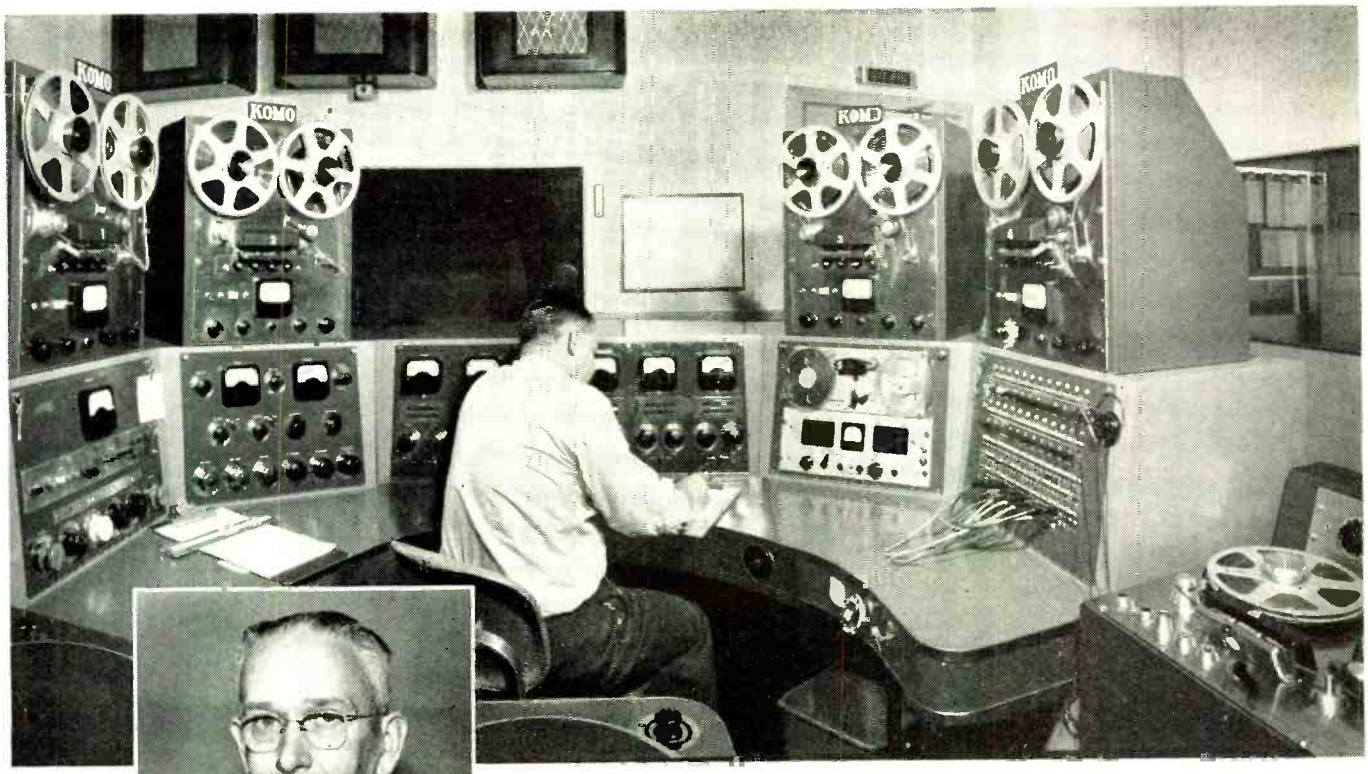
PETITION DENIED: *The first thing we do, let's kill all the lawyers.*

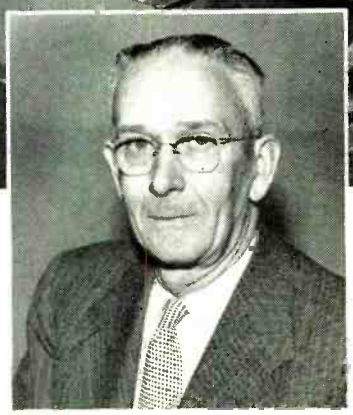
CORPORATE STRUCTURES often turn out to be the square holes for round-pegged rugged individualists. It happened to a couple of reps we know who took over sales manager jobs . . . too much free wheeling to suit the company. And now we have the case of the well known, and independent, journalist who took a top level consulting job with one of the industry giants. He'll be back on his newspaper by the time you read this.

MACHINERY MODERNIZATION can reduce production costs according to a report from the American Textile Machinery Association. In recent surveys it was found that to operate mills with machinery installed prior to World War II excessive payrolls and other costs could have paid for new and more efficient machinery. Items costing 15 cents per pound can be reduced by modernization to about 9.7 cents per pound, a reduction of slightly more than 36 %

TAXPAYERS SAVED MONEY at the recent Army tactical television demonstrations in Ft. Meade. By employing commercially available equipment no special research and development expenses were involved and no special military specifications had to be complied with.

INDUSTRY NEWS starts on page 52





"18,000 HOURS and still within specs"

says Francis Brott, Chief Engineer, KOMO, Seattle

"Our first Ampex recorder showed us what a real professional machine can do. After 18,000 hours of heavy use, the frequency response and audio characteristics of our Model 300 head are still within the original published specifications. This kind of performance sold us completely on Ampex — that's why we've added four Ampex 350's."

This new Model 600 weighs 28 pounds — price $498 ($545 including carrying case.) (A matching amplifier-speaker unit, Model 620, weighs 16 pounds, price $149.50.)

NOW an Ampex for every broadcast need

With the addition of the new lightweight Model 600 series, Ampex now offers your broadcast station a superior machine to meet every tape requirement . . . from distant field pickups to major network recordings. For top-ranking performances and rehearsals and programs involving extensive editing, dubbing and "spot" announcements, choose from the Series 350 . . . for recordings "on location" that assure studio fidelity and accuracy, choose from the Series 600. All Ampex recorders have the same basic head design.

THE ULTIMATE IN PRECISE TIMING WITH HIGHEST FIDELITY

Ampex timing accuracy is so excellent (± 0.2%) that tapes are always on speed — without program crowdings or cutoffs. Ampex reproduction is so faithful that it is indistinguishable from a live broadcast — the result of an unsurpassed combination of broad frequency response, wide dynamic range and imperceptible flutter and wow.

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AMPEX CORPORATION

For a convincing demonstration, contact your Ampex Distributor today (listed in Yellow Pages of Telephone Directory under "Recording Equipment")
Canadian General Electric Company in Canada.
Write today for further information and complete specifications; Dept. U-1880

AMPEX CORPORATION, 934 CHARTER STREET, REDWOOD CITY, CALIFORNIA

INDUSTRY NEWS

Robert K. Hartman has been named Director of Government Operations for CBS-Columbia and CBS Labs., both divisions of Columbia Broadcasting System.

W. P. Hollis has been promoted from asst. sales manager to sales manager of Kellogg Switchboard & Supply Co., Chicago, Ill.

William H. Gove has become Vice President and Director of Sales for EMC Recordings Corp., St. Paul, Minn. Mr. Gove will direct the firm's merchandising programs.

Woodford D. Miller and **Wilbur Jackson** have been advanced from assistant v.p. to vice presidents at Robertshaw-Fulton Controls Co. Mr. Miller is manager of the Robertshaw Thermostat Div. with plants in Youngwood, Scottdale and Indiana, Pa. Mr. Jackson is works manager at Grayson Controls Div., Lynwood, Cal.

W. D. Miller

W. Jackson

W. Paul Jones, vice chairman of the board of Servel, Inc., has become president of Kellett Aircraft Co., Camden, N. J. Mr. Jones continues in his position as chairman of the aircraft company, which he has held for four years.

Lawrence W. Jones, formerly manager of sales administration, has been made automotive products manager, a newly created post in the radio communications division of Bendix Aviation Corp. He will direct the division's auto-radio administrative and service efforts.

Joseph F. Whitaker has been appointed vice-president in charge of sales by Weller Electric Co., Easton, Pa. In his new capacity, Mr. Whitaker will plan and supervise the national promotion and sales of the company's soldering guns, soldering kits, and power sanders.

Robert A. Canning has been named manager of quality control at Carboloy Dept. of General Electric Co. Mr. Canning was formerly manager of production engineering for Carboloy.

(*Continued on page 56*)

TUNG-SOL

6550

BEAM POWER AMPLIFIER

HIGH POWER CAPABILITIES (Up to 100 watts output in pairs) **LOW DISTORTION OUTPUT • EXTREMELY UNIFORM CHARACTERISTICS • LONG LIFE**

first in its power range . . designed specifically for audio service

The Tung-Sol 6550 is a brand new and direct approach to the high power design requirements of high fidelity audio amplifiers. For outputs up to 100 watts, two 6550's in push-pull will provide the same power now attained in most existing designs by the use of four or more tubes. In addition to greater audio output, use of the new 6550 results in simplified electrical balance, reduced maintenance and lower cost. The Tung-Sol 6550 is not directly interchangeable with the 6L6, 5881 or KT66 class of tubes. With proper circuitry, however, the 6550 will provide full power output with approximately the same grid voltage drive as the smaller tubes. The 6550 is produced under laboratory conditions with exhaustive quality control to assure premium performance and long life.

Rugged Construction — *The advanced design features which have made the Tung-Sol 5881 so extremely reliable are embodied in the 6550.*

1. Glass button stem construction is strong and compact and provides a rugged support for the tube structure.
2. Micanol wafer and metal shell base provides full lifetime electrical insulation and greater mechanical strength.
3. Cathode materials of exceptional stability give more uniform emission with greater life expectancy. Cathode is not poisoned by inactivity during standby periods.
4. Maximum control of grid emission achieved by gold plating and carbonizing.
5. Triple gettering promotes long, gas-free life. Getters are confined by a spray shield to prevent mica contamination.
6. Life tests are made under severe overload conditions to assure adequate safety factor.

MECHANICAL DATA

Coated Unipotential Cathode	
Outline Drawing	Bulb—Short St-16
Base	Large Wafer Octal 8-Pin Mical with Metal Sleeve B8-86
Maximum Diameter	$2^{1}/_{16}$"
Maximum Overall Length	$4^{3}/_{4}$"
Maximum Seated Height	$4^{3}/_{16}$"
Pin Connections	Retma Basing 7S
Pin 1—Base Shell	Pin 5—Grid No. 1
Pin 2—Heater	Pin 7—Heater
Pin 3—Plate	Pin 8—Cathode and Grid No. 3
Pin 4—Grid No. 2	
Mounting Position	Any

ELECTRICAL DATA

(INTERPRETED ACCORDING TO RETMA DESIGN CENTER SYSTEM)

DIRECT INTERELECTRODE CAPACITANCES — *No Shield*

Grid #1 to Plate	0.85 $\mu\mu$f
Input	14.0 $\mu\mu$f
Output	12.0 $\mu\mu$f

RATINGS

Heater Voltage (AC or DC)	6.3 ±10% VOLTS
Maximum DC Plate Voltage	600 VOLTS
Maximum Plate Voltage (Triode Connection)	450 VOLTS
Maximum Plate Dissipation (Triode Connection)	40 WATTS
Maximum DC Grid #2 Voltage	400 VOLTS
Maximum Grid #1 Voltage	−300 to 0 VOLTS
Maximum Plate Dissipation	35 WATTS
Maximum Grid #2 Dissipation	6.0 WATTS
Maximum DC Cathode Current	175 MA.
Maximum Heater-Cathode Voltage	
Heater Positive (Peak) (DC not to exceed 100V)	+200 VOLTS
Heater Negative (Peak or DC)	−300 VOLTS
Maximum Grid #1 Circuit Resistance (Fixed Bias)	50 KILOHMS
Maximum Grid #1 Circuit Resistance (Self Bias)	250 KILOHMS
Maximum Bulb Temperature	250 °C

HEATER CHARACTERISTICS

Heater Voltage	6.3 VOLTS
Heater Current	1.8 AMP.

The TUNG-SOL engineering which has produced the 6550 is constantly at work on a multitude of special electron tube developments for industry. Many exceptionally efficient general and special purpose tubes have resulted. Technical data sheets, or circuitry suggestions for the 6550 may be obtained by writing to Tung-Sol Commercial Engineering Department.

TUNG-SOL ELECTRIC INC., Newark 4, New Jersey — Sales Offices: Atlanta, Chicago, Columbus, Culver City (Los Angeles), Dallas, Denver, Detroit, Newark Seattle
TUNG-SOL makes All-Glass Sealed Beam Lamps, Miniature Lamps, Signal Flashers, Picture Tubes, Radio, TV and Special Purpose Electron Tubes and Semiconductor Products

TUNG-SOL®
ELECTRON TUBES

...El Menco First Again Announces Production of the..

Smallest Mica Capacitor

the "DuraMike" dm15...

Capacitor shown actual size

does more jobs — in less space — better! the first and only miniature mica capacitor with parallel leads

the DuraMike gives you . . .

1. **SUPERIOR PERFORMANCE:** The *DuraMike* El Menco Capacitors range from 1 to 390 mmf. at 500vDCw. 1 to 510 mmf. at 300vDCw. Made to meet all the humidity, temperature and electrical requirements of MIL-C-5 Specifications.
2. **SUPERIOR CONSTRUCTION:** The *DuraMike* El Menco Capacitor is phenolic coated, durable and tough. Temperature co-efficient and stability *equal to* or *better than* characteristic F. Will operate efficiently at temperatures as high as 125° Centigrade.
3. **GREATER VERSATILITY:** The *DuraMike* El Menco Capacitor is ideally suited for all military as well as civilian electronic applications . . . Parallel leads means that the El Menco *DuraMike* can be used in positions heretofore impractical. Has wide application in transistor circuits and other miniature electronic equipment. The *DuraMike* El Menco Capacitor is ideal for use in printed wiring circuits.
4. **GREATER ECONOMY:** The *DuraMike* El Menco Miniature silvered mica capacitor sells at prices even lower than our famous CM-15. Provides economy of size with maximum performance and widest application.

To solve your space problems to fit your needs!

Test the El Menco DuraMike capacitor for yourself! Write for free samples and catalog on your firm's letterhead.

Jobbers and distributors write to Arco Electronics, Inc., 103 Lafayette St., New York, N. Y.

El-Menco Capacitors

THE ELECTRO MOTIVE MFG. CO., INC.
WILLIMANTIC CONNECTICUT

molded mica · mica trimmer

INDUSTRY NEWS

(Continued from page 52)

A. L. Coulson has been appointed assistant sales manager of the Ford Instrument Co., Div., The Sperry Corp., Long Island City, N. Y. In addition to his company managerial duties, Mr. Coulson, a former naval officer, will act as Navy contracts manager. **W. F. Weber**, an electronics and radar specialist, has been appointed manager of Army contracts. **William V. Warner**, for the past two years manager of the company's Dayton office, has been appointed manager of Air Force contracts, and **James R. Coleman** will manage commercial contracts. **J. A. Barrett** will manage all sales, negotiations, and contracts on components.

Elmer O. Wilschke has resigned his post as operating mgr. of Altec Service Corp. to become vice-president in charge of operations for Fine Sound, Inc., New York, N. Y., developers of Perspecta Stereophonic sound method of recording.

E. O. Wilschke

T. M. Blake

Thomas M. Blake has become president of Littelfuse, Inc., Des Plaines, Ill. For the past eight years, Mr. Blake has been executive vice-president of the company. He will take over the responsibilities formerly handled by **E. V. Sundt**, present board chairman and consultant.

William R. Saylor, formerly of the sales engineering staff at Cambridge, Mass., is now manager of the branch engineering and sales office of General Radio Co., at 8055 Thirteenth St., Silver Spring, Md. opened to serve customers in Washington, D. C. and its adjacent territory.

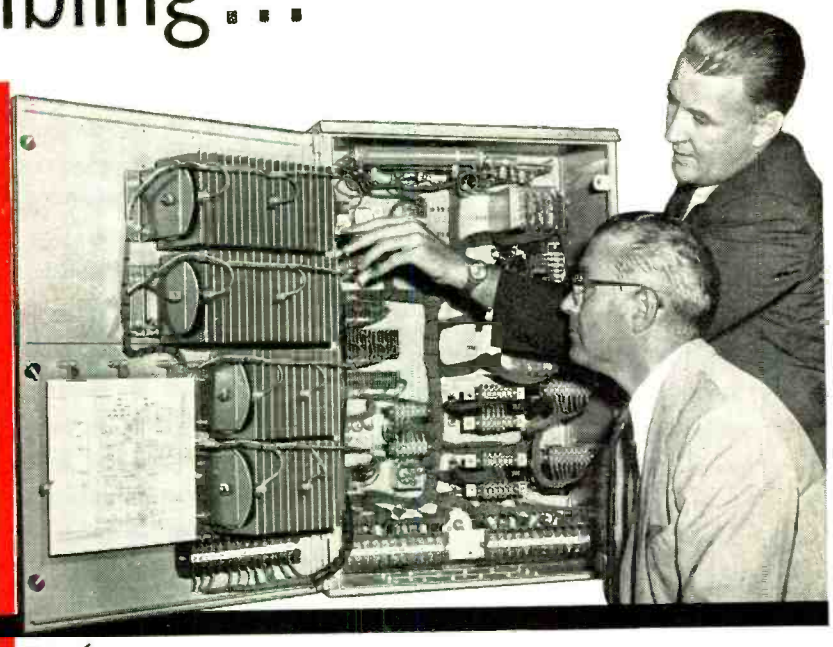
Arthur L. B. Richardson has been elected secretary and general counsel of Sylvania Products Inc., New York, N. Y. He was named general attorney for the company in 1953, following his service as manager of the patent law department.

National Broadcasting Co. has announced the appointments of three new vice presidents—**Davidson Taylor** in charge of Public Affairs, **Richard A. R. Pinkham** in charge of participating programs, and **Kenneth W. Bilby** in charge of public relations.

(Continued on page 58)

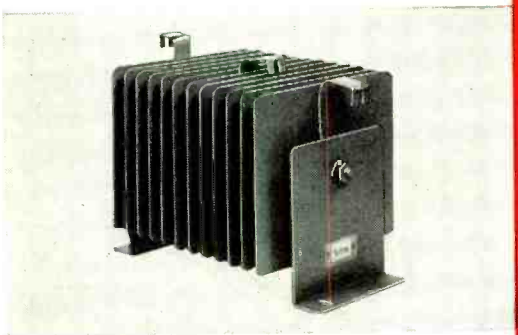
Costs go tumbling...

when standard **Radio Receptor** rectifiers do the work of specials in magnetic amplifier applications



Mr. Dornhoefer (upper right) inspects current production of magnetic amplifier regulator with Mr. J. F. Hysler. Rating of the motor generator set it regulates:

Output: 5KVA, 120 V, 3 phase, 400 cycles.
Input: 175 to 345 V, DC.
Regulation accuracy: ±0.5% on both voltage and frequency.
Ambient temperature: 50°C.
Made for and has passed H. I. shock tests.



One of the Radio Receptor rectifiers incorporated into Regulator Equipment Corp.'s magnetic amplifier regulator.

Here's a magnetic amplifier regulator just off the production line at Regulator Equipment Corp.'s plant in Paterson, N. J. It includes eight RADIO RECEPTOR selenium rectifier types using standard quality cells for a total of 18 units in all, and regulates the voltage and frequency of 400 cycle motor generator sets aboard many of Uncle Sam's submarines.

"The decision to use standard stacks," says Warren Dornhoefer of Regulator Equipment Corp., "is governed by such factors as desired magnetic amplifier performance, reactor core material, ambient temperatures, power supply frequency and many others. Naturally we aim for the right combination to give best overall results."

"It has been our experience," continues Mr. Dornhoefer, "that the standard RADIO RECEPTOR stacks we use perform highly satisfactorily in this mag-amp application and in others we have designed and produced. When we see such excellent results from the regular stacks we prefer to be realistic — particularly when delivery and cost are factors."

Naturally, stock rectifiers are not always the answer for every magnetic amplifier circuit. We can and do supply specials where necessary. We suggest you let us study your specs the next time you require rectifiers for this purpose. Chances are we can save you money — and time!

We also manufacture transistors and silicon and germanium diodes.

Semi-Conductor Division

RADIO RECEPTOR COMPANY, INC.

In Radio and Electronics Since 1922

SALES DEPARTMENT: 251 WEST 19th STREET, NEW YORK 11 TELEPHONE: WAtkins 4-3633, FACTORIES IN BROOKLYN, N. Y.

Really RR *Reliable*

INDUSTRY NEWS

(*Continued from page 56*)

G. J. Oehmen has been appointed as assistant to **John Mossman,** president of Phillips Control Corp., manufacturer of relays, actuators and electric components.

John J. Hyland, president and founder of Control Instrument Co., Inc., Brooklyn, N.Y., subsidiary of Burroughs Corp., was named to the newly created post of chairman of the board. At the same time **W. Paul Smith,** executive vice president, was named president.

Frank J. McGuinn has been promoted to sales manager of Irvington Varnish & Insulator Div., Irvington, N.J.

William J. Hopkins has been appointed district manager and head of Bogue Electric's new west coast office at 13415 Ventura Blvd., Sherman Oaks, Calif.

Nathaniel B. Nichols, manager of Raytheon Mfg. Co.'s research division has been appointed an assistant vice president.

N. B. Nichols

H. S. Killgore

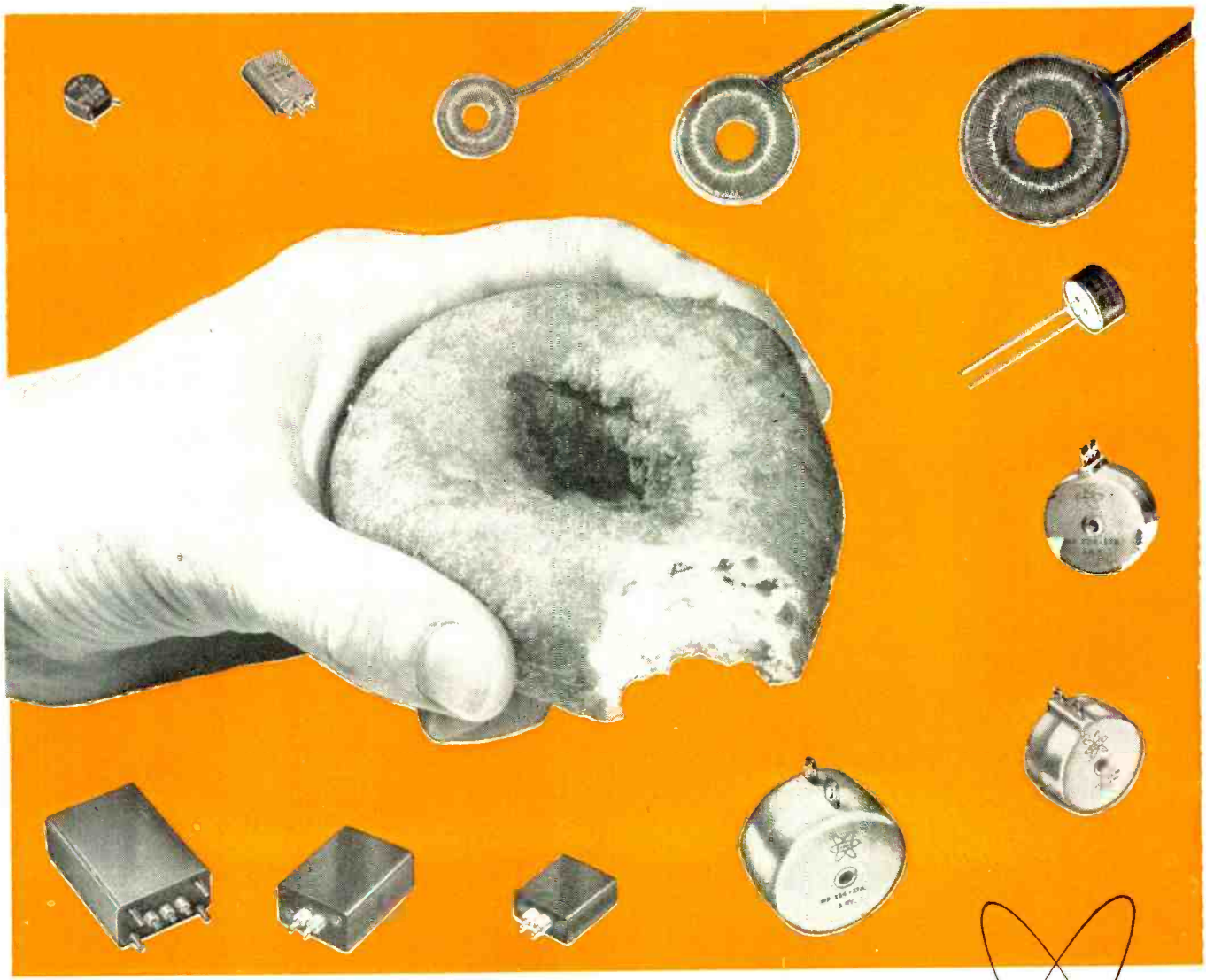
H. Scott Killgore has joined National Co., Inc., Malden, Mass., as manager of government sales. Mr. Killgore will be responsible for the direction of National's government sales representatives.

Douglas M. Considine has assumed position of Sales Promotion and Merchandising Manager of P. R. Mallory & Co., Inc., Indianapolis, Ind.

Harold Wrigley has become Works Manager and **Charles S. Basney** New Products Manager at Barry Corporation, Watertown, Mass.

Charles E. Beard has been appointed Sales manager for U. S. Air Force equipment manufactured by General Electric Co.'s Heavy Military Electronic Equipment Dept., Syracuse, N. Y. Mr. Beard was a project manager for Air Force ground radar equipment prior to his new appointment.

(*Continued on page 166*)



The BEST ONES are Made by C-A-C

"Doughnuts" in a most complete variety of sizes and types . . . made to MIL-T 27 specifications. CAC's advanced engineering provides characteristics and performance for every need. This same engineering has made CAC the largest exclusive producers of Toroids in the country today.

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CLEVELAND—Ernie Kohler Associates
Olympic 1-1242
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HAMBURG—Cooper-Morgan, Inc.
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P. O. Box 152, Hamburg, N. Y.
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Delmar 9242
6315 Brookside Plaza, Kansas City, Mo.
LOS ANGELES—Samuel O. Jewett
State 9-6027
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MERIDEN—Henry Lavin Associates
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(Henry Lavin) P. O. Box 196, Meriden, Conn.

NEEDHAM—Henry Lavin Associates
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(Robert V. Curtin) 82 Curve St., Needham, Mass.

NEW YORK—Harold Gray Associates
Lackawanna 4-4258
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PHILADELPHIA—Charles R. Hile Co.
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only Sprague makes them all!

YOU CAN CHOOSE FROM 5 DIFFERENT STYLES OF TANTALEX* CAPACITORS

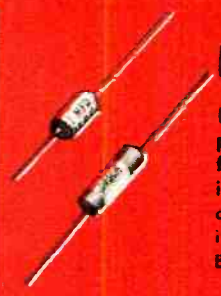
Looking for tantalum electrolytic capacitors? You'll save time and trouble by checking Sprague's complete selection *first*. Sprague makes more types of tantalum capacitors than *any other manufacturer*.

Sprague Tantalex capacitors provide maximum capacitance in minimum space . . . exhibit no shelf aging under long testing periods . . . have extremely low leakage current. And most important, they give unusually *stable* performance, because they're made with tantalum, the most stable of all anodic film-forming materials.

There's a complete range of sizes and ratings available in Tantalex capacitors . . . from the ultra-miniature 10 mf, 4 volt unit in a case only ⅛" in diameter by 5/16" long . . . to the 7 mf, 630 volt unit in a case 1⅛" in diameter by 2 19/32" long. As for case styles, Sprague makes them all, from tiny tubular and cup units to the large cylindrical types.

For complete details relating to your miniaturization or high temperature problems, write Sprague Electric Co., 233 Marshall St., North Adams, Mass.

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



NEW! TYPE 101D for low-cost transistor circuitry

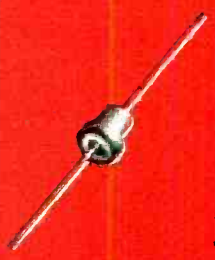
Especially useful for filter, coupling, and by-pass applications in transistor electronics, these foil type miniature Tantalex capacitors were intended for use in hearing aids, pocket radios, and similar uses. Operating temperature range is —20 to +65°C. Request Engineering Bulletin 353.

NEW! TYPE 102D for −55°C to +85°C operation for military use

Here are tubular capacitors hermetically sealed in cases of silver plated copper. Intended for applications from 3 to 150 vdc, their small capacitance drop-off at extremely low temperatures, extremely low leakage current, and low power factor are of particular interest. Request Engineering Bulletin 351.

NEW! TYPE 103D ultra-miniature capacitors for transistor circuitry

Only ¼" in diameter, and from 3/16" to ½" in length, these are the smallest electrolytics made. Providing relatively large values of capacitance in the very minimum of space in bypass coupling, and filter applications, they are ideally suited for transistor hearing aids and military amplifiers in which small size is all-important.
Request Engineering Bulletin 352.



NEW! TYPE 104D miniature "cup" capacitor for military use

These low-voltage units consist of a sintered porous tantalum anode housed in a miniature silver thimble, which serves as both cathode and container for the electrolyte. Volume is less than 1/10 cubic inch; operating temperature range —55 to +85°C, and up to 100°C with a voltage derating of 15%. Request Engineering Bulletin 354.

TYPE 100D for −55 to +125°C operation for military use

These hermetically sealed capacitors are available in voltage ratings up to 630 volts at 85°C or 560 volts at 125°C. They are of the sintered porous tantalum anode type, with internal construction to withstand high g shock, severe vibration, and thermal cycling. Request Engineering Bulletin 350A.

WORLD'S LARGEST CAPACITOR MANUFACTURER

SPRAGUE

*Trademark

Export for the Americas: Sprague Electric International Ltd., North Adams, Mass. CABLE: SPREXINT

TELE-TECH
& Electronic Industries

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

A Salute to *International Standardization*

A milestone in international understanding was marked by the International Electrotechnical Commission (IEC) during its recent meeting in Philadelphia. Just 50 years ago this organization was set up to facilitate the coordination of national standards. In its earliest years, under the presidency of Lord Kelvin, IEC formulated the standardization of terms related to power generation and similar equipment.

With the emergence of the electron tube and the growing complexity of the technology, IEC expanded its activities. Under the direction of many distinguished industry leaders, including a number of Americans such as Prof. Elihu Thomson, Dr. C. O. Mailloux, James Burke and Dr. Harold S. Osborne, IEC has been instrumental in achieving a remarkable feat: Probably in no other field of endeavor is there such complete global understanding and agreement of basic terms as there is in the electronic-electrical art.

Today, some 30 countries representing every continent are members of IEC. There are more than 40 technical committees and subcommittees working on subjects chosen by the membership. All this is financed on the modest annual budget of $56,000.

There are several factors making international standardization essential. First, standardization is a prerequisite for economy, which contributes to higher productivity with its corresponding standard of living. This is illustrated by the plight of a manufacturer who must make essentially the same product for several buyers, each providing different specifications. This might include one standard for the military, another for his country's commercial market, and still another for a foreign country.

Interwoven with economic considerations is a military factor. Regional alliances such as NATO demand easy interchangeability of equipment and mutual understanding of terms. Concerning such aspects as performance and testing requirements, standardization has often proven vexing. So it is gratifying to note that IEC has made considerable progress along these lines during their recent meeting, particularly regarding components.

Standardization also has the meritorious effect of lowering trade barriers, permitting a better interplay of competition on the basis of known technical qualities. Standardization need not hamper individual design. Instead it will eliminate product differences just for the sake of difference, thereby promoting the broadest possible international acceptance of goods.

For their persistent efforts and fine accomplishments, we are proud to salute the men who have worked so diligently on the IEC.

(Texts of messages to IEC delegates from President Eisenhower and from Dr. W. R. G. Baker, RETMA Engineering Director, appear on page 26.)

Military Equipment & Reliability

All of us in recent years have been made increasingly aware of the great effort to enhance the reliability of military electronic equipment. Although initially such programs dealt primarily with improvements in techniques of vacuum tube manufacture, the great strides made now show equipment reliability to be dependent on a great many other factors as well.

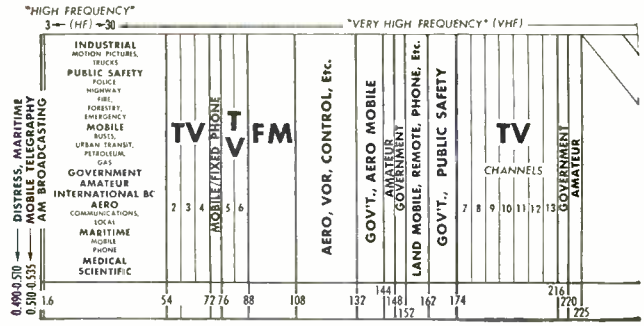
Generally, however, tube failures, inadequate designs and improper field maintenance are still listed as major causes of unreliability. But also, the amount of reliability information that can be made available to the design engineer and the amount of this information that can be incorporated into the design that he is undertaking have been shown to be extremely important factors. Unlike the designers of commercial electronic systems who know the installation, operation and maintenance requirements intimately and at first hand, military equipment designers at times do not have access to all this information. Neither do they always receive adequate performance data once the equipment has been designed and is in the field.

Reliability studies over the past five years now assume practical proportions and it becomes possible to feed back important design information. The editors of TELE-TECH AND ELECTRONIC INDUSTRIES in cooperation with the many groups, committees, and private organizations engaged in reliability studies will be glad to present the results of these studies as an industry service from time to time as they become available. Two articles in this issue will be of especial interest. "One Hundred Points for Equipment Designers" prepared by the U.S. Navy Electronics Laboratory is on page 68 and "Electron Tube Grid Currents" by the Advisory Group on Electron Tubes is on page 70.

(The paper "Reliability of Military Electronic Equipment" by Lewis M. Clement, Chairman of RETMA's Electronic Applications Committee (Reliability), and given at the Third JETEC General Conference, September 17, 1954, presents an excellent summary on the progress of military equipment reliability.)

RADARSCOPE

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



SIGHT FOR THE BLIND through electronic means is reported by the *Industrial Research Newsletter*. Electronics possibly could bring "sight" patterns to the minds of those who were blind at birth, according to a scientific paper published by Franz Ollendorff, professor of electrical engineering at the Israel Institute of Technology at Haifa. Prof. Ollendorff raises questions on eidetic vision, pointing out the possibility of using electroencephalographic methods to bring mental images to the blind.

"SOLUTION CERAMICS" is the name given to a radically new, flexible ceramic coating process developed at Armour Research Foundation. These solution ceramic coatings which offer considerable promise for electronic applications, differ from conventional porcelain enamel or other coatings in that they are not brittle and can be sprayed on almost any solid surface at only a few hundred degrees. The new coatings are resistant to chemical attack even at high temperatures.

$2 BILLION FOR COLOR TV SETS will be spent by American families by the end of 1957, according to an estimate made by RCA President Frank Folsom. He also predicted that 10 million color receivers will be in use by 1959, including more than 350,000 sold during 1954-55, 1,780,000 during 1956, 3,000,000 in 1957, and about 5,000,000 in 1958.

MICROWAVE ANTENNA

A new type of antenna resembling a giant sugar scoop has been designed by Bell Telephone Labs engineers to receive and transmit telephone and television signals. The horn-reflector antennas, to be used on Bell System radio relay routes, may eventually handle up to about 20,000 telephone circuits or 30 television programs at one time. They would handle simultaneously microwave radio systems in the 4,000, 6,000 and 11,000 MC bands.

ARMY SIGNAL CORPS has announced that it will purchase 2,000,000 replacement tubes, covering 200 different types, during fiscal 1955. The Department of Defense has also revealed that the rate of obligation for military procurement during fiscal 1955 will almost double that of last year. That is, the rate of contract placement will rise from $9.2 billion to about $17 billion. Air Force electronic equipment procurement is expected to have a significant increase along with the overall rise.

GOVERNMENT FREQUENCIES

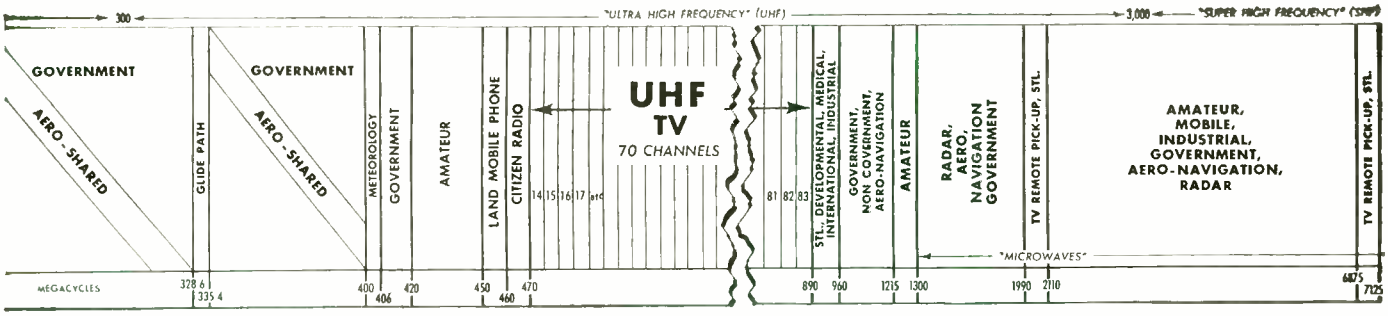
SURVEY OF USAGE and requirements of spectrum space for federal government agencies appears to be in the making. In the past federal agencies have had a virtual priority of frequency selection. The appointment of a cabinet committee by President Eisenhower, headed by Defense Mobilization Director Arthur S. Fleming and composed of the Secretaries of State and Defense has the study of the government frequency situation as a major task. The report is to be completed within six months. This survey long advocated in editorials of TELE-TECH & ELECTRONIC INDUSTRIES is a most constructive step for the advancement of the radio art. (See editorial Dec. 1953; Oct. 1953; Aug. 1951.)

PERSONNEL MANAGEMENT

HANDWRITING ANALYSIS, long held in the same light as reading palms or tea leaves, is coming into its own as an effective tool for personnel evaluation. An investigation by the editors of TELE-TECH has turned up some startling facts. Clinical psychologists have considerable respect for graphology, or handwriting analysis, as a psychodiagnostic instrument. In Europe, industrial firms have utilized it successfully for many years to test prospective employees. In the United States, industrial acceptance has been slow to come, possibly due to pseudo-scientific entertainers who practice the art, but it *is* coming. To check the validity of graphology in describing a personality in a full and scientific sense, we set up a controlled test. Beyond a shadow of a doubt, the test proved that handwriting analysis in competent hands is fully accurate and thoroughly revealing.

ATOMIC TESTS

FEDERAL CIVIL DEFENSE Administration has invited TV-electronic manufacturers to participate in atomic tests to be conducted early next year at the Nevada Proving Ground under the joint sponsorship of the FCDA and the AEC. Industry action is being co-



ordinated through the RETMA. FCDA states, "We believe that the electronics communications industry will derive important technical data from this test. In addition to this . . . RETMA members may wish to capitalize on their participation in institutional advertising or public relations campaigns following the test." Those firms interested in participating should write to Hon. Val Peterson, Administrator, Federal Civil Defense Administration, Washington 25, D.C., Attention: L. H. Lieberman, Atomic Test Operations. In addition, the company should inform Virgil Graham, Associate Director of the RETMA Engineering Dept.

RADIO RELAY

LONG-HOP MICROWAVE relay has received an extra boost in an application to the FCC by AT&T Long Lines for authority to use UHF for a Florida-to-Cuba link considerably beyond the line-of-sight limitations of present systems. The proposed system would provide more phone circuits and permit experimentation with international TV. AT&T stated that "transmission for distances up to 150 miles without intermediate amplification in the frequency range of approximately 500 to 1000 MC and in the bandwidths required for broadband telephone and television transmission is presently feasible." It was reported that over-the-horizon transmission above 1000 MC has been considered, but that further developmental work on high power amplifiers and large antennas was still required.

ENGINEERING MANPOWER

CONTINUED EMPHASIS on the critical need for more engineers, as has been stressed in these pages, is slowly starting to produce results. In connection with the announcement that President Eisenhower has appointed a cabinet committee to study the continuing shortage of young college trained engineers and scientists, Dr. John T. Rettaliata, president of Illinois Institute of Technology, made some astute observations. Some of his remarks paralleled our editorial, "Stop Wasting Engineers" (Sept. 1954 TELE-TECH, page 57) in describing the rapidly increasing number of Soviet engineers and our wasteful draft policies. In addition, Dr. Rettaliata pointed out that many high schools are moving toward more general education which prevents students from pursuing engineering programs later in college. It was also noted that women make up a sizeable percentage of Soviet engineering personnel—at least 20%. In the U. S. women engineers constitute a fraction of 1% of the total.

STANDARDIZATION

SPOT CHECK of tape and tape recorder manufacturers, sound studios and prerecorded tape companies has been made by the editors of TELE-TECH & ELECTRONIC INDUSTRIES. One of their big worries is the problem of standardization of a play characteristic for 7½ in./sec., the speed which is expected to become most popular because it provides a compromise of good quality and long playing time. The NARTB curve is for 15 in./sec. only. So the various manufacturers go along using their own curves, and tapes made on one machine may not reproduce properly on another, be it professional or home service. The result is that a really big push on low-cost playback units has not started, which, in vicious circle fashion, discourages music companies from making prerecorded tapes. So one of the pressing needs in the industry—if we expect to avoid the chaos produced by the record speed and equalization curve confusion—is for responsible organizations like NARTB, AES and RETMA to get together and draw up a standard for 7½ in./sec. which will be economical to achieve and still retain good quality.

NEW 21-in. COLOR TV TUBE

A 21-in. rectangular color TV picture tube, reported to be the first of its kind, makes its debut before officials of Allen B. DuMont Laboratories credited with guiding its development. Shown (l to r) are Dr. Allen B. DuMont; Dr. Thomas Goldsmith, vice-president, research; Kenneth Hoagland, chief engineer, tube division; and F. P. Rice, manager, tube division. The tricolor picture tube is of the shadow mask type, employs three electron guns, and has a metal cone

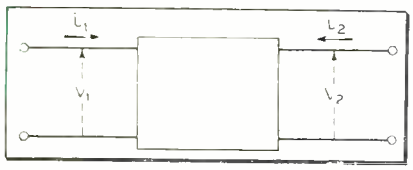


Fig. 1: Network for equation (1)

The Microwave Gyrator

Ceramic ferromagnetic materials which have become available during the last decade make design of an anti-reciprocal electrical circuit element possible. Microwave applications include circulators, attenuators, modulators and switches

By C. L. HOGAN, Division of Applied Science, Harvard University

ENGINEERS have, in the past, become so accustomed to dealing with passive electrical networks which were reciprocal that they have come to accept the theorem of reciprocity intuitively as being almost synonymous with the second law of thermodynamics. It has, however, been known for a long time that several passive systems in nature are anti-reciprocal. As applied to electrical networks, the theorem of reciprocity states in simple terms that if one inserts a voltage at a given point in the network, and measures the current resulting at some other point, their ratio, called the transfer impedance, will be the same if the positions of voltage and current are interchanged. Until recently no practical passive electrical networks were known which violated this theorem. In 1946 E. M. McMillan[1] showed that an anti-reciprocal electrical-circuit element could be realized by means of a mechanically coupled piezo-electric and electromagnetic transducer, and in a series of articles published about six years ago Tellegen[2] discussed the application of a new anti-reciprocal circuit element, which he called a gyrator. He described the gyrator as a passive four pole element, which was defined by the following set of equations. (See Fig. 1.)

$$V_1 = Zi_2$$
$$V_2 = -Zi_1 \quad \ldots\ldots\ldots\ldots \quad (1)$$

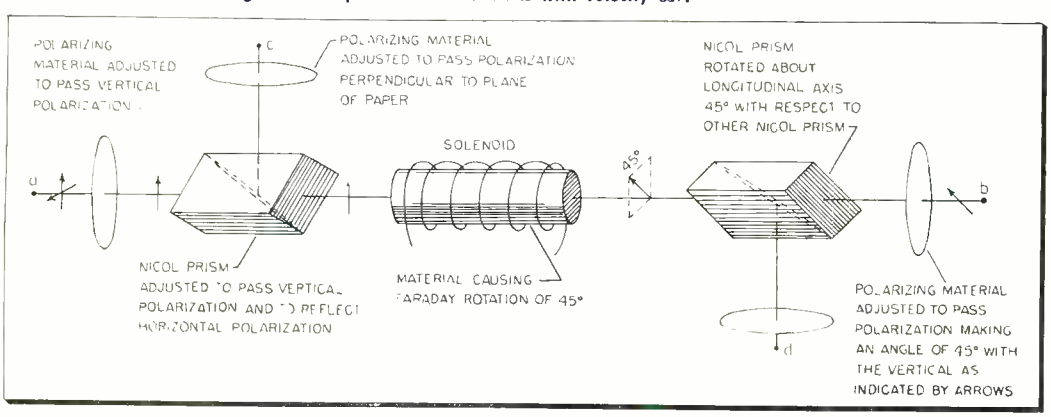
Since the coefficients above are of opposite sign, the gyrator violates the theorem of reciprocity. Tellegen discussed several ways in which the gyrator could be realized in principle at least. So far none of the methods which he suggested has yielded a low loss practical circuit element.

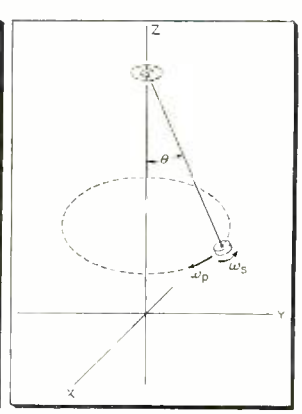
Faraday Rotation

It has long been known that the Faraday rotation in optics is anti-reciprocal. In order to observe the Faraday rotation, polarized electromagnetic waves must be transmitted through a transparent isotropic medium, parallel to the direction of the lines of force of a magnetic field. The effect is usually produced by placing the material along the axis of a solenoid. The rotation of the plane of polarization is positive if it is in the direction of the positive electric current which produces the field, and negative if in the opposite direction. All transparent substances show the Faraday rotation. Its anti-reciprocal property distinguishes the Faraday effect from optical rotations caused by birefringent crystals or by the Cotton-Mouton effect which are reciprocal. That is, if a plane-polarized light wave is incident upon a birefringent crystal in such a manner that the plane of polarization is rotated through an angle θ in passing through the crystal, then this rotation will be cancelled if the wave is reflected back through the crystal to its source. In the Faraday rotation, however, the angle of rotation is doubled if the wave is reflected back along its path. Hence, if the length of path through the active material is adjusted, so as to give a 90° original rotation, the beam, on being reflected, will have its plane of polarization rotated a total of 180° in passing in both directions through the material. Thus, the Faraday rotation in optics affords an anti-reciprocal relation quite analogous to the anti-reciprocal property of the gyrator as defined by Tellegen.

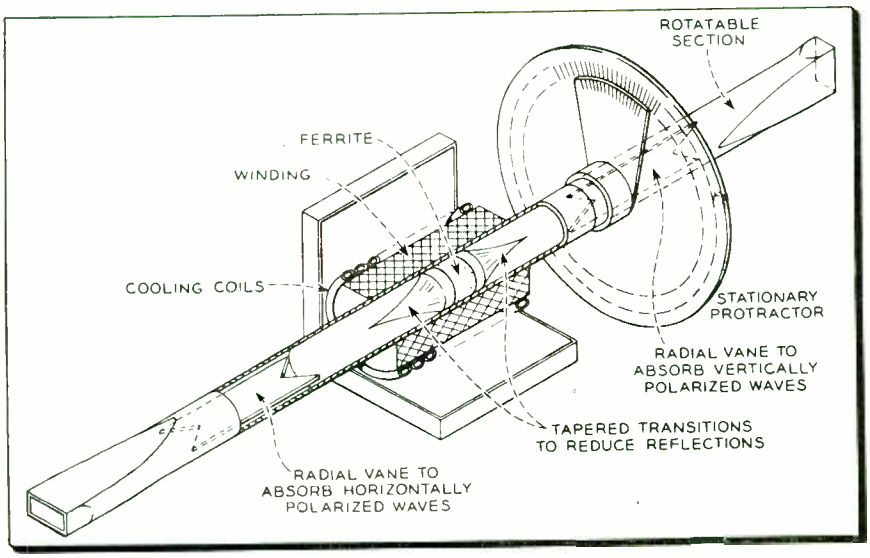
Lord Rayleigh[3] has described a one-way transmission system in optics which makes use of the Faraday rotation. Lord Rayleigh's one-way system consisted of two polarizing Nicol prisms at 45° with each other, with the material causing the Faraday rotation placed between them. Thus light which was passed by the first crystal and whose plane of polarization was rotated 45° would be passed by the second crystal also, but in the reverse direction the ro-

Fig. 2: (l) If four polarizing discs were added to Rayleigh's one-way transmission system an unusual system having important microwave analogs can be created. Fig. 3: (r) If a gyrascope that is supported in a gravitational field is lifted from the minimum energy position it precesses about a vertical axis at angle Θ. The precessional motion is with velocity ω_p.





—A New Circuit Element



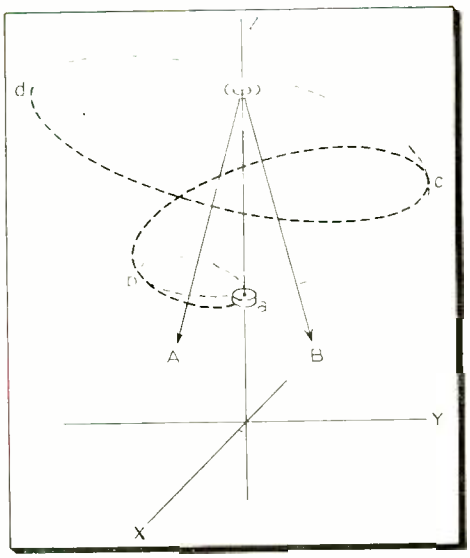


Fig. 4: (l) System for measuring Faraday rotation at microwave frequencies. Fig. 5: (r) Prescess paths with different forces

tation would be in such a sense that light which was admitted to the system by the second crystal would not be passed by the first. Actually Lord Rayleigh's one-way transmission system was much more complex and interesting than his original description would indicate. If four polarizing discs such as Polaroid are added to Rayleigh's one-way transmission system a very unusual system which has important microwave analogs can be created. There are, in a system such as this, four possible input or output branches as indicated in Fig. 2. If for instance a source of light were placed at position a in the figure, the light would become vertically polarized in passing through the first polarizing sheet. This polarization would be passed by the Nicol prism on that side and would then be rotated 45° when passing through the material in the solenoid. The second Nicol prism and polarizing material are so adjusted that this light wave is then passed without further change to point b. If now a mirror is placed at position b, and the light is reflected back through the system, it is obvious that it will arrive at the Nicol prism on the left hand side with a horizontal polarization and will thus be reflected from the Canada balsam cement to position c. Thus light can travel through the system from point a to point b but cannot travel the return path from b to a. All light leaving point b and directed into the system will arrive at point c instead of a. Light starting at point c will arrive at point d and light starting at point d will arrive at point a.

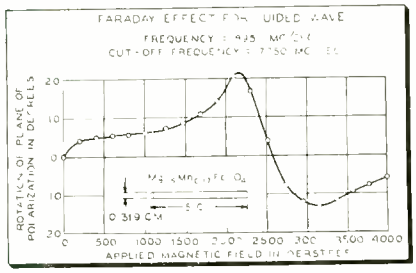
Unique Effect

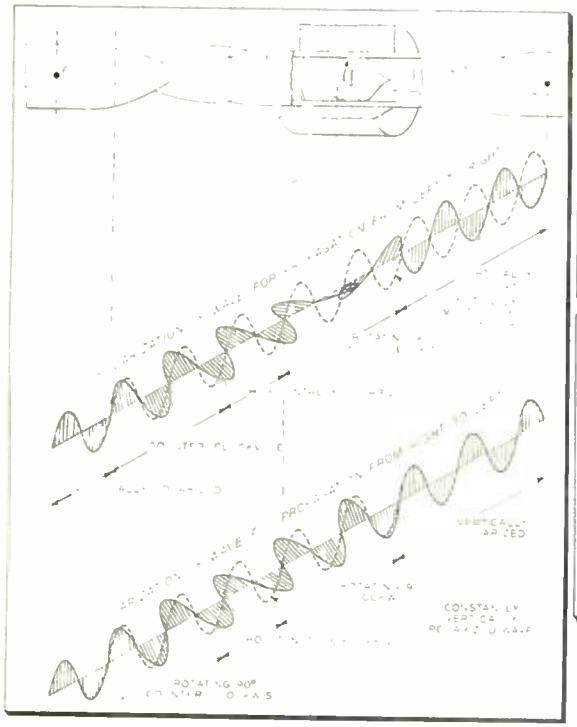
There is no evidence that Lord Rayleigh ever built this system, since all the substances with which he was familiar showed extremely small Faraday rotations. To realize a rotation of the plane of polarization of 45° in the optical region would have required maintaining a field of several thousand oersteds over a pathlength of approximately one meter.

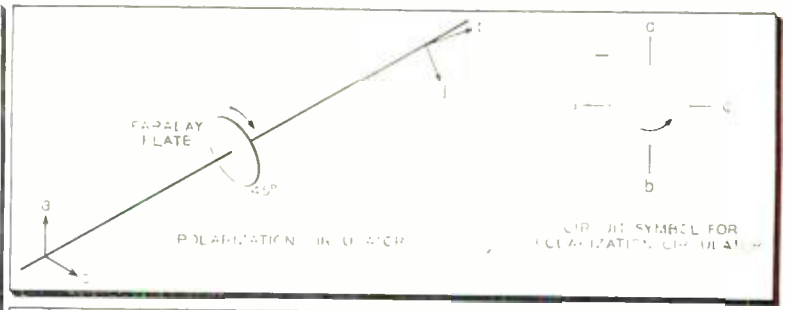
Since Rayleigh's time, however, it has been discovered that the Faraday effect in ferromagnetic substances is unique in that it shows rotations many orders of magnitude greater than the rotations exhibited by any other substances. For instance, Koenig[4] reports rotations of 382,000°/cm. by passing light through thin layers of magnetized iron. These data of necessity, however, were taken on extremely thin sections, and the total rotation obtained for any specimen did not exceed 10°. In order to obtain appreciable rotations in a device of practical size it is necessary to obtain a material which shows a rotation at least intermediate between those reported for iron and other ordinary materials, and, in addition, in order to make effective use of these rotations, the material must be essentially transparent to the radiation which is being used. A decade ago, no materials existed which satisfied these requirements for radiation of any frequency which was of concern to the communications engineer. However, today several ceramic ferromagnetic materials exist which do satisfy these requirements in the microwave region. These materials have commonly come to be known as ferrites, or ferrospinels. They are prepared by sintering finely divided mixtures of iron oxide with the oxide of some other divalent metal, such as nickel oxide. The finished material is related both chemically and crystallographically to the ancient lodestone, or magnetite. The unique characteristic of these materials is that they combine the ferromagnetic property with an extremely high resistivity. The resistivity of several ferrites is of an order of magnitude which approaches that of some insulating materials. Hence, it is possible to propagate microwave radiation through these ferrite materials with extremely low attenuation.

In order to understand how these ferromagnetic materials induce such a large rotation of the plane of po-

Fig. 6: Curve showing experimentally measured values of plane of polarization rotation as function of applied magnetic field







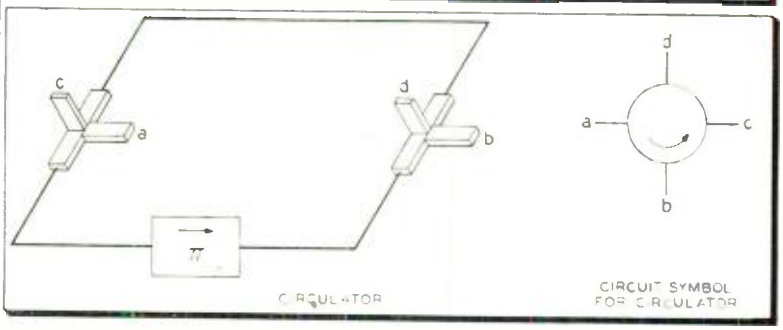


Fig. 7: (I) Microwave gyrator with action describing diagrams
Fig. 8: (above) Circuit symbol for polarization circulator
Fig. 9: (below) Gyrator with two magic tees yield new system

Microwave Gyrator (Continued)

larization, it is necessary to resort to present day theory of the physics of ferromagnetism. Modern physical analysis indicates that many of the properties of ferromagnetic materials can be explained by assuming that the electron behaves as if it were a negatively charged sphere which is spinning about its own axis with a fixed angular momentum. This rotation of charge imparts to the electron a magnetic moment which is a function of the electric charge on the electron, the angular velocity of the electron, and its size. Thus, the electron behaves as if it were a spinning magnetic top, whose magnetic moment lies along the axis of rotation, and its behavior can be understood by considering a spinning gyroscope suspended in gymbal rings at a point not coinciding with its center of gravity. If a gyroscope thus supported in a gravitational field is lifted away from its position of minimum potential energy and then released, it will not return to the position of minimum energy, but will precess about the vertical axis. This is illustrated in Fig. 3, where the spinning gyroscope makes an angle θ with the vertical Z-axis. Its equilibrium motion in the absence of damping is a precessional motion about the vertical axis with a velocity ω_p. If the gyroscope be regarded as initially hanging vertically downward, as indicated in Fig. 4, and then a gravitational force is suddenly made to act along the Y-axis, so that the net gravitational force acts along A, it is obvious that the gyroscope will begin to precess about the gravitational field direction as indicated by the small dotted circle. However, if after completing a half-cycle, the horizontal component of the gravitational field is reversed, so that now the net gravitational field acts along the vector B, the gyroscope will begin to precess about B as indicated by the intermediate sized dotted circle. If the horizontal component of the gravitational field is again reversed after the gyroscope completes another half-cycle in its precession, the gyroscope will again begin to precess about the direction A, and the actual path of precessional motion will be along the path abcd. If this process is continued indefinitely, the gyroscope will precess in larger and larger circles around the vertical until the damping becomes large enough to contain the gyroscope in some equilibrium circle. The above model affords a classical picture which can be used quite readily to describe the motion of the electrons in a ferrite. If the ferrite is initially saturated along the Z-axis by a steady magnetic field, the electrons will come to rest with their magnetic moments lying along the Z-axis as the gyroscope in Fig. 3. If now, an alternating magnetic field is applied along the Y-axis, the electrons will begin to precess in larger and larger circles about the Z-axis, until they finally reach some equilibrium position under the influence of the magnetic fields and the damping.

Precessional Motion

If the alternating magnetic field along the Y-axis is resolved into two counter-rotating circularly polarized magnetic fields, it is easily shown that the component which is rotating in a direction opposite to that of the precessional motion of the electron cannot do work upon the electron, nor can the electron give energy to the field. The component of magnetic field, which is rotating in the same direction as the precessional motion of the electron, can, however, do work upon the electron and hence it is this component alone which is effective in exciting the precessional motion of the electron. Thus we should expect that the permeability of a saturated ferromagnetic material would be different for the oppositely rotating circular magnetic fields. Hence it is to be expected that if an electromagnetic wave is propagated through a ferromagnetic material, which is magnetized either in a direction parallel or anti-parallel to the direction of propagation of the wave, the wave will split into positive and negative circularly polarized components, which will travel with different velocities through the ferromagnetic material. Since the two circular components travel with different velocities in the medium, they will, upon emerging from the medium, unite to form a plane polarized wave whose plane of polarization has been rotated with respect to the incident polarization. The exact

(*Continued on page 137*)

Broad Applications for New Transducer

Last month at the Decker Aviation Co., 1361 Frankford Ave., Philadelphia, Pa., Dr. Kurt S. Lion, Associate Professor of Biophysics at the Massachusetts Institute of Technology, described his earlier experimental studies of gas discharge tubes in high frequency electric fields. These experiments led to the development of the T-42 Ionization Transducer now being introduced to industry by the Decker Aviation Co. The construction and operating details of T-42 presented here should have especial interest because of innumerable applications for such a unit throughout the electronic industries.

IN 1938, in Frieburg, Switzerland, while engaged in experimental studies of gas discharge tubes in high frequency electric fields, Dr. Kurt S. Lion exposed a gas discharge vessel containing two electrodes to a radio frequency electric field (between the plates of a capacitor) and found that a relatively high dc voltage developed between the two electrodes. The magnitude of this voltage varied between −60 and +60 volts as a function of the position of the vessel in the electric field.

In the intervening years, relatively little time has been spent in basic research leading to an understanding of the process from a theoretical viewpoint. The effect however, appears to reside in the generation of space charges within the glow discharge and the pick-up of these charges by the electrodes acting as probes. The logarithmic characteristic of the probe furnishes a dc output voltage, the magnitude of which is a function of the excitation conditions.

Symmetry

Symmetry in the vicinity of the electrodes leads to zero output voltage, while any slight assymetry, due to an unbalanced field or any other cause, leads to an output voltage. Voltages of several hundred volts have been observed and systems have been built whereby a 1/1000 mm. movement of the discharge tube in the high frequency field, produces an output voltage of greater than two volts; a displacement sensitivity of more than 2000 volts per millimeter.

There are numerous configurations in which the transducer may be used. Figs. 1, 2, 3 and 4 show four basic arrangements.

In Fig. 1, a high frequency source S is connected to a ring electrode r-f which surrounds the glow discharge tube and which is free to move in the direction of the double arrow. The other pole of the source is connected through capacitors C to the internal electrodes A and B. The output voltage is taken from the electrodes A and B through resistors R. The source produces a glow discharge in the tube, which, if the ring electrode r-f is symmetrically located with respect to the electrodes A and B, results in no potential difference between electrodes A and B. The capacitors C serve to block the dc voltage developed between A and B and the resistors R prevent any short circuit of the high frequency voltage arising between A and B.

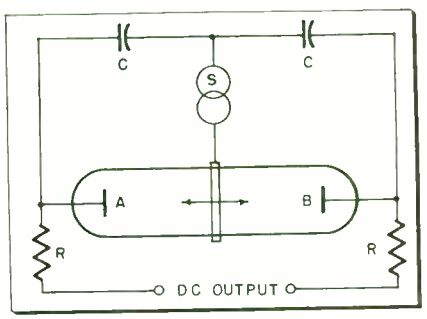
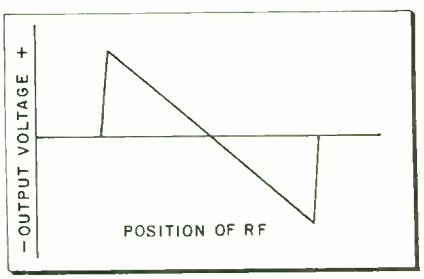


Fig. 1: Basic transducer circuit

Fig. 1a: Output voltage vs displacement



DC Voltage

The dc voltage developed between A and B may be positive or negative depending upon the direction of assymetry and of a magnitude directly related to the degree of assymetry. The calibration curve of this device (Fig. 1A) is astonishingly linear and stable. This type arrangement, however, is one of the least sensitive. 1 to 100 volts per inch are obtainable depending upon the total displacement to be measured.

Fig. 2 shows an arrangement used for measurement of variation of capacitance. The source S is connected to a fixed external electrode r-f surrounding the discharge tube. The other pole of the source is grounded. Connecting electrodes A and B to ground are capacitors C_1 and C_2. The output voltage is again taken from electrodes A and B through resistors R. A difference in the capacitance between C_1 and C_2 will result in a dc output voltage, the magnitude and sign of which is a function of the relationship between C_1 and C_2. Output voltages developed with this arrangement are independent of the absolute values of C_1 and C_2 and are a function only of their relative values. It is therefore possible to obtain the same output voltage for one micro-micro farad variation as for one micro farad variation of C_1 and C_2 or both. Sensitivities of 100 volts per micro-micro farad have been obtained. Output voltages of ±20 volts have been observed. Used as illustrated in Fig. 2, the transducer may be used to drive a sensitive indicating system, such as a micro-ammeter, optical oscillograph or similar devices. Care must be used to prevent

(*Continued on page* 160)

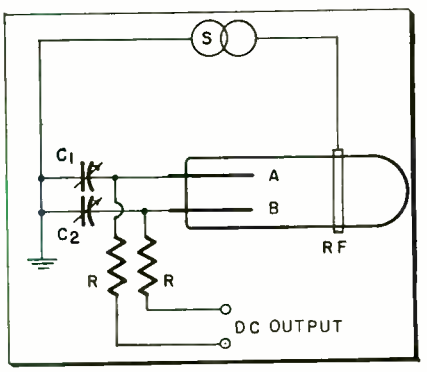
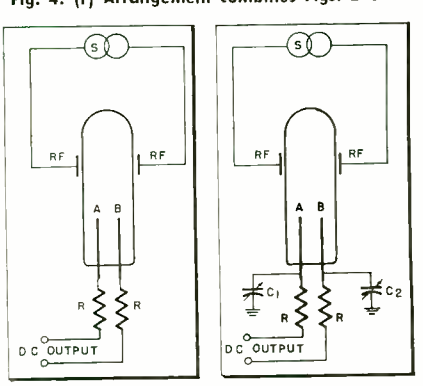


Fig. 2: Measuring capacitance variation

Fig. 3: (l) Third basic circuit arrangement
Fig. 4: (r) Arrangement combines Figs. 2 & 3



100 Points For Electronic

Here is a handy check list for the designers reliable and (b) meet rigid specifications. developing military products, many points

CIRCUITRY

Use tubes from the Armed Services Preferred List of Electron Tubes. Do NOT use selected tubes under any circumstances.

Provide 10 per cent (at least 2) spare terminals on terminal strips and boards.

Undesired radiation must be within the limits specified by MIL-I-16910.

Provide protection from damage due to overload, excessive heating, etc.

Fuse or otherwise protect both sides of the line, and provide spare fuses in a convenient location.

Conductors shall be bound into a cable and held by means of lacing twine or other acceptable means. Long conductors or cables should be secured to the chassis by cable clamps.

Allow sufficient slack in the ends of flexible conductors to preclude breakage due to vibration.

Keep use of relays to a minimum.

Wires and cables run through holes in metal partitions must be protected from mechanical damage by grommets or other acceptable means.

All soldering lugs, studs, and terminals must be provided with a means for mechanically securing the wire lead prior to soldering.

Do not use solderless lugs unless specifically approved.

Do not use acid or corrosive soldering fluxes.

Do not depend on soft solder for mechanical strength.

Do not join leads without a support at their junction.

Keep "parts peculiar" to an absolute minimum.

Pilot lights should be of the lock type and replaceable from the front. Do not series connect pilot lights.

CONTROLS

Controls infrequently required shall be accessible when the equipment is open for maintenance purposes. Maintenance controls shall be screwdriver adjusted.

All controls should be clearly labeled with standard nomenclature and marked, indexed, or metered such that the control position can readily be identified.

Controls shall be arranged to facilitate smooth and rapid manipulation.

Adequate end stops shall be provided on all controls with limited degree of motion.

All control shafts and control shaft bushings shall be grounded.

Provide control locks where specified.

Glass windows shall be secured to the panel by means of clips or other devices. Do NOT use cement alone.

Provide dimmer control for all dial and indicating lights.

Light leakage shall be prevented.

Control knobs should be kept to a minimum and have standard shape and color. Control knobs should be secured by means of 2 setscrews.

Controls and indicators which are only occasionally required should be mounted behind hinged doors.

All moving parts shall operate smoothly and quietly without introducing objectionable electrical noise.

Backlash and torque-lash shall be kept to a minimum.

Tuning instructions and calibration charts shall be mounted on the equipment when such instructions and charts are required.

SAFETY

Provisions shall be made to prevent personnel from coming into contact with voltages in excess of 50 volts while installing, operating, or interchanging assemblies or plug-in parts.

All external metal parts shall be at ground potential. Antenna and transmission line terminals shall be at ground potential except with regard to the energy to be radiated.

Provide safety covers for potentials from 50 to 400 volts where interlocks are not provided. Interlocks and automatic discharging devices must be provided where potentials exceed 400 volts.

Provide personnel protection from moving machinery.

Provide CRT with safety glass.

Adequate safety factors and derating must be used in order to insure maximum reliability of equipment in service.

Use miniature parts and subassemblies where possible, coordinated with cognizant Bureau of Ships codes.

Doors or hinged covers should be rounded at the corners and provided with slip hinges and stops to hold them open.

Plugs and connectors should not expose "hot" leads.

MAINTENANCE

All circuits must be readily accessible for servicing.

Make provision to lock assemblies in the maintenance position.

A servicing power outlet, separately fused, shall be provided on each major unit.

Built-in test equipment (meters, etc.) should be used, to determine qualitatively whether the equipment is operating normally.

Do no provide portable test equipment.

Provide test points for checking essential wave forms and voltages where terminals are not otherwise accessible.

Provide voltage dividers with test points for measurement of voltages in excess of 1000 volts.

Insure complete interchangeability of all removable units, maintenance parts, etc.

Provide means for by-passing interlocks and have warning indicator.

Special tools must be mounted in a convenient place in the equipment. Minimize need for special tools.

Parts mounted on terminal strips and boards must be accessible for servicing.

All terminal strips and boards shall be marked by a standard system. Publication NavShips 250-916 may be used as a guide.

Rear of plug connectors must be accessible for test and service.

Range indicators should be of large counter types suitably placed with provision for transmission to remote positions (or as required by the equipment specification).

Provide running-time meters where required by the specifications.

MARKING

Conductors should be color coded in accordance with Standard MIL-STD-122.

Design Engineers

of electronic equipment which has to (a) be Although prepared primarily for engineers plicable in non-military designs

Noninsulated leads should be color coded by means of color spots near all terminals.

Part reference designations shall be located adjacent to each part. Type designation of each tube and the reference designation shall be marked on the tube side of the chassis adjacent to the socket.

Markings shall be permanent and legible.

Transmission line terminals shall be marked with the characteristic impedance of the line.

Positive identification of scales in use shall be provided.

Clearly mark all "non-tamper" factory adjustments.

Indicate parts which MUST be replaced at specified intervals.

Transformers, chokes, capacitors, etc., shall have circuit diagrams with current, voltage, and impedance ratings stenciled on the outside (MIL-T-27).

Lubrication points shall be accessible and clearly marked.

ASSEMBLY

Electron tubes, ferrule-type resistors and fuses, and other plug-in items must be secured by easily released positive holding clamps.

Mounting of parts shall be compatible with the size and weight of the parts so as to preclude lead breakage from fatigue under conditions of vibration.

Leave adequate (1/16 inch) pigtail on leads and do not mount more than three wires on one terminal.

Threaded devices shall conform with Specification MIL-S-933 or MIL-B-857 and Handbook H 28. For bushings or collars for mounting variable resistors, toggle switches, etc., Specification 16E7 applies.

Screws, studs, nuts, etc., shall be of nonferrous material. Corrosion-resistant steel or nickel-copper alloy may be used where required for reasons of strength.

Avoid threading aluminum alloy into aluminum alloy parts.

Self-tapping screws should not ordinarily be used. If used, approval must be obtained from the bureau or agency concerned.

Devices for retaining panels and cover plates shall be of captive types with slotted or knurled and slotted heads.

Use external tooth-type lock washers.

Provide rotating antenna assemblies with local power safety switch and means for hand training for maintenance.

Removable side and back plates for terminal tube mounting shall be provided.

All set screws shall have one type of head.

Do not use flat-head screws on thin panels.

Center-of-gravity mounting should be employed where possible.

Do not mount components on tube socket lugs except where required for performance reasons.

MATERIALS

Do not mount parts with rivets.

Do not use wood, magnesium, inflammable materials, fungus supporting materials, toxic materials, hygroscopic materials, dissimilar metals in contact, and electrical tape.

Use glareproof and shatterproof glass.

Iron and steel shall not be used except where required for electromagnetic or strength reasons.

Plate or otherwise treat metals to protect them from corrosion.

Materials for embedding electronic parts in assemblies shall be in accordance with Specification MIL-C-16923.

Finish enamel shall conform with Specification MIL-E-15090 or TT-E-485, as indicated.

Operating conditions (may be modified by equipment specification MIL-E-16400):

a. −54° to +85°C (nonoperating)
b. −54° to +65°C (operating)
c. 95 per cent relative humidity
d. For ceratin equipment, wind 90 knots operating and 150 knots nonoperating
e. Ice loading as specified by equipment spec.
f. Shock and vibration (MIL-S-901, 40T9, MIL-T-17113, etc.)
g. Line voltage and frequency (excursions per equipment spec.)
h. Salt spray (for external finishes and materials)

Avoid use of friction of pressure contacts where possible.

Equipment shall be dripproof, splashproof, or waterproof as required by the equipment specification. See Standard MIL-STD-108.

LAYOUT

Equipment shall be of the lightest weight consistent with sturdiness, safety, and reliability.

Provide suitably labeled lifting-eyes on equipment weighing more than 150 pounds.

Provide adequate ventilation facilities. Do not provide openings in top.

Restrict use of liquid cooling.

When forced-air cooling is used, provide suitable dust filters. Mounting and size to be coordinated with bureau or agency concerned.

Electronic equipment should use as few lubricants as practicable.

Size restrictions:

a. Surface vessel installation—
   (1) Height 72 inches
   (2) 30-inch-by-30-inch hatch with round corners on 7½-inch radius.
   (3) 26-inch-by-45-inch door with round corners on 8-inch radius.
b. Submarine installation—
   (1) 72 inches high
   (2) 25-inch diameter circular hatch
   (3) 20-inch-by-38-inch door with round corners on 10-inch radius.

Use of cable plugs and connectors should be kept to absolute minimum.

Avoid cable entrances on front panels.

Provide space heaters where necessary.

See Specification MIL-E-16400 for more detailed requirements.

This information has been prepared by the Engineering Division of the U. S. Navy Electronics Laboratory for distribution to representatives of electronic equipment manufacturers. Its purpose is to help in the production of improved electronic equipment by providing Bureau of Ships contractors with a miscellany of design information not readily available elsewhere.

Electron Tube

An analysis of the characteristics for six out of the eight forms occurring in practical circuits and which are a threat to equipment reliability

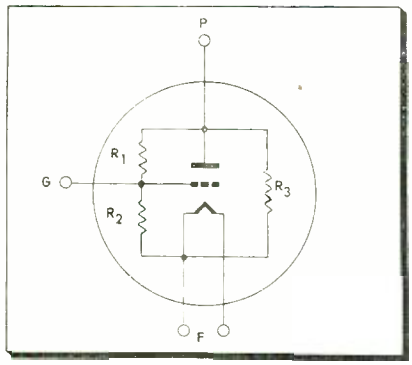


Fig. 1: Circuit designers should modify tube symbols on schematic diagrams to be as shown

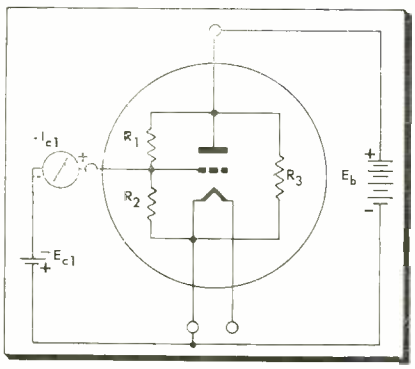


Fig. 2: Circuit for testing gas ionization current and internal inter-electrode leakage.

By Advisory Group on Electron Tubes
Office of the Asst. Secy. of Defense
Research & Development
346 Broadway, New York City

TO the equipment designer grid currents are probably the most vicious of detrimental properties of electron tubes. It is not unusual to have a two year interval between the original bread-board of a circuit and the time when a serious grid current hazard is recognized. The frequent lack of recognition of grid current hazards has no doubt been fostered by the over simplified description of an electron tube as a device which operates with a negative grid voltage and draws no current from the signal source.

There are at least eight distinct forms of grid current, which might be given the following arbitrary titles:

1. Inter-electrode leakage
2. Gas ionization current
3. Grid emission current
4. Positive grid electron current
5. Secondary grid emission current
6. Negative grid electron current
7. Grid photo-emission current
8. UHF input admittance characteristic associated with transit time and lead inductance.

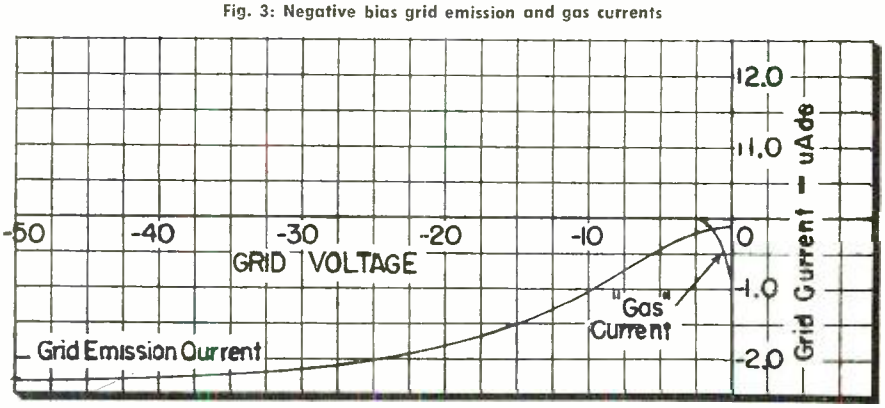
In this article only the first six will be discussed. The last two are quite civilized and non-hazardous forms of grid current. There are few unpredictable variations in VHF characteristics within a given tube with variations in supply voltages, or after extended periods of operation. The first six forms of grid current frequently threaten equipment reliability. Even when some of these currents serve to perform useful circuit functions, they should be kept under surveillance from the point of view of performance variation.

The glass and micas used in electron tubes possess unusual electrical insulation properties. However, the surfaces of these insulators may become contaminated during operation of the tube. The hot cathode is a source of evaporated conducting material that may be deposited on the insulation surface; the higher the temperature of the cathode the greater the rate of development of the conducting layer. The resistance of this leakage path is not constant in reference to temperature and applied voltage. As the temperature and/or voltage is increased the value of resistance decreases. (In addition to the variations of resistance with temperature and voltage, it must also be cautioned that leakage paths are essentially intermittent.)

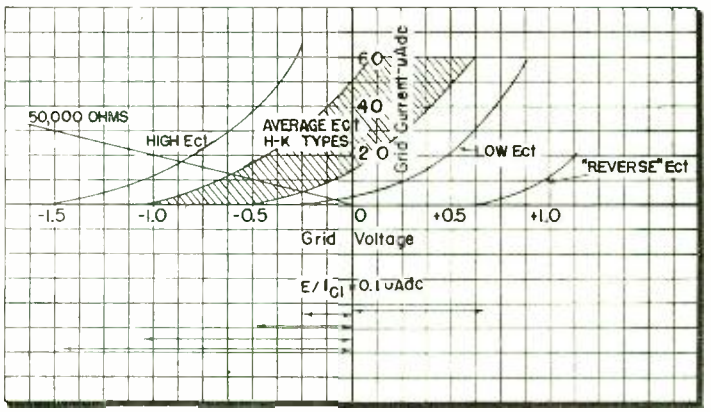
All MIL-E-1 specifications for electron tubes include a test for inter-electrode leakage as an initial acceptance test, known as insulation of electrodes. Most types use a value of 10 megohms minimum. Some of the later specifications describing tubes for more reliable performance, place a much higher limit on this resistance value, and usually include limits for life test. The inter-electrode leakage test is usually made with normal heater voltage, and a negative dc voltage applied to the grid, with all other electrodes connected to the cathode. This dc measurement is a good index of this property at audio and low radio frequencies. (The intermittent character of leakage must be borne in mind.) This minute layer of conductive material has still lower resistance at higher frequencies, and that is one reason why there are high frequency operation tests on some types.

In general, the higher the heater or filament voltage the more rapid the development of this unwanted conductance. For these reasons the circuit designer should modify the tube symbols on his schematic diagram as indicated on Fig. 1. (To more accurately present the problem, switches should be shown in the resistance paths of Figure 1 to warn of intermittent existence.) This figure also includes a tabulation of typical composite resistance values. An examination of the MIL-E-1 specification sheet will indicate in which decade a given tube may be classified. (Very few of MIL-E-1 specification sheets carry a reference to electrode insulation as it is required by paragraph 4.8 of the general section unless specifically altered by the specification sheet.) Most limits are for initial test acceptance only. Pres-

Fig. 3: Negative bias grid emission and gas currents



Grid Currents



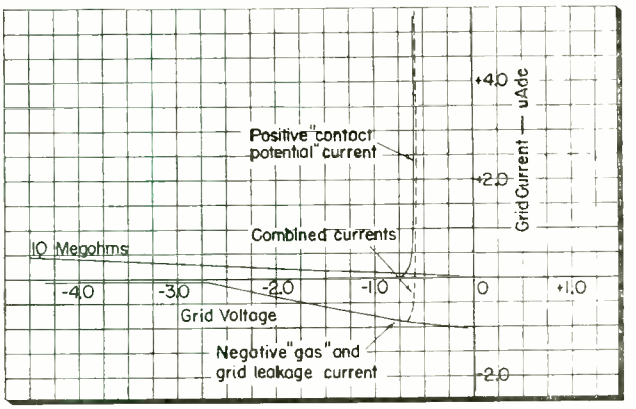


Fig. 4: (l) Typical contact potential currents. Fig. 5: (r) Typical negative bias grid currents

ently most types stop at 10 megohms with only a few having a higher minimum value.

Gas Ionization Current

The existence of grid current produced by gas ionization, and the resulting dc circuit effects are quite well known. For a given gas level, temperature, and plate voltage, this grid current will be essentially proportional to the cathode current. None of the conventional types of electron tubes are completely and permanently free of gas. During operation the "getters" are constantly absorbing the "high activity" gas that is released in varying amounts from the grids, plate, bulb, micas and other parts. This phenomenon explains the behavior of some tubes, which have been in storage for some time, having gas currents even higher than the established limit when first operated and then "cleaning up" and remaining a good tube throughout its use.

The presence of gas inside the envelope tends to produce an emission poisoning effect on the oxide coated cathode materials, particularly at high cathode operating temperatures. This serves as an incentive to the tube manufacturers to keep the gas level down, since the penalty can be life test failures and lot rejections.

Fig. 2 indicates the schematic circuit for testing gas ionization current and the tubes' internal inter-electrode leakage. This circuit is shown mainly to indicate the correct polarity for the dc current meter. The positive terminal of the meter is connected to the grid terminal for electrode insulation, gas ionization, and grid emission tests. The corresponding MIL-E-1 convention for such grid current limits is a negative sign in front of the number.

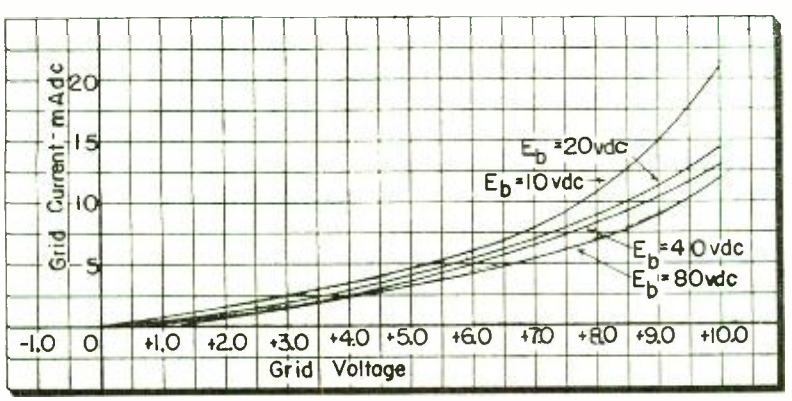
Fig. 2 also indicates a tabulation of typical values of negative grid current limits. There is a large gap in grid current limits between 0.1 microampere and 10^{-13} and 10^{-15} amperes for electrometer tubes. Therefore, equipments which require grid currents in this region are dependent upon uncontrolled tube properties. No assurance of reliability can be given, even though the heater voltage is controlled within a few per cent, and the plate voltage and plate current are kept very low to reduce gas evolution and gas ionization current. The miniature double triode, 5755, is a special purpose tube with a maximum grid current limit of 10^{-9} amperes (0.001 microamperes).

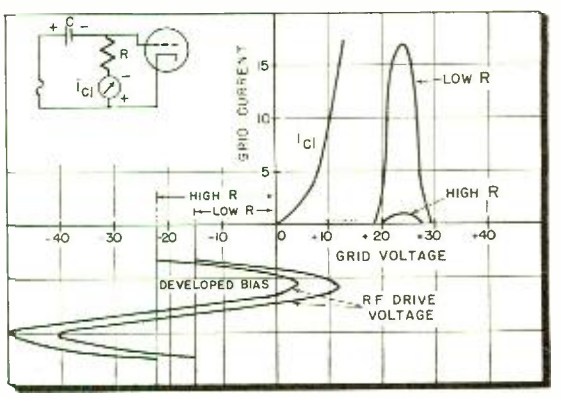
Grid Emission

Grid emission is a result of the grid becoming heated during operation. The proximity of the grid and the cathode combined with the small diameter of the grid wires in many types aggravate this condition. Many methods are used to minimize the magnitude of the grid emission current. The most useful from the application standpoint is good control of the heater or filament voltage, particularly limiting the maximums.

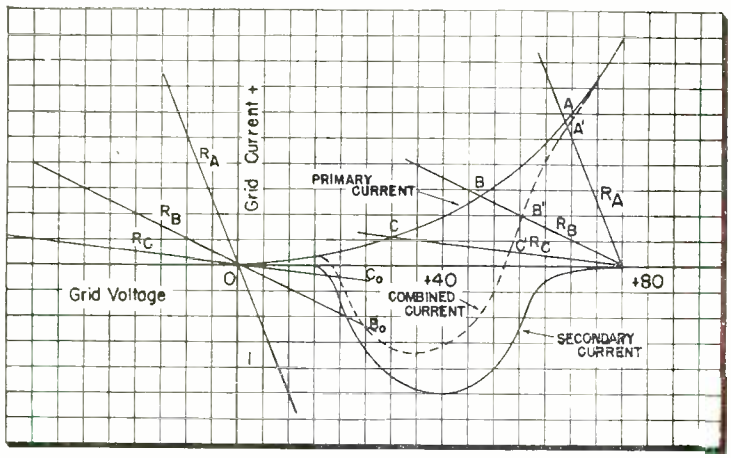
Fig. 3 shows a typical plot of grid emission current at negative grid voltage values, together with a sec-

Fig. 6: (l) Typical positive grid current characteristics H-K type. Fig. 7 (r) Grid current projection—Class C operation





Grid Currents (Continued)



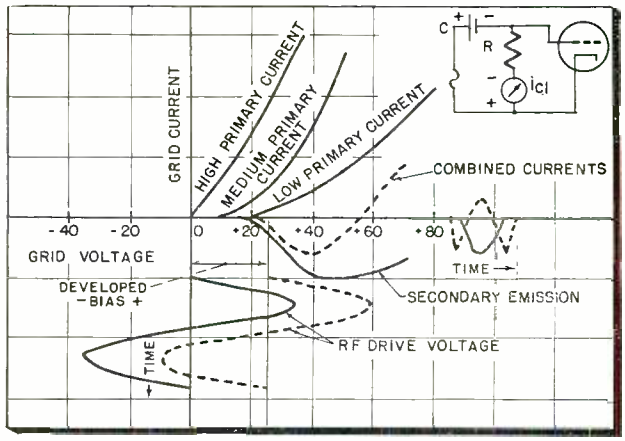


Fig. 8: (l) Secondary grid emission—Static Operation. Fig. 9: (r) Class C Operation—grid current projection with secondary grid emission

ond curve for the gas ionization current. On this type, the plate current cuts off at about −3 volts on the grid, as indicated on the gas ionization curve. Since grid emission, leakage, and gas currents have the same polarity, a convenient diagnostic tool is to make a rapid grid current measurement at −1.5 volts and a higher voltage (−45) on the grid. An increase in current indicates grid emission and/or leakage.

Grid Electron Current

The title was chosen to identify grid currents resulting from electrons arriving at the grid, usually emitted from the cathode. This current generally starts when the grid voltage is still negative in reference to the cathode. The potential resulting in this effectively positive voltage is commonly referred to as contact potential. One convenient conception of contact potential is shown in Fig. 10. It should be emphasized that this is not the property that the physicists would call contact potential; in fact, the voltage polarity is reversed. This is, however, a very convenient tool to predict circuit behavior. A hypothetical battery is located between the cathode base metal and the cathode coating, or the space just outside of the cathode coating, which might be called the virtual cathode surface. In effect this hypothetical battery causes grid current to flow although the grid voltage is still negative as indicated in Fig. 4. Fig. 4 also shows the relationship of grid voltage—grid current for different tubes with various levels of "contact potential." (Although the spread of contact potential for any given lot of tubes is not as great as shown, it must be observed that no particular level can be assured as seldom is contact potential a specified acceptance test item in MIL-E-1.) The most common method of measuring contact potential is to determine the voltage necessary to limit the grid current to 0.1 microamperes. The arrows in the lower portion of Fig. 4 show the value of contact potential.

A 50,000 ohm zero bias cathode grid resistance line is drawn on the graph of Fig. 4 to indicate the low grid loading impedance for small signals. It becomes obvious that higher grid resistance values tend to increase the small signal grid loading impedance on tubes working in the contact potential region. Associated with all these tubes is a plate current and transconductance relationship; for fixed eternal grid voltage, the high contact potential have higher plate current and transconductance (lower effective grid voltage). This is very important on high transconductance and high mu types. It should be noted that the intercept of the 50,000 ohm line, of Fig. 5, develops a higher external bias for the higher contact potential tubes. The relationship is in the right direction to compensate for high plate current. Fig. 5 is another graph of grid currents with the dotted curve representing the sum of negative and positive current. A zero bias, 10 megohm grid resistance line is shown on this graph. The intercept of this line with the combined currents curve indicates that a tube with one microampere grid current would have grid loading impedance of approximately 100,000 ohms. Zero bias applications should include high screen and plate supply resistance, which in turn establishes low cathode current and low power dissipation within the tube.

Fig. 11 shows a typical relation between heater voltage and contact potential as measured at 0.1 microamperes. Fig. 6 is a graph of positive grid current versus grid voltage for several plate voltage values of a typical triode. In the case of a graph such as this the data represents one tube, at one time. These currents may change by a factor of two or three to one from tube to tube or for the same tube with time, or variations in heater voltages. For this reason, the use of the positive grid current characteristic as a circuit element to achieve a certain degree of attenuation is not recommended. The familiar class C operation graphical of RF grid voltage vs grid current is shown on Fig. 7. The curves are plotted for two different grid resistance values; the higher grid resistance produces better rectification efficiency, resulting in a

(*Continued on page* 153)

INSULATION OF ELECTRODES

	Typical Resistance Values	Equivalent Current At −100 Vdc	Typical I_{c1} Limits		Class of Tube
R_g — all = $\frac{R_1R_2}{R_1+R_2}$	10 meg.	10 μAdc	−2.0 to −5.0	μAdc	H-K Power Types
	100 meg.	1.0 μAdc	−0.5 to −2.0	μAdc	Most H-K Types
	500 meg.	0.2 μAdc	−0.1 to −0.5	μAdc	
R_p — all = $\frac{R_1R_3}{R_1+R_3}$	2000 meg.	0.05 μAdc	0.001	μAdc	5755
	10^{15} ohms Low Voltages	Electrometer	-10^{-13} to -10^{-15} Amp.		Electrometer Types

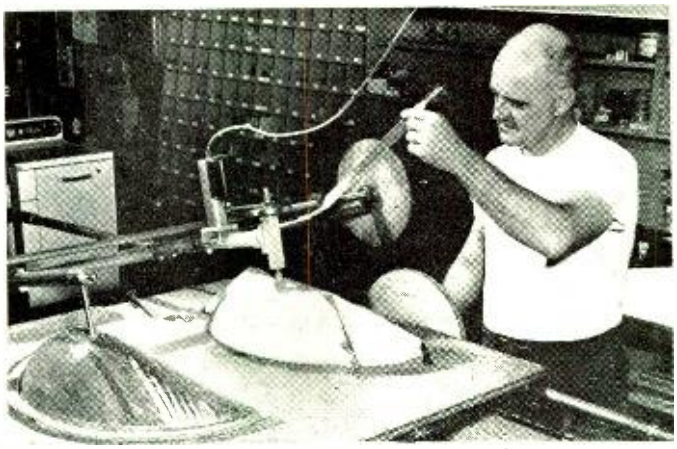


Fig. 1: Pantograph machine for cutting styrofoam lens segments

Fig. 2: Model of compressed styrofoam spherical-wedge lens

Three-Dimensional Microwave Lens

Design data for Luneberg type lens operating at 9375 MC.

By GLEN P. ROBINSON
Scientific Associates Inc.
Atlanta, Ga.

LENSES for focusing microwave energy may be designed by the same principles used in designing lenses in optics. For example, a spherical wave emitted from a feed or point source may be collimated by passing it through a convex shaped medium with an index of refraction greater than unity.

For some applications it is desirable to fix the shape of a lens and to focus the radiation by varying the index of refraction within the lens. An example of such a lens is the Luneberg lens[1], which is spherical in shape and has the property of collimating energy emitted from a point source on its surface or, conversely, of focussing a plane wave incident upon the lens to a point on the surface. The particular advantage of this type of lens over present types of microwave lenses or reflectors is that rapid and wide-angle scanning and tracking may be accomplished by moving a small feed horn rather than by moving the entire antenna assembly.

The index of refraction in a Luneberg lens decreases from a value of $\sqrt{2}$ at the center to a value of unity at the periphery according to the law,

$$n = \sqrt{2 - \left(\frac{r}{r_0}\right)^2}, \qquad (1)$$

where r_0 is the radius of the sphere.

The problem of developing a practical means of fabricating a Luneberg lens depends essentially on finding a low-loss dielectric material whose index of refraction can be accurately controlled. To realize the Luneberg law exactly, it would be necessary to vary the index of refraction continuously while forming a sphere.

Modern plastic materials afford many interesting possibilities for obtaining dielectric materials having an index of refraction in the desired range. For example, Dow Styrofoam (foamed polystyrene) is a low-loss dielectric material whose index of refraction may be controlled simply by varying the density of the material. This may be done over wide limits by mechanical compression, or in the manufacturing process, over somewhat narrower limits. Another means of producing dielectric materials of controlled index of refraction is to start with a plastic whose dielectric constant (equal approximately to the square of the index of the refraction) is of the order of 2.5 in the solid state, and expand the material to a lower density foam. The density and hence the index of refraction of the resulting material may be controlled by regulating the degree of expansion. Still another method of producing dielectric materials of controlled dielectric constant is to foam mixtures of high-dielectric constant materials, such as titanium dioxide or lead chloride, in a low-dielectric constant matrix, such as expanded polystyrene.

Fig. 3: Styrofoam segments being compressed into spherical wedges

Of the various dielectric materials suitable for fabrication of a Luneberg lens, compressed Styrofoam has the advantage of ease of precise control of index-of-refraction by practical methods. Scientific Associates, Inc., has constructed a compressed Styrofoam Luneberg Lens two feet in diameter. The relatively simple fabrication techniques are described below.

The lens is built up of 186 identical spherical wedges; that is, sections formed by slicing a sphere through the North-South axis. Each wedge is formed by compressing a specially shaped Styrofoam segment in such a way as to obtain a wedge-shaped segment with an index of refraction which varies radially according to the Luneberg law.

First, studies were made of Styrofoam samples to determine the dependence of index of refraction on

(*Continued on page* 124)

Microwaves

System operational

By P. J. BREWSTER
Project Engineer
Philco Corp.
Government & Industrial Div.
Philadelphia 44, Pa.

THE West Virginia Turnpike, extending south from Charleston to the Virginia border was literally carved thrcugh mountains ranging in altitude to 3500 feet. One of these mountains was tunneled while the others were leveled in order to maintain a road grade less than five percent. There are no "ups" and "downs," so common to motorists who travel the natural mountain highways, but instead, a ribbon of smooth concrete, with curves banked sufficiently to allow the motorist to enjoy his journey to the fullest extent. This link is the first of a number which are planned to connect the State of Florida with the Middle-West. The Turnpike was constructed under the supervision of Howard Needles, Tammen & Bergendoff, Consulting Engineers, with Mr. C. H. Peterson as Project Engineer.

A modern highway, maintained by competent personnel, requires a modern communication system to aid in keeping the road clear of possible blocks, and as an invaluable instrument for use in the event of emergencies. The communications chosen by the Turnpike Authority consists of a Philco microwave system employing the new Model CLR-7 equipment, supplemented by a versatile VHF mobile radio system, supplied by Bendix Radio to Philco specifications.

The communication system installed on the turnpike is fully automatic. It is also full party line so that each patrolman can maintain strict surveillance of the entire length of the Turnpike. Messages transmitted by any roving or mobile stationed patrolman or toll booth officer may be heard by the remaining patrolmen and toll booth officers. It is also possible for a toll booth officer or patrolman to communicate with another, within VHF range, without energizing the microwave system.

The backbone of the communications system is the CLR-7 microwave link. Three stations, (Fig. 1), Malden Mountain, Lick Knob, and Bald Knob, are located adjacent to the highway, within one and one half miles of the road.

Each of the three stations (Figs. 3 & 4) includes a concrete block building which houses the CLR-7 microwave and the VHF land station equipments. The microwave and VHF antennas are located on the roof. The Malden Mountain and Bald Knob stations operate as terminals and the Lick Knob station as a fully automatic repeater, receiving and transmitting in two directions simultaneously. This station has two microwave antennas, one for receiving and transmitting in each of the two required directions.

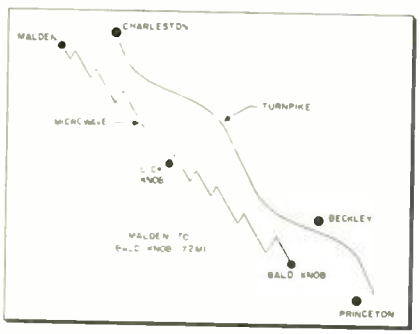
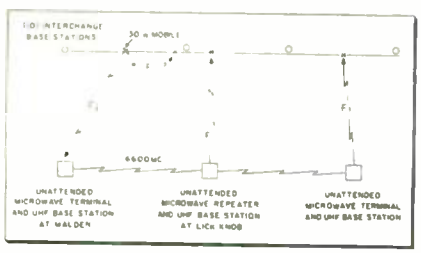


Fig. 1: Turnpike and microwave routes

Fig. 2: Turnpike microwave and UHF functions



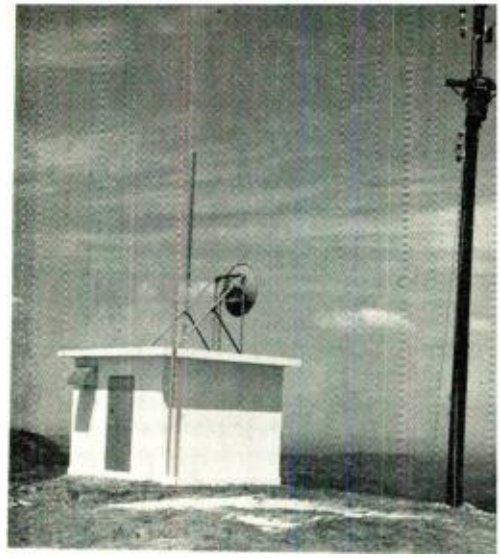


Fig. 3: Bald Knob microwave and VHF station

Line-of-Sight

Inasmuch as the locations of these stations are high in altitude (Fig. 5) line-of-sight with sufficient intra-path clearances was established without the necessity of tower located reflectors. Towers and reflectors are commonly utilized in some system locations in order to increase the intra-path clearances required to maintain the desired signal levels.

Located along the highway are ten toll or inter-change (Fig. 6) stations, which are equipped with 30 watt, a-c operated, semi-remote VHF station equipments. The 24 vehicular or mobile stations are equipped with a 30 watt, battery-powered VHF equipment. Both the toll booth and vehicular stations operate on a push-to-talk basis.

The microwave located VHF land station equipments are full duplex in operation, transmitter and receiver operating simultaneously. The receivers are equipped with a squelch operated relay which is used to key the local transmitter upon reception of an on-frequency signal and initiate a keying tone which in turn keys or actuates the two other microwave located transmitters.

The CLR-7 microwave equipment has an operating system bandwidth, exceeding 400 kc, sufficient to carry 24 or more multiplexed telephone channels; however, the spectrum utilized for this system does not exceed 6.5 kc. The remainder of the system spectrum may be utilized for additional channels which may be required at a later date. The system is so designed that when additional equipments are attached to the system, the present units do not become antiquated.

Self Contained Units

The microwave units, (Figs. 7 & 8) are self contained and include thermostatic controlled air blowers to maintain constant temperatures inside the cabinet to insure operating frequencies within the tolerance authorized by the F.C.C. The unit is also commonly referred to as a "feedback repeater." This design allows received signals to be re-transmitted automatically without the use of expensive, separate, receivers and transmitters. It is often found that by use of back-to-back transmitter-receiver equipped repeaters, system bandwidth is decreased and intermodulation and crosstalk is increased. In the Philco system, r-f frequencies "lock-in." In other words, the frequency originating at the terminal is the controlling one for the entire system, as the repeater automatically locks-in on the incoming frequency and transmits the same, plus or minus the i-f frequency of

Fig. 4: Lick Knob repeater station

Fig. 5: Rugged terrain from Lick Knob

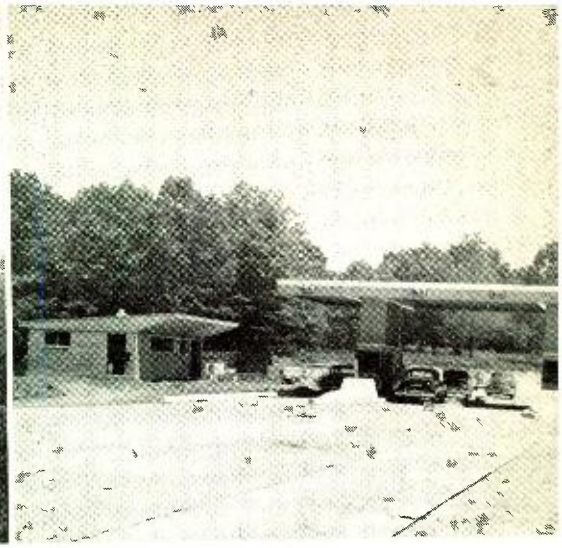


Fig. 6: Beckley toll booth. VHF equipment left

on West Virginia's Turnpike

information on recently installed 6575-6875 MC equipment

the receiver, which is 90 mc. The West Virginia system operates in the Industrial band, 6575 to 6875 mc.

Operation

When a toll booth operator or vehicular stationed patrolman desires to communicate with another toll booth operator or patrolman nearby, he selects transmitting frequency number 2 by manipulating the frequency selection switch on his control unit, and then pushes his microphone push-to-talk switch. The intelligence is intercepted by all other toll booth and vehicular stations within range, which is approximately 25 to 30 miles, in normal terrain. The operator, transmitting, directs his message to the called station by preceding the message by a called number. Since the toll booth and vehicular station equipments are simplex in operation, the called station returns the call when the transmitting station has completed his message. The receiving station returns the call in the same manner as the transmitting station.

If a toll booth operator or patrolman desires to communicate with another officer without knowing the location of the latter, he selects transmitting frequency number 1 on his control box, operates the push-to-talk switch on his microphone, and this signal is then intercepted by the nearest microwave located VHF receiver. When the signal is intercepted by a receiver, the squelch relay is operated, the local transmitter is keyed or put "on the air," at 6025 cps tone is transmitted to the two remaining VHF microwave located stations thereby keying their transmitters. The voice intelligence intercepted by the initial receiver is connected to the microwave, and in turn re-transmits the intelligence through all three microwave located transmitters. When the calling station releases his "push-to-talk" switch, the receiver squelch relay returns to normal, de-energizing the local transmitter, releasing the transmitting keying tone, and thus de-energizing the two remaining transmitters.

Fig. 7: Photo shows CLR-7 Microwave Terminal

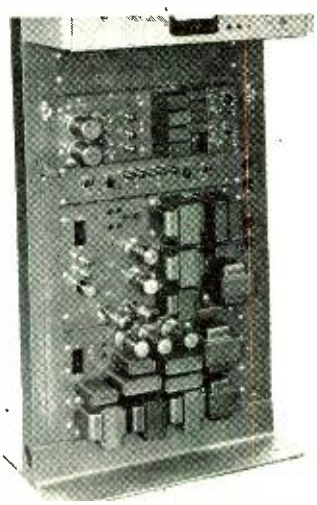
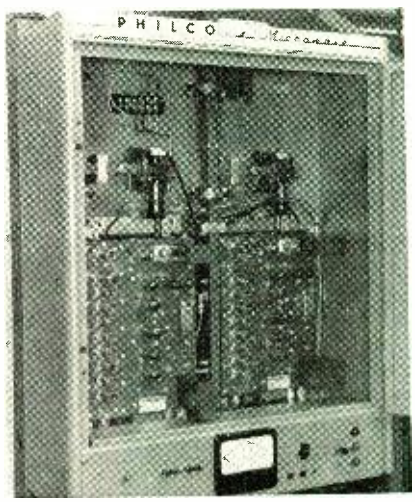


Fig. 8: Amplifier (i-f) chassis and klystrons



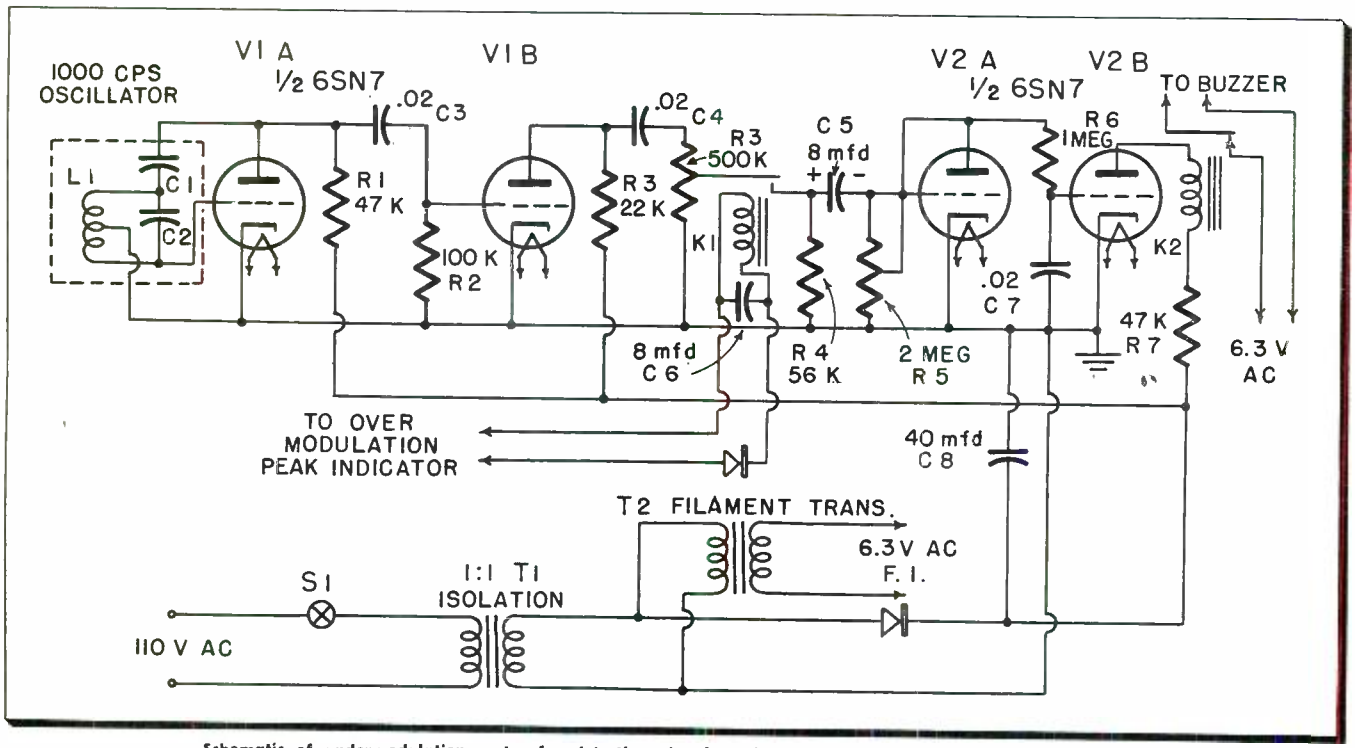
Control Panel

Associated with the microwave located VHF transmitter and receiver is a control panel, containing interposing relays, audio level meter, and control circuits necessary to carry out the functions previously described. One of the highlights of the system is a circuit which prevents two adjacent microwave located receivers from being actuated simultaneously, guarding against echo effect or two toll booth or patrolmen

(*Continued on page* 133)

CUES for BROADCASTERS

Practical ways of improving station operation and efficiency



Schematic of undermodulation meter for detecting signal level decreases not always noticeable to the ear

Undermodulation Monitor

RACINE WATKINS, KTSM, El Paso, Tex.

THIS simple and easy to build undermodulation monitor has proved very effective in detecting slight decreases in audio levels which are not always noticeable by ear. A drop of 3 db, while hardly noticeable to the ear, is approximately 50% in audio power; therefore we feel it is important to KEEP THE PEAKS FLASHING!

V1A and V1B are an audio oscillator and amplifier which supply ac voltage for V2A. V2A rectifies this voltage and quickly charges C5 to approximately near the sine wave voltage. When the sine wave is removed C5 discharges slowly through R5. Thus it is the time constant of this capacitor and resistor which mainly determines the time taken for the monitor to warn of a low audio feed.

V2B is a DC amplifier with its grid connected, through an audio filter R6, C7, to the negative side of C5 when C5 is charged. As long as the capacitor is charged the tube is cut off and relay R2 has no current through its winding; consequently the buzzer will not sound.

Tape "Stickage"

TALMADGE R. ENGLAND, Chief Engineer, WMIK, Middlesboro, Ky.

A problem that has many broadcast engineers scratching their heads is magnetic tape sticking to the recording and playback heads. The trouble first shows up as a "squeak" on playback, later gets so bad that the transport mechanism is actually stopped. It is especially perplexing when one finds that cleaning the heads and a short length of tape only serves to aggravate the trouble.

We found that the difficulty was simple adhesion. That is to say, after the heads have had a hundred or so tapes run across them, they become so smooth that the intermolecular forces between the head and tape material is actually sufficient to stop the machine—or break the tape. That these forces can be appreciable is evident to all who are familiar with Johansson Blocks. (Used by machinists to calibrate gauges, etc.) Knowing the cause, the remedy is simple: lightly burnish the heads with crocus cloth, and follow with a thorough cleaning with carbon tet.

$$$ FOR YOUR IDEAS

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

Thermocouple Protection

DON V. R. DRENNER, Engineer, KGGF, Coffeyville, Kansas

REPEATED burnouts of the tower base thermocouple for a remote antenna indicating meter during summer thunderstorms was solved recently by an a.c. operated shunt relay across the thermocouple. A d.p.d.t. antenna relay was installed adjacent to the thermocouple. The normally open contacts were connected to each side of the thermocouple, and the center contacts strapped with a heavy copper bus bar.

The relay is normally in an energized condition, (thus shorting out the thermocouple) except when a reading is being taken. This assures the relay opening for a normal con-

tinuous reading should the fuses blow or the relay coil become defective.

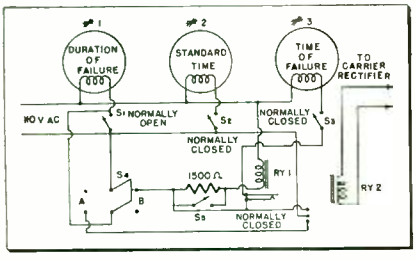
Carrier Interruption Clocks

LYMAN W. PACKARD,
KFI, Buena Park, Calif.

THE exact time of a carrier interruption, and its duration, is an important item in broadcasting, particularly during a commercial program. The transmitter technician has no time to look at his clock to ascertain this information for he is too busy trying to locate the cause of the interruption. We have used a simple clock relay system for many years to indicate the exact time of a carrier failure (clock #3) and the duration of that failure (clock #1).

With switch #4 in "A" position, current from the carrier rectifier passes through relay coil Ry 2, the contact will be in the "up" position, and no voltage will be supplied to clock #1.—(This clock is always set at 12:00—"straight up.")—When a carrier failure occurs, the contact on Ry 2 will drop to the lower position and start clock #1. This will continue until carrier is on again, at which time clock will stop, giving exact duration of the failure.

Clock #3, which is running at the correct time, will stop when the carrier fails, but will not start again when operations become normal, be-



Carrier interruption clock arrangement

cause the 1500 ohm resistor in series with relay coil Ry 1 will not allow sufficient current to pass thru it to close contacts. This can be done by manual operation of switch 5. With switch #4 in "B" position, the transmitter can be shut down without having all the clocks start operating.

Checking Station Frequency

DAVID L. DODD,
KCLX, Colfax, Wash.

WHEN located in the wide open spaces, it is difficult for measuring services to hear stations on the class IV channels. At all times of the day there are stations on the class IV channels, and it is not likely that all those stations will be off frequency more than 5 CPS. Thus the following method can be used to make a check to keep within the 20 CPS limits.

Equipment needed will be a radio receiver and an oscilloscope. Disconnect the plate supply of the transmitter, leaving only the oscillator section on. Pick up a strong enough signal from a distant station on the same frequency to be of use. Keep the signal from the local oscillator sufficient to maintain a good heterodyne.

Calibrate the scope with 60 CPS source, set frequency control on scope to calibrate down as low as possible (in our case 3 CPS). Turn on the transmitter oscillator, and heterodyne the incoming signal. Check on scope for pattern which will determine your frequency, or your frequency in relation to the station or stations on that channel. Adjust your oscillator until you get the desired pattern on your calibrated scope. WARNING: Make sure you check the calibration of your scope before making any adjustment to your oscillator.

This method will keep you well within the limits of the F.C.C. It does not however take the place of your regular frequency check with a frequency measuring service.

Remote Recorder Control

JOHN WHITACRE, Chief Engineer,
WILS, Lansing, Mich.

A G.E.-3587 24 volt transformer, two GE-3563 remote control relays, four momentary push button switches, and a quantity of bell wire are used for remote control operation of our Magnecorder. The transformer and relays are mounted in the speech rack near the tape recorders, and the switches mounted on the panel of the RCA 76-B2 Consolette, two on each side of the V.U. meter.

To convert the Magnecorder Tape Recorder to accommodate this type of switching, remove the lead from terminal #5 (on terminal strip located left of the Jones plug on the puller mechanism) that junctions on the 4 mfd. condenser, and insert the two wires from the G.E. relay between these two points. Refer to the diagram for the rest of the wiring detail.

By putting duplicate switches in the auxiliary control room in parallel with those on the RCA consolette in the regular control room we have extended the remote switching.

Tape Storage

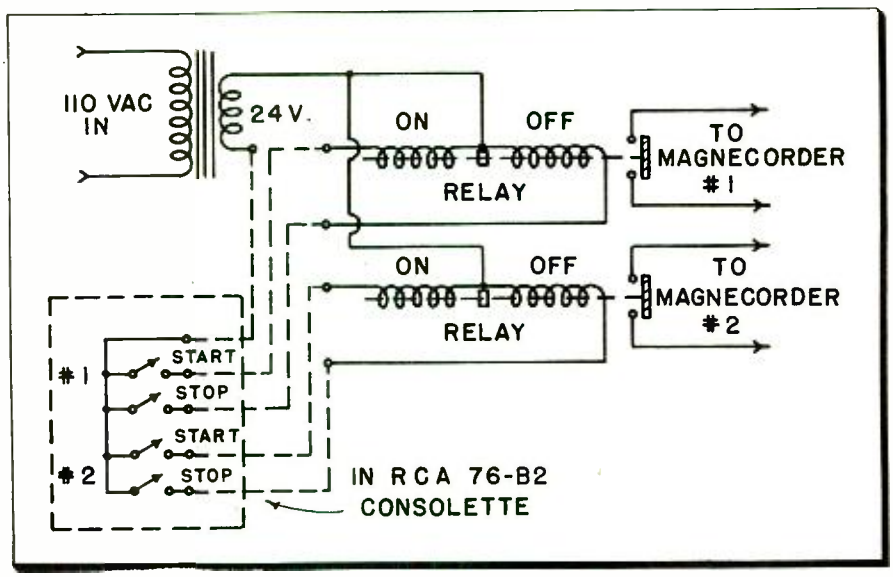
JOSEPH M. WILLIAMS,
WPOR, Portland, Maine

ALMOST convenient way to store magnetic recording tapes is to use the metal cabinets made for 8mm motion picture film. These cabinets are obtainable at most photographic supply houses, and hold twelve of the commonly used seven inch plastic tape reels. To conserve space it may be necessary to stack the cabinets on top of each other. If this is done it will be advisable to mount rubber grommets under the front corners of the upper cabinet to allow the door to swing open.

Stored in this manner the tapes are always ready for immediate use. As the cabinets are constructed of steel, the tapes are protected from stray magnetic fields and from dirt. The film cabinets used at WPOR are made by Brumberger of Brooklyn, N. Y. (Model #1010 made for 400' reels and cans of 8mm film.)

(*Continued on page* 104)

Remote control for two magnetic tape recorders to control consolette



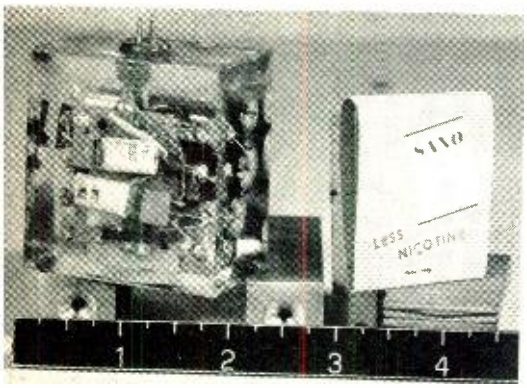


Fig. 1: Completed transistor sonar preamp

Designing a

Methods for deriving the transistor equivalent-circuit parameters and their application in the design of a developmental 2-stage, R-C coupled amplifier

By ROGER V. FOURNIER
and
HARRY TERKANIAN
U.S.N. Underwater Sound Labs
New London, Conn.

THE design of transistor amplifiers on the basis of the circuit relationships available in the literature requires that the transistor equivalent-circuit parameters, namely, the base resistance, r_b, the emitter resistance, r_e, the collector resistance, r_c, and the transfer resistance, r_m, be available. In the design of the circuit under discussion, both the Raytheon CK721 and the RCA TA153 transistors were considered. The parameters were obtained through the use of the General Radio Vacuum-Tube Bridge, Type 561-D.[1]

By connecting the transistor to the bridge and adjusting the bias so that the desired emitter current flows, it is possible to obtain a measurement of the coefficient on the plate resistance and transconductance settings. The reciprocal of the plate resistance coefficient is the output conductance, g_{cce}, and the transconductance coefficient is the forward transfer conductance, g_{cbe}. By reversing the transistor base and collector connections and their power supplies, the input conductance, g_{bbe}, and the reverse transfer conductance, g_{bce}, are measured. The two-generator nodal-derived equivalent circuit of Fig. 2A is then transformed to the two-generator, loop-derived equivalent circuit of Fig. 2B.[2] This is further transformed to the one-generator, loop-derived equivalent circuit shown in Fig. 2C. A final transformation yields the most commonly used equivalent circuit, shown in Fig. 2D. This latter equivalent circuit is particularly useful since many of the design relationships derived in the literature are based on this representation. The terminology is the same as that used in connection with general four-terminal networks except that the third subscript in Figs. 2A and 2B represents the element that is common. In Fig. 2C a presubscript is used for the common element.[3]

R. V. Fournier

H. Terkanian

Advantages

While the above method of obtaining transistor parameters involves considerable computation, it is superior to other methods tried in that it does not require the high resistance power supply which is necessary for the measurement of high collector resistances. Also, since it is a bridge null method, it provides greater accuracy.

Two RCA transistors were measured on the bridge, each one at the emitter current at which it was used in the circuit. The parameter values presented in Table I were computed from these measurements.

In making the calculations from Transistor L2771 the value of $r_c - r_m$, which is a difference between two parameters very nearly alike in magnitude, is not obtained by direct subtraction of r_m from r_c but is computed as one of the parameters of the equivalent circuit of Fig. 2C. Hence, like the other parameters, its value is also accurate to three significant figures.

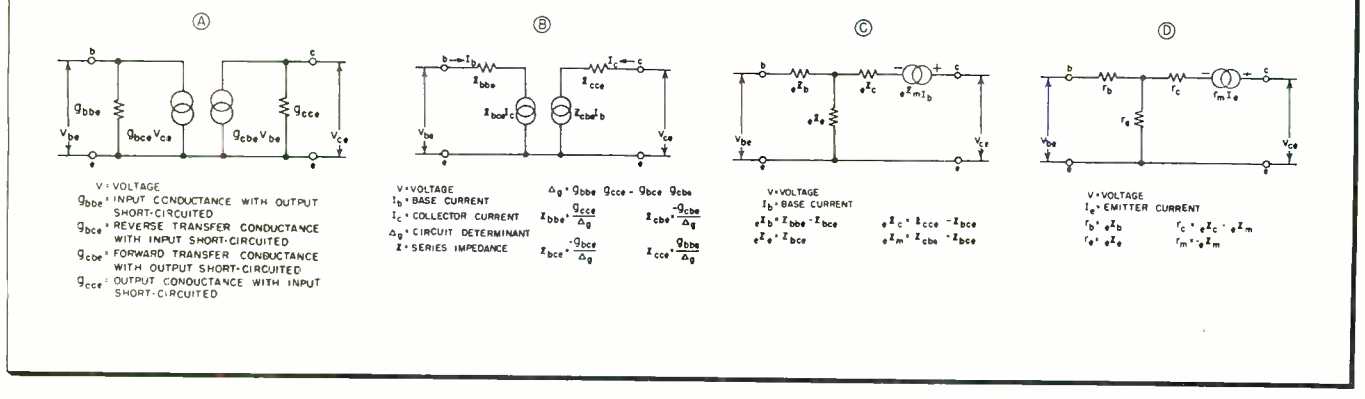
Gain Calculations

The actual circuit diagram is shown in Fig. 3, while the equivalent circuit may be seen in Fig. 4A. Using previously derived design relationships,[4] we obtain the impedance, R_{in}, looking into the input terminals of the second transistor, as follows:

$$R_{in2} = r_{e2} + r_{b2} + \frac{r_{e2}(r_{m2} - r_{e2})}{r_{e2} + r_{c2} - r_{m2} - R_L}, \quad (1)$$

where R_L is the load resistance. If we

Fig. 2: Equivalent circuits (a) 2-generator nodal-derived (b) 2-generator loop-derived (c) 1-generator loop-derived[1] (d) 1-generator loop-derived[4]



Transistor Sonar Preamplifier

substitute in Eq. 1 the parameter values given in the table above and let R_L be the parallel combination of 1 kilohm and 16 kilohms, then

$$R_{in2} = 16.8 \text{ kilohms.}$$

The load resistance for the first stage, R_{L1}, consists of the 11—, 20—, and 10-kilohm resistors and R_{in2} all

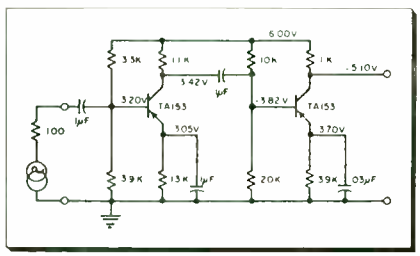


Fig. 3: Diagram of the transistor sonar preamp

in parallel. Therefore,

$$R_{L1} = 3320 \text{ ohms.}$$

The 3.3-kilohm and 3.9-kilohm resistors shunting the source resistance, R_{g1}, have a parallel resistance of 1.79 K, which is high compared to R_{g1}. Therefore, this resistance can be ignored in the calculation of voltage amplification. Using the diagram of Fig. 4B, we now obtain the amplification of the first stage:

$$\frac{V_2}{V_1} = \frac{R_{L1}\,(r_{e1} - r_{m1})/(r_{e1} + r_{b1} + R_{g1})}{(r_{e1} + r_{c1} - r_{m1} + R_{L1}) - r_{e1}\,(r_{e1} - r_{m1})} \quad (2)$$

Solving Eq. 2, we get:

$$\frac{V_2}{V_1} = -43.3.$$

The negative sign indicates a 180° phase reversal obtained with the grounded emitter connection. This amplification, expressed in db, is

$$20 \log \frac{V_2}{V_1} = 32.7 \text{ db.}$$

This is the first-stage voltage gain.

The output resistance, R_{o1}, of the first stage is obtained as follows:

$$R_{o1} = r_{e1} + r_{b1} - r_{in1} + \frac{r_{e1}\,(r_{m1} - r_{e1})}{r_{e1} + r_{b1} + R_{g1}}. \quad (3)$$

Solving Eq. 3, we get

$$R_{o1} = 339{,}000 \text{ ohms,}$$

a value which is high compared to that for the 11-, 20-, and 10-kilohm resistors shunting it. Therefore, R_{g2}, the source resistance of the second stage, is equal to the parallel resistance of the 11-, 20-, and 10-kilohm resistances, or

$$R_{g2} = 4140 \text{ ohms.}$$

Using the diagram shown in Fig. 4C, we now obtain the voltage gain of the second stage:

$$\frac{V_4}{V_3} = \frac{R_{L2}\,(r_{e2} - r_{m2})/(r_{e2} + r_{b2} + R_{g2})}{(r_{e2} + r_{c2} - r_{in2} + R_{L2}) - r_{e2}\,(r_{e2} - r_{m2})} \quad (4)$$

Substituting in Eq. 4, we get

$$\frac{V_4}{V_3} = -4.$$

This voltage amplification, expressed in db, is

$$20 \log 4 = 12.0 \text{ db.}$$

The relationship between V_3 and V_2 is

$$\frac{V_2}{V_3} = \frac{R_{in2}}{R_{g2} + R_{in2}} = \frac{16{,}800}{4140 + 16{,}800}$$

and

$$\frac{V_3}{V_2} = 1.24.$$

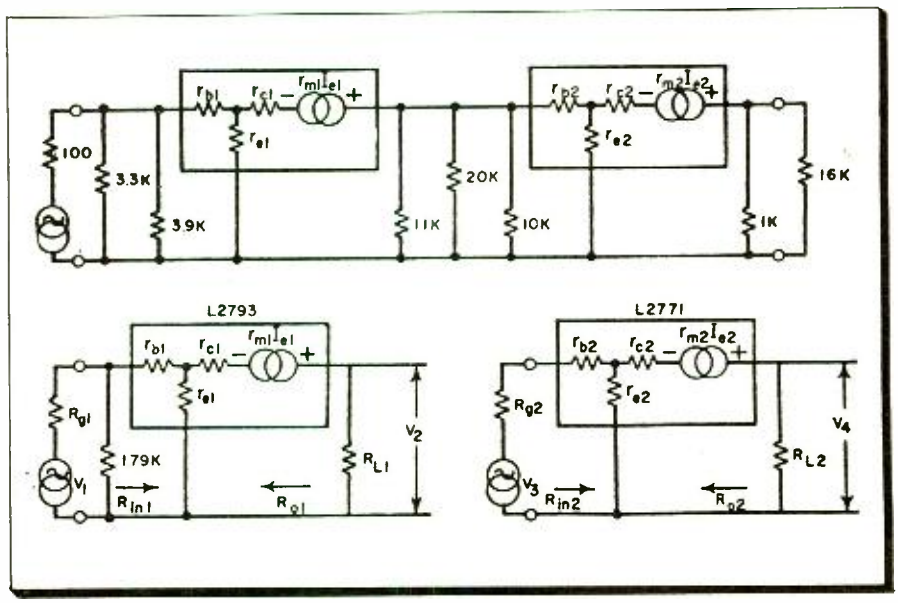
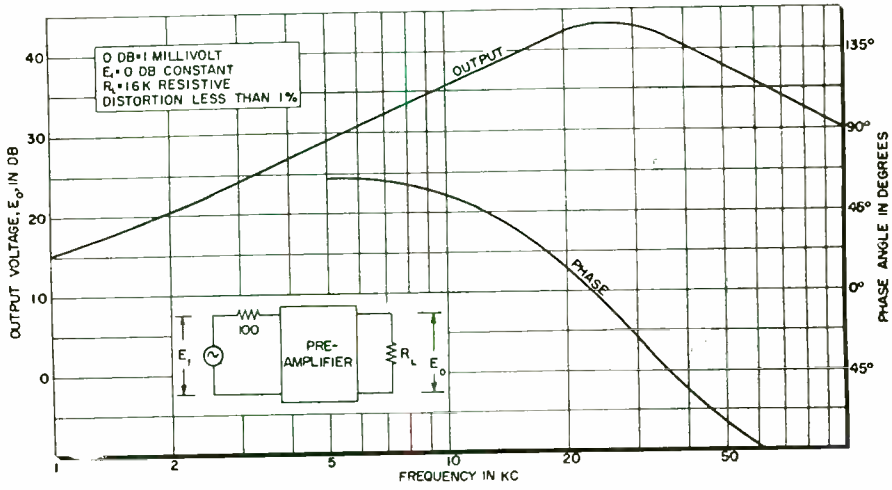


Fig. 4: Equivalent circuits (top) at 25 kc (bottom left) of 1st stage, (r) of 2nd stage

Fig. 5: Frequency response and phase shift in the transistor preamplifier



Transistor Preamplifier (Continued)

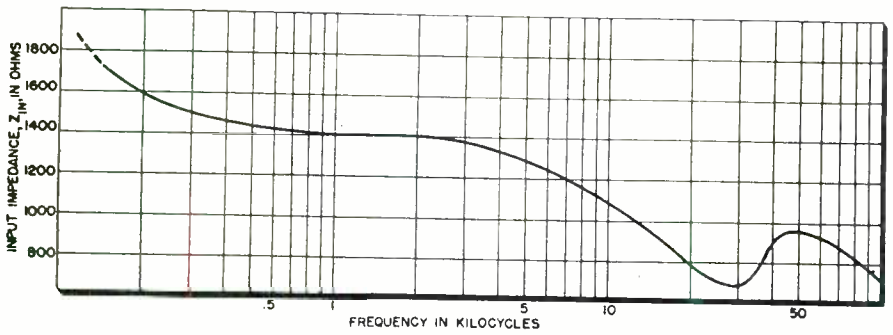
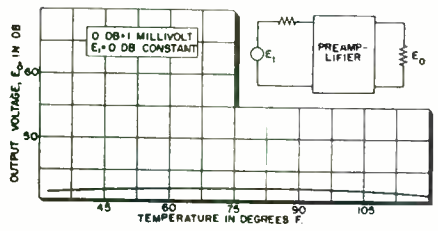


Fig. 6: The input impedance, as shown, is approximately 700 ohms at mid-frequency



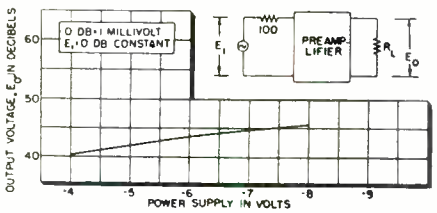


Fig. 7: (l) Curve for temperature-stabilized circuit. Fig. 8: (r) Gain varies sharply with supply voltage

This voltage ratio, expressed in db, is

$$20 \log 1.24 = 1.88 \text{ db.}$$

The result is a total over-all gain of 32.7 db + (12.0 db − 1.88 db), or 42.8 db, against a measured gain of 43 db.

Circuit Description

The final circuit, as shown in Fig. 3, utilizes two grounded emitter stages. While it is felt that the requirements could also be met by using a single transistor and an output transformer, it was thought to be economically wiser to use two transistors instead. The bypassed emitter resistors and the four base stabilizing resistors were selected to provide the proper biases as well as temperature stability. Because of the low signal voltages involved, a collector supply voltage of only −6 v was required.

Performance

The frequency response and the phase shift are shown in Fig. 5. The gain is down at frequencies below mid frequency, since the reactance of the capacitor bypassing the second emitter increases. This reduction in emitter resistance bypassing provides increased negative feedback and an accompanying reduction of gain as frequency decreases. The dropoff above mid frequency is due to a decrease in the current amplification factor at higher frequencies.

As shown in Fig. 9, the preamplifier output is linear to 0.4 v.

The input impedance, which appears in Fig. 6 shows an impedance of 700 ohms at mid-frequency. While this does not match the 100-ohm generator, it is suitable since the noise figure has been met. Furthermore, it will result in less loss of generator voltage in the generator resistance. The output impedance is 1000 ohms.

The circuit noise was kept at a minimum by operating both transistors at low collector voltage. The first stage has a collector-to-emitter voltage of 0.37 v, while the emitter current is 0.23 ma. Operation at lower values did not result in any further improvement in the noise figure. The noise figure is the total noise power in the output divided by that portion of the output noise power contributed by the thermal noise of R_g, the 100-ohm generator. This ratio is expressed in db. The total noise voltage out was read on a Ballantine vtvm, while the noise contributed by thermal agitation in R_g was computed. Therefore, the Ballantine readings were increased by 1 db, since the Ballantine reads low by that amount on Gaussian noise. All noise figures are given for a 3-kc band width. With nine different transistor combinations tried in this amplifier, the noise figure varied from 9 db to 1 db for the 3-kc band width. The average noise figure was 5 db.

Since the resistance of germanium, the element used in transistors, varies with temperature, the gain of earlier circuits tried in this development varied by as much as 25 db in the temperature range from 32° F. to 122° F. A change in temperature

(*Continued on page 128*)

TABLE I
Parameter Values for Two RCA Transistors (TYPE NO. TA153)

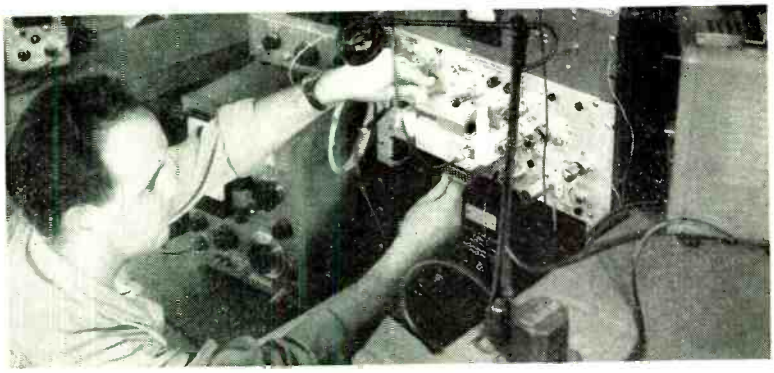
Serial No. L2793	Serial No. L2771
Collector Voltage (V_c) = 4.5 v	Collector Voltage (V_c) = 4.5 v
Emitter Current (I_e) = 0.27 ma	Emitter Current (I_e) = 0.9 ma
r_{b_1} = 3.720 kilohms	r_{b_2} = 2.40 kilohms
r_{e_1} = 62.2 ohms	r_{e_2} = 33.4 ohms
r_{c_1} = 13.8 megohms	r_{c_2} = 5.27 megohms
r_{m_1} = 13.8 megohms	r_{m_2} = 5.26 megohms
$r_{c_1} - r_{m_1}$ = 13.7 kilohms	$r_{c_2} - r_{m_2}$ = 11.2 kilohms

TABLE II
Summary of Characteristics For Vacuum-Tube and Transistor Preamplifiers

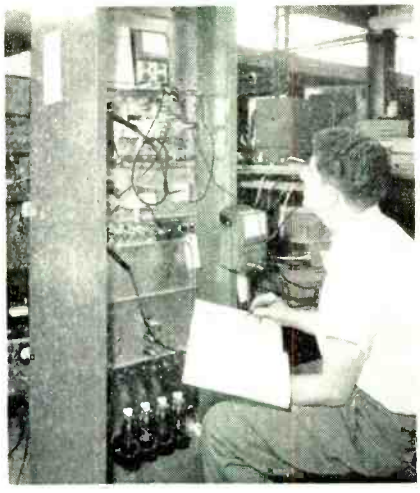
	Vacuum-Tube Preamplifier Characteristics	Transistor Preamplifier Characteristics
Input Impedance	100 ohms	740 ohms
Output Impedance	1000 ohms	1000 ohms
Over-all Voltage Gain	40 db (approx.)	43 db
Transformer Voltage Gain	22 db	
Vacuum-Tube Voltage Gain	18 db	
Noise Figure	10 db	5 db
Signal Voltage (input)	0.5 μv	0.5 μv
Relative Gain Variation	±2 db	±4 db
Relative Phase Variation	±5°	±13°

Microwave Production Testing

I-F strip is lined up in a screened booth using a cathode-ray oscilloscope before sub-panel is inserted in transmitter-receiver



R-F cavity of transmitter receiver panel is adjusted on special test rack, which includes power supply, metering and local oscillator



Composite rack test of r-f terminal assembly. Shown from bottom are power supply, automatic transfer panel, blank, afc, local oscillator modulator, transmitter-receiver panel and test meter. Test points also serve for field tests

Repeated checking of r-f and multiplex panels assures high system reliability

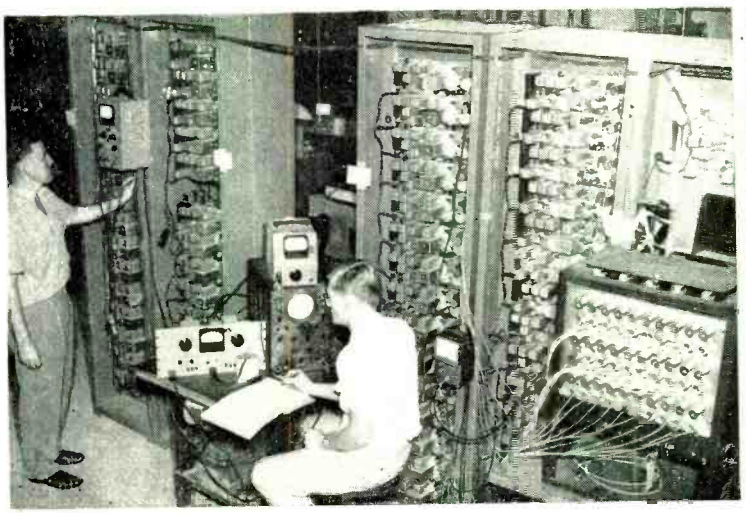
By R. J. BINGHAM
Electronics Div.
Westinghouse Electric Corp.
Baltimore, Md.

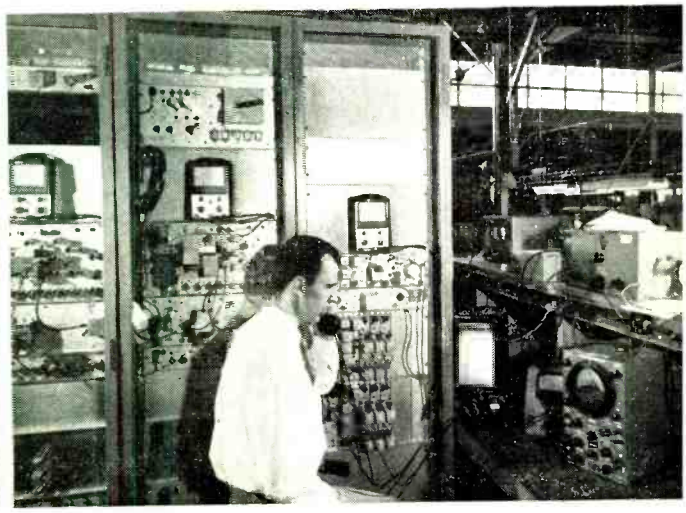
THE multi-channel microwave equipment in production consists of two main assemblies, the r-f assembly and the multiplexing assembly. These, in turn, can be broken down into appropriate arrangements of panels and sub-panels. Consider first the r-f equipment. In the r-f terminal assembly the major units are a transmitter-receiver panel, a local oscillator-modulator panel, an automatic frequency control panel and a power

(*Continued on page* 114)

Telegraph transmitters and receivers are lined up using own jig-mounted power supplies. Crystals and filters are inserted in stock units

Below left: Composite rack test of 30 voice channels employs 30 audio oscillator signals of different frequencies to modulate sub-carrier from 305 to 595 kc. Intermodulation, crosstalk, distortion and noise are checked against allowable limits. Below right: Systems test of one terminal, including standby equipment, requires assembly essentially as used in its final application in the field





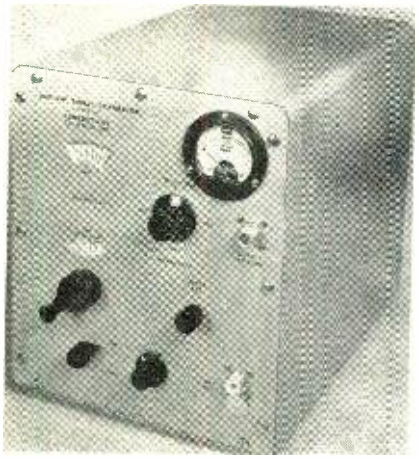


Fig. 1: Panel view of signal generator

A Wide Range

Frequency calibration, output measurement, and costs keynote design features in this new instrument that covers VHF and UHF bands with but one tuning element

By M. L. SNEDEKER and P. E. LANNAN
Designers for Industry, 2915 Detroit Avenue, Cleveland 13, Ohio

P. E. Lannan

M. L. Snedeker

THE advent of UHF television, brought an urgent need for a moderately priced precision signal generator capable of covering both the VHF and UHF bands and preferably utilizing only one tuning element.

The coverage of both these ranges represents a frequency range of 20 to 1. The top frequencies involved preclude the use of lumped-constant circuits so, initially, transmission-line configuration seemed to be the most desirable method. The physical length of a conventional $\lambda/4$ line at 50 MC, however, was somewhat awe-inspiring, if not discouraging.

The usual expedient of arranging the line into a practical configuration by forming it into an arc still resulted in a prohibitively large arrangement.

The possibility of utilizing a helically-wound parallel wire transmission line was suggested.[1] Previous work with lines of this type had been of considerably lower frequencies. Furthermore, the lines used were not continuously variable.

The idea of providing a continuously variable shorting bar riding upon the two parallel wires of the helix was conceived, and a breadboard model constructed. Very good results were obtained insofar as strength of oscillation was concerned, but the frequency range was insufficient. The top frequency was well below that desired, and numerous modes were evident.

Mode Shifts

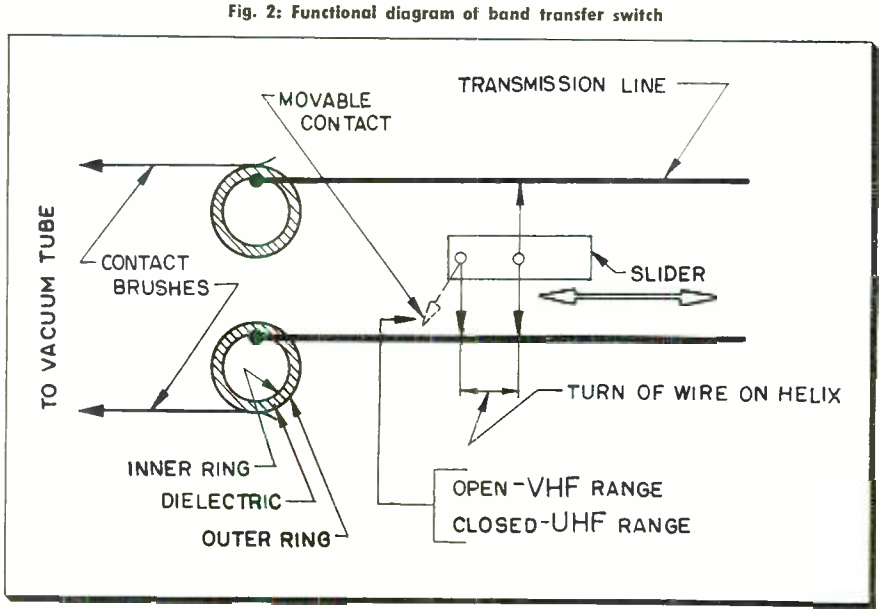
In any practical oscillator circuit the frequency of oscillation will be that at which the circuit operates most efficiently. As a result, frequencies other than that determined by the individual components can be generated. This is due to capacitance to ground, length of ground paths, or uncontrolled coupling. Consequently, in an oscillator which is capable of being operated over a wide frequency range, at certain points in the tuning there may be generated frequencies which are not integrally related to the fundamental or desired frequency. This is referred to as a "mode shift." As tuning progresses the frequency changes in accordance with the variation of elements. Oscillations may or may not be resumed in the original mode, depending upon circuit configurations.

The extremely wide frequency range covered by this instrument affords ample opportunity for these unwanted mode shifts to occur, but by choice of suitable values of plate, cathode and filament chokes, a limited amount of control can be exercised over the frequency at which they do occur. It was possible to shift them into a region where they did not impair continuity of coverage over the ranges desired.

Construction

The oscillator circuit utilized is essentially a plate-grid circuit; the distributed inductance and capacity are varied by a movable shorting contact. The helix is supported by a rod of suitable dielectric material and the wires are arranged in such a way that at the end of the helix nearest the oscillator tube they terminate in two rings, each wire of the helix connecting to one of these rings. Over these inner rings

Fig. 2: Functional diagram of band transfer switch



Signal Generator

is placed a thin sleeve of insulating material. Two outer rings concentric and coplanar with the inner ones are secured over this sleeve. Brushes which connect directly to the oscillator tube socket make contact with these outer rings and permit contact with them during rotation of the helix. Since the outer and inner rings are separated by a dielectric, each wire of the helix is in effect connected to the tube through a condenser, as shown in Fig. 2.

Beneath the helix is a plate running in a slot and carrying upon it a fork which fits closely against the helix rod. This plate is constrained to move longitudinally as the rotor is turned, since the wires of the helix act as a lead screw. Mounted upon this movable plate are multiple contact fingers which bear firmly upon the wires of the helix and are so arranged that all fingers are metallically connected to the movable plate. This arrangement provides a means of short circuiting the transmission line and permitting the short circuit point to be varied. The entire length of the helical winding may be utilized as a transmission line; the portion lying between the vacuum tube (or more properly the rings,) and the shorting fingers constituting the active length. When the length of transmission line is a minimum the frequency of the generated oscillations will be the highest. When the shorting plate is in such a position that all or nearly all of the wire of the helix is in the circuit, the frequency of oscillations will be the lowest.

Wide Range Oscillations

Utilizing a form of appropriate diameter, length and winding pitch for the helix, oscillations can be made to occur over an extremely wide range. The upper frequency is limited by the lead length and capacitance of the vacuum tube employed. The lowest frequency is limited only by the length of the wire of the helix.

For a bottom frequency of 50 MC a rotor assembly approximately 10 in. in length was required. Considerable time was spent in investigating the possibilities of a larger diameter (and therefore shorter) rotor. Diameters of ¾ in. and 1 in. were tried but both these exhibited mode characteristics not present in the ½ in. rotor. These mode shifts could not readily be eliminated or shifted out of the desired ranges. The ½ in. rotor was therefore utilized.

Various spacings of the parallel-wire helix were investigated, ranging from .080 in. to .250 in. Different pitches of winding were also tested. Of all combinations investigated, that of .125 in. spaced 4 turns/in. proved optimum.

In order to insure rigidity and at the same time provide a maximum of wire surface, rectangular grooves were chased in the rotor form .025 in. deep and .015 in. wide. These provide the necessary anchorage with a minimum of wire below the surface of the rotor rod. The rotor rod may be of polystyrene or Rexolite; the latter is more readily machined and slightly more heat resistant. Materials such as Plexiglas and Lucite were not utilized because of their higher losses as compared to polystyrene.

Several methods of making contact with the condenser slip rings were explored. The final design consists essentially of a rectangular "U," the bottom of which is firmly affixed to the shortened pins on the tube socket. This formed part rests flat against the socket surface. Fig. 3. This results in a short, low inductance path from the tube base to the slip rings. Heat treated and silver plated beryllium copper material provides adequate contact pressure on the rings diametrically opposite and on the center line of the rotor.

Band Switching

UHF operation is achieved by unbalancing the transmission line one full turn. This is accomplished by incorporating three contact fingers. See Fig. 2. The contact nearest the tube carries a rigid tab which bears on a polystyrene rod. This rod parallels the rotor and is located about ½ in. above and to its left as seen from the dial end of the rotor. Fig. 4. It is eccentrically pivoted so that when turned it lifts the forward contact away from the rotor and the two contacts remaining provide a short circuit at corresponding points on the rotor wires. This provides a balanced line. With the eccentric rod turned to permit contact of the finger on the wire, one conductor of the balanced transmission line is no

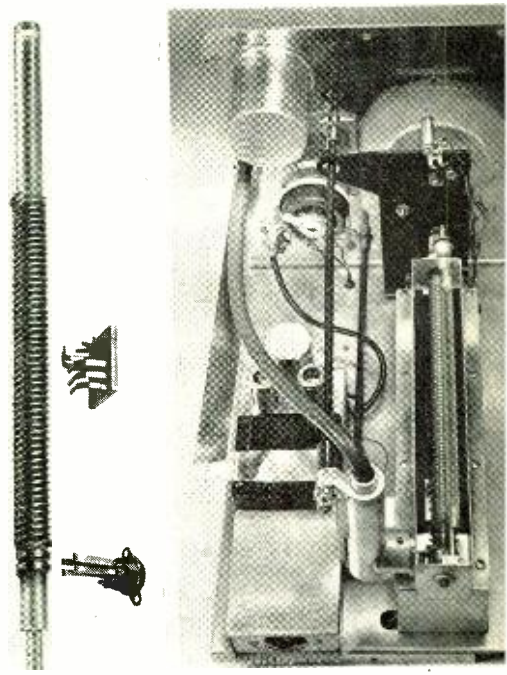


Fig. 3: (l) Rotor assembly. Fig. 4: (r) Interior view of wideband signal generator

longer than the other and the line is unbalanced. This causes oscillation to occur at UHF. With the line balanced, oscillations occur at VHF.

The rotor winding consists of two #16 gage silver-plated copper wires held in place by the grooves. Two inner rings ⅛ in. wide and spaced approximately ⅛ in. apart are pressed on the "neck" of the rotor. Two holes of proper size to allow for passage of the wire are drilled diagonally through the rotor so that one of the wires can be soldered to each of the rings and in such a way that the points of connection are diametrically opposite. The wires are then wound tightly and secured through two clearance holes at the shaft end of the rotor. A cylinder of teflon about .002 in. in thickness is then placed over the inner rings and the two outside rings carefully pushed on over the teflon so as to lie directly over the inner rings. This assembly thus provides two cylindrical condensers in both the plate and grid lines. These capacities are in the order of 20μμf. The rotor assembly is shown in Fig. 3.

The contact fingers are mounted on a brass plate which also carries a U-shaped fork, which engages with the "lead screw" provided by the helix of the rotor wire. Since these wires are tightly secured, more than adequate rigidity is provided for this method of driving the slider. In addition to the three fingers at the left of the slider, two additional fingers mounted opposite and one turned behind them are provided to insure a

Signal Generator (Continued)

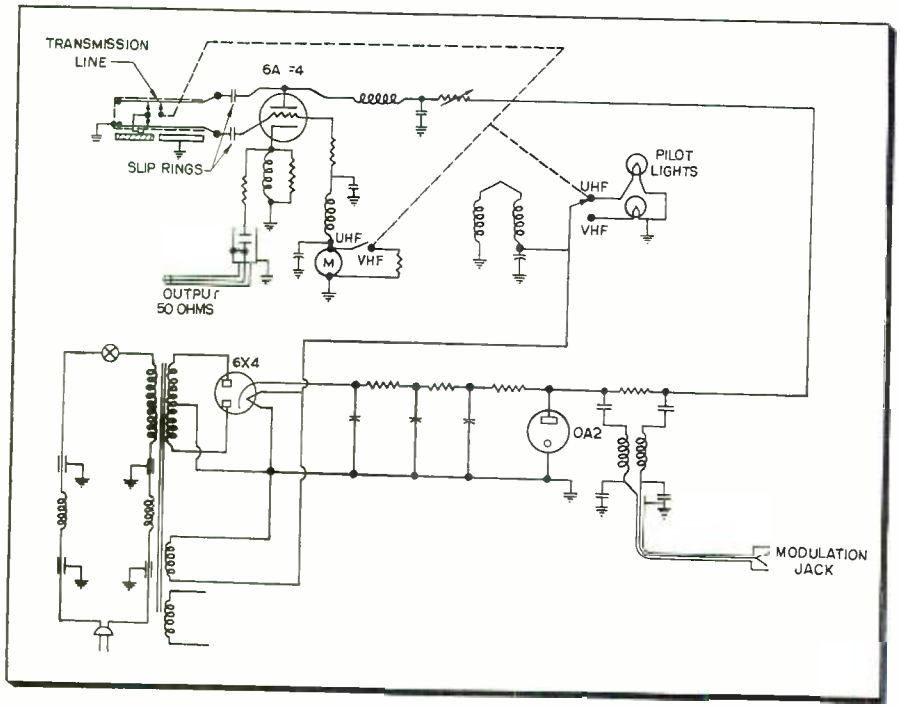


Fig. 5: Schematic diagram of the signal generator

positive R.F. short on the line. These "back-up" fingers are also mounted on the brass slider. See Fig. 3. The fingers are of beryllium copper, Alloy #125, heat treated after forming and silver plated. They are held in place on the slider by clamping strips. Individual fingers are used to provide better contact than can be obtained with two contacts formed from one piece.

As the rotor is turned, the driving fork propels the slider along the rotor, causing the point of short-circuit to change and therefore varying the frequency of oscillation. The unused portion of the line is left open-circuited. This is the condition arrived at for the frequency ranges covered by this development; shorting the end of the line or terminating it in a resistor of appropriate value will cause the mode shift to occur at different frequencies.

The early tests were made utilizing a metallic ground guide or "way" for the slider, but it was found that a non-metallic guide with a wide ground strip upon which the slider made contact served as well. Furthermore, changing the length of this ground strip provided an additional means of controlling the frequency at which the mode shift occurred.

Attenuator

The attenuator is of the capacitive disc wave guide below cutoff type. The output cable is terminated with a 68 ohm resistor at the end which carries the disc pickup. This disc is soldered to the inner conductor of the RG9 flexible cable which is supported within the sliding tube of the attenuator assembly. Affixed to the outer end of this tube is a collar carrying a rack with which a small pinion gear is held in mesh. This gear is rotated by a front-panel controlled shaft. This causes the rack to move in or out and varies the distance between the pickup disc at the inner end of the tube and a fixed disc located near the bottom of the attenuator assembly. This fixed disc is connected through an isolating resistor to the cathode of the oscillator and serves as a source of r-f energy to the attenuator. The plane of the fixed disc and the moving disc are parallel. The attenuation secured is proportional to the distance between the fixed or "propagating" disc and the movable disc. Approximately 40 db of attenuation is obtained for each linear distance of travel (equal to the tube diameter) by which the two discs are separated. The diameter of the pinion gear and the pitch of the rack are so related that one complete turn of the attenuator knob provides approximately 80 db attenuation. Further rotation of the knob is possible to provide a theoretical lower limit of 2 to 3 μvs, but this value varies with frequency. All attenuator parts are silver plated and positive contact between the fixed and movable tubes is provided by serrated rings. The attenuator is so adjusted that the output available is from 100,000 μvs to approximately 10 μvs. The meter indicates rectified grid current. A shunt is provided on the UHF/VHF transfer switch so that the meter current is kept within proper limits. This is necessary since in the VHF range the efficiency of oscillation is much higher than the UHF. The input to the attenuator is adjusted by varying the oscillator plate voltage. Calibration for a mid-scale "zone" is achieved by varying the position of the fixed attenuator disc with respect to the moving disc with the attenuator tube "full in." A more precise calibration may be obtained by plotting indicated grid ua vs. frequency with the attenuator set for 0.1 v input.

Leakage

Leakage from the instrument is in the order of 10 μvs rising to 20 μvs between 600 MC and 700 MC. A heavy ground strap is provided to minimize circulating currents. The power supply is filtered and shielding is provided to keep the r-f leakage out of the line cord.

The steel cabinet is copper plated inside and out; flanges at the top and sides provide good contact between the cabinet and front panel and a flexible contact strip at the bottom of the front panel insures good contact at that point.

The main tuning shaft, attenuator control shaft, transfer switch shaft and on-off switch are all actuated by non-metallic rods in order to further reduce leakage.

The dial apertures are not excessively "hot" but some leakage does appear there. The greatest difficulty experienced in reduction of leakage was with the external modulation input terminals. In the interest of convenience for the user, it was originally planned to use binding posts for this purpose but this arrangement proved impractical. A panel connector equipped with a hood and shielded cable was used instead. The chokes in the modulation input circuit are of bifilar construction.

Dial Drive

The frequency indicating dial is driven by a gear train having a 30 to 1 ratio. Anti-backlash gears are incorporated. Calibration can be read through either of two apertures, one for UHF (300-900 MC), the other for VHF (50-300 MC). Illumination of

(*Continued on page* 133)

Use of Microwave for Industrial Control

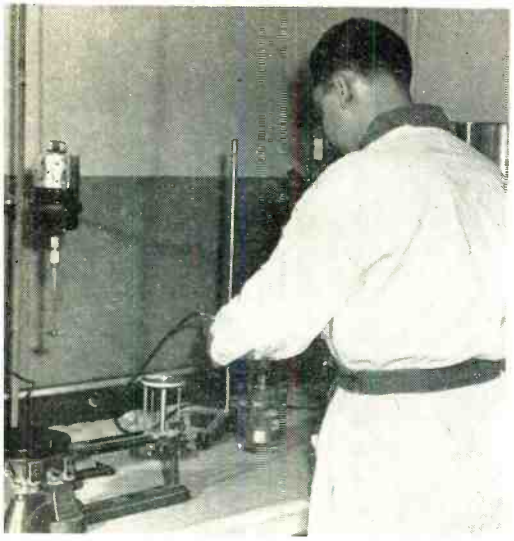
W. C. White, General Electric Research Laboratory, Schenectady, New York

BASIC PROPERTIES → / ↓ APPLICATION FACTORS	CONDUCTION AND TRANSMISSION OF MICROWAVE POWER	FORMATION OF A BEAM	BEAM INTERRUPTION	BEAM REFLECTION	BEAM POLARIZATION	FORMATION OF STANDING WAVES	DOPPLER EFFECT
GENERAL FEATURES and NUMERICAL VALUES	Can be transmitted over parallel wires or through coaxial cables or a wave guide with a minimum greatest diameter of about three inches.	The beam can be formed from a horn, parabolic reflector or lens structure. The larger the diameter of such structures the sharper the beam in terms of the angular width, therefore, impractical to obtain a small diameter narrow angle beam at this frequency.	The interrupting object must be an electrical conductor with the transmitter and receiver a few inches apart, each attached to a short length of wave quide. The object to be detected may be no larger than the size of a match box, but at greater distances between the two units, the object must be correspondingly larger. A wire screen of about two inch mesh spacing is quite transparent while one of one-quarter inch mesh spacing is quite opaque.	The reflecting surface must be an electrical conductor and have an area of several square inches at close range extending to several square feet at distances of a number of yards. A concave surface tends to focus the reflected waves whereas a convex surface scatters the waves.	A polarizing screen consists of a number of parallel rods or strips of conducting material. These strips should be about one inch apart and should be at least six inches long.	The movement of a reflecting surface by one-fourth wave length, about 1¼ inches, will change a received signal from a maximum to a minimum or vice versa. This is repeated over distances of many wave lengths. For such use, the receiving dipole must be in a position to pick up radiation from both the transmitter and the reflecting surface.	The frequency of a wave reflected from a moving conductor is lower if the object giving the reflection is receding from the transmitter, or higher if approaching it. At 2450 megacycles, a movement of five inches per second gives a frequency difference of two cycles per second in the transmitter circuit. This can be amplified and detected. The faster the motion, the higher the difference in frequency.
ADVANTAGES FOR USE OF MICROWAVES VERSUS LIGHT	Can be transmitted farther and more efficiently if many turns, corners or "windows" are involved.	The beam forming structure can be inside an enclosure to protect it from heat, fumes, dirt or water. The beam forming structure need not be smooth or polished ond a close spaced metal screen is in many cases satisfactory.	The object to be detected may be opaque to light such as cardboard, wood, plaster, brick ceramic or any nonconductor. A paper or cloth towel is "transparent" when dry and "opague" when wet. The human being as a whole as well as the head, leg, arm, or hand is opaque.	An insulating material with a high dielectric constant such as a plastic material can also reflect the waves even though it is transparent to those waves. This phenomenon is much the same as the fact that glass is transparent to light but also has a high reflecting surface. The reflecting surface may be uneven, rough, and dark.	The simplest ways of producing wave beams results in a polarized wave and the same is true of a microwave receiver. Thus, no extra items are needed to take advantage of polarization.	The wave length of light is so short that this effect is very difficult to utilize except under very special conditions.	In the case of light, the wave length is so short that the principle appears to have no industrial application.
LIMITATIONS or DISADVANTAGES RELATIVE TO LIGHT	Can not be transmitted through very small diameter holes or pipes.	For a given desired angular width or diameter of beam, the forming structure is much larger.	Due to the fact that a beam of light can be conveniently made very small in diameter, a small fraction of an inch, it can detect an object of about an inch, or smaller than for microwaves. In general, an application which is satisfactory with light beam interruption is lower in cost than for the use of microwaves.	The efficiency of reflection from flat highly conducting surfaces is very high, but unless the mirrors are made very large, only a small portion of the radiated power is reflected except at very short distances.	As in previous comparisons, o polarizing screen must be larger for microwaves than for light.	Although a change of position of the reflecting surface is easily detected, the direction of the change is not determinable except by very special arrangements. The amount of movement detected is of course expressed in terms of interception of wave fronts and not necessarily at distances traveled by the object.	If the reflecting object moves much less than five inches per second, there is increased difficulty in building a simple amplifier for these very low frequencies.
NATURE OF PROBABLE APPLICATIONS	Unlike a lamp, the source of radiation energy is separate from the radiator. The radiator and the conduction medium can be made of refractory metals or even graphite. Thus for use inside a furnace at a bright red heat, a simple wave guide of graphite or wires of a refractory metal can extend outside to both the source or receiver of the waves.	In the case of light, the source and the beam forming equipment must be an integral part. In the case of microwaves, the two are separated and therefore under adverse operating conditions such as heat, smoke, corrosive fumes and rain, the source of microwave power can be some distance from the beam forming structure.	The fact that nonconducting solids like wood, brick, plaster, and plastics are transparent allows moving conducting objects to be detected inside an enclosure or passageway with both units of equipment on the outside. This applies, of course, to a person walking down a hallway.	Large irregular shaped metallic objects such as an automobile, can serve as reflectors over a considerable distance. As indicated above, it is easy to detect a concave from a convex reflecting surface. Radar, of course, is the best example of the great usefulness of the reflection phenomenon.	A polarizing screen is a good reflector in one direction and a very poor reflector when turned 90°. Therefore, as an example, objects might be labeled with pieces of paper on which parallel conducting strips are formed and this could be used to sort out such devices into two classes.	It is easy to detect slight changes of position of slow motion of conducting or metallic objects. In like manner, movement of the receiver or transmitter can be detected. By means of a conductor, the distance traveled by such motion can be expressed in terms of quarter wave lengths for indication or recording.	This principle has been applied in the so-called electric "cop" for determining the speed of automobiles. Also can be applied to detect or measure the speed of moving objects that are electrical conductors. It is useful up to about 100 yards with small simple equipment. By this principle, an automobile traveling at right angles to a beam will also be detected due to the varying contour of the sides of the car. The speed, however, is not determinable.

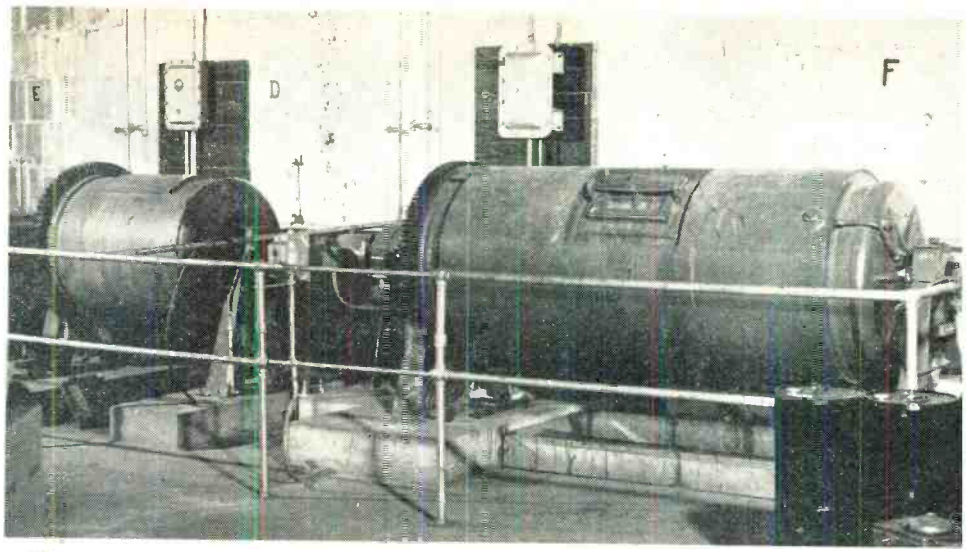
ALTHOUGH for removed in the spectrum of electromagnetic radiations from light, microwaves, both exhibit the fundamental properties of radiation, reflection, polarization, standing waves, Doppler Effect and conduction.

However, their vast difference in frequency (wave length) causes great differences in many aspects of these properties. It is convenient, therefore, to make a comparison between light and microwaves.

For the tabulation above, the microwave frequency is 2450 mc (about a five inch wave length). This is a frequency designated by the FCC for experimental and industrial use and is easily obtainable from triodes of reasonable cost and satisfactory life for the necessary power outputs, a few tenths of a watt or even less.



1 TESTING: Sample of coating ingredient is tested for magnetic and chemical properties at Technical Tape before batch is used in production of "Encore" recording tape



2 MILLING: Revolving drums at Reeves Soundcraft contain many steel balls. Iron oxide powder is mixed with liquid binder. Action of steel balls makes particles uniformly wet and lump free. After day or two, suspension is filtered and pumped into storage tank

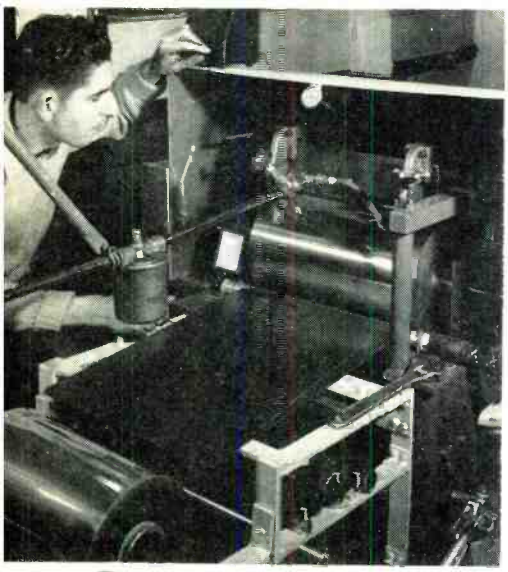
Manufacturing

Seldom revealed details of production manufacturers of recording tape to supply

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

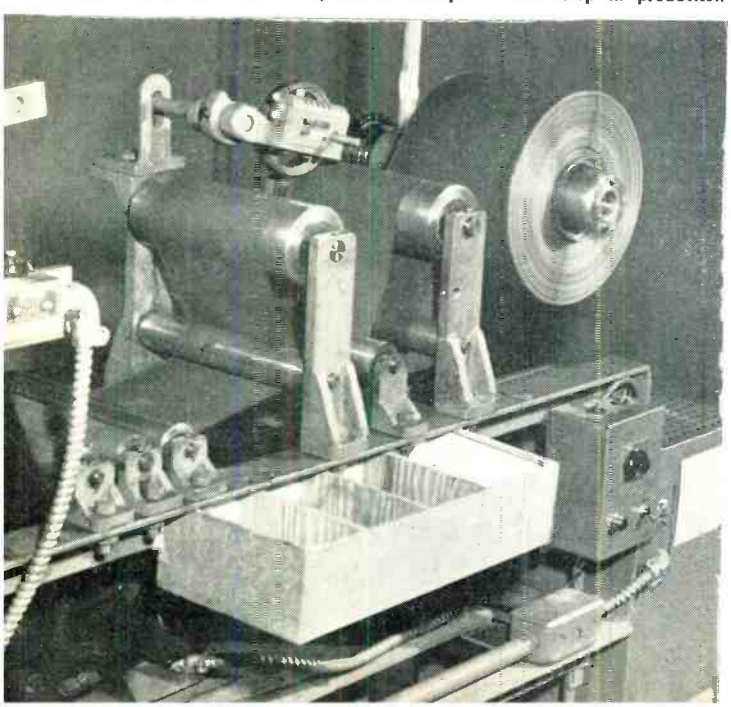
MAGNETIC tape recording is one of the fastest growing facets of the electronic industries. Just five years ago it was of minor importance, but during 1954 the industry expects to sell 450,000 tape recorders and about $10 million of tape. With the growing use of tape in audio, computing and telemetering, and with video recording expected in less than two years, prospects are for the sale of magnetic tape to rise—possibly to the phenomenal figure of $100 million annually in five years.

Today there are about 90 recorder manufacturers, and each of them has a good picture of how the next one makes his units. In sharp contrast, there are only five prime tape producers (although much tape is made under the label of other companies), and each jealously guards the secrets of his production techniques. "Outsiders" are generally not admitted to tape plants, and the few that are must be screened to make

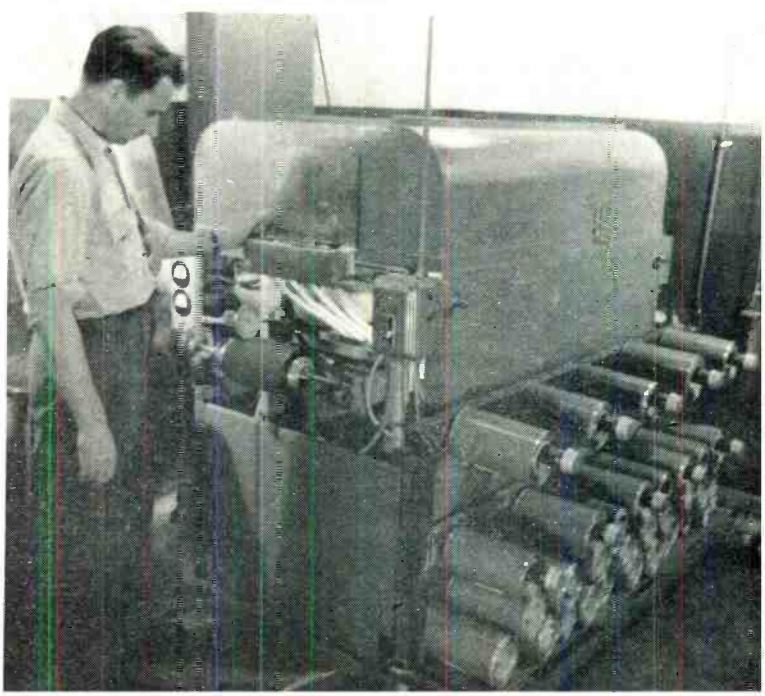


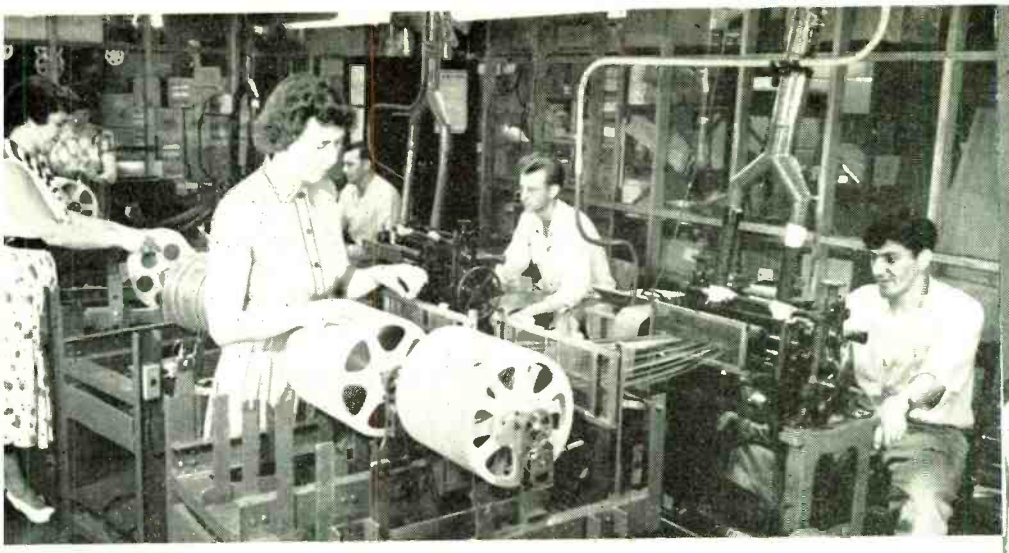
3 COATING: Acetate base for "Irish" is prepared at Orradio. Oxide suspension from agitated storage tank is pumped to coating head which deposits layer on moving base. Wide roll of wet tape is then passed into drying chamber

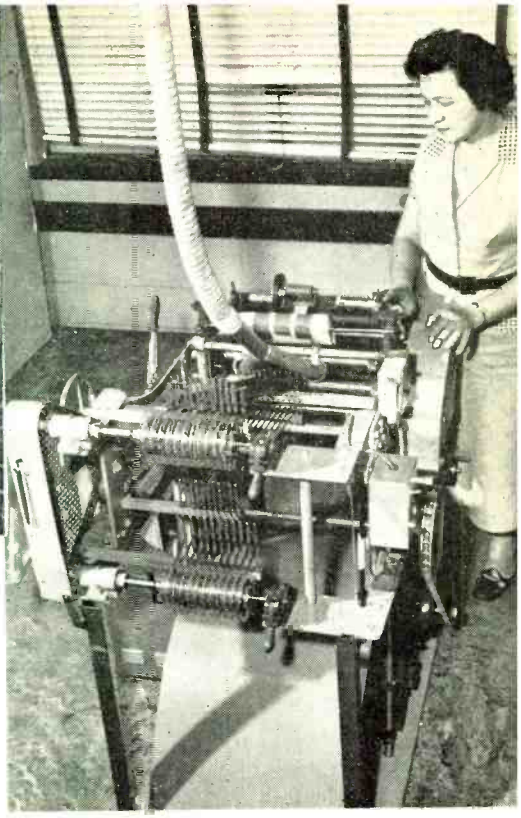
4 DRYING: After tape has snaked its way over rollers for several hundred feet in heated drying chamber, oxide coating is firmly bonded to base and may be rolled up for next step in production



5 POLISHING: "Soundcraft" tape in the making at Reeves is "micro-polished" by dry lubricant, rotating brushes and self-rub to produce extremely smooth surface on tape







6 SLITTING: (above) Wide roll of "Soundcraft" tape is fed into slitting machine where revolving blades slit strips ¼-in. wide. Strips fan out to take-up reels. (r) Close-up of slitter at Technical Tape. Vertical vacuum tube sucks up tape trim edges

Magnetic Tape

processes employed by the few prime fast growing home and commercial market.

sure confidential processes are not revealed.

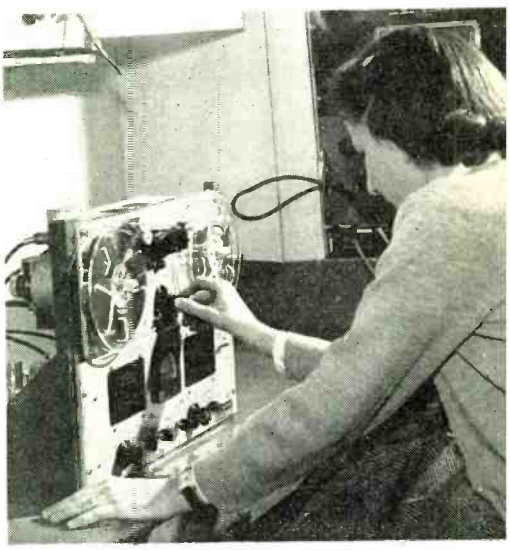
Perhaps the main reason for this competitively secretive attitude is the fact that the trick in making good tape is the product of extensive practical experience, and the details of such know-how does not fully reveal itself in analysis of the tape. Interestingly enough, personal examination of several tape plants reveals that the production processes are similar, if not identical, in many respects.

The following description of how magnetic tape is made is a composite of the operations of several companies and does not imply that all firms use all of the processes exactly as noted. By not identifying specific companies with variations in the steps to be described, and by generalizing on a few small points—points of interest only to the tape manufacturers—otherwise secret information may be revealed.

Milling

First the iron oxide pigment, which has been batch tested for chemical and magnetic properties, is placed in a revolving milling machine consisting of a heavy metal drum containing a large number of steel balls. This operation separates the pigment particles to make them

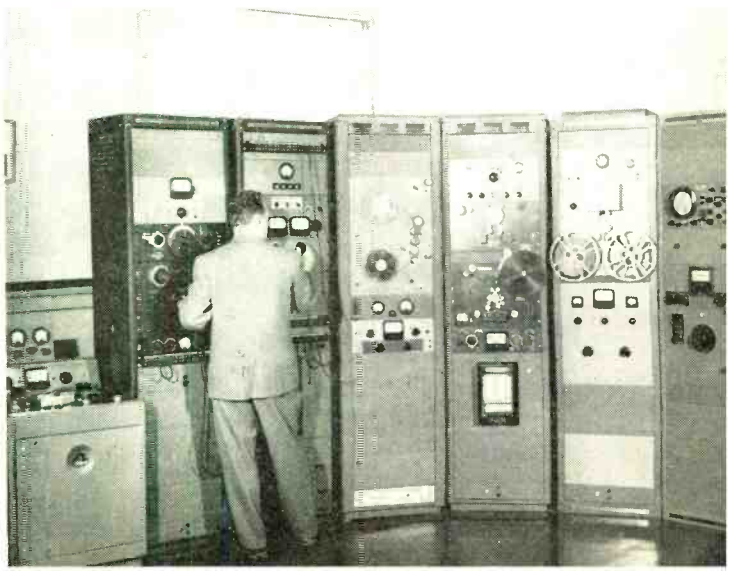
(*Continued on page* 120)



7 PERFORMANCE TEST: Sample reels of tape are given final check for frequency response and amplitude variation at Orradio

8 INSPECTION: "Encore" tape receives final physical inspection and cleaning prior to packaging. In some firms large magnets bulk erase any test signal remaining on sample reels

9 QUALITY CONTROL: All important manufacturing stages are closely monitored. Here custom-made quality control and test equipment at Audio Devices checks uniformity of "Audiotape"



An Automatic Antenna Pattern

Closed-loop microwave unit records ratio between two power levels as function of third independent variable. Pattern measurements reproducible to within 0.2 db.

THIS paper describes one type of pattern recorder in which the whole recording equipment is placed within a servomechanism loop. By this technique, very high measurement accuracies have been achieved. Measurements of radiation pattern at specific angles have shown the static recording to be almost completely independent of dc power supply voltage from 0 to rated value. This, of course, is a consequence of the overall serve loop which makes the instrument very insensitive to changes in the electronic circuits of both the receiver and transmitter.

Fig. 1. shows the "Recorder" *block diagram.* (The dash lines on the picture are mechanical linkages, the double lines are waveguide, the single lines are electrical connections.) A monitor channel samples a portion of the oscillator power. The remainder is radiated by the transmitter antenna to the receiver, or test antenna which operates directly into a precision microwave attenuator. The rectified attenuator output is the servo feedback signal. It is compared to the reference level of about one microvolt from the monitor. The difference between these two audio voltages is the error signal which drives the first electronic amplifier. The amplifier output energizes the servo motor, which in turn, drives the attenuator to maintain a zero error. A cosine arm moves the recorder pen in exact step with the db. signal level received through the pattern of the test antenna.

By
LAWRENCE LECHTRECK
Emerson Electric Manufacturing Co.
8100 Florissant Ave.
St. Louis 12, Mo.

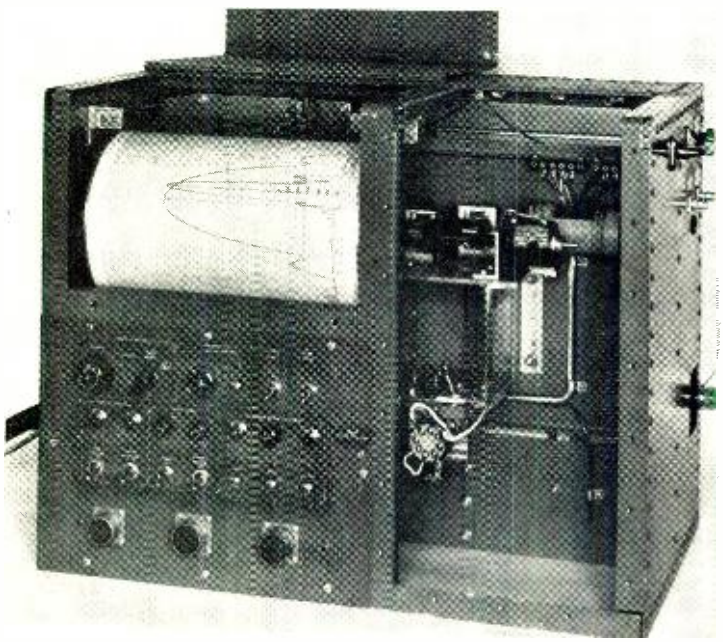
Minimum Error

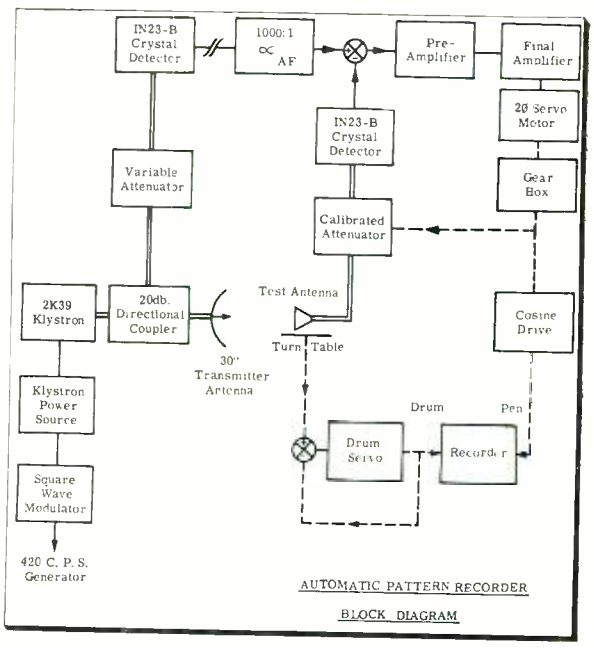
Since the servo maintains a minimum error, both the monitor and signal crystals are operated at a constant power level throughout the pattern measurement. The recording accuracy is, therefore, independent of the crystal law and is determined only by the accuracy of the precision attenuator.

In order to utilize a simple ac amplifier and 2 phase servo motor, a 400 cycle carrier is generated through the square wave modulation of the klystron at the power line frequency. The voltages in the monitor, signal, and error channels are 400 cycle square waves synchronized with the power line; the fixed windings of the servo motor are connected to the same line and provide sense information to this motor.

The error amplifier is a sharply tuned, low noise, high gain unit. Its gain is in the order of 160 db; the noise level has been found to be a few 1/100's of one microvolt. A twin "T" band rejection filter is used to restrict the receiver bandwidth to the minimum that will provide a stable, fast servo response. A high receiver sensitivity has made it possible to use klystron tubes for the measurement of a very wide variety of antennas. For example, one X band pattern range was used to measure radiation patterns of antennas ranging in size from about one inch to three feet in diameter. A 15 in. antenna was measured over a 45 db. range of microwave pattern

Fig. 1: (r) Block diagram of system (l) Photo of recorder





Recorder

amplitude, which is the limit of our precision attenuator.

The error measurer is merely the push-pull windings of a carefully shielded transformer at the input of the error amplifier.

Monitor Channel

The monitor channel serves two purposes. First, it is the reference level to which the received signals are attenuated in pattern measurement. And, secondly, it compensates for fluctuations in the power of the microwave source. A change in klystron output produces a like change in both signal and monitor voltages and hence, the error remains zero, and is insensitive to fluctuations in this transmitter power.

The power received by the test antenna is fed into a metalized glass attenuator terminated in a matched crystal. The microwave power incident on the signal crystal is kept constant and equal to the power incident on the monitor crystal throughout the pattern measurement. The attenuation inserted in the signal channel by the servo is, therefore, an exact measure of the radiation pattern of the antenna. The law of the attenuator is very closely a log cosine function of the distance of insertion of the resistive element. A modified cosine linkage will, therefore, furnish db. pattern information to the recording pen.

The presentation of the antenna pattern information has generally followed the form suggested by O.A, Tyson in his Radiation Lab. Report. In order to accurately measure low amplitude wide angle radiation, he has suggested a rectangular plot of radiation angle vs. logarithmic pattern amplitude. This is the system we have used. The recorder pen is directly coupled to a cosine linkage and the microwave attenuator. The pen and attenuator are driven by the servo motor to a zero error which occurs when the pen indicates the correct pattern amplitude.

The recorder drum is connected to a second servo which keeps the recording paper in step with the platform. The test antenna is secured to the platform and this assembly rotates at a constant speed. 40° per minute has been found to be a suitable rate. Two angular scale factors permit the measurement of patterns over any two angular ranges—say a total of 360° and 30°.

Fig. 2 shows the *equations* for some of the parts we have been talking about. It will be shown that, despite the nonlinearity of the crystals, the attenuator, and the cosine arm; the input to output relationship is exactly linear and furthermore that the loop gain is constant for all values of input power. Consider the complete recorder as a servo. The loop gain and time lag must be constant for all input levels so that the servomechanism will have a uniform response and stability. The input and output must be linear so that there is an exact relationship between the recording and the true antenna pattern. That these requirements on loop gain, time constant, and system linearity are met can be shown by simple manipulations of the transfer functions of each element.

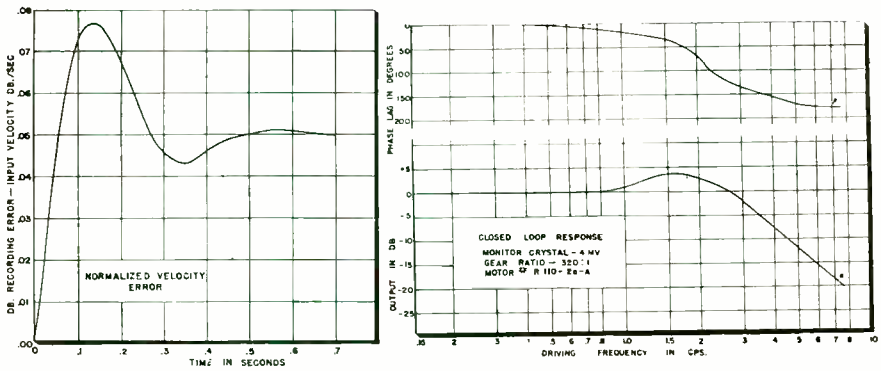


Fig. 5: (l) Recorder velocity error vs time. Fig. 6: (r) Bode plot of recorder response

Attenuator: $10 \log \frac{P_{in}}{P_{out}} = \alpha L = A(1-\cos\frac{\theta}{n})$

Signal Detector: $E = K P_{out}$

Mixer: $e = -k_m + E$

Amplifier: $e_m = k_a e$

Motor: $\frac{S\theta}{e_m} \quad \frac{K_m}{1+TS}$

Cosine Drive: $x = A_1\left(1-\cos\frac{\theta}{n}\right)$

Fig. 2: Recorder equations

System: $\Delta x = 10\,\Delta(\log P_{in}) = \frac{4.34}{k_m}\,\frac{S(1+ST)}{K_a K_m}\,\Delta\theta$

or Output = (Input) $-K_2 S(1+TS)$ (Output)

and Error = $K_2(1+TS)S$ (Output)

$\frac{\text{Output}}{\text{Input}} = \frac{M^{-1}}{M^{-1} + S(1+TS)}$

where $M^{-1} = 20$ = Voltage gain

$T = .079$ = Time constant

Fig. 3: Combining equations in Fig. 2

Velocity Response:

let $10\,\Delta \log P_{in} = vt$

and $\frac{\delta}{\delta t}\,\Delta x = v$

then $\frac{\text{error}}{v} = \frac{12.6 + S}{S(S^2 + 12.6S + 252)}$

and $\frac{\text{error}}{v} = .05 + .068\,\epsilon^{-6.3t}\sin(14.6t - \phi)$

Fig. 4: Equations for velocity error

Symbols

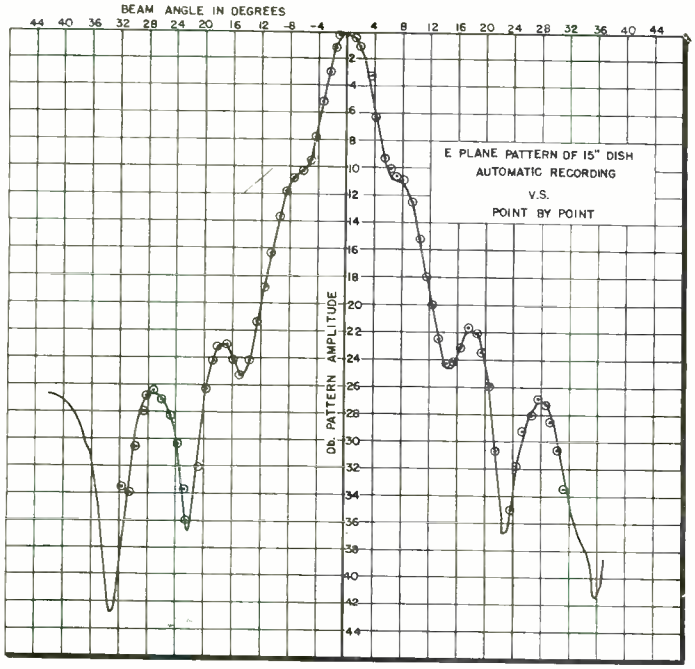
P_{in}, P_{out} are input and output power levels at the precision attenuator
θ is rotation of attenuator shaft
A, n are constants of attenuation curve
K is sensitivity of the detector in μ volts/μ watt.
k_m is the monitor voltage level
k_a is the voltage gain of the amplifiers
E is the signal crystal voltage output
e is the amplifier input or error voltage
e_m is the voltage applied to the error winding on the servo motor
θ is the rotation of the attenuator shaft
K_m is the motor and gear velocity per unit voltage
T is the time constant of the motor and load

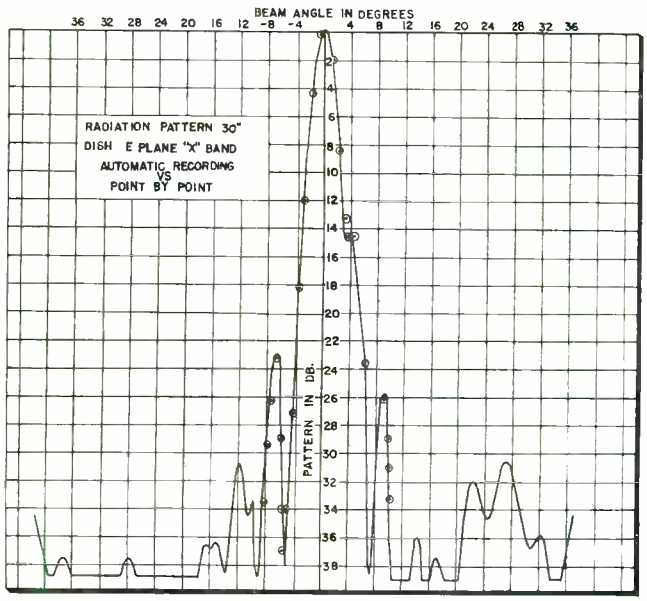
These equations are combined in Fig. 3.

Here $\delta\chi$, the output or pen displacement, is seen to be equal to the logarithmic input power less an error proportional to the rate of change of this logarithmic pattern amplitude. The recorder equation is, therefore, of the same form as the conventional velocity servomechanism. The loop voltage gain is about 20; the time constant is roughly 80 milliseconds.

The feedback elements of the servo are the precision attenuator and its crystal detector. Since the crystal is operated at a constant power level, its rectification sensitivity is constant over the time required to measure one pattern—say 2 minutes. The precision attenuator is guaranteed to have an accuracy in the order of 1/5 of 1 db. For slow speed inputs to a servo, the instrument transfer function is essentially equal to its feedback gain. The feedback gain of this instrument is seen to be a constant; that is the gain is not a function of line voltage, amplifier gain, or other parameters which one might expect to vary during the measurement of an antenna pattern. The static error is, therefore, reduced to the contribution of mechanical friction and has no component arising from the electronic amplifier.

For an exponentially increasing radiation intensity, the recording error should be proportional to the





Figs. 7 & 8: Comparison of point by point and automatically recorded patterns

Pattern Recorder (Continued)

product of the antenna speed of rotation and the slope of the radiation pattern, in db. per degree. This product is the rate of change of the servo input in db. per second.

Fig. 4 gives the equations for this velocity error. The antenna pattern was assumed to consist of a flat region followed by a ramp pattern increase with time. This corresponds approximately to an element of antenna pattern driven in azimuth at a uniform angular velocity.

The term on the left side of the first equation is the servo input signal which is assumed to be the product of a constant "v" and "t", the time after the initiation of the pattern ramp element. For this type of antenna pattern element, the recording error per unit velocity is seen to be the sum of a constant plus an exponentially damped sine wave. The constant (.05) is the reciprocal of the loop gain and the damping factor, 6.3, is the reciprocal of twice the servo time constant.

Velocity Error

Fig. 5 shows a graph of the recorder velocity error as a function of time after the start of the ramp. The recording error never exceeds 1/14 of the driving velocity in db./second. For common antenna sizes and platform speeds, this source of error is well below ¼ of one db. The static error is ideally zero; in practice, gear backlash and static friction produce errors in the order of ¼ db. Measurements were made of the system response to a large amplitude step function. The saturation velocity was 25 db./second with a ⅛ of one db. overshoot.

Fig. 6 is a conventional Bode plot of the recorder response. The half power point is near 3 cycles per second.

Figs. 7 and 8 give a *comparison* of point by point and automatically recorded patterns. The same reference element was used in both cases so as to eliminate the error caused by the calibration of the precision attenuator. This figure shows the superposition of the two sets of measurements of a 15 in. antenna. The circles are point by point measurements and the solid curve the automatic recording: (Db. axis vs. Beam Angle)

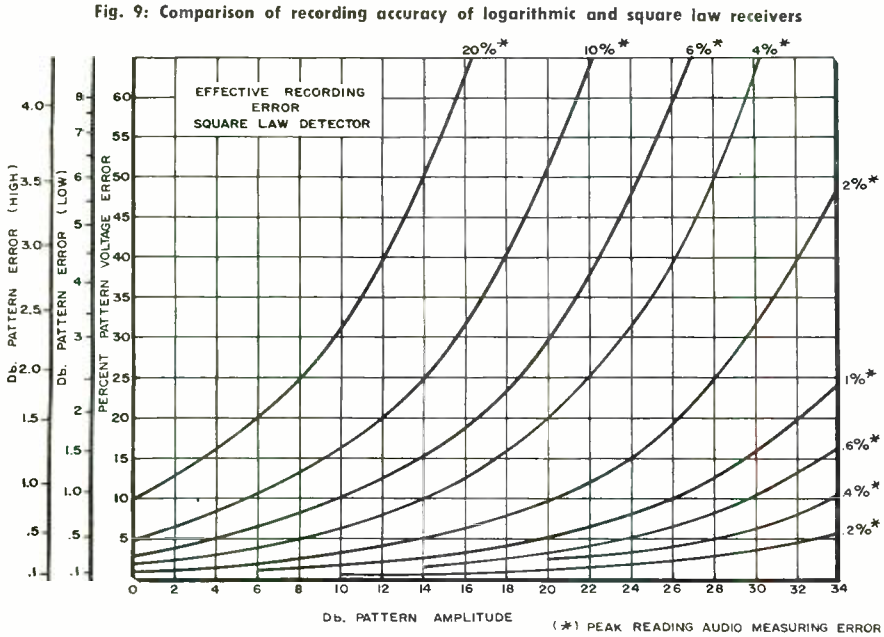
The conventional use of antenna recordings is in the comparison of beam peak. This is why the two patterns were normalized at the zero beam angle point. The pattern errors appear to be largest at the start and finish of steep pattern slopes.

This lag in the servo response generally produces maximum errors at the side lobe peaks and troughs of the side lobes. In these plots the maximum total error was in the order of ⅛ of 1 db.

Fig. 8 shows the same type of data taken on a 30″ antenna. Both of these samples were parabolic reflec-

(*Continued on page* 135)

Fig. 9: Comparison of recording accuracy of logarithmic and square law receivers



Rotary Joints for Microwaves

Development of production type unit provides data of general interest for broadband, high speed, and high power waveguide joints. Theory and practice of broadband matching with quarterwave capacitive transformers illustrated

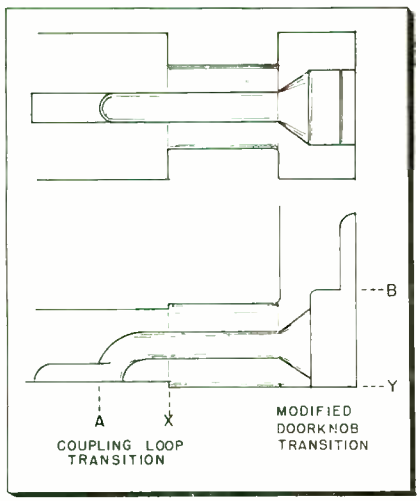


Fig. 1: Prototype 90° waveguide rotary joint

By JOHN GUERRAERA and JEROME FISCH
Reeves Instrument Corp.
215 East 91 Street
New York City

IN order to construct a rotary joint in waveguide transmission line, it is necessary to transform the waveguide mode into a mode possessing circular symmetry. The coaxial TEM mode is most often used because of the compactness that its use affords. For this reason, a considerable number of transitions from waveguide to coaxial line have been developed and studied. Designs for broadband matching exist for many of them.

One of the simplest waveguide to coaxial transitions is the magnetic coupling loop. This appears ideal mechanically for use in rotary joints because of its rigid and simple construction, and because it is the only known type that permits the waveguide to rotate about its own center line. Because of these essential mechanical properties, it was decided to investigate methods for broadband matching of the magnetic loop.

Coupling Loop

The coupling loop transition is relatively insensitive to frequency, due to its lack of any obviously resonant dimensions. While this is in itself an encouraging feature, there are very few significant variables that can be used for matching. It was soon found, for example, that any variation between the coaxial inner conductor diameter and the loop stock diameter merely aggravated the mismatch of the loop. The next approach consisted of systematically varying the length of the loop (distance XA in Fig. 1) in order to find an impedance characteristic suitable for matching with a lumped reactance, such as an inductive iris. By this procedure, a position of A was found in which the impedance seen at A was mainly resistive and nearly constant over a bandwidth of nearly 30%. The impedance at A in this range was approximately:

$$\frac{Z_A}{Z_0} = 0.57 + j0.8 \left(\frac{F}{F_0} - \frac{F_0}{F}\right)$$

This impedance vs. frequency function was ideal for matching with a quarter wavelength transformer for two reasons. Firstly, the nearly constant magnitude and phase is suitable for matching by a transformer, and secondly, the reactance term of the loop impedance is of the proper sign to be cancelled by the off-resonance reactance of the transformer. By adding a capacitive step before the loop to serve as a quarter-wavelength transformer, the VSWR curve of Fig. 2 was obtained. The rounded corner of the step was used mainly to prevent voltage breakdown, and had little to do with the matching.

Matching of "Doorknob" Transition

The results of the loop matching served to demonstrate the accuracy with which the waveguide capacitive step represents a quarter-wavelength transformer. Although its electrical parameters have not been precisely calculated, it appears to be capable of general use as a broadband matching device similar to the inductive iris. If properly proportioned, the capacitive step has sufficient power handling capacity for use in high power rotary joints. The general applicability of the capacitive step transformer is demonstrated by its successful use in matching another waveguide to coaxial transi-

(*Continued on page* 134)

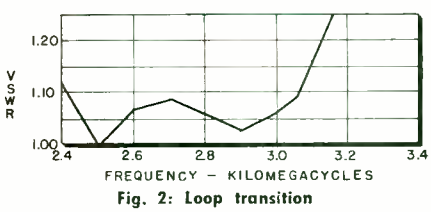


Fig. 2: Loop transition

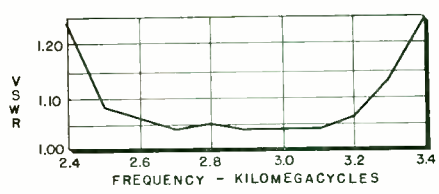


Fig. 3: Doorknob transition VSWR

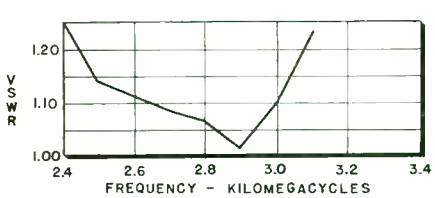


Fig. 4: S band 90° Rotary joint VSWR

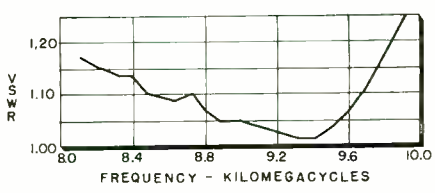


Fig. 5: X band 90° rotary joint VSWR

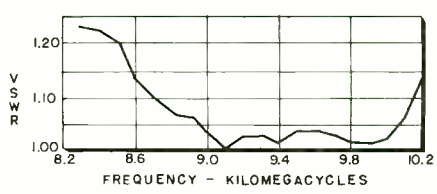


Fig. 6: X band 180° doorknob rotary joint VSWR

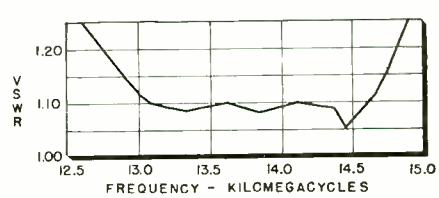


Fig. 7: Ku band 180° doorknob rotary joint VSWR

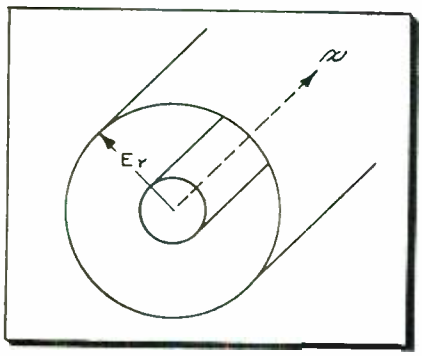


Fig. 1: Computing the potential of a co-ax line

Calculating the

The characteristic impedance of lines fully or partially loaded with various dielectrics can be determined from the known constants of the separate layers

By E. B. HERMAN
Engineering Products Dept.
RCA Victor Div., R.C.A.
Moorestown, N. J.

AT times it is of considerable value to be able to calculate the characteristic impedance of a coaxial line having several different dielectrics in the space between the inner and outer conductors. If the dielectric constant of each layer is known, the characteristic impedance of the coaxial line may be determined. In addition, it may be desirable to reverse the process and determine how much dielectric is required to change the characteristic impedance of a coaxial line to a predetermined value. A method will be presented which will enable the solution of both problems.

Impedance of Co-ax Line

The characteristic impedance of an infinitely long uniform transmission line has been defined as the ratio of the applied voltage to the resulting current, when both the voltage and the current are periodic functions of time.[1] Thus, on a voltage current basis, characteristic impedance may be given as

$$Z_o = \frac{V}{I} \qquad (1)$$

Also, characteristic impedance may be defined on a power basis by

$$Z_o = \frac{P}{(I_{rms})^2} \qquad (2)$$

Where P is obtained by integrating Poynting's vector over the cross section of the transmission line.

Since it is relatively easy to calculate the potential of a coaxial line, the first concept of characteristic impedance will be considered in this paper. The potential of a coaxial line may be calculated by taking the line integral of the electric field (E_r) along the radius vector. (See Fig. 1.) Thus

$$V = \int_a^b \vec{E}_r \cdot d\vec{r} \qquad (3)$$

In Sarbacher & Edson (ref. 3) $\vec{E}_r$ is derived for a coaxial line from Maxwell's Field Equations and is shown to be

$$\vec{E}_r = \frac{I}{2\pi r}\sqrt{\frac{\mu_m \mu_o}{k_e \epsilon_o}}\, e^{j(\omega T - \beta x)} \qquad (4)$$

where the units used are rationalized practical units with

I = maximum longitudinal current carried by the center conductor expressed in amperes.
μ_m = the permeability as given in standard tables.
$\mu_o = 4 \times 10^{-7}$ henry/meter in rationalized practical system.
k_e = the dielectric constant as given in standard tables.
$\epsilon_o = 1/36 \times 10^{-9}$ farad/meter in rationalized practical system.
r = distance along radius of coaxial line in meters (see Fig. 1).
x = distance along axis of coaxial line in meters (see Fig. 1).
ω = angular frequency in radians per second.
t = time in seconds.
β = phase constant of transmission line in radians/meter.

Since $Ie^{j(\omega t - \beta x)}$ represents the current associated with a traveling wave, it is possible to consider only the amplitude of the current in the computation of Z_o. Thus

$$I = |Ie^{j(\omega t - \beta x)}| \qquad (5)$$

Then the amplitude of $\vec{E}_r$ would be

$$|\vec{E}_r| = E_r = \frac{I}{2\pi r}\sqrt{\frac{\mu_m \mu_o}{k_e \epsilon_o}} \qquad (6)$$

for μ_m & k_e constant in the region $a \le r \le b$.

Substituting Eq. 6 in Eq. 3 gives the expression

$$V = \int_a^b E_r\, dr = \frac{I}{2\pi}\sqrt{\frac{\mu_m \mu_o}{k_e \epsilon_o}} \int_a^b \frac{dr}{r} \qquad (7)$$

which when integrated becomes

$$V = \frac{I}{2\pi}\sqrt{\frac{\mu_m \mu_o}{k_e \epsilon_o}}\, \ln \frac{b}{a} \qquad (8)$$

where ln implies logarithm to the base e. Substituting Eq. 8 back in Eq. 1 shows

$$Z_o = \frac{V}{I} = \frac{I}{2\pi}\sqrt{\frac{\mu_m \mu_o}{k_e \epsilon_o}}\, \ln \frac{b}{a} \qquad (9)$$

Converting μ_o and ϵ_o to their numerical values Eq. 9 becomes

$$Z_o = 60\sqrt{\frac{\mu_m}{k_e}}\, \ln \frac{b}{a} \qquad (10)$$

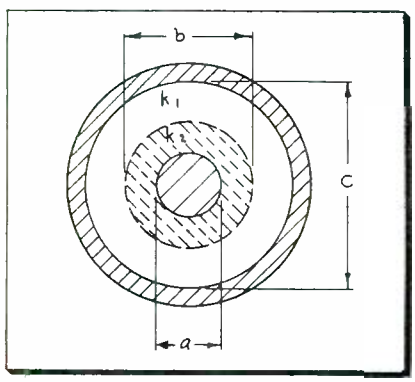
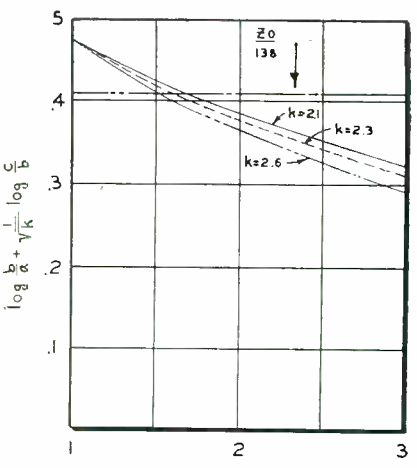


Fig. 2: Dielectric a function of radius

Fig. 3: Eq. 17 solved for three values of k_2



Impedance of Co-Axial Lines

or when converted to logarithm to the base 10 Z_o becomes the more familiar

$$Z_o = 138 \sqrt{\frac{\mu_m}{k_\epsilon}} \log \frac{b}{a} \qquad (11)$$

where b = radius of inside of outer conductor in any unit and a = radius of outside of inner conductor in same units as b (see Fig. 1). Eq. 11 is the form for the characteristic impedance of a coaxial transmission line having uniform dielectric that is found in most handbooks.

If, however, the dielectric is not constant in the region

$$a \leq r \leq b$$

of a coaxial transmission line but were to vary as a function of radius

$$[\text{i.e. } K_\epsilon = k_\epsilon (r)]$$

such that

$k_\epsilon = K_1$ for $a \leq r \leq b$ and $k_\epsilon = K_2$ for $b \leq r \leq c$. See Fig. 2 for the new configuration.

Eq. 7 would then change to

$$V = \frac{I}{2\pi} \sqrt{\frac{\mu_m \mu_o}{\epsilon_o}} \left[\int_a^b \frac{dr}{\sqrt{K_1}} \cdot \frac{1}{r} + \int_b^c \frac{dr}{\sqrt{K_2}} \cdot \frac{1}{r} \right] \qquad (12)$$

or when integrated

$$V = \frac{I}{2\pi} \sqrt{\frac{\mu_m \mu_o}{\epsilon_o}} \left[\frac{1}{\sqrt{K_1}} \log \frac{b}{a} + \frac{1}{\sqrt{K_2}} \log \frac{c}{b} \right] \qquad (13)$$

which when sub. in 1 becomes

$$Z_o = \frac{1}{2\pi} \sqrt{\frac{\mu_m \mu_o}{\epsilon_o}} \left[\frac{1}{\sqrt{K_1}} \ln \frac{b}{a} + \frac{1}{\sqrt{K_2}} \ln \frac{b}{c} \right] \qquad (14)$$

which can be placed in the same form as Eq. 11 by substituting for μ_o, ϵ_o and changing to logarithms to the base 10, then

$$Z_o = 138 \sqrt{\mu_m} \left[\frac{1}{\sqrt{K_1}} \log \frac{b}{a} + \frac{1}{\sqrt{K_2}} \log \frac{c}{b} \right] \qquad (15)$$

Or in a more general way suppose there were "n" different dielectric layers between the inner and outer conductors, then

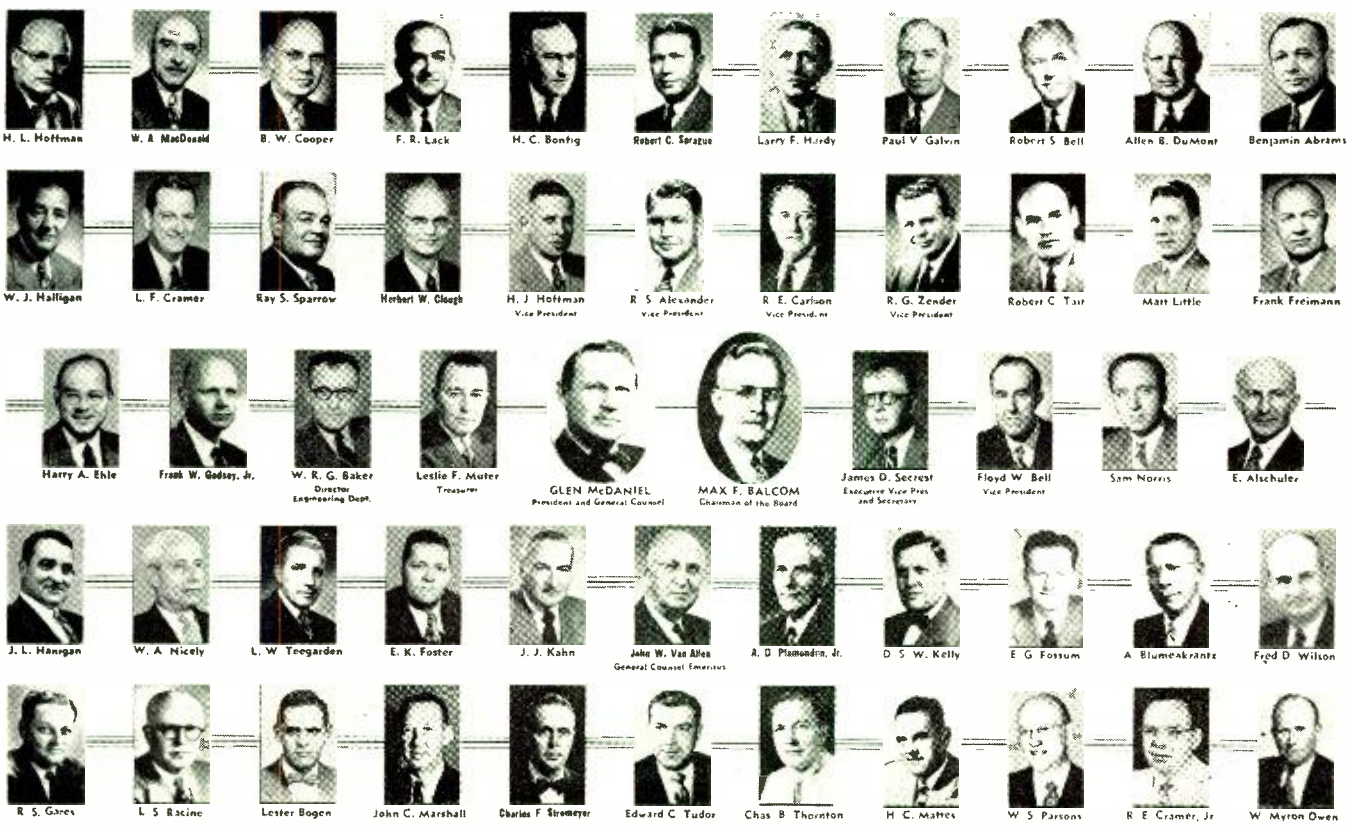
$$Z_o = 138 \sqrt{\mu_m} \left[\frac{1}{\sqrt{K_1}} \log \frac{r_1}{r_o} + \frac{1}{\sqrt{K_2}} \log \frac{r_2}{r_1} + \ldots + \frac{1}{\sqrt{K_n}} \log \frac{r_n}{r_n - 1} \right] \qquad (16)$$

where all the units are practical units.

From Eq. 16; then, we can calculate the characteristic impedance of

(*Continued on page* 136)

THIRTY-FIRST BOARD *of* DIRECTORS *and* OFFICERS RETMA 1954-55



Remote Control System for

Audio frequency signalling and telemetering system, suitable for use on common-carrier lines, meets FCC requirements for remote operation of small transmitters

By S. H. VAN WAMBECK, Ch. Engr.
Hammarlund Mfg. Co., Inc.
460 W. 34th St., N.Y. 1

EARLY in 1953 the FCC, because of the shortage of station engineers, and as a measure of assistance to some small stations, authorized the remote control of broadcast transmitters of 10 kw and less, having non-directional radiation. A discussion of the principles involved and the equipment available for such control should be of value.

To meet the minimum requirements under the FCC ruling, the control system must provide for the following:

a. turning the filaments On-Off

b. turning the main plate supply On-Off

c. adjusting the plate voltage to the final amplifier

d. de-energizing the transmitter in the event that normal control is lost

e. metering of plate voltage and current on the final amplifier

f. metering the antenna current

g. monitoring of frequency and modulation level.

It is also necessary that the remote operator be able to determine the condition of the beacon and obstruction lamps at the transmitter whether by metering or by alarm.

Simultaneous metering of the various quantities is not stipulated but means must be provided for making any required readings when necessary. The remote control must not interfere with local operation of the transmitter in an emergency. From a business viewpoint, station owners are generally interested in equipment which is constructed to transmitter standards and is comparable in quality and appearance to the transmitter and studio equipment with which it will be used. (See Figs. 2 and 3.) Station appearance should not be degraded and plant investment must be protected.

The foregoing sets out the minimum functional requirements but does not cover the expanded facilities necessary to meet many local situations or to provide additional protection to valuable transmitter equipment. A brief summary will serve to identify many other items which are frequently desired in the control system.

1) Metering of station supply voltage.

2) Raise-lower control of filament voltage.

3) Raise-lower control of additional plate voltages.

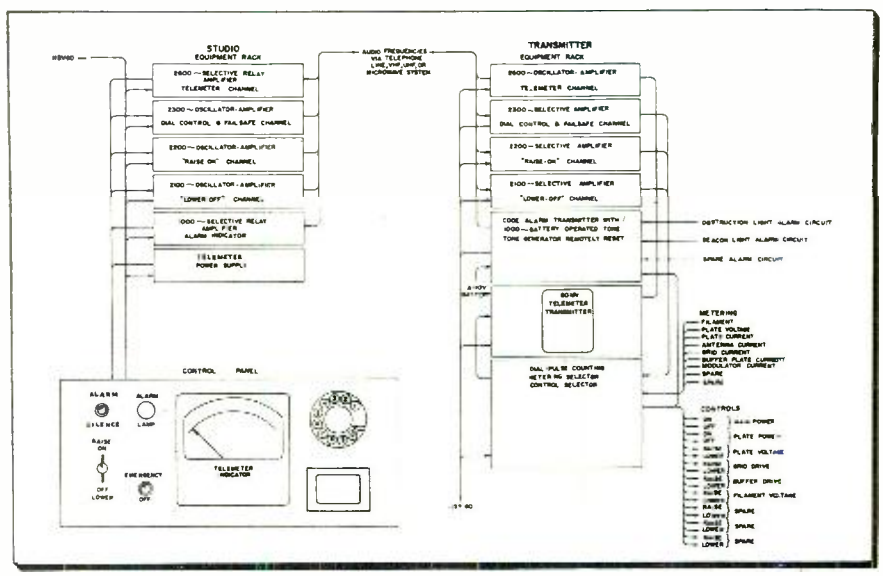


Fig. 1: Basic units are tone generator and modulator at transmitter, frequency selective gear at studio

4) Overheat alarm.

5) Fire alarm.

6) Unauthorized entry alarm.

7) Control of two transmitters at a single location.

8) Metering of filament voltage.

9) Metering of additional plate voltages and currents.

10) Facilities to operate control over VHF or microwave.

11) Facilities to control with supersonic frequencies on line which simultaneously carries program material.

12) Provision for simultaneous phone conversation over control circuit.

13) Remote reset of circuit breakers.

Without exhausting the list of possibilities, it is evident that the control and metering equipment for this field must be very flexible. What is equally important, however, is the requirement for an economical system. Financial necessity will dictate the purchase of remote control facilities in many stations. In these situations the initial cost, as well as the long term economics, will influence the choice of equipment. However, the purchaser with limited capital must be extra cautious not to let low first cost obscure other expenses and possible loss of air time.

Controlled Functions

Before going into details, a short outline of a complete system may be useful. Any system must provide for a number of remote control functions with the operator's panel located at the studio and the responding equipment at the transmitter. In some arrangements it is also necessary to have report-back equipment, which transmits information from the radio transmitter to the studio. For example, it is fairly common to use an alarm type indication for certain items which must be supervised. An alarm transmitter at the

Broadcast Transmitters

station automatically alerts the studio when an abnormal condition exists.

There must also be a metering system which will permit the reading of various electrical quantities at a remote point. (Fig. 4.) In association with this there is required some form of switching which will connect the metering facility successively to the various metering points.

A basic system must also include equipment which will function in a fail-safe manner in the event of loss of control and take the transmitter off the air. The apparatus which provides this function may also be used for 'Emergency Off' to de-energize the transmitter in case the normal control equipment fails to function.

The complete equipment complement must also include those auxiliaries which are necessary for interconnection between the radio transmitter and the control terminal equipment.

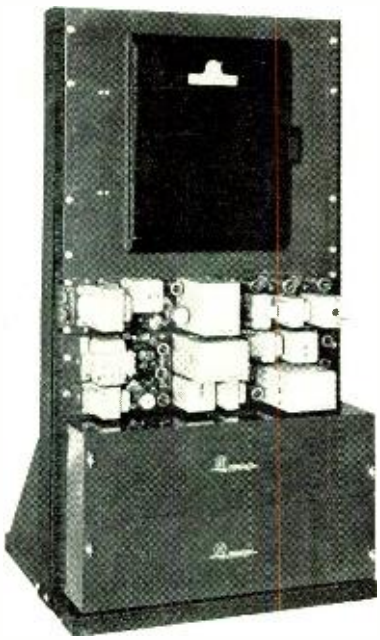
Many forms of remote control are available but these can be first broken down into dc and ac classifications. Both of these forms have been applied to the broadcast transmitter problem.

Since there are a number of items which must be controlled there must be some means for selecting the particular operations. A standard stepping switch which is positioned by operation of a dial at the control point offers one possibility. Various arrangements of relays are also applicable to this selectivity problem. While systems now offered differ in detail they all employ some form of stepping switch or relay chain.

DC System

The simplest dc system utilizes a dial at the control end (See Fig. 1) to send pulses of dc which actuate a step switch at the radio transmitter. When a given function has been selected in this manner the desired operation of On-Off or Raise-Lower is initiated by a second dc current which is transmitted on a polarized basis from a line conductor to ground. After a given control function has been completed it is necessary to reset the stepping switch to zero before the next dialing is started. It is also necessary to reserve a line exclusively for control purposes and to be sure that this line has dc continuity and that it will operate with polarized voltages to ground. In some areas it is rather difficult to obtain lines which will operate under these conditions. Although such dc practice was common in the telephone field many years ago, it has been largely superseded in modern practice. If the line is leased from one of the Bell System subsidiaries there is generally some opposition because the dc requirements impose limitations on the other uses to which the same circuit may be placed by the company.

Instead of dc it is possible to use an audio frequency tone and operate a stepping switch by means of a dial very much as in the dc application. The audio tone may be selected to fall in any convenient zone in the voice spectrum so there is no problem in transmitting it over a standard telephone circuit. One tone may serve for dialing and also for fail-safe. Two additional tones serve to transmit the operating order, one tone being for On and the other for Off. Reset of the stepping switch is controlled by a different length of dialing pulse. In some equipment the stepping switch is automatically reset when a second number is dialed.



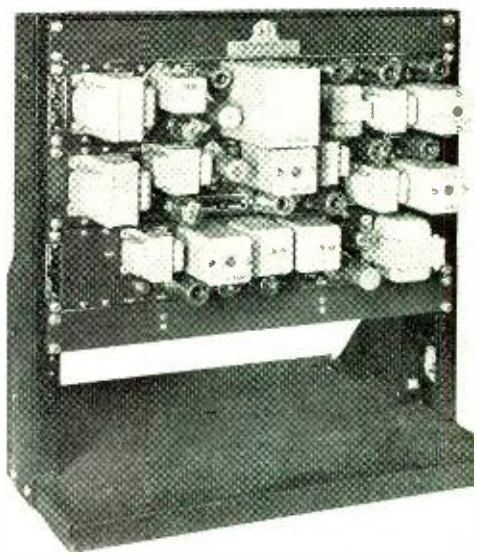


Fig. 2: (l) Equipment for transmitter end. Fig. 3: (r) Studio control equipment for audio system

Relay Chain

Instead of a stepping switch there is the possibility of obtaining the same type of selectivity with a relay chain. The relays close successively as the digits are dialed. The last relay, corresponding to the digit selected, remains latched to complete the control circuit through which the operating orders will be channeled. When a new number is dialed the previous relay setting is released and the selection starts over from the first relay in response to the successive dialing pulses. While this is somewhat more expensive than the stepping switch it offers certain functional advantages in the design.

Another arrangement involving relays establishes a desired control circuit or path by choice of relays out of successive groups. For example the first group responds on the basis of whether the digit is in the first half or the second half of all possible functions. The second group of relays then identifies which quarter it is in, the third group identifies which eighth, the next group which sixteenth, etc. The relays in the successive groups may be selected by different frequencies or by some form of dialing. This is a well known arrangement for selective control but possesses no particular unique virtues.

Since this phase of remote control reduces essentially to a matter of switching and there are several systems which are more or less comparable, it may be well to examine

(*Continued on page* 144)

New Electronic Products

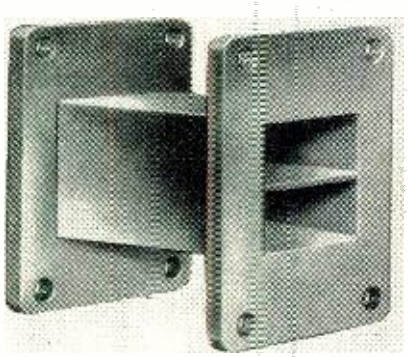
FREQUENCY METER

The Model 410 frequency meter, designed for laboratory, production, and field testing, is useful with reduced accuracy down to 500 MC. Accuracy varies between 0.25% at 1,000 MC and

0.05% at 3,000 MC. Each unit is individually calibrated and can be used as a direct reading frequency meter, as a reaction type frequency meter, as a coaxial line band-pass filter with adjustable output coupling, and as a modulation monitor with output for oscilloscope viewing of amplitude or pulse modulation. Dimensions, $2\frac{5}{16}$ x $5\frac{1}{4}$ x $6\frac{13}{16}$ in. Fully covered in bulletin FM-003. **Aircom, Inc., 354 Main St., Winthrop, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 117)

JUNCTIONS

Hybrid junctions for the X-band, operating from 8,200 to 9,700 MC, have top wall construction and integral flanges which make these small, compact waveguide components easy to install. Input VSWR is less than 1.07. Isolation is in excess of 35 db. The coupling (power division) is 0.25 db. High precision casting of beryllium, copper or aluminum to close tolerances



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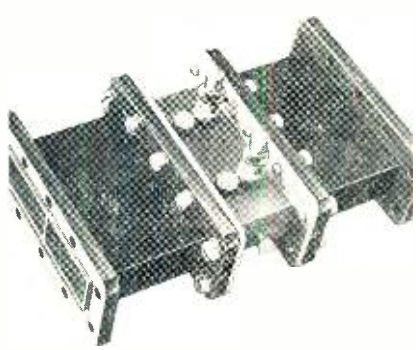
MORE TECHNICAL INFORMATION describing the new products presented here may be obtained by writing on company letterhead to New Products Editor, TELE-TECH & ELECTRONIC INDUSTRIES, 480 Lexington Ave., New York 17, N.Y., listing numbers given at end of each item of interest. Please mention title of position held.

TRAVELING-WAVE TUBES

Two developmental types of traveling-wave tubes recently announced are an S-band type for use in the input stage of microwave receivers, operating over a frequency range from 2,700 to 3,500 MC; and a C-band type for relay applications covering from 5,900 to 6,900 MC. Both types have the lowest noise level of any comparable tubes developed beyond a laboratory stage for S-band and C-band applications, it is said. The low noise advantages result from a three-region velocity gun which "de-amplifies" tube shot noises. The S-band tube will operate in a solenoid with a noise figure of less than 10 db for a gain of 20 db; the C-band tube has a figure of 12 db with a 20 db gain. **Radio Corp. of America, 30 Rockefeller Plaza, New York 20, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 114)

DUPLEXER

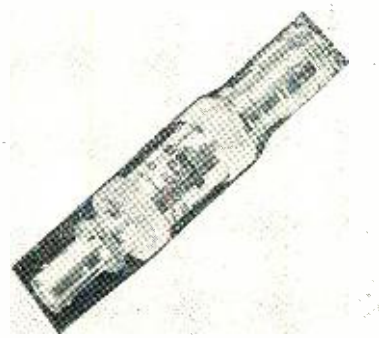
A new short slot hybrid type of balanced duplexer in the 1.250 x 0.625 O.D. waveguide size features high power broad-band operation with insertion loss of less than 0.6 db. Rectangular r-f and pressure gaskets are employed to insure intimate metal contact between the dual TR tube and the hybrid flanges. These gaskets keep r-f leakage to a minimum and assure air tightness under pressurized conditions. Frequency



range, 8,500 to 9,600 MC. Power capacity, 250 kw (peak). High level VSWR, 1.15 (transmit). Low level VSWR, 1.20 (receive). **Airtron, Inc., Dept. A., 1103 W. Elizabeth Ave., Linden, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 118)

BOLOMETER MOUNT

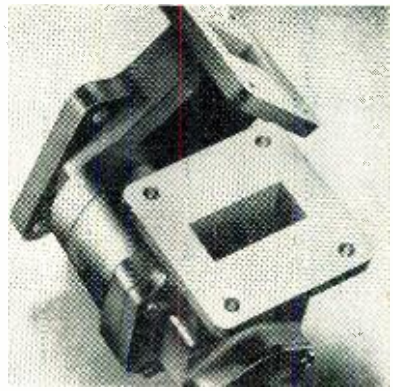
The Model 157 bolometer mount for measuring relative r-f power is designed for operation with pulse modulated waves where crystal detector usefulness is often limited. The instrument can be



used on pulse modulated or unmodulated waves in a direct reading dc bridge setup, or with an audio transformer and voltmeter on modulated waves. In either circuit, maximum sensitivity is obtained when the unit is operated with approximately 7 ma bias, resulting in a maximum power input capability of 20 mw. **Sierra Electronic Corp., 1050 Brittan Ave., San Carlos 2, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 112)

ROTARY JOINT

A new design of rotary joint for antenna systems in the "X" band frequency range in production employs a coaxial rotary section with standard rectangular waveguide input and output, eliminating the bandwidth limiting factor and resonance usually associated with standard circular waveguide sections. The unit is made of aluminum. The design of transition from rectangular to coaxial section permits peak power up to 250 kw at a duty cycle of 0.001 at atmospheric pressure over a

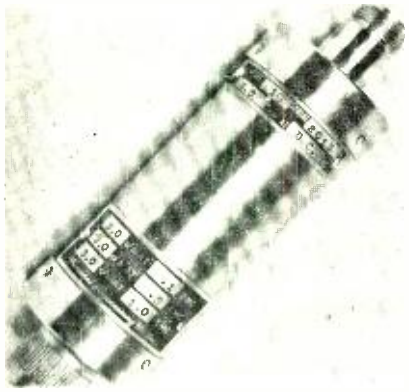


11% bandwidth with a maximum VSWR of 1.07. Weight is 1½ lbs. **Raytheon Manufacturing Co., Equipment Engineering Div., 150 California St. Newton 58, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 113)

For Microwaves

COAXIAL PAD

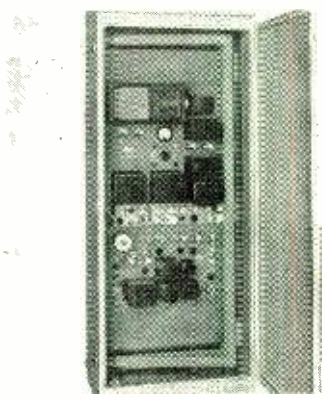
Models 10, 11, and 12 high precision coaxial pads are designed for 10 w input with accuracies usually found at audio frequencies. Power sensitivity is below 0.001 db per db/w, e.g., a 10 w



input to a 10 db pad changes the insertion loss less than 0.10 db. The 3 and 10 db pads are within ±0.1 db of nominal between dc and 1,000 MC. A calibration, accurate to 0.05 db is furnished for 400, 750, and 1,000 MC and to 0.02 db at dc. Long term stability is commensurate with the accuracy of calibration. **Weinschel Engineering Co., Inc., 10503 Metropolitan Ave., Kensington, Md.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 119)

MICROWAVE STATION

The MM-9, commercial, packaged, micro-wave radio station is a compact weatherproofed metal cabinet that houses complete transmitting and receiving equipment for "line of sight," one-hop, point-to-point communication. Measuring 5 ft. high, 2 ft. wide, and 15 in. deep, the package houses a microwave receiver, transmitter, and exciter. Transmitter power output is 2 w with an output impedance of 52 ohms. Transmitter and receiver have an operating



frequency range of 890 to 960 MC. Baseband channel extends up to 30 kc. **Communications Marketing Dept., Engineering Products Div., Radio Corporation of America, Camden, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 1111)

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PORTABLE TOWER

Portable aluminum alloy towers up to 300 feet high are available with features that enable transportable microwave radio relay and radar systems. Patented construction folding sections are assem-

bled without tools. Base is leveled on a simple foundation. Guying systems eliminate turnbuckles, and other guy hardware. Features important to mobile systems are resistance to movement that might interrupt or deflect line-of-sight radio waves, capacity to withstand high wind and ice loads, and lightweight material. Inside stairways, non-skid platforms, and a system of handrails are built into the tower sections. **Up-Right, Inc., 1013 Pardee St., Berkeley 10, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 1112)

SLIDE SCREW TUNER

New slide screw tuners operate over the entire X-band frequency range 8,200-12,400 MC. Used primarily for "flattening" and cancelling VSWR's, the unit consists of a slotted waveguide section and a precision carriage with an adjustable probe. The longitudinal position of the probe is controlled through a rack and pinion drive. Depth of insertion is varied by a knurled screw. Carefully designed choke sections, incorporated in the unit, insure negligible radiation or contact losses. **Transline Associates, 57 State St., Newark 4, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 1110)

LOAD ISOLATOR

The Model X100 load isolator eliminates or greatly reduces "long line" effects. Operated with a tunable magnetron, the unit provides a minimum of 9 db isolation over the 8.6 KMC to 9.6

KMC operating band. The isolator can be used with magnetrons operating up to 100 kw peak and 100 w average power and into a load VSWR of 2:1. The input VSWR with the output terminated is 1.15 maximum. **Litton Industries, Microwave Components Div., 336 N. Foothill Rd., Beverly Hills, Calif., or 215 A. Fulton Ave., Mt. Vernon, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 1119)

MODULATOR

The Stark modulator is the first unit of a new line of electronic equipment designed for microwave spectroscopy applications. The instrument provides a referenced high voltage, and a variable frequency square wave to be applied to the waveguide electrode containing gas under test. The square wave facilitates viewing Stark effect in microwave spectroscopy by supplying a high voltage wave-shape capable of working into a capacity load presented by the Stark cell. **Polarad Electronics Corp., 100 Metropolitan Ave., Brooklyn, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 115)

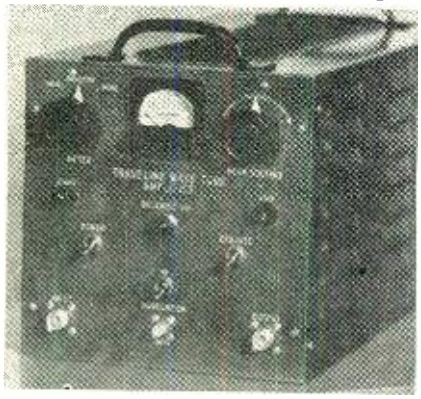
FIVE INCH CRT

The Type GL-5FP14-A cathode ray tube, used in aircraft PPI equipment, has a maximum line width limit specification of 0.25 mm. as compared with the older GL-5FP14 type maximum line width limit of 0.50 mm. The GL-5FP14-A is electrically and mechanically interchangeable with the GL-5FP14, but its high resolution gun employs smaller apertures in its grid structures. The new tube is all glass, employs magnetic focus and deflection, has a 53-degree deflection angle, and a medium-long persistence phosphor. Information is available at the **General Electric Tube Dept., Schenectady 5, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 116)

New Microwave Equipment

MICROWAVE AMPLIFIERS

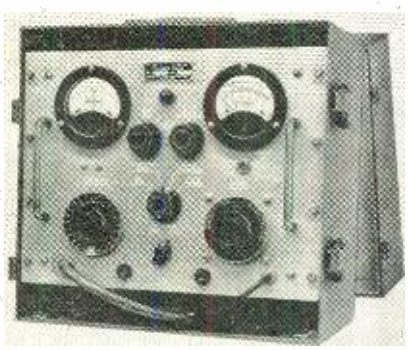
A group of traveling wave tube microwave amplifiers is available that provides 30 db of gain over the frequency range 1-2 KMC, 2-4 KMC, and 4-6 KMC. Both low level tubes with good



noise figures and tubes providing 1 w of power output are available in all bands. Complete packaged units, including any one of the tubes and their associated power supplies and modulating circuits, are available for use on the test bench. For information on these and other tubes in development, write to **Roger White Electron Devices, Inc., 12 W. Island Rd., Ramsey, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 1113)

RF POWER METERS

Power meters, Models 94A, 94B, and 94C, are self-contained packages for making direct, accurate CW and pulse power measurements over the frequency spectrum from 20 to 10,000 MC. Each meter consists of an r-f power bridge, and a set of broadband r-f components. The r-f bridge is calibrated with the r-f accessories and provides both high and low power ranges. Model 94A is used from 20-1,000 MC; Model 94B from 1,000 to 4,000 MC; and 94C from 4,000 to 10,000 MC. Each contains a bolometer mount and interchangeable



low-power and high power bolometer elements for high sensitivity or high power capacity. **Bruno-New York Industries Corp., 460 W. 34th St., New York 1, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 1115)

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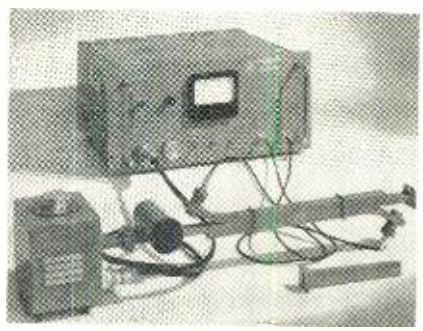
VSWR MEASURING SYSTEM

Model 110B, similar in construction and circuitry to that of Model 110A, features a ratiometer that reads VSWR directly and requires no adjusting. Oscillator is tuned through the X-band. The new unit includes a new low range VSWR scale that reads down to 1.02, and an



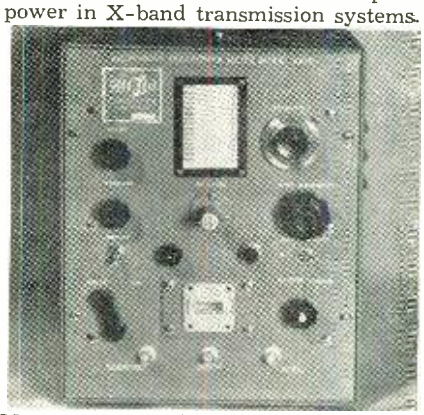
added attenuation scale. Oscillator continuous frequency coverage, 8,500-9,600 MC. RF source, V260 klystron, 1,000 CPS square wave modulation. Bi-directional coupler directivity, greater than 40 db. Waveguide fitting, UG-39/U. Wavemeter accuracy, ±1 MC. Cabinet dimensions, 8¾ x 19 x 13 in. Price, $2195.00. **Color Television, Inc., 973 E. San Carlos Ave., Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 1118)

"S" BAND WAVEMETER

Model 229 "S" band wavemeter is a coaxial type instrument covering the frequency range from 2.3 to 4.5 KMC. The unit features a precision-ground lead screw for measurement accuracy, a cavity body made from a solid block for mechanical stability, and use of Invar in the line displacement portion providing a high frequency stability throughout the range 10°C to 40°C. Maximum accuracy is at 22°C at which instrument was tested and calibrated. Power handling ability by absorption method is 0.5 mw to 1 w maximum; by transmission method, it is from 1 mw to 25 w peak power. Approximate Q load is 2,000. **Amerac, Inc., 116 Topfield Rd., Wenham, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 1117)

PEAKPOWER METER

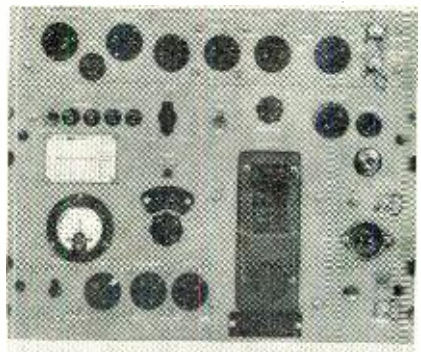
The Model 100 X peakpower meter used with an external synchroscope and standard wattmeter bridge provides direct-reading measurements of peak power in X-band transmission systems.



Measurements of peakpower accurate to 0.2 db are made of any amplitude-modulated wave train having the following variables: pulse repetition rate, 10 to 20,000 pps, pulse width, 0.1 to 10 μ sec, minimum power level, 10 μ w, maximum power level, 3 mw. Use of directional couplers or attenuators of known characteristics in the transmission system enables direct-reading peakpower measurements at any level up to the megawatt region. **Cubic Corp., 2841 Canon St., San Diego 6, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 1116)

MICROWAVE GENERATOR

Model BHS is a portable signal generator designed for testing and adjusting beacon equipment and radar systems that operate in the 8,500-9,600 MC frequency range. The test set measures the power and frequency of external signals and supplies output signals of known power level and frequency that are pulse or square wave modulated, or unmodulated continuous wave. Power measurements are made by a calibrated attenuator and a thermistor.



Frequency measurements are made with a highly precise frequency meter and read on a calibrated dial. Readings are at 1 MC intervals. **General Communication Co., 681 Beacon St., Boston 15, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 1114)

Survey of

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MAGNETIC SERVO AMPLIFIER, R6G16W1, by Polytechnic Research & Development, 202 Tillary St., Brooklyn 1, N.Y., operates any two phase, 60 CPS, servo motor requiring up to 16 w into the control phase. Only power supply required is 115 v, 60 CPS, single phase. (Write for No. A111)

CAPACITOR, Type XC, by the Gudeman Co., 340 W. Huron St., Chicago 10, Ill., has insulation resistance of 50,000 megohm-μf minimum at plus 25°C., 100 megohms-μf minimum at plus 125°C., and 20-megohm-μf minimum at plus 165 C. (Write for No. A112)

MICROPHONES by Astatic Corp., Jackson & Harbor Sts., Conneaut, O., include a new convertible hand and desk type microphone. Model M302, crystal version, has 30 to 10,000 CPS frequency range with flat response. Model M301, ceramic version, has 30 to 8,000 CPS. (Write for No. A113)

REGULATOR TUBE, 6BD4A, a new high voltage unit for anode and convergence supplies of color TV receivers, announced by CBS Hytron, Div. of Columbia Broadcasting System, Inc., Danvers, Mass., replaces and supersedes the 6BD4. (Write for No. A114)

CAPACITORS. New fixed paper-dielectric capacitors in drawn rectangular cases, announced by the Capacitor Dept., General Electric Co., Hudson Falls, N.Y., give greater protection against leakage and eliminate drawn can solder seams. (Write for No. A115)

SSB FILTER, S-16000, companion piece to S-15000 SSB, by Burnell and Co. Inc., Dept. F., 45 Warburton Ave., Yonkers 2, N.Y., is a new single side band filter that utilizes toroidal coils instead of crystal elements. Fixed tuned. (Write for No. A116)

STANDARD "ACOUPERF," 800 varieties of perforated non-metalic sheet material, by Pearson Industries, 4624 N. Sheridan Rd., Chicago 40, Ill., for use as retaining walls for sound-deadening blankets, has no resonant frequency; 10 perforating patterns, 10 colors, 4 gauges. (Write for No. A117)

CONTACT BURNISHING TOOL, No. 3-316, by P. K. Neuses, Inc., W. Euclid & Dwyer Sts., Arlington Heights, Ill., designed for silver, platinum, gold, palladium, tungsten, molybdenum and other precious metal contacts, is non-residual. No carbonaceous build-up. No film. (Write for No. A118)

ELECTRONIC RELAY, Model 300A, made by Deltron Inc., 2905 Leithgow St., Philadelphia, Pa., for the chemical, industrial, medical, electrical, and food processing fields, will operate on a closure through a resistance of several megohms. Size, 4x5x6 in. Steel case. (Write for No. A119)

STANDARD MISMATCH. Type FXR X510, announced by F-R Machine Works, Inc., 26-12 Borough Place, Woodside 77, N.Y., determines the absolute accuracy of microwave VSWR equipment. Units have an accuracy of better than 1%. (Write for No. A1110)

HV PROBE, made by Boland & Boyce, 236 Washington Ave., Belleville 9, N.J., enables accurate high voltage measurements with any VTVM, multimeter, or voltmeter having 10,000 ohms/v or more by use of detailed instructions and a complete set of plug-in precision resistors. (Write for No. A1111)

ANODE CONNECTOR, by Industrial Hardware Mfg. Co., Inc., 109 Prince St., New York, N.Y., is designed to eliminate any supporting harness. Connected to the CRT, the unit is slip proof and eliminates personal danger from high voltage or fire. (Write for No. A1112)

CRYSTAL, JK-G3, smaller than a thumbnail, made by James Knights Co., Sandwich, Ill., offers extreme compactness, a high Q for maximum performance, minimum aging drift. Vacuum sealed. Frequency range from 10 MC to 100 MC. (Write for No. A1133)

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RETAINING RING, series 5139, made by Waldes Kohinoor, Inc., 47-16 Austel Pl., Long Island City 1, N.Y., can be locked positively in its groove and used as a shoulder against rotating parts eliminating need for other fastening. (Write for No. A1126)

SIDE BAND VESTIGIAL FILTER made by Kay Electric Co., Pine Brook, N.J., when used with any TV r-f carrier generator, passes upper and rejects lower side band of any one VHF TV channel. Available for any single channel from 2 to 13, inclusively. (Write for No. A1127)

GETTER. A thermal activated metal substance, "Tag," developed by Pioneer Electronics Corp., 2235 S. Carmelina Ave., Los Angeles 64, Calif., absorbs the minute amounts of gas that develop within a TV picture tube after manufacture. (Write for No. A1128)

HAND WIRE STRIPPER, announced by Crown Industrial Products Co., 1037 Amsterdam St., Woodstock, Ill., is made of hardened steel. Has interchangeable matched cutters, and a patented 'lock-open" feature that holds jaws open to remove wire. (Write for No. A1129)

CONTROL UNIT, Type MCA-901-A, enables the 25-54 and 144-174 MC two-way radios, made by Allen B. Du Mont Labs., Inc., 750 Bloomfield Ave., Clifton, N.J., to be converted from battery to 117 v ac operation for convenient base station use. (Write for No. A1130)

POTENTIOMETER, Type 415, has been developed by Daven Company, Dept. RB, 191 Central Ave., Newark 4, N.J., to operate at ambient temperatures of over 125°C. and maintain rated performance characteristics. Nominal 330 degree function angle. (Write for No. A1131)

VTVM Model 202, ac vacuum tube voltmeter, by Shasta Div., Beckman Instruments, Inc., P.O. Box 296-Sta. A, Richmond, Calif., has a wide frequency range from 20 CPS to 2 MC—full scale ranges from 0.001 to 300 v in twelve steps. (Write for No. A1132)

OSCILLOGRAPH. The "R-1" cathode ray unit records continuously to 16 separate phenomena at 50,000 CPS. Chart speeds 3 to 400 in./sec. All channels recorded on 8 in. wide paper. Made by William Miller Instruments Inc., 325 Halstead Ave., Pasadena 8, Calif. (Write for No. A1134)

COMMUNICATIONS RECEIVER. The Super Pro-600-JX, made by Hammarlund Manufacturing Co., Inc., 460 W. 34th St., New York 1, N.Y., is available as a diversity model that provides facilities for operating two receivers in a conventional dual diversity system. (Write for No. A1135)

CONTACT METER RELAYS, called "Simplytrol," are a development of Assembly Products, Inc., P.O. Box 191, Chagrin Falls, O. Variations of these meters detect heat, light, and radiation, as well as changes in voltage, current, speed, etc. (Write for No. A1113)

LEVEL INDICATORS, called "Telstors" by Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Philadelphia 33, Pa., are in special explosion-proof cases designed to meet requirements of Article 500, National Electrical Code, Class I and Class II Groups. (Write for No. A1114)

CONNECTOR. The MRX14-2, by Winchester Electronics, Inc., Dept. M, Norwalk, Conn., combines 14 conventional and two general purpose r-f contacts. The two coaxial contacts have a nominal impedance of 53 ohms. All contacts are rated at 5 amps. (Write for No. A1115)

POWER SUPPLIES, developed by Power Equipment Co., 55 Antionette St., Detroit 8, Mich., have a self-saturating bridge circuit that corrects ac input line voltage fluctuations and variations in the dc load, independently to ac line frequency maintenance. (Write for No. A1116)

LAMINATE. A copper-clad etched circuit laminate. CuCLAD XXP grade, made by Mica Insulator Co., 797 Broadway, Schenectady, N.Y., is guaranteed to withstand resistance between 230-240°C. without blistering, with no change during a half-hour heat test. (Write for No. A1117)

DIODES. Raytheon Manufacturing Co., Receiving Tube Div., Newton 58, Mass., recently announced types CK735, CK736, CK738, and CK746 silicon diodes; CK740, CK741, CK745, and CK747 gold-bonded junction germanium diodes; and CK6485 for wide band i-f amplifier use. (Write for No. A1118)

BEAM POWER TUBE. RCA-6524, a twin-unit beam power tube for mobile equipment operates in the UHF range from 450 to 470 MC. Engineered as a push-pull r-f power amplifier or as a frequency tripler. RCA Tube Div., Harrison, N.J. (Write for No. A1119)

COMPOUND DELAY PACKAGES, Nos. 1 and 2, are distributed constant lines, being produced by PCA Electronics Inc., 2180 Colorado Ave., Santa Monica, Calif., for use as pulse storage elements in digital computers. Size, $\frac{7}{8}$x1$\frac{5}{8}$x4 in. (Write for No. A1120)

FREQUENCY COUNTER. The DS-6100 has an events/sec range from 10 to 100,000. Time base is a 100 kc crystal controlled oscillator circuit with five stable divider stages. Direct read out from 0-100,000 events. (5 decades). Fan cooled. Weighs 28 lbs. Detectron Corp., 5420 Vineland, N. Hollywood, Calif. (Write for No. A1121)

METAL PATTERN. Pattern C-i-S, by Rigid-Tex Metals Corp., 690 Ohio St., Buffalo 3, N.Y., has a 7$\frac{3}{4}$-in width, an 0.005 in. pattern depth in a 0.025 in. thickness. Based on type 302 annealed stainless steel. Furnished solid or perforated. (Write for No. A1122)

POROUS CARBON that is 75% air, developed by Stackpole Carbon Co., St. Marys, Pa., retains the desirable carbon characteristics of high electrical conductivity, resistance to chemical attack, and stability under high temperature. (Write for No. A1123)

RELAY, Type TS, by Comar Electric Co., 3349 Addison St., Chicago 18, Ill., is a miniature telephone-type dc relay designed for all types of electronic equipment. Available with coils for all standard voltages up to 125 v dc, or 6500 ohm coil. Average coil consumption 3 w. (Write for No. A1124)

MOTOR-ALTERNATOR. Model SA-40, 420 cps synchronous motor-alternator, made by Electric Motors and Specialties, Inc., King and Hamsher Sts., Garrett, Ind., has single motor and alternator shaft. Input v. 115,60 cps, single phase. Output, 250 va, unity pf, 115 v. (Write for No. A1125)

SPEAKERS, 4 and 5 in., designed for peak performance are available at Heppner Manufacturing Co., P.O. Box 612, Round Lake, Ill. Break or cast magnet can be used. Plugs, transformers, and/or brackets are to customer's specifications. (Write for No. A1137)

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TIME CALIBRATOR, crystal-controlled, Type 300, provides 10 MC sine-wave and 5 sharply peaked pulse outputs having repetition rates variable in decade steps from 1 μsec to millisec. By Allen B. DuMont Labs., Inc., 760 Bloomfield Ave., Clifton, N. J. (Write for No. A1175)

DELAY LINE, Model V 103-A, designed by Control Electronics Co., Inc., 1925 New York Ave., Huntington Sta., N. Y. for permanent installations in computers, radar, and TV test equipment provides variable delay line of 0 to 3.1 μsec. (Write for No. A1176)

FREQUENCY METER. The FXR Type 410A is a direct reading reaction unit with a high Q cavity, coupled to the narrow side of the waveguide to create a normal 30% absorption dip in the transmitted power. F-R Machine Works, Inc., Electronics & X-Ray Div., 26-12 Borough Pl. Woodside 77, N. Y. (Write for No. A1177)

ELECTROMAGNETIC CLUTCH, controlled by a 24 v dc circuit, assures safe positive operation because no field adjustment of the torque value can be made. Provides constant horsepower output. I-T-E Circuit Breaker Co., Rectifier Div., Phila., Pa. (Write for No. A1178)

MEGOHM METER. The "Megpot," by National Instrument Co., Div. of General Hermetic Sealing Corp., 99 E. Hawthorne Ave., Valley Stream, N.Y. combines a megohm meter that tests to 10 million megohms at 250 or 500 v dc with a 3,000 v ac high potential test set. (Write for No. A1171)

FREQUENCY STANDARD. Model 701, provides stabilized frequencies in the range 10 kc to 50 MC at 10 kc, 100 kc, or 1 MC intervals. Stability of one part in 10^7/24 hrs. has been achieved. New London Instrument Co., P.O. Box 189, New London, Conn. (Write for No. A1172)

MICROPHONES. Model D-10, for home tape recorders. Model C-12, polydirectional type. Model D-20, dynamic carboid type, Model D-36, a patented dynamic type, and Model 60K, a pressure receiver studio type, made by AKG, Vienna, Austria, are being introduced in the U. S. by Electrovert, Inc., 489 Fifth Ave., New York, N.Y. (Write for No. A1173)

ADAPTER KIT, Type 515-A, installed in the Type 250-A RX meter, wide range impedance bridge, provides a direct Type N coaxial connection to the bridge for continuous operation between 500 kc and 250 MC. Made by Boonton Radio Corp., Boonton, N. J. (Write for No. A1174)

VARIABLE COUNTER, a high speed pulse unit, built around the Burroughs Corp. beam switching tube and a new sequence gator, provides a versatile counting device for test and control applications. Burroughs Corp., Electronic Instruments Div., 511 Broad St., Philadelphia, Pa. (Write for No. A1167)

MAGNETRON, a new three cm. pulse tube, Type GL-6527, is designed for airborne radar gun-sights and operation without pressurization to 60,000 ft. Electrically and mechanically interchangeable with the type 2J42 magnetron. General Electric Tube Dept., Schenectady 5, N.Y. (Write for No. A1169)

MULTIPLEXER UNIT, by Burroughs Corp., Electronic Instruments Div., 511 N. Broad St., Philadelphia Pa., enables ten synchronized sweeps to be thrown on one single-gun oscilloscope screen at one time. Basically, the new unit is an ultra high-speed electronic switch and a new beam switching tube. (Write for No. A1170)

POWER CAPSULE, Model PC2, announced by Bogue Electric Manufacturing Co., 150 Iowa Ave., Patterson 3, N.J., is a 12 kv power supply cable of delivering load currents up to 2.5 ma. Delivers an output voltage of +12 kv with 3% total regulation for a 10% line voltage change. (Write for No. A1157)

MORE TECHNICAL INFORMATION describing the new products presented here may be obtained by writing on company letterhead to New Products Editor, TELE-TECH & ELECTRONIC INDUSTRIES, 480 Lexington Ave., New York 17, N.Y., listing numbers given at end of each item of interest. Please mention title of position held.

TURNTABLES. Two new turntables by Rek-O-Kut Co., 38-01 Queens Blvd., Long Island City 1, N.Y. are indentical 12-in., 3 speed units except for motors. Model B-12 has a 4-pole induction motor; Model B-12H has a hysteresis-synchronous, self-lubricating motor. (Write for No. A1164)

ELECTRONIC SWITCH, Model 19, 12-channel unit, by Century Geophysical Corp., 1333 N. Utica, Tulsa, Okla., provides a convenient method for displaying 12 separate signals on a conventional single-channel CRT. Operates from 110 v, 60 CPS, ac power. (Write for No. A1165)

YOKE CORES, two new microgap ferrite deflection units for TV receivers are available at Ferroxcube Corp. of America, 233 East Bridge St., Saugerties, N.Y. One is a 70° core with improved performance characteristics; the other is the corresponding 90° core. (Write for No. A1166)

SELENIUM DIODES, Types 4VI, 5V1, 2Y1, and 3Y1, by International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif., are rated for a maximum ac input voltage (RSM) from 52 v to 130 v and for maximum dc output voltage from 60 v to 80 v. Output current from 5 to 11 ma. (Write for No. A1160)

UHF POWER TRIODE, RCA-6383, is a compact, liquid-and-forced-air cooled power triode designed for UHF service where transmitter design factors of light weight and high power output are prime considerations. Max. dissipation 600 w. Tube Div., Radio Corp. of America, Harrison, N.J. (Write for No. A1161)

STAND-BY ANTENNA, Type 1020, for TV transmitters that serve channels 7 through 13, consists of 2 separate Type 1020 slotted ring bays mounted one above the other. Can be used without a diplexer. Made by Alford Manufacturing Co., Inc., 299 Atlantic Ave., Boston, Mass. (Write for No. A1162)

THYRATRON, type AX5727, an inert gas-filled tube, designed for relay and servo-control applications by Amperex Electronic Corp., Engineering Dept., 230 Duffy Ave., Hicksville, L. I., N.Y., is a ruggedized version of the standard Type 2D21. (Write for No. A1163)

TIMER. Model 471 counter chronograph for testing radar and sonar equipment, made by Potter Instrument, Inc., 115 Cutter Mill Rd., Great Neck, N.Y. has 8 MC crystal-controlled oscillator that produces timing pulses exactly 1/8th μsec apart. (Write for No. A1156)

NUT RETAINER. The self-anchoring "Speed Grip," made by Tinnerman Products, Inc., P.O. Box 6688, Cleveland 1, Ohio, is pressed to locked, screw-receiving position by a simple hand tool. Installed, nut cannot be rotated, or driven out. (Write for No. A1168)

RESISTORS, new subminiature Type J precision wire wound resistors by Resistance Products Co., 714 Race St., Harrisburg, Pa. are made for guided missiles, aircraft, and other applications where space is limited and accurate performance is required. (Write for No. A1158)

SHOCK MOUNTING, Model K164 all-metal, center-of-gravity type mounting protects the Lear remote controlled ADF equipment from vibration and shock in airborne operations. This single stage mounting affords maximum stability. Made by Robinson Aviation, Inc., Teterboro, N.J. (Write for No. A1159)

SILVER-ZINC BATTERIES by AMF Contract Div., American Machine & Foundry Co., 261 Madison Ave., New York 16, N.Y. include single and multiple cells. Range from cigarette size to those no larger than a jet aircraft battery. (Write for No. A1152)

POWER SUPPLY, Model 701, unregulated, provides dc voltages from 0 to 250 at max. load of 90 ma (360 v open circuit) and ac filament power of 6.3 v at 3 a, center-tapped. Shasta Div., Beckman Instruments, Inc., P.O. Box 296, Richmond, Calif. (Write for No. A1153)

POTENTIOMETERS. Series AJ "Helipot" 10-turn, miniaturized, precision potentiometers are available for servo and/or bushing mounting—1½ in. long by ⅞ in. in diam. Helipot Corp., 916 Meridian Ave., S. Pasadena, Calif. (Write for No. A1154)

CROSSBAR SWITCH. New Type P crossbar switch for color TV by James Cunningham, Son & Co., Rochester 8, N.Y. has 2 lines and 10 links with a maximum of 6 conductors per circuit. The upper 2 conductors can be made as magnetic coil holding circuits. (Write for No. A1155)

OSCILLOSCOPES, large screen, with 21 and 17 in. rectangular tubes, designed by Electromec, Inc., 3200 N. San Fernando Blvd., Burbank Calif., provide more information in more readable form. For data plotting, production test, wave analysis, etc. (Write for No. A1149)

TAPE RECORDER, Model R5MS, is a ¼ in. tape unit contained in a welded steel rack cabinet approx. 22 x 20 x 15¾ in. in size. Accommodates reels up to 10½ in. in diam.—2,500 ft. of tape. Stancil-Hoffman Corp., 921 N. Highland Ave., Hollywood 38, Calif. (Write for No. A1151)

RELAY. "Magseal," said to be the smallest functional relay, requires only 18 mw to effect contact closure. Comes in a wide variety of sizes. G. M. Giannini & Co., Inc., 918 E. Greens St., Pasadena 1, Calif. (Write for No. A1146)

RESISTORS. A new line of non-inductive precision wire type resistors of patented design eliminates bobbins. Units have smaller size and closer tolerance control. Monson Manufacturing Corp., 6059 W. Belmont Ave., Chicago 34, Ill. (Write for No. A1147)

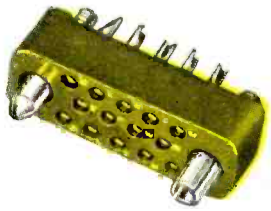
VOLT-AMMETER RECORDER. The "Dynamaster," is a new wide strip electronic recorder made by The Bristol Co., Waterbury 20, Conn. for measuring and recording current and voltage simultaneously. Accuracy within 1/20th of 1%. (Write for No. A1140)

CRYSTAL MICROPHONES. New low cost microphone, Model 926, designed by Electro-Voice, Inc., Buchanan, Mich., for public address, paging, home tape recording, and amateur radio communications has smooth frequency response of 70 to 8,000 cps. Output level, —60 db. (Write for No. A1141)

TUNER. The 310 FM Broadcast monitor tuner, in addition to 2 μv sensitivity, features a full 150 kc i-f passband and two MC wide limiters and detector, high r-f selectivity, high converter linearity, etc. Homer Hosmer Scott, Inc., 385 Putnam Ave., Cambridge, Mass. (Write for No. A1142)

SOLDERLESS CONNECTOR. A completely solderless coaxial cable connector by Entron, Inc., 4902 Lawrence St., Bladensburg, Md. has electrical reliability, high mechanical strength, and effective shielding obtained by radial grounding contact. (Write for No. A1143)

CINCH PRODUCES



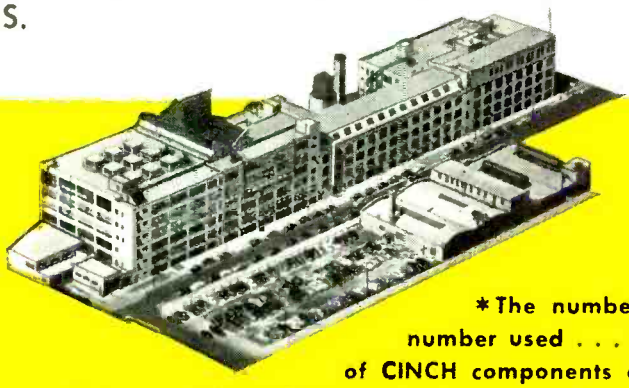
A LARGE VARIETY OF SMALL COMPONENTS...IN *STANDARD USE

THIS IS A LIST OF CINCH COMPONENTS (INCLUDING THOSE OF-CINCH-JONES DIVISION):

SOCKETS: TUBE (RECEIVER, TRANSMITTER AND SPECIAL): BATTERY, ALL TYPES • C-R TUBE • CRYSTAL • ELECTROLYTIC • GLASS TYPE; 4 TO 7 PRONG LAMINATED • INFRA-RED RAY TUBE • HIGH ALTITUDE AIRBORNE TYPES • KINESCOPE; MAGNAL, DUODECAL, DIHEPTAL • LOKTAL-MINIATURE-MULTIPLUG-NOVAL OCTAL (MOLDED BAKELITE, STEA-TITE, TEFLON, KEL-F AND LAMINATED) • PLEXICON • PRINTED CIRCUIT • SPECIAL SOCKETS TO SPECS • SUB-MINIATURE; HEARING AID TYPES • TV; 110V CIRCUIT BREAK-AWAY • VIBRATOR • PENCIL TUBE TRANSISTOR • DIODE

ANTENNA JACKS • METAL STAMPINGS • BANANA PINS AND JACKS • MICRO-CONNEC-TORS • BARRIER TERMINAL STRIPS • MOUNTING DEVICES • FANNING STRIPS • PHONO TIP JACKS • BATTERY PLUGS & SOCKETS • PRINTED CIRCUIT, CONNECTORS SHIELDS, TUBE-MINIATURE & NOVAL & BASES SOLDERING LUGS—200 VARIATIONS • BINDING POSTS • DIODE SOCKET • CONNECTORS, MULTI CONTACT • FUSE STRIPS, BLOCKS & BOARDS • GRID CAPS • STRAP NUTS • GRID CAP SHIELDS • TRANSISTOR SOCKET • TUBE HOLDERS—SPRING TYPE • HERMETICALLY SEALED TUBE SOCKETS • VIBRATOR PLUGS AND SOCKETS

TERMINAL ASSEMBLIES: BLOCKS, BOARDS IN LAMINATED AND MOLDED, ASSEMBLED WITH LUGS, PINS, SCREW TERMINALS, CONTACTS, CLIPS, TURRET LUGS AND OTHER HARDWARE TO SPECIFICATIONS.



Centrally located plants at Chicago, Shelbyville, Indiana and St. Louis.

Cinch components are available at leading electronic jobbers — everywhere

*The number of users and the number used . . . testify to the choice of CINCH components as Standard. Ample physical properties, space and production facilities is producing many variations of these standard electronic components for military, and commercial, use.

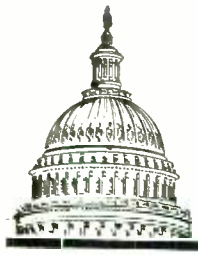
Cinch ELECTRONIC COMPONENTS

CONSULT CINCH'

CINCH MANUFACTURING CORPORATION

1026 South Homan Ave., Chicago 24, Illinois

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



WASHINGTON
News Letter

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

NEW FCC CHAIRMAN—With an excellent reputation as an administrator and a background of more than a decade of service on the Ohio Public Utilities Commission, George C. McConnaughey has taken over the helm of the FCC succeeding veteran FCC career Commissioner Rosel H. Hyde who had been chairman since the beginning of the Eisenhower administration. The new FCC chieftain who came to the Commission from a year of successful leadership of the War Contracts Renegotiation Board, is a vigorous proponent of the free enterprise system and adheres to the philosophy that regulatory agencies should not interfere with the rights of management to operate their own businesses if they conduct the affairs in the public interest. A competent lawyer who knows thoroughly the communications field from his state commission career, Chairman McConnaughey was expected to familiarize himself speedily with broadcasting and television developments.

STERLING RESIGNS—The departure of FCC Commissioner George E. Sterling by voluntary resignation because of ill health ended the governmental career of 31 years of a leading radio engineer in the federal service. Commissioner Sterling's term, which is filled by Chairman McConnaughey, ran until June 30, 1957. The retiring Commissioner, known throughout the entire radio field, started as a radio inspector with the Commerce Department and with the former Federal Radio Commission, and rose through the ranks in engineering capacities to become Chief Engineer of the FCC, and in 1948 Commissioner. When he recovers his health, it is known that Mr. Sterling will be called upon for consulting engineering work.

INDUSTRIAL COMMUNICATIONS—While the FCC has concentrated its attention upon television in recent years to expedite its implementation to the public, the Commission is faced with a highly important responsibility in another sphere of its activities—the safety and special radio services. The industrial communications and mobile radio services in this latter sphere have mushroomed tremendously in the past two years and now the FCC is authorizing between one and two thousand systems a month. Broad policies to insure efficient usage of the spectrum allocations for these services and to prevent serious interference with television are awaiting formulation by the FCC. Up to the present the policy making and issuance of rules and standards have been to a major degree on a make-shift and temporary basis, so that the manufacturers of the microwave and radio equipment, and the users of the various services are definitely concerned with the outlook.

GOVERNMENT FREQUENCIES—The situation under which federal government agencies have had virtual priority of selection of spectrum space, without full appraisal as to usage and requirements, appears now on the road to an impartial survey and possible solution. The appointment of a Cabinet committee by President Eisenhower which is headed by Defense Mobilization Director Arthur S. Flemming and composed of the Secretaries of State and Defense has as a major task the study of the government frequency situation and will complete its report in six months. At the same time, the ODM will be working towards the same goal through its Assistant Director in charge of telecommunications, Harold Botkin, on leave as Assistant General Manager of the American Telephone & Telegraph Co. Long Lines Department. This survey has been advocated in editorials by TELE-TECH as a most constructive step for the advancement of the radio art.

SUPERSONIC AVIATION—The advent of the jet airplane with the huge increases in the speed of flying is causing the radio and electronics engineering officials of aviation and the radio-electronics industry to resurvey the present radiocommunications services and electronic navigation aids serving American aviation. The imperative need for expedited progress and modernization of the "Common System" for aviation which was inaugurated several years ago by the plans of the Radio Technical Commission for Aeronautics' Special Committee 31 was emphatically advocated at the recent fall assembly of the RTCA in Washington. Traffic control improvement with the speedier flying and the growth of airplane movements, the RTCA participants felt, had to be implemented immediately or there would be danger of serious accidents.

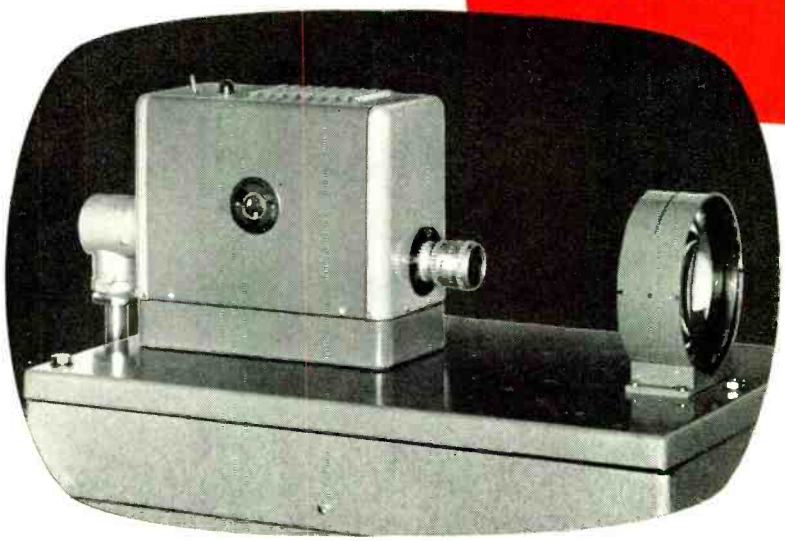
National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Editor

Your FILMS and COSTS BOTH LOOK BETTER

with the new

GPL VIDICON FILM CHAIN



- Low first cost; low operating cost
- Operates unattended; frees studio manpower
- Photo-conductive tube
- Stable black level
- No shading correction required
- No back or edge lighting required
- Lowest "noise" level in television
- Easy to multiplex

STATION OWNERS & OPERATORS

Test this GPL chain in your station, with your projectors and monitors . . . your operating conditions. See for yourself its almost automatic operation, its quality with all types of film. No charge, no obligation. Just write, wire or phone.

SEE THE GPL 3-VIDICON COLOR FILM CHAIN
ON DISPLAY AT
SMPTE EXHIBIT
OCTOBER 18th-22nd
AMBASSADOR HOTEL
LOS ANGELES

TWO MAJOR ADVANTAGES for station owners sum up the features of this new Vidicon Film Chain produced by GPL.

First, it sets a new high for quality.

Second, it saves dollars. And more dollars.

It's built around a photo-conductive tube, with long-proven GPL circuits and construction techniques. It is compact, simple and rugged . . . easy to maintain, flexible for 4 *or more* multiplex combinations. All your existing projectors, monitors, master monitor and standard racks can be used. *A stable black level, and almost complete absence of spurious signals, eliminates the need of constant attention. You save man-hours that previously went into monotonous monitoring.*

This GPL chain has the lowest noise level in television. The grey scale reproduction is true. In all, with this GPL combination of both quality and economy, you can afford to retire your iconoscopes to slides. And, in equipping a new station, the GPL Vidicon is unmatched for value.

General Precision Laboratory

INCORPORATED

PLEASANTVILLE NEW YORK

GPL

Write, wire or phone for information

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

Regional Offices: Chicago • Atlanta • Dallas • Glendale, California

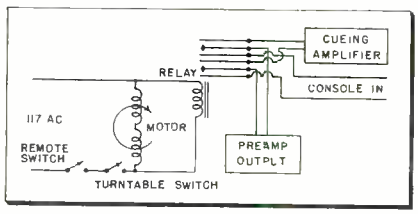
CUES for BROADCASTERS

(Continued from page 77)

Muting Pick Up

THOMAS F. LINDSEY, Chief Eng., KTOW, Oklahoma City, Okla.

LIKE many small stations we needed a simple, inexpensive and accurate method of switching our transcription pick up arms from the input of the console to the input of



Circuit for switching transcription pickup arm between console and cueing amplifier

the cueing amplifier at any time the motor of the table was stopped. The accompanying diagram shows the circuit. Relays were Advance 117 ac relays with DPDT contacts, and were mounted in the audio rack on shock mounts to prevent clicks of closing contacts being picked up on an open mike.

Repairing Erase Heads

EARL R. WARD, Chief Engr., KGFF, Shawnee, Okla.

WHEN the r-f type erase head becomes worn, the tape does not touch the head across the entire width of the tape. This causes an increase in noise level and when badly worn the previous program will be audible.

On the Magnecord, disassemble the erase head and hone the surface that comes in contact with the tape. This can be done by laying 00 sand paper on a flat surface, or with fine grit hone stone. This requires about 15 minutes and works as well as a new erase head.

Eliminating Tube Hum

PETER H. VAN MILLIGAN, WMBI, Chicago, Ill.

WE use three Western Electric consoles and when using 1620 type tubes found bad hum. This was caused by heater emission to cathode because the cathode resistor is not bypassed. To remedy this I lifted the transformer center tap to all 6.3 volt heaters and inserted a .5mfd condenser in series from center tap to ground. This condenser now assumes a charge proportional to the heater emission and biases the cathode with respect to the heater, and by passes any hash to ground.

This circuit can be used in any similar application to provide automatic bias instead of resorting to the conventional power supply bias for biasing between heater and cathode in low level stages.

MICROWAVE GIFT FOR EDUCATIONAL TV

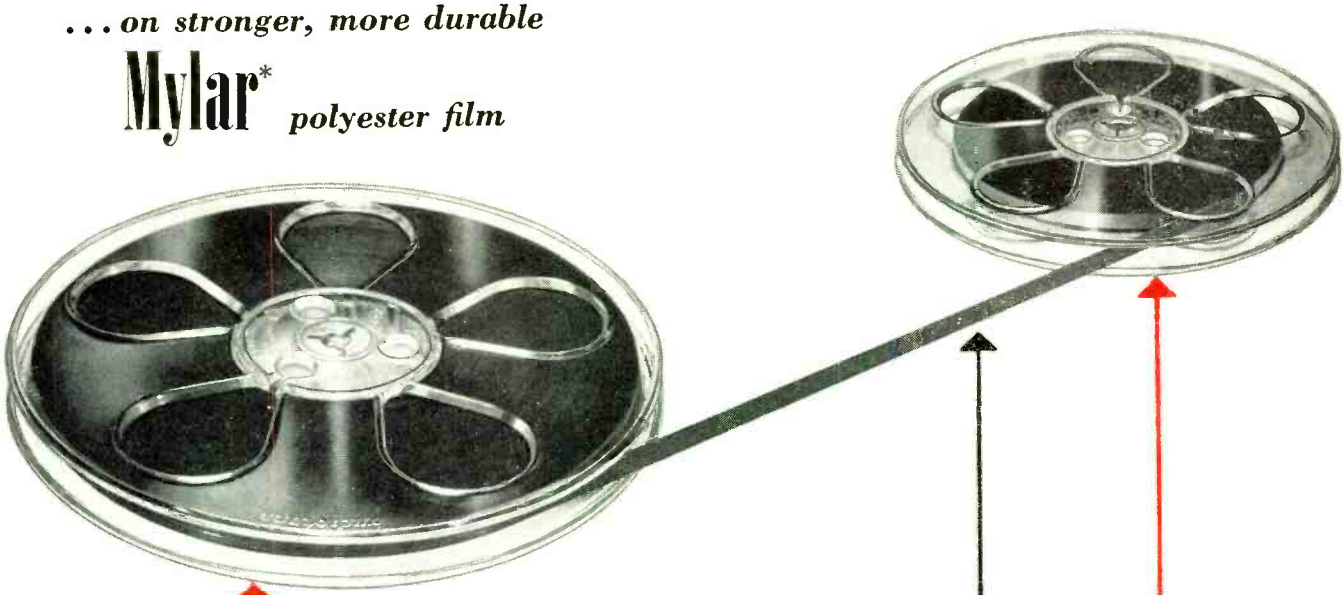
Standing beside the Raytheon microwave relay TV link which has been donated to WGBH-TV, new educational station in Cambridge, Mass., are (l. to r.) Parker Wheatley, general manager & director of Lowell Institute Cooperative Broadcasting Council; Gordon S. Humphrey, assistant vice-president of Raytheon Mfg. Co., Waltham, Mass.; and Hartford N. Gunn, Jr., director of operations for the station. Kneeling is Arthur W. Richardson, chief engineer of WGBH-TV and FM.

new type LR Longer Recording audiotape TRADE MARK

gives you 50% MORE recording time per reel

. . . on stronger, more durable

Mylar* *polyester film*



With Type LR Audiotape, you get the equivalent of a *reel-and-a-half* of ordinary tape . . .

900 ft on a 5″ reel
1800 ft on a 7″ reel
3600 ft on a 10½″ reel

Type LR Audiotape is made on a 1-mil base of stronger, more durable "Mylar" polyester film — withstands extreme temperatures, is virtually immune to moisture, gives maximum tape life under all conditions of use and storage.

This new *Longer-Recording Audiotape* saves time and effort, eliminates reel changes, gives uninterrupted continuity of recording and playback for *any application* where recording time exceeds the conventional reel capacity.

Laboratory tests, as well as unsolicited testimonials by radio stations and recording experts, have conclusively demonstrated the superiority of LR Audiotape — in both performance and durability. It is also important to note that the largest users of longer playing tape are now insisting that it be made on "Mylar" polyester film, the base material used for LR Audiotape — additional proof of its superior quality.

Ask your dealer for a supply of longer-lasting, longer-recording Type LR Audiotape. A copy of Bulletin No. 211, giving complete data and specifications on LR Audiotape, is yours for the asking.

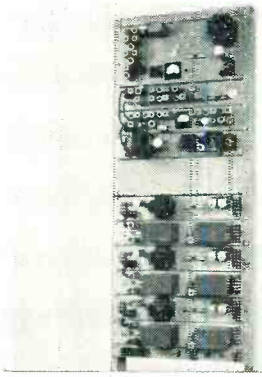
*Du Pont Trade Mark

AUDIO DEVICES, Inc.

444 Madison Avenue, New York 22, N. Y.
Offices in Hollywood — Chicago
Export Dept., 13 East 40th St., New York 16, N. Y., Cables "ARLAB"

TRANSMITTER-RECEIVER

FM radio equipment, type 14BW, is a wide-band, phase/frequency modulated, transmitter-receiver assembly for point-to-point, multi-channel radio communications in the 890-960 MC band.



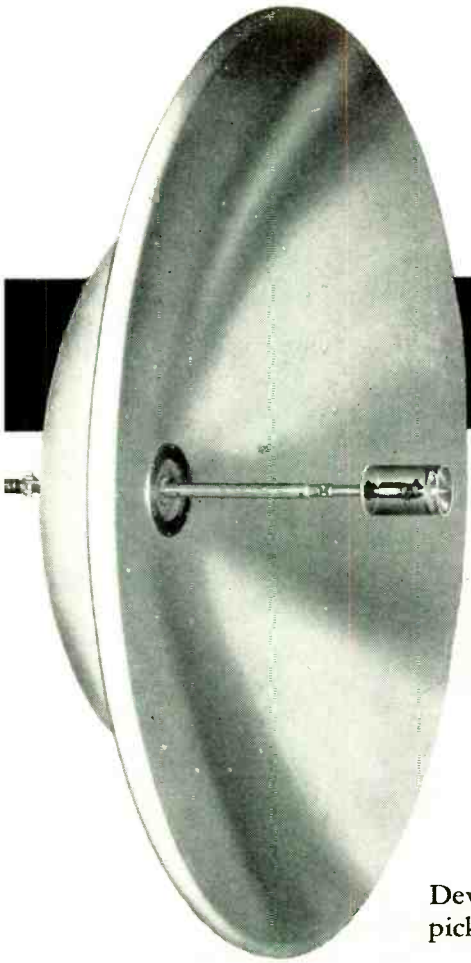
The transmitter, temperature-controlled, crystal oscillator provides a frequency stability of better than ±0.002%. Frequency response, ±1 db, 1,000-80,000 cps; ±3 db, 250-110,000 cps. Signal/noise ratio, at least 50 db, unweighted. **Budelman Radio Corp., 375 Fairfield Ave., Stamford, Conn.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 1120)

CALIBRATOR

Model 238-1A crystal sweep calibrator for oscilloscope time base calibration produces narrow pulses at intervals of 1, 10, 100, 1,000, and 10,000 μsecs. Pulse spacing is accurate to 0.01%. Pulse outputs are positive and are preset by internal adjustments for each

range to a level of 3.0 v. Output impedance is 93 ohms. Operates on 115 v. ac, 50-420 CPS. **Loral Electronics Corp., 794 East 140th St., New York 54, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 1121)

MORE TECHNICAL INFORMATION describing the new products presented here may be obtained by writing on company letterhead to New Products Editor, TELE-TECH & ELECTRONIC INDUSTRIES, 480 Lexington Ave., New York 17, N.Y., listing numbers given at end of each item of interest. Please mention title of position held.



the TOP choice for TV . . .

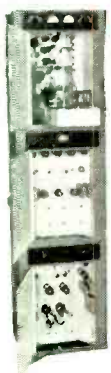
Federal's FTL-27C

MICROWAVE RELAY LINK

. . . the most widely accepted system for the relaying of video signals

Developed specifically for studio-transmitter links, inter-city relays and remote pick-up service, Federal's FTL-27C provides design features of the highest order.

Among these outstanding features are: Automatic unattended operation . . . immediate on-air operation . . . self-contained test circuits . . . and numerous other facilities for *dependable* operation and *simplified* maintenance.

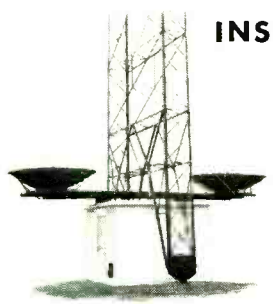


TRANSMITTER

- Direct frequency modulated
- Reflex klystron power oscillator
- 5 watts *minimum* power output
- Crystal controlled
- Built-in wavemeter, r-f power measuring devices and local monitoring facilities
- Internal receiver for off-air monitoring

RECEIVER

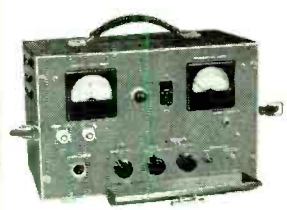
- Single superheterodyne type
- Crystal controlled
- Double tuned preselector
- Wide frequency response
- High signal to noise ratio
- Constant video level over wide range of input signals



INSTALLATION

- Circular parabolic antenna for both receiver and transmitter
- Antenna may be ground-mounted for use with tower-mounted reflectors
- Provides stable klystron operation and simplifies maintenance
- Reduces transmission line costs

SOUND CHANNEL



- Exclusive FTL development
- Allows simultaneous transmission of audio and video over TV link
- Eliminates need for leasing high-quality telephone lines
- Fully self-contained

Distributed by GraybaR ELECTRIC COMPANY

FEDERAL TELECOMMUNICATION LABORATORIES — FTL — DIVISION OF IT&T

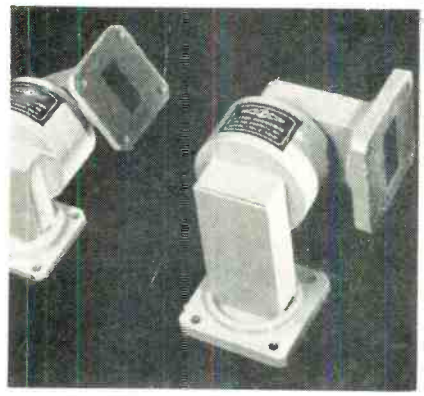
Federal Telecommunication Laboratories

TELEVISION BRANCH ROUTE 17, LODI, N.J. Main Office: 500 Washington Avenue, Nutley, N.J.

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

ROTARY JOINT

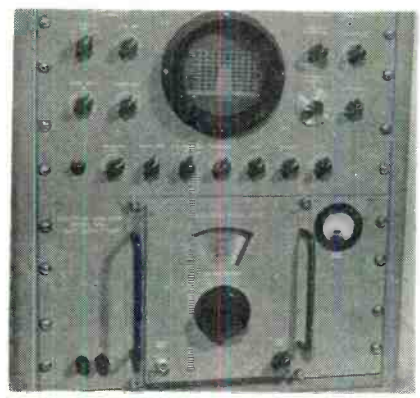
The Model X250R rotary joint is designed for X-Band operation at 250 kw. The unit provides waveguide runs as an integral part of the assembly and therefore eliminates any blind soldering



or extra flange connections. A maximum VSWR of 1.15 is maintained over the 8.6 KMC to a 9.6 KMC band. Variations of VSWR and phase with rotation are negligible. This rotary joint is available with either RG 51/U or RG 52/U waveguides. For further information, contact **Litton Industries, Microwave Components Div., 336 No. Foothill Rd., Beverly Hills, Calif.**, or **215 S. Fulton Ave., Mt. Vernon, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 1122)

SPECTRUM ANALYZER

The Model SPA-1 spectrum analyzer is a low-cost package covering the range of 50 MC to 4,000 MC with two interchangeable tuning heads, RF-2 and RF-3. Unit features a direct reading frequency dial, accurate to 1%; continuously variable differential markers of ±50 kc to ±5 MC to measure fre-



quency dispersion; continuously variable sweep rates of 1 CPS to 60 CPS; continuously variable i-f width between 9 kc and 100 kc; and continuously adjustable sweep width of 10 MC to 0. High inherent stability. Sharp, brilliant display. Three selectable amplitude scales; 20 db linear, 40 db log, and 6 db square law. Sensitivity to 100 dbm. **Panoramic Radio Products, Inc., 10 S. Second St., Mt. Vernon, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 1123)

MORE NEW PRODUCTS ON P. 110

New G-E ELECTROSTATIC-FOCUS GUN GIVES NEEDLE-SHARP TV PICTURES!

- **Spot is smaller, rounder.**
- **Greatly improved focus at high picture brightness.**
- **Better edge-to-edge picture detail.**

GENERAL ELECTRIC'S electrostatic picture tubes with new high-resolution gun—most recent product of G-E Tube Design Service—enable designers and builders to increase TV sales by offering *superior fringe-area reception*, as well as improved pictures under all conditions.

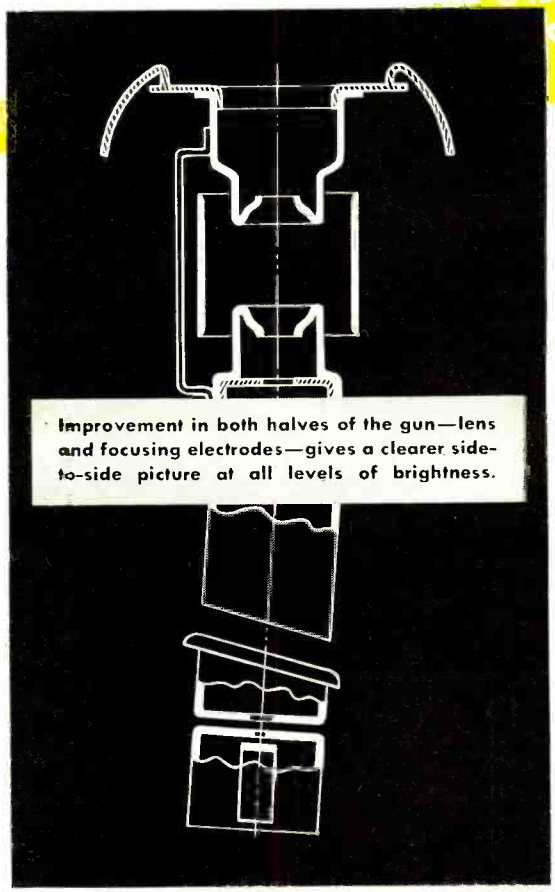
Because the gun gives substantially better focus at high picture brightness, snow and interfering-signal excitations in TV fringe areas will not "bloom" to the same extent as before . . . marring the picture less. Also, the screen image has superior detail, helping to maintain picture quality.

Better fringe reception is only one of many improvements you can build into your TV sets by specifying G-E picture tubes with the new gun. Wire or write for complete information! *Tube Department, General Electric Company, Schenectady 5, N. Y.*

ALL G-E electrostatic picture tubes are equipped with the new high-resolution gun. Types include:

17RP4/17HP4	21ALP4-A	21FP4-A	21YP4
17VP4/17LP4	21ATP4	21FP4-C	21YP4-A
21ALP4	21AUP4-A	21XP4-A	

Nominate a candidate for the Third Annual Edison Award for radio amateurs! Help honor outstanding public service! Entries close January 3, 1955. Write General Electric Tube Department for the rules!



Improvement in both halves of the gun—lens and focusing electrodes—gives a clearer side-to-side picture at all levels of brightness.

Check these standout design features of General Electric's new gun:

- Lens structure (lower half) has new spacings and dimensions that give a much smaller electron beam with the sharper resolution this makes possible. Also, Grid 1 now is "coined" or pressure-formed for utmost dimensional accuracy. In addition to creating a smaller beam with sharper resolution, the new spacings reduce grid-cathode shorts.
- Grid-1 drive characteristics now provide a much more desirable relationship between brightness and drive voltage.
- Bushings of the focusing electrodes (upper half) are new and advanced in design. Beam distortion over the entire picture area is held to a minimum, and focusing characteristics are more uniform, tube to tube.

Progress Is Our Most Important Product

GENERAL ELECTRIC

162-1A6

ELECTRONIC SWITCH

The Type 350 electronic switch is designed to convert any cathode ray oscillographs in the range of dc to 15 mc into a dual-trace unit. By converting a single oscillograph trace to two traces, the

unit enables a number of signal comparisons such as timing, phase, input versus output relationships, circuit interaction, etc. To enable the display of a large variety of signals with a wide variety of repetition rates, the switch offers triggered or recurrent switching. Can be triggered from oscillograph-gate output at rates from 0 to 100 kc, or will switch at recurrent rates of 1, 10, 100 kc. **Allen B. DuMont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 1124)

SERVO AMPLIFIER

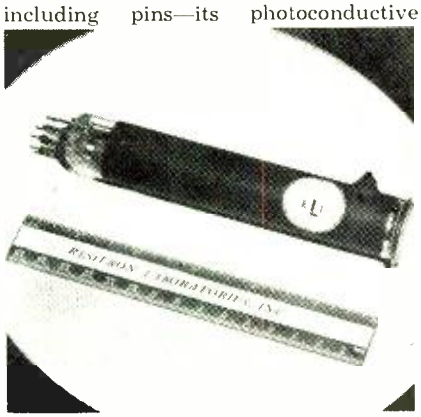
Type R40G10W1, a new magnetic servo amplifier, will deliver up to 10 w reversible phase ac output into the control phase of MK7 and MK8 servo motors for reversible phase ac or reversible polarity dc input. Designed for operation at high temperatures in control or servo systems where one cycle response is mandatory. The reactor unit is only 2½ in. high and 2¼ in. in diam. Completely encased in a molded resin, except for the moisture and

fungus proofed rectifier supplied for external mounting. Weight, 12 oz. Required power supply 115 v, 400 cps, single phase. **Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 1125)

MORE TECHNICAL INFORMATION described the new products presented here may be obtained by writing on company letterhead to New Products Editor, TELE-TECH & ELECTRONIC INDUSTRIES, 480 Lexington Ave., New York 17, N.Y., listing numbers given at end of each item of interest. Please mention title of position held.

CAMERA TUBE

A small camera tube, 6198, is designed for industrial, military, amateur, and TV broadcast uses. Approximately 1 in. in face diameter and 6¼ in. high—including pins—its photoconductive



spectral response closely approximates that of the human eye; however, photoconductive surfaces with different spectral responses are available on request. The design of the tube is adaptable to a wide variety of commercially available lenses. **Resitron Laboratories, Inc., 2025 Pontius Ave., Los Angeles 25, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 1126)

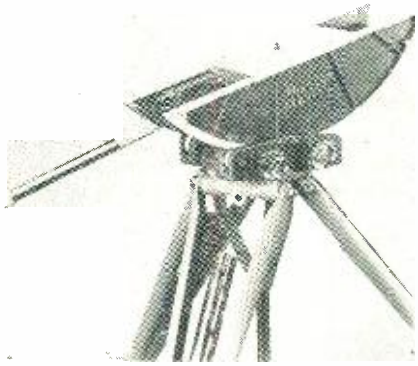
SOLDERING INSTRUMENTS

The new line of ORYX miniature soldering instruments, designed for manufacturers of precision devices, are only 6 in. in length and weigh no more than a pencil. The units, made in Great

Britain, have no ceramic or mica formers to break or flake, and require only 20 or 30 seconds to heat. A variety of operating voltages is available, as are tips as small as $^{1}/_{16}$ in. Details and price information can be obtained from **Television Accessories Co., Dept. 15, P.O. Box 6001, Arlington 6, Va.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 1127)

CRADLE HEADS

Two new camera heads provide positive balance of the camera in every position. One model is available for standard monochrome cameras, the other for RCA color TV cameras. Both



fit all standard tripods, pedestals, dollies, cranes or hi hats. When the camera is tilted up or down, the cradle rotates around a constant center of gravity. The cradle head rides on four phenolic covered ball bearings mounted in the base. Tilt ranges from 38 down to 30 up. An adjustable tilt drag is provided. Camera balancing for added accessories is accomplished by moving the top camera plate with a lead screw. **Houston-Fearless Corp., 11801 W. Olympic Blvd., Los Angeles 64, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 1128)

REFLECTION BOXES

A new device used with a linear Balun enables simple visual observation of the ability of a tuner to provide a proper match with a 300 ohm transmission line over the VHF and UHF TV bands. Also, it eliminates lab or factory transmission lines. Model V-5A is designed as a 50 ohm system to be used with the V-6A Balun for matching input circuit over the UHF band. The V-

5B covers the same frequency range for generators having a 75 ohm output impedance. The V-7A for use with 50 ohm source, and V-7B, matching a 75 ohm source, cover the VHF band. **Linear Equipment Laboratories, Inc., Brightwater Place, Massapequa, L. I., N. Y.**—TELE-TECH & ELECTRONIC INDUSTRIES. (Write for No. 1129)

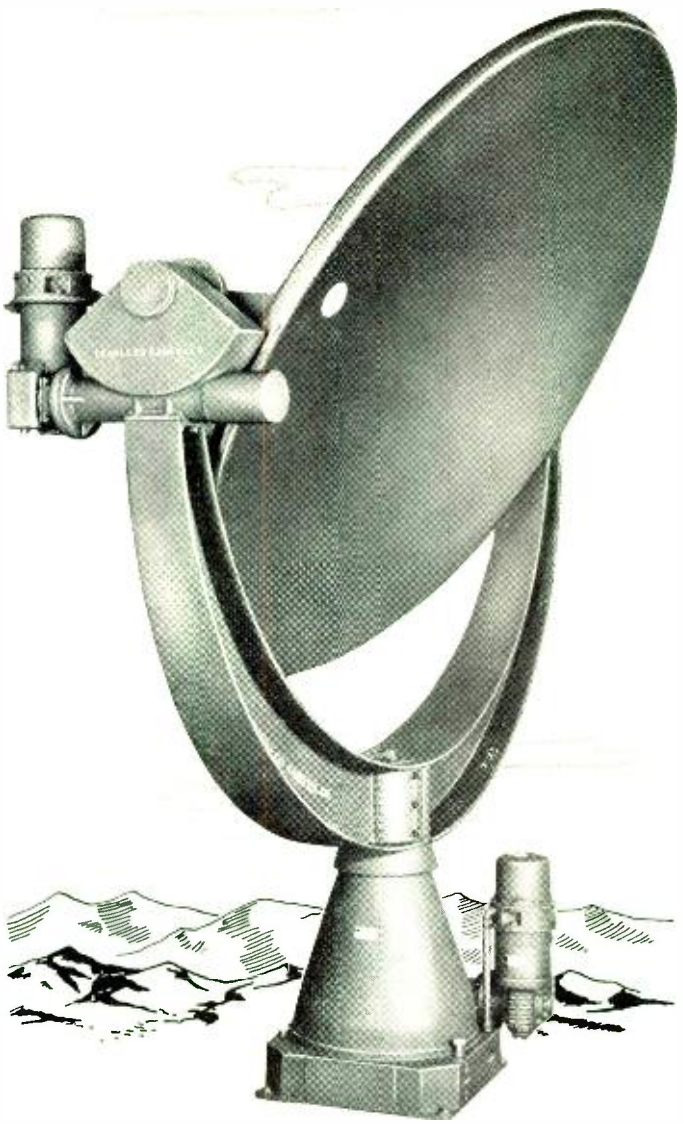
HIGH ATOP A TOWER OR A MOUNTAIN IN WIND, RAIN, SNOW AND ICE

. . . this new Houston-Fearless

MICROWAVE PARABOLA

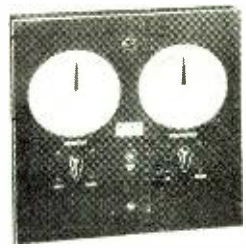
operates completely by

REMOTE CONTROL!



There's no need to climb an icy tower in zero weather, wind or rain to position this new Houston-Fearless Remote Control Microwave Parabola. It's all done from the remote control panel (shown below) right in the station.

This Houston-Fearless Parabola can be mounted anywhere within 1500 ft. (or more, if required) of the transmitter. It rotates 370° in azimuth and tilts 15° up and 30° down. Large dials on the remote control panel, calibrated in degrees, show the exact position. It is driven by 1/6 HP motors producing a torque of 10,500 inch pounds @ 1 RPM, sufficient to operate under severe icing conditions. Magnetic brakes prevent overide when Parabola is stopped at any exact position. Designed to operate in the open without protection, it will withstand a wind velocity of 120 mph. Motors and rotating shafts run on sealed, anti-friction bearings and require no lubrication during the life of the unit. Here is complete dependability and freedom from servicing where it really counts. Write for complete information.



Write for information on specially-built equipment for your specific needs.

The HOUSTON FEARLESS Corporation

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• COLOR DEVELOPERS • DOLLIES • TRIPODS • PRINTERS • CRANES

11805 W. OLYMPIC BLVD • LOS ANGELES 64, CALIF.

"WORLD'S LARGEST MANUFACTURER OF MOTION PICTURE PROCESSING EQUIPMENT"

Production Testing

(*Continued from page* 81)

supply panel.

After panel assembly, the transmitter-receiver panel i-f strips, along with the remaining circuitry of the panel, are tuned up to the proper frequency, bandpass characteristics and power output.

On the local oscillator-modulator panel, the intermodulation characteristics are checked by using an intermodulation test set. The local oscillator is then checked at the high and low points of its frequency range.

In operation, the frequency of the local oscillator is controlled by the AFC. In test, the crystal controlled oscillator of the AFC panel is tuned to provide the required heterodyned frequency of 21 MC. The associated 21 MC i-f strip and discriminator are tuned. Output is checked and it is determined that ± 0.2 volt will cause the local oscillator tuning motor to run.

Rack Test

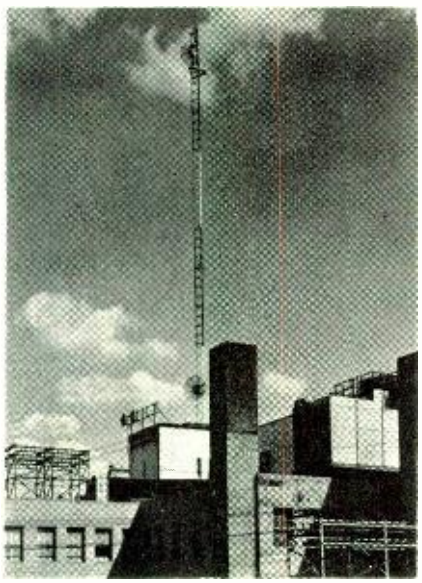
The above three panels, along with the power supply panel are then assembled for a composite rack test. This test checks all previously tested quantities and, in addition, serves other functions. The power supply is loaded to full load conditions. All cabling and plug connectors between units are automatically checked. The transmitter-receiver and local oscillator are retuned to the purchaser's frequency, and crystals are inserted. The receiver sensitivity and bandpass, the noise figure, intermodulation and distortion are determined. Finally, after tuning the duplexer, the transmitter is rechecked for power and bandwidth through the duplexer. These, of course, comprise only a portion of the total r-f testing procedures.

The multiplexing equipment is constructed on an even more pronounced sub-panel basis, and thus the tests may be performed in a similar manner. The elements of this structure provide the basic equipment necessary to supply the most frequently requested services.

Individual voice band panels or telegraphic receiver and transmitter sub-panels are fed from their own individual power supplies. Transmitter output power and receiver sensitivity are checked. The operation of relays used in all ring-down functions on the voice channels is checked. Signalling is accomplished by a frequency shift of the subcarrier. This shift is checked and the

associated discriminator is tuned.

The units are then consigned to stock in quantity, to be taken from stock subsequently as required to make composite assemblies according to order. Multiplexing frequency determining crystals are added and oscillators are tuned to user frequency specifications. Filter units are then added and a complete receiver alignment is made. The receiver sensitivity and bandpass characteristics are checked, followed by transmitter power output and bandpass characteristics.



End result of production testing is reliability better than 99%. Recent installation of system for power company in Charlotte, N. C., is shown here. Tower is for one of eight stations which supply 15 voice and 4 telegraph channels

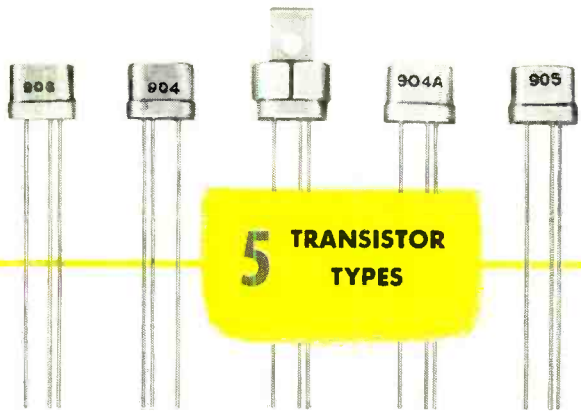
At this point one of the most vital phases of microwave system testing occurs—that is, the composite testing of multiplexing equipment. Complete racks of multiplexing equipment, assembled in essentially their final delivery form, are connected together. All cabling is thoroughly checked. A composite signal is sent into and out of the multiplexing equipment cabinets to check coaxial cable connections to the radio frequency equipment cabinet alongside. Modulation of r-f equipment is set up to the particular system requirements and preparation for the final and most rigid test of all is completed.

Pairs of functioning units, consisting of r-f and multiplexing equipment, and assembled essentially as they are in final operation, are operated through a lossy line which simulates actual free space attenuation. The stations are, to all effects, "on the air." Transmission is then checked in both directions.

silicon

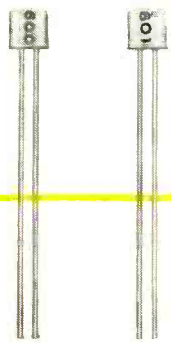
semiconductor devices available now in production quantities

HIGH VOLUME PRODUCTION of *silicon* semiconductor devices enables Texas Instruments to offer you an enlarged line of five types of silicon transistors and two types of silicon junction diodes . . . all available for immediate delivery in production quantities!



5 TRANSISTOR TYPES

SILICON TRANSISTORS-produced commercially by and available *only* from Texas Instruments – are now available with alpha (current amplification factor) to over 0.975 and with alpha cutoff frequency to over 8 megacycles . . . stable to 150° Centigrade (302° F)!



2 JUNCTION DIODE TYPES

SILICON JUNCTION DIODES are also manufactured by Texas Instruments from grown single crystals and feature back currents as low as 0.001 microamp and safe operation to 150° Centigrade! All TI semiconductor devices – *silicon* or germanium; diodes, triodes and tetrodes – are made with glass-to-metal hermetic seals.

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TEXAS INSTRUMENTS
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IBM Opens New Research Labs

THE first look at the newly-completed IBM Research Labs, a few miles from Poughkeepsie, N.Y., indicates that IBM's computer research is leading them into widely diversified fields of electronics.

With the buildings only 50% occupied, the departments already established are dealing with research and development in the fields of magnetic cores, printed circuits, transistors and semi-conductors, and cathode-ray storage tube design. Additional sections are concerned with the circuit applications of these products.

Highlight of the opening ceremonies was the unveiling of the latest product of IBM's research, the experimental all-transistor, printed-circuit calculating unit (Fig. 1). This new machine, which is comparable to their type 604 electronic calculator, uses 2,200 transistors, many of their own design. The original 604 uses 1,250 vacuum tubes, and is approximately twice the size of the transistorized model.

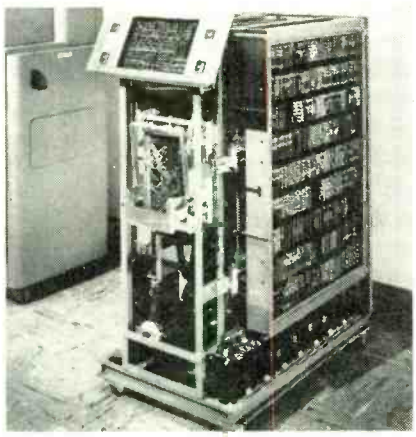


Fig. 1: IBM's all-transistor calculating unit

In addition to reducing the size of the machine, transistors effect a 95% reduction in the power requirement of the unit, doing away with the need for forced air cooling and a bulky power supply.

Heavy emphasis is being placed on transistor research with both point-contact and junction transistors being investigated for their applicability to computers.

Explaining their activity in this field, company officials pointed out that only through their own research could they develop components sufficiently reliable for computer use. Through the semi-conductor research department, which is concerned with analyzing and purifying germanium, they can arrive at the exceptionally high quality material

New IBM Labs *(Cont.)*

which is needed in computers.

Printed circuit research, which contributed so much to the design of the transistorized calculator, is seen as the key to further miniaturization of the computer units. (See Fig. 2) The present modular, stacked design of computer components can be expected to give way to printed circuits. Company officials were quick to point out, however, that the development of this new printed circuit, transistorized calculator does not mean the end of vacuum tubes. Their plans call for further use of vacuum tubes for many years.

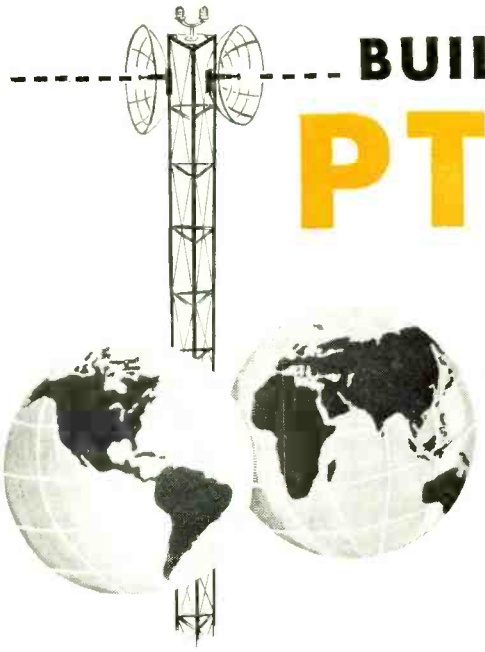
Magnetic cores are the subject of IBM's research because of their excellent "memory" characteristics. They can be magnetized either clockwise or counter-clockwise, alternately, and hold their polarization indefinitely, hence the "memory" feature. Those being developed at IBM range upward from 1/16-in. diameters with tolerance held to .0005-

Fig. 2: Calculator has 595 of these printed ckts

in. Here again, a research department is concerned with producing better ferrite materials, while the development group separately emphasizes the manufacture of better cores.

IBM is also concerned with improving existing products. Their tube design section at the lab has recently developed a new type of screen for their standard cathode-ray memory tube. A fine grid, woven of wire 0.0004-in. in diameter, takes the place of the fluorescent screen, and provides an increase of up to 10 times the storage capacity.

Also demonstrated at the opening was the new IBM 78 gas counting tube. This tube contains argon gas which is made to glow in separate compartments of the tube. The glow will move from step to step depending on the changes in voltage. It is said to provide reliable performance where the counting speeds required are not so fast that the more expensive vacuum-tube counters need be used.



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Microwave at its simplest and best

No other radio relay system can match the breadth of the experience built into Federal's Pulse-Time Modulation Microwave . . . culmination of over two decades of research, engineering, manufacturing and installation by associated companies of the world-wide International Telephone and Telegraph Corporation.

Here is the multi-channel system that is outstanding for its advanced design—featuring modern telephone techniques . . . streamlined circuitry . . . fewer tubes . . . simplest, smallest RF equipment . . . highest RF output . . . easy, economical maintenance.

Here is the system that is engineered to do a complete communications job for pipelines, railroads, utilities, telephone operating companies and many others . . . *and do the job dependably!*

Over 6,000 route-miles of Federal PTM Microwave have already been installed in the U. S.

Whatever your requirements, Federal is ready to help you plan microwave links and networks of any length or channel capacity . . . to deliver a "turn-key" installation . . . all from one reliable source of supply. For details, write Dept. H-466.

PTM and Other Microwave Milestones by IT&T System Companies:

- **FIRST** public demonstration of UHF communication (across the English Channel, 1931).
- **FIRST** commercial UHF link (Lympne, England to St. Inglevert, France, 1933).
- **FIRST** multi-channel radiotelephone link (Stranraer, Scotland to Belfast, Northern Ireland, 1936).
- **PIONEER** laboratory development of pulse systems of modulation—PTM (pulse time modulation), PCM (pulse code), PAM (pulse amplitude), and PWM (pulse width).
- **FIRST** public demonstration of PTM multiplex microwave point-to-point communication (New York City, 1945).
- **FIRST** public demonstration of PTM multiplex microwave broadcasting (New York City, 1946).
- **FIRST** commercial-type PTM microwave radiotelephone installation in: Eastern Hemisphere (the Netherlands, 1947); Western Hemisphere (Canada, 1948).
- **FIRST** private-line microwave installation (Keystone Pipe Line Co., United States, 1949).
- **FIRST** PTM microwave link for an aviation communication system (Mexico City Airport, 1949).
- **FIRST** television across English Channel, using portable microwave links (Calais-London, 1950).
- **FIRST** microwave television link to carry simultaneous sound (United States, 1951).
- **FIRST** long-distance intercity microwave television link in Eastern Hemisphere (Manchester-Edinburgh, 1952).
- **PIONEER** development of "Microstrip"—a substitute for wave guide. Announced to industry, 1953 (United States).

Federal PTM Microwave—First in "FIRSTS"

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MICROWAVE MOVIES

16 mm. color prints on "PTM" available without charge. Write to *Film Distributing Dept.*

Magnetic Tape (*Continued from page 87*)

uniformly wet and lump free. The mill is kept turning for one or two days for a given load. Fine milling here is a prerequisite for good tape because there are about 10^7 particles in 1 in. of ¼-in. wide tape, and a nodule as small as 0.002 in. can cause trouble if it is coated on the tape.

After the oxide is milled it is passed through a prefilter by gravity feed or air pressure. The prefilter may pass particles only 25 microns or smaller. The oxide in liquid binder suspension is pumped to a storage tank which keeps the liquid continuously agitated to prevent settling. A sample is tested under a microscope, and if acceptable, the batch is passed through a 5 or 10 micron filter to the coating room.

Coating

In the coating room, a roll of acetate (or mylar) base from one of the three suppliers in the field is given a very thin precoat (about 1/20 mil) of solvent to act as an adhesive for the iron oxide. The base is generally 1-1½ mil thick (manufacturers are also working on ½ mil stock to increase reel footage), about 4000 ft. on a roll, and about 9 or 12 in. wide (although some producers are reportedly using rolls twice as wide). After the precoat solvent is dried by the warm air it passes through in the

Tape slitting and reeling at Audio Devices

drying chamber, the oxide suspension is pumped from the storage tank to the coating head. In some cases, precoating is eliminated.

The base, continuously feeding off the main roll at a speed of 150 to 200 ft./min., passes under the coating head through which the oxide suspension flows, to be deposited across the entire width of the moving base. A constant gravity or pressure feed level in the coating head maintains uniform pressure. The height of the head above the base determines the coating thickness, which is about ½ mil when dry.

Still on one long continuous roll, the coated base goes into the drying chamber where it passes horizontally and then vertically over a series of rollers for a total travel distance of several hundred feet. The warm air is made dust-free by passage through a precipitator. For the first 15 seconds or so after the coating is laid, the tape touches the rollers only on its uncoated side to prevent smearing of the oxide. After this time it can touch rollers on the coated side.

After the tape is sufficiently dry, it passes under a magnetic recording and playback head assembly which indicates on a meter or strip chart the tape's relative input and output as a quality control check. The tape is rolled up and taken to the polishing machine.

Polishing

The object of polishing the tape is to smooth out minute bumps in the oxide coating, thereby reducing the friction which causes recorder head wear. The various tape makers have their own ideas on how this should be done. One means of polishing utilizes a dry lubricant sprinkled on the moving tape. Rotating brushes, such as nylon and horsehair types,

Announcing

THE MOST IMPORTANT MAGNETIC TAPE DEVELOPMENT IN SIX YEARS...

the irish FERRO-SHEEN process

DESTINED TO REVOLUTIONIZE THE MAGNETIC TAPE INDUSTRY

A completly new concept in the art of magnetic tape manufacture.

***FERRO-SHEEN* combines:**

- **A NEW Oxide and Binder Treatment**
- **A NEW Magnetic Surface Material**
- **A NEW Plastic Base**

. . . together in a new hot melt lamination process, resulting in the strongest bond, the highest uniformity of oxide particles, and the smoothest surface ever attained in recording tape manufacture.

This is how *FERRO-SHEEN* Improves Magnetic Tape:

EXTENDS FREQUENCY RANGE—Its mirror smooth surface permits vastly improved contact with the magnetic head; utilizing all the response available in the magnetic medium . . . all the highs . . . all the lows: Frequency is now limited only by the recorder you use.

REDUCED "DROP-OUTS" — Nodules and agglomerates that result in "drop-outs" are virtually eliminated.

DRASTIC REDUCTION IN HEAD WEAR — Absolutely no abrasion; it's friction free with "built-in-lubrication".

UNEXCELLED ADHESION — Oxide and film are almost homogeneous. No embrittlement with age — permanently plasticized.

***FERRO-SHEEN* is now available in Three New Tapes:**

1. **irish Sound-Plate Mylar #220**—The tough film tape pioneered by Irish . . . now on Mylar, Du Pont's new miracle polyester film. For all applications requiring the safeguarding of recorded material such as Tape Masters and Program Storage. Also recommended for broadcast remotes and other applications under adverse conditions of temperature and humidity: electronic photography —electronic computers, etc.

2. **irish Long Playing Tape #LP-6:00**— Up to six hours of recording on a standard 7" reel. Extra-thin, extra strength, because of its 1 mil Mylar base. Playing time is extended 50% over conventional tape.

3. **irish Shamrock #300**— Sets a new high in standards for professional recording. Protects those valuable magnetic heads. Extended frequency response. Higher output. Lower noise level. And many other excellent features that you will enjoy discovering.

ask for *FERRO-SHEEN* irish TAPE

The Finest Tape Your Recorder Can Use

Available at all leading sound dealers.

ORRADIO industries, inc.
Opelika, Alabama

American Pioneers in Magnetic Tapes

Export Division: Morhan Exporting Corp., New York, N. Y.
In Canada: Atlas Radio Corp., Ltd., Toronto, Ontario

Magnetic Tape

(*Continued from page 120*)

buff the coated surface and remove any excess lubricant. Further polishing to smooth nodules is obtained by self-rub. That is, the tape is doubled back on itself, and the two coated surfaces press against each other as they move in opposite directions.

Slitting

The last major production operation is slitting the wide roll of tape into ¼-in. strips, and winding each strip on a reel. One version of the cutter consists of a metal cylinder with vane-like circular blades jutting out of the cylinder ¼ in. apart. As the cylinder rotates on its axis, the blades press against the wide moving roll of tape to slit it. The narrow tapes thus formed fan out to their respective take-up reels. The trim edges of the wide tape that are cut off in the process are sucked into a vacuum intake.

Sharp edges along the tape are necessary for proper reproduction and strength. In some cases the circular knives are completely cold, reliance being placed on mechanical pressure to produce a clean cut. In other cases, blades are heated to utilize the thermal cutting properties of hot metal.

Control samples are taken out of each group of reels and tested. Small changes in output level or coating are permanently recorded on a strip chart. Excessive variations at this stage are not frequent since a whole series of quality controls have kept a watchful eye on operations from milling the iron oxide through winding the final reels.

The reels of tape are carried along a conveyor belt which passes over magnets. The magnets bulk erase any test signal remaining on the tape. After packaging the tape is on its way to the stock room—but only for a very short stay. Early shipment follows to fill the growing demand for more magnetic tape.

Magnetic Tape Manufacturers

Audio Devices, Inc. ("Audiotape")	T-120 Marvyn Rd. Opelika, Ala.
444 Madison Ave. New York 22, N.Y.	**Reeves Soundcraft Corp.** ("Soundcraft" tape)
Minn. Mining & Mfg. ("Scotch" tape)	10 E. 52 St. New York 22, N.Y.
900 Fauquier St. St. Paul 6, Minn.	**Technical Tape Corp.** ("Encore" tape)
Orradio Industries ("Irish" tape)	W. 177 St. & Harlem River Morris Heights 53, N.Y.

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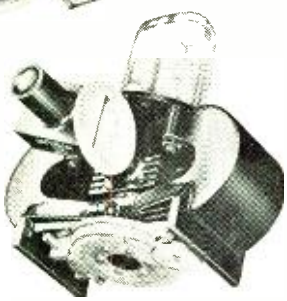
Two of these tubes just declassified

RK6230/QK299B — tunable pulse magnetron (8900-9400 Mc), 1 Kw average peak power

RK6410/QK338 — fixed frequency, pulse magnetron (2750-2860 Mc), 5 megawatt average peak power



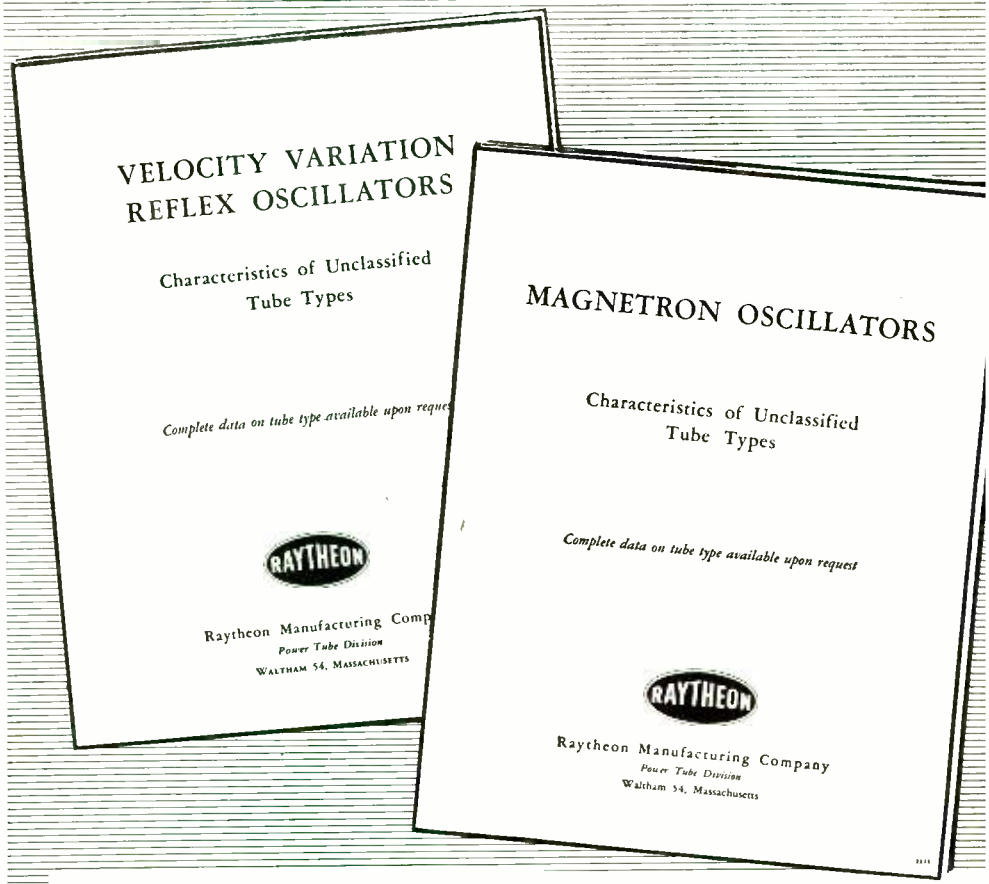
RK2J51 — tunable pulse magnetron (8500-9600 Mc), 50 Kw average peak power

RK5976—mechanically tunable klystron (6250-7425 Mc), average power 100 milliwatts

RK6116 — thermally tuned ruggedized klystron (8500-9660 Mc), average power 25 milliwatts

RK5721—klystron tunable with external cavities from 3600 to 10,500 Mc. Average power 125 milliwatts in the 2¾ reflector mode (4290-8340 Mc)

Raytheon also manufactures transmitting tubes, storage tubes and square law tubes



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Microwave Lens

(Continued from page 73)

density. This relation was found to be linear,

$$n = 1 + Kd. \qquad (2)$$

Upon substituting this relation in the Luneberg equation given above, it was found that the density of compressed Styrofoam in a wedge must vary radially as follows:

$$d = \frac{-1 + \sqrt{2 - \left(\frac{r}{r_o}\right)^2}}{K}. \qquad (3)$$

Using this expression for the density, on fixing the radius and angle between the faces of the wedges, the required mass in a "cylindrical" volume element perpendicular to the lower face of the wedge and bounded by the upper surface may be calculated as a function of the position of the volume element on the lower face. The fact that this mass must be obtained from uncompressed Styrofoam determines the equation of the

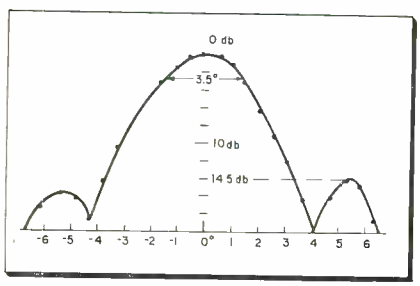

Fig. 4: Far-zone gain pattern of preliminary compressed Styrofoam spherical-wedge lens

upper surface before compression. The thickness, z, of the uncompressed segment must follow the law,

$$z = \frac{ra \sin \theta}{d_o r_o} \cdot \frac{-1 + \sqrt{2 - \left(\frac{r}{r_o}\right)^2}}{K} \qquad (4)$$

where,

a = thickness of wedge at the equator ($\theta = (\pi/2)$
d_o = density of uncompressed Styrofoam
K = slope of index vs. density law Equation (2)
r_o = sphere radius
θ = azimuth angle.

The next step in the fabrication of the lens was to construct a wood pattern with an upper surface following Equation (4), in which the parameters were given the following values:

$a = 0.4$ inch.
$K = 0.0089$ cu. ft./lb.
$r_o = 11.8$ inches
$d_o = 1.72$ lb./cu. ft.

By means of a pantograph machine, 186 segments duplicating the

pattern were cut from uncompressed Styrofoam. (See Fig. 1).

Next, the uncompressed segments were placed in pairs between dies and compressed to the desired wedge shape in a hydraulic press. Fig. 3 shows two of the segments in place in the press.

Assembly

Finally, the wedges were assembled into a sphere as shown in Fig. 2. Gain pattern measurements were made at 9375 MC for several lens orientations with both horizontal and vertical polarization. Fig. 4 shows the elevation antenna gain pattern with vertical polarization and with the lens axis vertical.

Comprehensive tests of the lens indicate that it is somewhat birefringent, that is, the lens is sensitive to polarization. However, provided the electric vector of the illuminating source is maintained in a plane including the north-south axis of the lens, the gain pattern is essentially independent of the sphere orientation. Further measurements are being conducted with an effort towards improving the primary feed pattern and consequently the side lobe level.

References

1. Luneberg, R. K., *Mathematical Theory of Optics*, Brown University Advanced Instruction and Research in Mechanics, Providence, Rhode Island, Summer 1944.

This work was supported by the Signal Corps under Contract No. DA-36-039 SC-56712.

The author is indebted to Messrs. W. W. Wright and M. W. Long for their valuable assistance in the microwave measurements.

New UHF Transmitter and Antenna

Rounding out its line of high power TV broadcasting equipment, GE announced availability of a new 23-kw UHF transmitter and a 50-gain UHF antenna. The new 23-kw UHF television transmitter features two 12-kw amplifiers in parallel. It uses three operating klystrons, two visual and one aural.

The new transmitter is priced at $175,000. When used with an existing 1-kilowatt transmitter, it is priced at $130,000. Equipment needed for boosting the transmitter power to 23-kilowatts in a station presently using a GE 12-kilowatt transmitter is priced at $85,000.

The new UHF helical antenna has a gain of 50. It is 114 feet long and utilizes 14 bays. The antenna is an extended version of the current 25 gain helical antenna supplied by GE to over 35 UHF broadcasting stations. The antenna is priced at approximately $75,000.

Better Solar Battery

A one-third increase in the efficiency of the Bell Solar Battery—first successful device to convert the sun's energy directly into useful amounts of electricity—is revealed by Bell Telephone Labs. Five months ago scientists had achieved a 6% efficiency in converting sunlight directly into electricity when the battery was first demonstrated. The experimental cells which now yield a record 8% efficiency are comparable to those of steam and gasoline engines. "Although there is room for improvement," Mr. Gerald Pearson reports, "this value of 8% is ten to fifteen times better than the best photovoltaic devices available. We are optimistic that in time a 10 or 15% efficiency can be achieved." The maximum theoretical efficiency is estimated to be 22%. The Bell Solar

Gerald L. Pearson, co-inventor of solar battery, checks atomic structure of silicon ingot. Battery's efficiency is now up to 8%

Battery is a simple-looking apparatus made of wafers of specially prepared silicon, whose particular properties make it especially suitable for converting the sun's energy into electricity. The improved cells can be electrically linked together to deliver power from the sun at the rate of 80 watts per square yard of surface.

Certain factors that tend to decrease the device's efficiency can be partially eliminated. At present, a considerable amount of the radiant energy is lost by reflection from the silicon surface and a part of the electrical energy is lost within the cell itself. Increased efficiency had been obtained in experimental cells by reducing these losses. The battery was invented by a three-member team of Bell Laboratories scientists —Mr. Pearson, Calvin S. Fuller and Daryl M. Chapin, physicist, chemist and electrical engineer, respectively.

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IN A WIDE RANGE OF SIZES AND RESISTANCE VALUES

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TAB-TERMINAL TYPE
Characteristics G, F, and V

Style	Over-all length	Diameter	*Watts	††Watts
RW-29	1-3/4"	1/2"	8	11
RW-30	1"	19/32"	8	11
RW-31	1-1/2"	19/32"	10	14
RW-32	2"	19/32"	12	17
RW-33	3"	19/32"	18	26
RW-34	3"	29/32"	30	43
RW-35	4"	29/32"	38	55
RW-36	4"	1-5/16"	60	87
RW-37	6"	1-5/16"	78	113
RW-38	8"	1-5/16"	110	159
RW-47	10-1/2"	1-5/16"	145	210

FERRULE-TERMINAL TYPE
Characteristics G, F, and V

Style	Over-all length	Diameter	*Watts	††Watts
RW-10	11-7/16"	1-5/16"	140	203
RW-11	9-5/8"	1-5/16"	116	168
RW-12	7-7/16"	1-5/16"	86	125
RW-13	5-1/8"	1-1/16"	50	72
RW-14	4-7/16"	1-1/16"	40	58
RW-15	2-15/16"	3/4"	20	29
RW-16	2-3/8"	3/4"	14	20

FLAT TAB-TERMINAL TYPE
(Stack Mounting) Characteristic G

Style	Over-all length	Width of Core	Thickness of Core	†Watts
RW-20	2-1/2"	1-3/16"	1/4"	15
RW-21	3-1/4"	1-3/16"	1/4"	22
RW-22	4-3/4"	1-3/16"	1/4"	37
RW-23	6"	1-3/16"	1/4"	47
RW-24	7-1/4"	1-3/16"	1/4"	63

AXIAL-TERMINAL TYPE
Characteristics G and V

Style	Length of Core**	Diameter	†Watts	††Watts
RW-55	1-3/8"	5/8"	5	7
RW-56	2"	5/8"	10	14

*Watts free air MIL Characteristic "F" or "G" **2-1/2" wire leads
†Watts free air MIL Characteristic "G"
††Watts free air MIL Characteristic "V"

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Transistor Preamp

(*Continued from page 80*)

causes a change in I_{co}, the collector current for zero emitter current. This change shifts all the collector characteristic curves and can cause a shift in operating point which would result in a change in gain. The operating points of this amplifier are then stabilized by a method which utilizes a stability factor, S, presented below.[6]

$$S = \frac{1 + \frac{R_1}{R_2} + \frac{R_1}{R_3}}{1 - \alpha + \frac{R_1}{R_2} + \frac{R_1}{R_3}},$$

where R_1 is the emitter resistor, R_2 and R_3 are the base stabilizing resistors, and α is the current amplification factor.

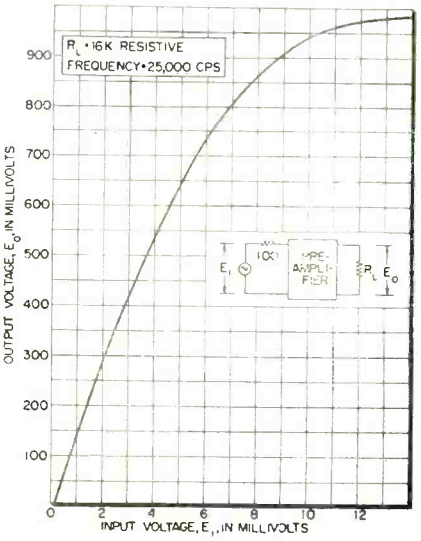

Fig. 9: Preamplifier output is linear to 0.4 v

The resistors are further identified in Fig. 10, which shows that the gain of an amplifier having a low stability factor results in greater stability with temperature. In this test, the circuit used was the final circuit developed except that different values of R_2 and R_3 were selected to give different first-stage stability factors. In the final circuit, the first stage had a stability factor of 1.13, while the second stage had a stability factor of 2.49.

The temperature stability of the circuit is shown in Fig. 7. The upper temperature, 122° F., is the manufacturer's maximum ambient temperature rating for the TA153. The total gain variation for the range from 30° F. to 122° F. varied from 0.6 db to 1.5 db for various transistor combinations.

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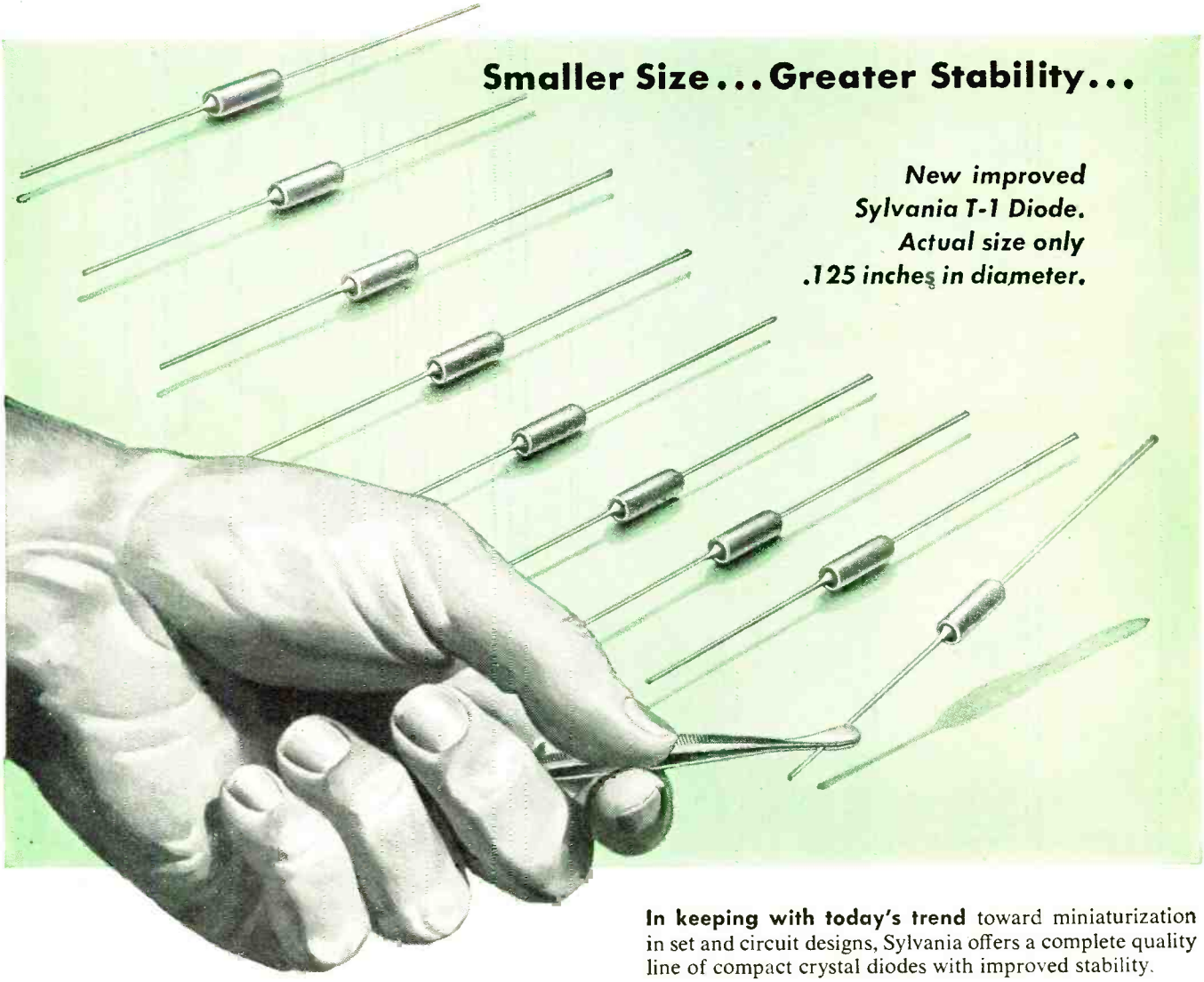

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Transistor Preamp

(*Continued from page* 128)

cuit is obtained at the cost of increased power consumption. Out of a total supply power of 0.013 watt to operate the amplifier, 0.006 watt, or nearly half the power, is used in stabilization. For this application, however, the added power drain is of no consequence.

Attempts to stabilize earlier circuits were unsuccessful until it was found that the leakage resistance of electrolytic capacitors used for bypassing and coupling increased with increasing temperature. The final circuit utilized paper capacitors exclusively.

The variation in amplifier gain with power supply voltage change, shown in Fig. 8, is large. This is due to the fact that the load line of the first stage, shown in Fig. 11, intersects the base current curves close to the curved region. The current amplification factor, α_{cb}, for a

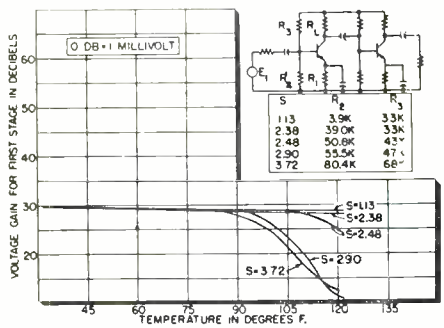


Fig. 10: Gain varies with stabilizing factors

grounded emitter stage is expressed as follows:

$$\alpha_{cb} = \frac{\partial I_c}{\partial I_b}\bigg|_{V_c},$$

where αI_c is the change in collector current and αI_b is the change in base current. Thus, it can be seen that as the supply voltage decreases, the quiescent point moves down and to the left into the curved region, causing αI_c to decrease while αI_b remains constant. Since operation close to this curved region is dictated for the first stage by the low noise requirement, the solution to this variation in gain lies in a regulated supply voltage.

The variation in voltage gain and phase shift was measured with several different transistor combinations in the same circuit. Out of 25 combinations, 17 gave a gain of 43 $\pm$ 2 db, while 3 were higher and 5 were lower. None was off by more than $\pm$4 db. Out of 11 combinations, 4 had a phase shift outside the desired

±5° phase variation from the mean. In order to make a quantity of these amplifiers fall within the above limits, it would be necessary to select the transistors for that specific purpose. However, free substitution of transistors in an amplifier would not be feasible. A solution to this problem would be to make the amplifier an integral, replaceable item and to permit the gain and phase shift of

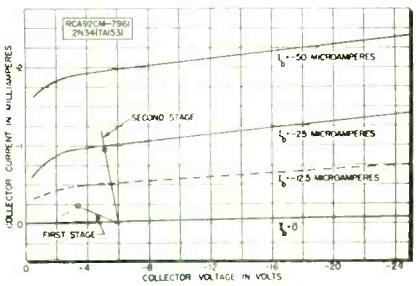


Fig. 11: Load lines for the transistor amp

each amplifier to be tailored to meet the requirements. Gain and phase can be trimmed by adjusting the resistor and capacitor in the emitter of the second stage. Since the transistor has longer life than that of the vacuum tube, this idea should be given consideration.

The characteristics of the vacuum-tube preamplifier and the transistor preamplifier are summarized in Table II.[6]

Transistor vs. V-T Ckt

The total power consumed by the transistor preamplifier is 0.013 watt as compared with the total plate and filament power of 2.2 watts needed for its vacuum-tube counterpart, which utilizes a 6SL7 tube. For the entire multi-channel system of 48 transistor preamplifiers this power consumption is 0.624 watt as compared with 105.8 watts for an equal number of vacuum-tube preamplifiers. The difference represents a saving of approximately 105 watts.

The transistorized preamplifier (see Fig. 1) is 1⅛ by 2¼ by 2⅝ inches in size, or 7.37 cubic inches. The 2⅝-inch dimension is the overall height and includes the plug. Each vacuum-tube preamplifier is 2 by 3 by 4½ inches in size, or 27 cubic inches.

The comparative volumes of the two preamplifier types, on a 48-channel basis, are 354 cu. in. for the transistor amplifier and 1300 cu. in. for the existing vacuum-tube preamplifier. This difference in volume represents a saving of 946 cu. in.

It should be pointed out that compactness of size was not particularly stressed in this development. It is believed that with a little further development, smaller-size capacitors

Transistor Preamp

(*Continued from page 131*)

and small deposited-carbon resistors (according to MIL-R-10509A) could be utilized. The transistor preamplifier would then have a volume of less than 5 cu. in.

References

1. L. J. Giacoletto, "Terminology and Equations for Linear Active Four-Terminal Networks, Including Transistors," *RCA Review*, vol. XIV, no. 1, March 1953, pp. 28-46, and "Transistor Characteristics at Low and Medium Frequencies," by the same author, in *Tele-Tech and Electronic Industries*, vol. 12, no. 3, March 1953, p. 97 ff.

2. L. J. Giacoletto, "Terminology and Equations for Linear Active Four-Terminal Networks, including Transistors," *loc. cit.*

3. The terminology used in Fig. 1 is explained in greater detail by Giacoletto in the articles cited in footnote 1.

4. R. L. Wallace, Jr., and W. J. Pietenpol, "Some Circuit Properties and Applications of n-p-n Transistors," *Bell System Technical Journal*, vol. XXX, no. 3, July 1951, pp. 530-563.

5. R. F. Shea, "Transistor Operation: Stabilization of Operating Points," *Proceedings of the I.R.E.*, vol. 40, no. 11, Nov. 1952, pp. 1435-1437.

6. S. J. Haefner, *op. cit.*

Coming Events

(*Continued from page 22*)

ACM: Assoc. for Computing Machines.
AES: Audio Engineering Society.
AIEE: American Institute of Electrical Engineers.
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 Services.
URSI: International Scientific Radio Union.

McDaniel Manager of Technical Information

H. C. McDaniel has been appointed manager of technical information for Westinghouse Electric Corp. Formerly manager of technical publicity, he will supervise both the technical publicity operations and the Westinghouse Engineer magazine. He replaces C. A. Scarlott, who has become manager of technical information services at Stanford Research Institute, Palo Alto, Calif.

COLOR TV MICROWAVE

American Tel. and Tel. engineers at a recent demonstration of the Raytheon KTR-100 microwave relay system, modified to transmit simultaneous color video and audio. Inset shows the KTR-100 and other test equipment used in the demonstration.

Signal Generator

(*Continued from page 84*)

the proper opening indicates the frequency range in use. Tuning range selection is by means of a transfer switch which in addition to shunting the level set meter and lighting the indicating pilot light rotates the finger-lifting eccentric rod by means of a dial cord drive.

This signal generator is now being produced commercially by Connecticut Telephone and Electric Corporation, Meriden, Connecticut.

References

1. *Paine*, Communications, *June 1944.*

W. Va. Turnpike

(*Continued from page 75*)

activating the system at the same time. In other words, the first station calling captures the system until the operator releases his push-to-talk switch.

When the microwave located transmitters are energized the intelligence is audible at all toll booth and vehicular stations, thus eliminating the necessity of any operator querying an operator for a circuit.

As can be seen by the foregoing description, the microwave located transmitters transmit on frequency F2 and receive on F1. The toll booth and vehicular stations transmit on F1 and F2 and receive on F2.

There is one executive station on the system located at the administration building near Charleston. The operation of this station is identical to a toll booth station.

Utilization of microwave communications in conjunction with the operation of a turnpike is only one step toward the future. Microwave may well be used for traffic control in the form of remotely diverting traffic lanes for the direction of the traffic load, warning signals, and traffic light control. Any controls that can be operated locally can be accomplished via microwave with the additional advantage of centralized supervision. By employing this modern method of control and centralized supervision, operational maintenance will be greatly reduced and safety significantly increased.

Custom Microwave Sources

Chicago Electronic Labs., 1214 W. Madison St., Chicago, Ill., now custom manufactures microwave pulsed power sources with outputs as high as 1.5 megawatts. Application of these units includes wave guide testing and antenna characteristic studies.

Rotary Joints

(*Continued from page 91*)

tion, as discussed below.

The "probe" type of waveguide to coaxial transition has found widespread use because of its mechanical simplicity and its broadband matching capabilities. However, it is not suitable for use in high speed rotary joints, due to its lack of sufficient mechanical rigidity. The "doorknob" transition was selected as the most promising prospect, both mechanically and electrically, for the remainder of the rotary joint. However, it was decided to simplify the "doorknob," in order to avoid the complex contours and critical dimensions of the conventional type. The result which was arrived at after preliminary study is shown in Fig. 1. It should be noted that the resonant end plate distance, usually employed as a matching parameter, has been eliminated. The remainder of the geometry was proportioned for simplicity, leaving the distance YB as the principal matching variable. The adjusting of this dimension and the addition of the capacitive step was conducted exactly as described above for the coupling loop transition. The resulting transition had the VSWR characteristic shown in Fig. 3, when followed by a coaxial termination.

Several types of complete rotary joints have been produced using the basic designs described above. These include 90° joints, using both above transition types in one joint, for "S band" and also for "X band." A 180° joint for "X band," using two similar step-matched doorknobs, has also been built and measured. Typical VSWR curves are plotted in Figs. 4, 5 and 6. The fabrication of these joints is accomplished using conventional machining techniques and accuracies, and no electrical matching or adjustment is performed during the process. All parts are interchangeable, and are machined on a quantity production basis.

Complete power breakdown data is not yet available for these joints. Preliminary pulsed tests of prototype models showed that the joints will operate without breakdown up to at least 1500 KW in "S band" and 175 KW in "X band." It has also been established that voltage breakdown usually occurs in the vicinity of the planes A and B in Fig. 1.

Honeywell Buys Heiland

Minneapolis-Honeywell Regulator Co. has purchased the assets of Heiland Research Corp. of Denver, manufacturer of precision scientific instruments.

Pattern Recorder

(*Continued from page* 90)

tor type antennas operating in the "X" band.

Fig. 9 is comparison of recording *accuracy* of logarithmic and square law receivers. The logarithmic recorder is assumed to have a constant maximum db. error for all pattern amplitudes. The square law receiver was assumed to have an accuracy expressible as a percentage of the pattern peak power. The scale on the left is the effective pattern error in db. as a function of pattern amplitude along the bottom scale. The contours are for various values of video measurement accuracy. For example at pattern ½ power a 7% video accuracy is equivalent to 0.5 db. pattern error. The logarithmic and square law recording techniques are of comparable accuracy for beam width measurements. However, for side lobe measurements say at 30 db. the logarithmic recorder would have again an 0.5 db. error and the corresponding accuracy required of a square law instrument might be ⅓% which might be very difficult to achieve. So that for beam width measurements the two techniques are comparable whereas in side lobe measurement the logarithmic procedure using conventional techniques appears to be the more accurate.

Sensitivity

The sensitivity of this instrument is not as good as that of a superhet or a two channel receiver; its sensitivity is higher than that of a recorder using a bolometer detector. The sensitivity of this instrument has been found to be more than adequate for most far field pattern measurements, it probably would not be adequate for certain low signal applications such as back scattering measurements of models.

As in any other recorder, the maximum usable antenna size is a function both of the permissible aperture illumination and of the frequency response of the recorder. In our case, a 30 in. antenna pattern could be measured in two minutes—which appeared to be adequate.

The microwave bandwidth of this type of recording instrument is very wide; the X band recorder is accurate over about a 20% spectrum. The instrument does have the disadvantage of an extra microwave component that must be changed between bands. Say in going from "X" to "L" band the calibrated attenuator would be replaced, which might not be necessary in some other recording systems.

Coaxial Impedance

(*Continued from page 93*)

a coaxial transmission line having various dielectric layers of different dielectric constants as long as the permeability remains nearly constant (approx. 1).

Decreasing Impedance

In the development of an impedance transformer, it was found necessary to lower the characteristic impedance of a short section of a coaxial line. The solution was first tried using paraffin. It was then necessary to convert to a more stable dielectric having different dielectric constants. What then would be the diameter of the new dielectric sleeving?

The problem was solved graphically by using the transcendental equation (15) with all the constant terms transferred to the left side of the equation as follows

$$\frac{Z_o}{138\sqrt{\mu_n}} = \frac{1}{\sqrt{k_1}}\log\frac{b}{a} + \frac{1}{\sqrt{k_2}}\log\frac{c}{b} \quad (17)$$

(See Fig. 2).

The correct diameter is obtained when the sum of the two terms on the right equals the constant term on the left.

As an example, let us consider the problem of placing a 56.6 ohm transformer on a 66 ohm coaxial air-filled transmission line. The 66 ohm line is composed of an outer conductor whose inner diameter is 3 in. and whose inner conductor has an outer diameter of 1 in.

In Fig. 2 is shown the coax line with a = 1 in.; b = x in.; c = 3 in.; $k_1 = 1$ and for k_2 there is the choice of 2.1, 2.3, and 2.6. Fig. 3 (curves) shows the solution of Eq. 17 for three values of k_2. The diameter of dielectric required for the transformer are as follows:

k_2	b
2.1	1 9/16 in.
2.3	1 5/8 in.
2.6	1 11/16 in.

It is interesting to contemplate what might happen to a coaxial line if k_e were a function of r. By looking at Eq. 7 and moving k_e into the integral

$$V = \frac{I}{2\pi}\sqrt{\frac{\mu_m\mu_o}{\epsilon_o}}\int_a^b \frac{dr}{\sqrt{k_e}\,r} \quad (18)$$

it would appear that if k_e were to vary as $\frac{1}{r^2}$ then we would have

$$Z \propto (b - a) \quad (19)$$

Also, if k_e were a function of $\frac{1}{r^4}$ then

$$Z_0 \propto (b^2 - a^2) \qquad (20)$$

In general, then, it appears that if the dielectric of a coaxial line is known, and can be expressed by an integrable function, then it is possible to determine the characteristic impedance of a coaxial line either completely or partially filled with dielectric other than air.

References

1. T. Morena, *Microwave Transmission Design Data*, McGraw-Hill 1948 CH-384.
2. N. Marcuvitz, *Waveguide Handbook*, MIT Rad Lab Series, Vol. 10 McGraw-Hill, 1951, Section 1.2.
3. R. I. Sarbacher and Wm. A. Edson, *Hyper and Ultra High Frequency Engineering*, John Wiley & Sons, Inc. 1943.
4. Gilbert, *Electricity and Magnetism*, p. 59, MacMillan 1947.
5. E. A. Guillemin, *Communications Networks*, Pg. 46, John Wiley & Sons 1947.

Southern Mobile Sales

Sales of Du Mont mobile radio products in New Orleans, La., and a fifteen-county area surrounding that city will be handled by E. Emile Rackle Communications, Inc., Arline Highway, New Orleans 20, La.

Microwave Gyrator

(*Continued from page 66*)

mathematical expression for the magnitude of the rotation of the plane of polarization has been previously derived by the author[5] and by F. F. Roberts.[6]

It is quite simple to measure the Faraday rotation at microwave frequencies. A typical system for doing this is shown in Fig. 5. In this system, two rectangular wave guides are separated by a circular wave guide, the proper non-reflective transitions being made at each end of the circular section, which is about 12 in. long. One rectangular guide is supported so that it can be rotated about the longitudinal axis of the system. The dominant TE_{10} mode is excited in one rectangular guide, and by means of the smooth transition this goes over into the dominant TE_{11} mode in the circular guide. The rectangular guide on the opposite end will accept only that component of the polarization which coincides with the TE_{10} mode in that guide, the other component being reflected at the transition. Absorbing vanes inserted in the circular section absorb this reflected component. The circular guide is placed in a solenoid to establish an axial magnetic field. Ferrite cylinders to be measured are placed in the mid-section of the cir-

Microwave Gyrator

(*Continued from page* 137)

cular guide. When a cylinder is used which does not completely fill the cross-section of the guide, it can easily be supported along the axis of the guides by means of a hollow polystyrene cylinder, or by means of a polyfoam support. In this device, the rotation of the plane of polarization is measured as a function of the static DC magnetic field applied to the axis of the guide by means of the solenoid. Fig. 6 gives the experimentally measured values of the rotation of plane of polarization as a function of the applied magnetic field for a particular sample of magnesium manganese ferrite.

As was previously indicated, the anti-reciprocal property of the Faraday effect affords a means of realizing a microwave circuit element which is analogous to Tellegen's gyrator. Such a microwave gyrator is

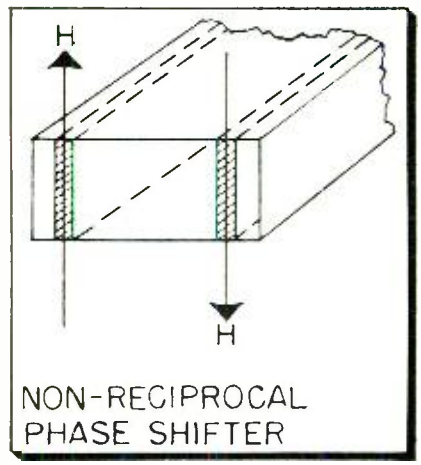


Fig. 10: Gyrator employing symmetrical oppositely biased ferrite slabs in waveguide

illustrated in Fig. 7 along with diagrams which help to explain its action. Beneath the gyrator are construction lines which indicate the plane of polarization of a wave as it travels through the gyrator in either direction. On each diagram is a dotted sign wave for reference only, which indicates the constant plane of polarization of an unrotated wave. It is noticed that for propagation from left to right in Fig. 7 the screw rotation introduced by the twisted rectangular guide adds to the 90° rotation given to the wave by the ferrite element, making a total rotation of 180°. For a wave travelling in the reverse direction, these two rotations cancel each other, producing a net zero rotation through the complete element. The unique property of the Faraday rotation becomes immediately apparent from this diagram. In the case of the rotation induced by the twisted rectangular

guide, the wave rotates in one direction in going from left to right through the twisted section, and rotates in the opposite direction when it transverses the section from right to left. For the case of the rotation induced by the ferrite element, the direction of rotation is indicated by the arrow in the upper figure for either direction of propagation. The important characteristic of the element is the time phase relation between two points such as A and B in the upper diagram. It is seen, with the help of the diagram illustrating the rotating waves that the field variations are in phase at points A and B for propagation from left to right, and they are 180° out of phase for propagation from right to left. In other words, the transmission line is a half wave length longer between A and B for propagation from left to right than it is for propagation from right to left.

If the rectangular wave guides on each side of the ferrite are rotated about the common axis, so as to make an angle of 45° with each other, then a one-way transmission system can be created which is similar to Lord Rayleigh's one-way transmission system of optics. This one-way transmission system can be used, for example, to isolate the generator or detector from the wave guide in microwave systems. In this application it has a great advantage over the attenuators which are presently used for this purpose, in that it can be made practically lossless for the direction of propagation which is desired, but the reflected wave will be completely absorbed, and hence more complete isolation can be effected. This device has been called a polarization circulator. The polarization circulator actually has four output branches and is identical to the optical system illustrated in Fig. 2. The four output branches correspond to the two different polarizations at each end of the device. Polarizations at right angles to each other can be separated and conducted to different microwave channels in the same manner that a Nicol prism does this for optical wavelengths. The polarization of the four output branches are indicated schematically in Fig. 8. It is noticed that power sent into the polarization circulator with polarization a is turned into polarization b. Also b is turned into c, c is turned into d, and d is turned into $-a$. This property is indicated very clearly by the circuit symbol suggested in Fig. 8, the phase inversion between arms d and a being indicated by the minus sign between the d and a arms. Another one-way transmission system can be

Microwave Gyrator

(*Continued from page* 139)

created by combining the gyrator with two magic tees. This combination is indicated in Fig. 9. Since this device has all the fundamental properties of the polarization circulator, with the exception of the phase inversion between arms d and a, it has also been called a circulator and the circuit symbol suggested which indicates its properties is given in Fig. 9. In Fig. 9, the letter π with the arrow over it is supposed to indicate a gyrator since the fundamental property of a gyrator is that it shows of phase shift of π radians (180°) for one direction of transmission but not for the other.

The elements discussed above represented the original form for the microwave gyrator and circulator.[5] Since these were first discussed, Kales[7] and his collaborators at the Naval Research Laboratories have shown how to build a gyrator without the inconvenience of using round wave guide. In this version a slab of ferrite is placed asymetrically in the rectangular wave guide and biased with a steady magnetic field or alternatively, two slabs of ferrite are placed symmetrically in the waveguide and biased in opposite directions with a steady field as shown in Fig. 10. If the length of the ferrite slab is adjusted to the proper length, the waveguide section can be made to be a gyrator. That is, it is a half wave length longer for one direction of propagation than it is for the other. This gyrator can obviously be connected to the two magic tees as illustrated in Fig. 9 to also construct a circulator.

This list of applications is obviously not complete, since it includes only the fundamental elements from which innumerable specific applications can be made. In addition to the applications discussed above, which depend upon the anti-reciprocal property of the element for their operation, there are several simple applications which are based only upon the fact that the amount of rotation, or phase-shift, can be controlled externally by adjusting the magnetic field. Among these, are electrically controlled attenuators, modulators, and microwave switches.

References

1. E. M. McMillan, J. Acous. Soc. of America 18, pp. 344-347 (1946)
2. B. D. H. Telegen, Phillips Research Reports, 3, 81-101 (1948); 3, 321-337 (1948) 4, 31-37 (1939); 4, 366-369 (1949)
3. Lord Rayleigh, Nature 64, 577 (1901)
4. H. König, Optik 3, pp. 101-119 (1948)
5. C. L. Hogan, Bell System Technical Journal 31, 1-31 (1952)
6. F. F. Roberts, J. Phys. et Radium 12, 305 (1951)
7. M. L. Kales et al., J. Appl. Phys. 24, 816 (1953)

Printed Circuit Symposium

A Symposium on Printed Circuits under the sponsorship of the Engineering Department of the Radio-Electronics-Television Manufacturers Association will be held Jan. 20-21 at the University of Pennsylvania. The technical program for the two-day meeting, which will include six sessions, is under the direction of Donald W. Cottle of the General Electric Co., Syracuse, N. Y., who has announced the following tentative broad outline of the symposium:

I. **Product Design Applications.** Conversion of specific products from conventional construction to printed circuit construction.
II. **Reliability and Serviceability.** Techniques for meeting Underwriters' Laboratories' requirements; specific reliability data, and special tests for reliability. Repairmen's acceptance of printed circuit products and their problems.
III. **Management Considerations.** Converting a manufacturing operation from conventional electronic products to printed circuit products. Economics of such changes.
IV. **Panel Session on Techniques of Producing Printed Wiring Boards.**
V. **Printed Components and Components for Use with Printed Wiring.**
VI. **Production Techniques and Manufacturing Methods.**

Joyce Appointed Rep

Dynamic Electronics-New York, Inc., engineers and manufacturers of electronic equipment for the Armed Forces and civilian industry, has appointed Temple Nash Joyce as representative on Government contract relations covering the field offices in Washington, D. C. and Philadelphia, Penna.

NBC Call Letters Change

FCC has approved the request made by N.B.C. to change the call letters of its company-owned stations effective Oct. 17, 1954. New York AM, FM and TV stations will switch from WNBC to WRCA. In Los Angeles, KNBH will become KRCA. In Washington, WNBW will become WRC-TV.

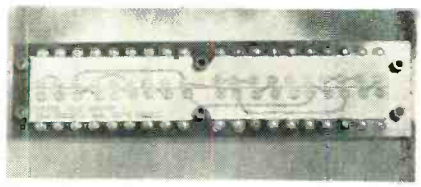
COLOR TV BULBS

W. M. Scott, Jr., (center) President, I-T-E Circuit Breaker Co., W. S. Hubbs, (l) general sales mgr., Special Prods Div., and H. H. Harman Jr., Mgr., TV Sales, discusses construction details of new I-T-E 21" metal color TV bulb for the new RCA 21" color picture tube. Metal is type 430 stainless steel and is now in production.

B.B.C. Execs Tour Du Mont's Tele-Centre

A group of top executives for the British Broadcasting Corporation recently inspected the Du Mont Television Network's Tele-Centre. Expressing great interest in the Tele-Centre's unique new features and great technological advances, the executives revealed that the proposed studio control room layout for the B.B.C.'s soon-due TV studios in White City, London, would be patterned after the Tele-Centre's split arrangement. The B.B.C. group included R. H. Howell, chief of building construction and maintenance; H. W. Baker, supervising engineer of the B.B.C.'s television studios; S. W. Watson, head of television design engineering; R. H. Mannons, head of television planning and installation; and Reginald Patrick, chief engineer for the B.B.C.'s New York Office. Guiding the B.B.C. group through the Tele-Centre were Rodney D. Chipp, Du Mont's director of engineering; Harry C. Milholland, manager of technical operations; and John Morrisey, of the international division, Allen B. Du Mont Laboratories, Inc.

TEMPLATES SAVE MAN-HOURS



Wiring jumper wires to resistor boards at Martin Aircraft, Baltimore, Md., is a simple matter. Removable paper templates with complete directions are taped to the center as shown in this close-up. New method saved 1500 man-hours of work on Matador assembly line.

DuPont Exhibits "Mylar"

Making the first stop of a nationwide tour of key cities, a traveling exhibit featuring the latest applications for Du Pont's new "Mylar" polyester film will be shown to the trade in the Hotel Roosevelt, New York City, Nov. 3, 4, and 5. Special displays will feature electrical and non-electrical applications, such as insulation, pressure sensitive and magnetic recording tapes, and industrial laminates; vapor barrier and thermal insulation protection materials, etc. Other displays will illustrate how the film's unusual combination of physical, electrical, thermal, and chemical properties permit new design changes and product improvements. The exhibit will be on display in Chicago, Nov. 16, 17, and 18; and in Cleveland, Nov. 30-Dec. 1.

Military Contract Awards

Electronic products, dollar value, and names of manufacturing contractors receiving awards as reported by U.S. Dept. of Commerce.

Transmitters, test-228,849—Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N.J.

Analyzers, computer-38,371—Akeley Camera and Instrument Corp., 175 Varick St., New York, N.Y.

Cables and Acces.-134,127—General Cable Corp., 808 Nat'l Fidelity Life Bldg., Kansas City 6, Mo.

Radar Sets-274,765—Raytheon Mfg. Co., Waltham, Mass.

Target Drones-3,266,190—Ryan Aeronautical Co., San Diego, Calif.

Voltage Regulators-29,988—Red Bank Div., Bendix Aviation Corp., Eatontown, N.J.

Resistors, etc.-45,316—Fairchild Camera and Instrument Corp., 225 Park Ave., Hickesville, L.I., N.Y.

Relays-36,220—Cook Electric Co., 2700 N. Southport Ave., Chicago 14, Ill.

Switches-89,050—Airsearch Mfg. Co., Div., Garrett Corp., 9851 Sepulveda Blvd., Los Angeles 45, Calif.

Tubes, electron-655,768—Radio Corp. of America, Tube Div., 415 South Fifth St., Harrison, N.J.

Computer-Indicators-62,284—Specialty Assembling and Packing Co., Inc., Brooklyn, N.Y.

Radio Sets-1,463,353—Crosley Div., Avco Mfg. Corp., Cincinnati 15, O.

Trainers, instr. flying-928,896—Link Aviation, Inc., Binghamton, N.Y.

Interverlometers-1,145,163—Ryan Industries, Inc., 19159 John R St., Detroit 3, Mich.

Transmitters, indicator-193,716—U.S. Gauge Div., American Mach. and Metals, Inc., Sellersville, Pa.

Transformers-52,704—Albert Mfg. Corp., 524 W. 43rd St., New York 36, N.Y.

Oscilloscopes-248,726—Lavoie Labs., Inc., Matawan, Freehold R., Morganville, N.Y.

Meters, field strength-37,476—Telerad Mfg., Corp., 1440 Broadway, New York 18, N.Y.

Alternators-187,749—Bendix Aviation Corp., Red Bank Div., Eatontown, N.J.

Regulator-Magnetic Amplifier-493,130-Cline Electric Mfg. Co., 3405 West 4th St., Chicago, Ill.

Switch, control stick-504,812-Guardian Electric Mfg. Co., 1621 West Walnut St., Chicago 12, Ill.

Components, radio beacon-6,515,910-Sperry Gyroscope Corp., Great Neck, Long Island, New York.

Indicator, tachometer-257,665-Kollsman Instrument Corp., 80-08 45th Ave., Elmhurst, New York.

Generator, tachometer-64,864-General Electric Co., 1 River Rd., Schenectady, New York.

Generator, acft-93,427-General Electric Co., 11 West Monument Ave., Dayton, Ohio

Electronic Parts & Materials-631,261-Lockheed Acft Service International Inc., New York International Airport, Jamaica 20, New York.

System, digital data recording-167,000-The Austin Co., Special Devices Div., 79 9th Ave., New York, N. Y.

Tape, magnetic sound recording-46,616-Audion Devices, Inc., 444 Madison Ave., New York 22, N. Y.

Test Sets-25,446-Servomechanisms, Inc., Westbury, L. I., N. Y.

Controller and Servomotor-26,060-General Electric Co., 1405 Locust St., Philadelphia 2, Pa.

Transmitter, aerohead-33,085-G. M. Giannini and Co., 580 Fifth Ave., New York, N. Y.

Antenna, reflector-36,162-Philco Corp., "C" and Tioga St., Philadelphia, Pa.

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Remote Control System

(*Continued from page 95*)

further the relative merit of dc versus ac as the signaling means. Dc is definitely the simplest. However, there is a distinct limit to the distance over which it will operate and it is not always possible to get a circuit which is suitable. If the distance over a metallic circuit is very great or if the control is to be exercised over a UHF or microwave system, the dc system is completely incompatible.

AC System

The ac system, regardless of the form of switching, must include suitable ac tone generators and corresponding selective tone receivers. This equipment is relatively simple and easy to maintain but it is important to select equipment that has been designed to insure stability of frequency and level under all operating conditions and that will give dependable service within a minimum of maintenance. In some cases the frequencies may all lie in the

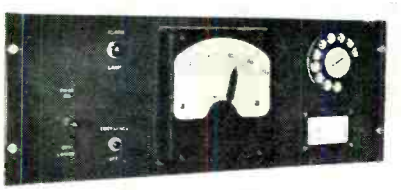


Fig. 4: Control panel for studio end of all-ac audio tone control system

audio frequency range between 300 and 2500 cps which can be readily transmitted over the average telephone circuit. In other cases it may be desirable to use higher frequencies in the supersonic range from approximately 17,000 cps up. This is generally encountered in UHF or microwave practice where the program material is handled over this same channel in the audio spectrum below 15,000 cps. If the control tones are closely grouped in a narrow band it may be possible to isolate this section of the spectrum with notching filters and use the same channel for simultaneous telephone communication. This would be applicable when the control frequencies fall in the normal telephone channel. The eliminated band would generally lie somewhere between 1,500 and 2,000 cps where loss of frequency components causes no appreciable degradation of telephone quality.

The audio-frequency, ac system offers distinct advantage over dc in that several control functions can be

separated on a frequency basis and transmitted simultaneously. The control signals will be transmitted by all standard telephone line equipment including repeaters so there is no need for special circuit facilities. Furthermore, the same line may be used for remote metering thereby reducing the rental charge for line service. Another point of great importance is the availability of alternate lines in case of line failure. There are relatively few lines suitable for dc control so the telephone company cannot generally give the same assurance of circuit continuity as is possible in standard circuits.

The remote metering problem has been solved in several ways. The simplest arrangement consists of merely installing a dc meter at the studio with direct dc connection to the transmitter over a telephone circuit. There must be suitable correction for the additional resistance introduced by the interconnecting line. Since all lines are subject to change in dc resistance and leakage it is necessary to have some means for calibration. Recalibration may be necessary at rather frequent intervals in some situations. In order to connect the metering circuit to the various metering points a stepping switch or relay chain is commonly used. The particular quantity desired is dialed over the regular control system. One functional point must be reserved for the calibrating operation.

This arrangement is limited to lines of relatively short length and requires frequent calibration. It is low in first cost, it provides continuous readings and is simple to maintain. It cannot be used over radio or microwave systems.

Telemetering

Two forms of standard telemetering are available. While these are more expensive they do offer certain advantages and have a much broader field of application. One form is termed Pulse Duration Telemetering. The transmitting equipment is arranged to send a pulse which is proportional to the quantity being observed. This pulse is recognized by the receiving equipment and a follower is held in contact with a uniform-lift cam for a length of time equal to the length of the pulse. The cam is run by a constant speed motor so the amount of lift is determined by the length of time in contact. This form of telemetering is predicated upon sampling, the sampling rate being either once in 5 secs or once in 15 secs, depending upon the requirement.

Remote Control System

(*Continued from page* 145)

The equipment is independent of the transmission line since it is not sensitive to levels over a wide range. It does not require frequent calibration.

The second form of standard telemetering is based upon frequency modulation or frequency shift. A very low audio-frequency, generally below 25 cps is controlled by the magnitude or quantity under observation. The higher the magnitude the higher the frequency, with correspondence being on essentially an instantaneous basis. The variable frequency tone sent out by the transmitter is recognized by the receiving equipment which converts it into unidirectional electrical pulses, the average value of which is equal to the transmitted quantity and is read on a dc meter. This form of telemetering has the advantage of providing continuous reading; however, it is the most costly and is somewhat more complex. In general it has the same advantages as the pulse duration type of telemetering discussed above.

Direct Transmission

If the distance between studio and transmitter is short the telemetering signal from either of the above systems may be transmitted directly. The transmission line must be capable of handling dc and very low frequency ac signals and must be reserved for telemetering. When the length of transmission line exceeds the practical limit for dc transmission or when the control system must operate over a radio or microwave system a subcarrier tone is necessary for the telemetering channel. The basic tone equipment includes a tone generator and modulator unit at the transmitter and frequency selective receiving equipment for the studio. The modulator equipment makes possible the transmission of tone pulses for pulse-duration telemetering or amplitude modulates the tone carrier in accordance with the low audio frequency generated in the FM type telemetering system. The audio subcarrier is readily transmitted over any voice frequency communication channel. Variations in amplitude, over a considerable range, and possible changes in frequency of the subcarrier do not influence the accuracy of the telemetered quantities.

If continuous metering of any type is available it is possible to meet the

monitoring requirements by remotely reading the output of the monitors installed at the transmitter. If the system does not provide continuous metering it is necessary to install monitors at the studio or other control point. Since a considerable amount of power is required to drive all standard monitoring equipment it becomes necessary to install a suitable radio frequency amplifier for this purpose. These are fix-tuned units and they must be capable of delivering the required signal to the monitoring equipment without change in frequency or without alteration of the modulation characteristic. It is obviously impractical to use any heterodyne type of amplifier as the local oscillator would introduce frequency error which would probably exceed the allowable deviation of the station.

General Problems

In a general sense, the problem of remotely controlling a broadcast transmitter is identical to that of remotely controlling any operation. A number of separate functions have to be performed and it is highly essential that these be accurately selected and reliably executed. Many ingenious arrangements can be conceived but the well established control art has developed certain techniques of proven dependability. A system based upon the use of audio subcarrier tones makes possible the necessary simultaneous operations over a single communication channel and provides maximum immunity from extraneous influences. (Fig. 2.) The tone system is rapidly replacing dc in telephone switching practice and in all branches of commercial remote control. This trend, based upon long experience, is indicative of the inherent dependability and versatility of the system.

The preceding remarks have necessarily been brief and rather general. At this point a summary of factors pertinent to the user and based upon overall system considerations will possibly provide the most useful conclusion.

In choosing a control system the purchaser should carefully consider each of the following factors:

A. The equipment should be built to transmitter standards.

B. The system should be economical. First cost is a natural prime consideration but the long term economy must be given proper weight. The system that requires two or three communication channels will incur substantially heavier month to month expenses than the

Remote Control System

(*Continued from page* 147)

system which operates over a single channel.

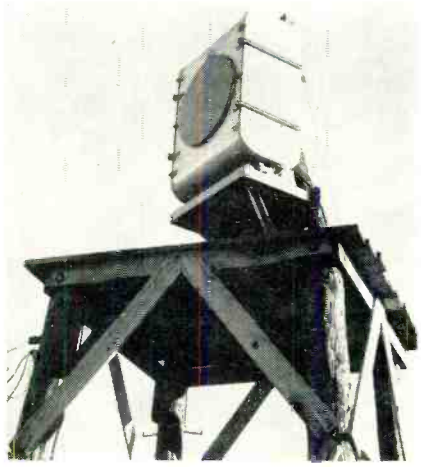
C. The unit should be designed for expansion and flexibility. As operating experience is accumulated the desirability of additional features may be evident. Furthermore, the requirements of the FCC may be adjusted from time to time based upon observed performance. For example, a radio or microwave control link may be desirable at some time in the future. The system which is most adaptable to this changing picture has minimum susceptibility to obsolescence.

D. The control system should provide maximum immunity to extraneous influences. If the operation can be influenced by the rerouting of a telephone circuit or by a change in circuit constants or by stray electric currents it is obviously not as reliable as the system which is immune to such factors. While it is impossible to foresee all possible sources of interference there are many well known sources which can be considered and avoided by proper design.

E. The control system should eliminate, so far as possible, the human element in routine operation. The best personnel can overlook details and the most carefully established set of procedures cannot guarantee that the individual executing them will not deviate from time to time. So the best system would be the one requiring minimum attention for adjustment and calibration.

(This paper was presented at the AIEE Winter Convention, Session on Broadcast Receivers and Automatic Transmitters, Jan. 22, 1954.)

MICROWAVE "TELELINK"



New microwave telephone link by Raytheon establishes communications for as many as 20 telephones in rural areas and ranges up to 50 miles in single hops. Operates in 6000 MC band with appr. 1 MC bandwidth

Military Contract Awards

(Continued from page 143)

Generator, pulse-159,499-Cosmos Industries, Inc., 31-28 Queens Blvd., Long Island City, N. Y.
Tube, electronic-84,952-Radio Corp. of America, Tube Div., 415 South 5th St., Harrison, N. J.
Tube, electronic-35,550-Allen B. Du Mont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N. J.
Line Section, radio frequency transmission-29,-400- Andrew Corp., 363 East 75th St., Chicago, Ill.
Tube, electron-162,750-Raytheon Mfg. Co., Power Tube Div., 138 River St., Waltham, Mass.
Frequency Recorder-45,600-Potter Aeronautical Co., 85-87 Academy St., Newark 2, N. J.
Wire-715,104-Whitney Blake Co., 1565 Dixwell Ave., New Haven 14, Conn.
Wire-2,700,552-Plastic Wire and Cable, Jewett City, Conn.
Wire-753,004-The Rex Corp., Hayward Rd., West Acton, Mass.
Wire-756,757-Lowell Insulated Wire Div., The Overlakes Corp., Lowell, Mass.
Wire-758,376-The Okonite Co., Passaic, N. J.
Wire-681-600-Essex Wire Corp., 1601 Wall St., Fort Wayne, Ind.
Wire-710,400-Phelps Dodge Copper Products Corp., 40 Wall St., N. Y.
Wire-1,228,224-General Insulated Wire Co., 69 Gordon Ave., Providence, R. I.
Oscillograph and Magazine-28,825-CEC Instruments, Inc., 3224 Peachtree Rd., Atlanta 5, Ga.
Magnetic Type Playback Equipment-67,517-Donner Scientific Co., 2829 7th St., Berkeley 10, Calif.
Calibrators and Spare Parts-52,604-Allen B. Du Mont Laboratories, Inc., Clifton, N. J.
Gyros-71,846-Control Engineering Corp., Providence Highway, Norwood, Mass.
Electrodes, welding-47,770-McKay Co., 1005 Liberty Ave., Pittsburgh 22, Pa.
Battery, dry-598,845-P. R. Mallory & Co., Inc., 60 Elm St., N. Tarrytown, N. Y.
Wattmeter-26,812-Bird Electronics Corp., 1800 East 38th St., Cleveland 14, Ohio.
Enlarger, "Electrofax"-68,372-Radio Corp. of America, RCA Victor Div., Camden, N. J.
Amplifiers, junction-3,189,341-Bendix Aviation Corp., Eclipse-Pioneer Div., Teterboro, N. J.
Cable Assys-48,235-Marathon Elec. Mfg. Corp., Wausau, Wis.
Transmitter, rate of flow-833,720-Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.
Master Control-126,358-Bill Jack Scientific Instrument Co., Selana Beach, Calif.
Generator, pulse-292,497-Motorola, Inc., Chicago, Ill.
Generator Set-38,574-General Electric Co., Washington, D. C.
Tubes, electron-81,038-Raytheon Manufacturing Co., Waltham, Mass.
Radar Set Spares-6,614,076-Gilfillan Bros., 1815 Venice Blvd., Los Angeles, Calif.
Receiving and Transmitting Sets-377,101-Olympic Radio and Television, 34-01 38th St., Long Island City, N. Y.
Radio Set Controls-44,200-Telephonics Corp., Huntington, L. I., N. Y.
Radio Sets-240,702-Motorola, Inc., 4545 West Augusta Blvd., Chicago, Ill.
Klystron Amplifier-55,634-Eitel-McCullough, Inc., 798 San Mateo Ave., San Bruno, Calif.
Miniature Facsimile Scanning Head-41,667-Minneapolis, Honeywell Regulator Co., Wayne and Windrim Ave., Philadelphia, Pa.
Electrodes-43,065-Arcos Corp., 1500 S. 50th St., Philadelphia 43, Pa.
Actuator and Spare Parts-64,664-Lear, Inc., 110 Ionia Ave., N.W., Grand Rapids 2, Mich.
Disconnect Assy.-67,498-R. E. Darling Co., 6825 Reed St., Betheseda 14, Md.
Actuator-38,174-Revere Camera Co., 320 E. 21st St., Chicago 16, Ill.

BULLETINS

OBTAIN THESE BULLETINS described here by writing on company letterhead to Bulletins Editor, TELE-TECH & ELECTRONIC INDUSTRIES, 480 Lexington Ave., New York 17, N.Y., listing numbers given at end of each item of interest. Please mention title of position held.

Resistors

Bulletin G-1, Catalog Section G (High Voltage Resistors), released by International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa., presents dimensional drawings and specifications covering the company line of high voltage resistors. (Write for No. B111)

Silver Zinc Batteries

A six-page, two-color brochure that describes the advantages and features of silver-zinc batteries is available at the AMF Contract Div., American Machine & Foundry Co., 261 Madison Ave., New York 16, N.Y. Includes technical charts and specifications. (Write for No. B112)

Oscillator

Waveforms Inc., 333 Sixth Ave., New York 14, N.Y., has released a data sheet covering the Model 512 extended-range oscillator. Presents performance characteristics, technical specifications, and a number of applications. (Write for No. B113)

Cuing Equipment

A brochure prepared by Tele-Q Corp., 1227 6th. Ave., New York 19, N.Y., presents a step-by-step, illustrated description of the Tele Q cuing system and outlines its operating advantages. (Write for No. B114)

Rotational Potentiometer

Technical Information Series Bulletin 853, covering the Type 2094 rotational potentiometer produced by Markite Corp., 155 Waverly Pl., New York 14, N.Y., gives design details, performance characteristics, and application advantages. (Write for No. B115)

Tamper Proof Sealer

Minnesota Mining and Mfg. Co., Adhesives and Coatings Div., 423 Piquette Ave., Detroit 2, Mich., data sheet describes how critical or delicate parts can be safeguarded from unauthorized handling with new 3 M sealer, EC-1252. Includes results of high and low temperature tests. (Write for No. B116)

Instruments

Communication Measurements Laboratory, Inc., 350 Leland Ave., Plainfield, N.Y., released a 16-page 1954 catalog containing descriptions and technical data covering its line of electronic generators, power supplies, megohm meter, vacuum tube voltmeter, delay line packages, etc. (Write for No. B117)

Resistors

Over 130 types of resistors and special products made by International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa., are listed in the revised 1954-1955 "Official Resistor Engineering Guide." Data for each type includes JAN or MIL equivalent. Write for guide, or Form S-074A. (Write for No. B118)

Insulation

Johns-Manville, 22 East 40th St., New York 16, N.Y., has issued descriptive folders covering a group of composite asbestos electrical insulations. Folder EL-54A covers Quinterra Type 3-GR; folder EL-49A covers Quinterra Types 5GR and 5GL. Folder EL-55A covers Quinorgo Nos. 4000-GR and 4000-GL. Testing samples are included. (Write for No. B1136)

BULLETINS

Electronic Instruments

The 1954-55 Neely Directory of Electronic Instruments and Industrial Equipment, issued by Neely Enterprises, 7422 Melrose Ave., Los Angeles 46, Calif., manufacturers' representatives, contains 27 pages listing and illustrating the items and equipment of the companies they represent.
(Write for No. B119)

Transformers

The 20-page, two-color booklet, "The Sola Constant Voltage Transformer-Theory of Design and Operation," presents underlying electromagnetic relations of the Sola magnetic principle, and vector diagrams, performance curves, etc. Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill.
(Write for No. B1110)

Electronic Products

Catalog No. 975, prepared by E. F. Johnson Co., Waseca, Minn., presents part of the more than 5,000 items manufactured by the company for the electronic industries. The equipment and components described, conform to regular company commercial standards.
(Write for No. B1111)

Aperiodic Coupling

An 8-page booklet, E-108, obtainable on request at Motorola Technical Information Center, 4501 West Augusta Blvd., Chicago 51, Ill., includes circuits of the aperiodic coupling network high pass filter and the potential device, insertion loss characteristics, and illustrations showing dimensions and drawings.
(Write for No. B1112)

Metals Patterns

Available on written request, is a selector that gives complete specifications on 26 metal patterns. A turn of a wheel shows a photo of each textured pattern. A window shows its number, width, thickness, and depth. Write to Rigidized Metals Corp., 657 Ohio St., Buffalo, N.Y.
(Write for No. B1113)

Controls

A bulletin prepared by Ketay Manufacturing Corp., 555 Broadway, New York 12, N.Y., describes its engineering and research staffs, its production facilities, and some of its available electrical devices and controls.
(Write for No. B1114)

Plants and Engines

"Power Points Digest," Vol. 10, No. 3, prepared by D. W. Onan & Sons Inc., Minneapolis 14, Minn., presents news about electric plants and engines.
(Write for No. B1115)

Audio and Video Products

Electro-Voice, Inc., Buchanan, Mich., has released a condensed catalog, No. 119, which gives basic facts about the many "EV" products developed and produced for the audio and video fields. Available on request.
(Write for No. B1116)

Rotary Electrical Equipment

Mission-Western Engineers, Inc., affiliate of Western Gear Works, 132 W. Colorado, Pasadena, Calif., has released bulletin, No. 254, that describes approximately 50 basic types of miniature and subminiature electric motors, blowers, and fans. Available on letterhead request.
(Write for No. B1117)

TV Transmitter

Bulletin TR-634 describes the series 12000 50 kw TV (high-band) transmitter designed to operate between channels 7-13. Bulletin TR-633, describes the series 9000 25 kw TV (low band) transmitter designed to operate between channels 2-6. Released by Allen B. Du Mont Laboratories, 1500 Main Ave., Clifton, N.J.
(Write for No. B1118)

(*Continued on page* 164)

News of MANUFACTURERS' REPS

Lee Fogelsong has joined the staff of **E. V. Roberts & Associates,** with offices in San Francisco, Los Angeles, California and Phoenix, Arizona.

A. J. Rissi, Monrovia, California, has been appointed to represent Rhein Sound Systems, Inc. of Orlando, Fla., and Premier Metal Products Co., Inc., New York, N. Y., in the Arizona and Southern California areas.

Richard R. Legg Co., Portland, Ore., has announced the appointment of **Blake W. Hirsh** who will cover the Alaska territory for the organization.

Texport Co. with offices at 5004 Ross Ave., Dallas, Texas, has become industrial representative for International Rectifier Corp., El Segundo, Calif., and will represent this company's line of rectifier, germanium diode and photoelectric cell products in Louisiana, Oklahoma and Arkansas.

James K. Dooley Co., 3606 Magnolia Blvd., Seattle, Wash., has been appointed exclusive rep for Dale Products, Inc. of Columbus, Neb. to serve the states of Washington and Oregon. A similar appointment went to **Thomas L. Stevens Co.,** 1151 S. Broadway, Los Angeles, Calif., for the state of Arizona in addition to the territory of southern California.

Arthur K. Elliott Co., located at 8305 Cherokee Lane, P. O. Box 8493, Kansas City 13, Mo., have been named sales reps for Clarostat Mfg. Co. of Dover, N. H. in the Kansas, Nebraska and western Missouri territory.

Walter M. Wyman, with offices at 1346 Chestnut St., Philadelphia, Pa., has been appointed sales rep in eastern Pennsylvania and southern New Jersey for Richardson-Allen Corp., selenium rectifier unit mfr. of College Point, N. Y.

Walter T. Hannigan Co., New England mfrs. rep., has announced the removal of its offices to the Professional Bldg., 272 Centre St., Newton 58, Mass., telephone DEcatur 2-6020.

Jack L. Weber has been appointed Indiana rep to handle speaker and transformer sales for Oxford Electric Corp., Chicago, Ill. His offices are at 4348 N. Park, Indianapolis 5, Ind.

Neely Enterprises, Los Angeles, Calif., have been appointed to represent the Industrial Div. of Sanborn Co., manufacturer of oscillographic recording systems, in California, Nevada, Arizona and New Mexico.

A. T. R. Armstrong, Ltd., Toronto, Ont., have become Canadian reps for Heldor Mfg. Co. of Paterson, N. J.

Grid Currents

(*Continued from page 72*)

less positive grid voltage swing and less peak grid and plate currents. The higher grid resistance is preferable from this point of view, providing that sufficient power output is achieved for the application, including sufficient power with the other variations in the tubes and in the circuits. Appreciable compensations for variations in the positive grid current characteristic is achieved by a relatively high resistance in this type of circuit.

Secondary Emission Current

Secondary grid emission has been considered a virtue in some class C applications because it reduces the RF grid drive power requirements; outside of specific cases, this may be a snare and a delusion. Without specific limits for secondary grid emission, on the MIL-E-1 specification sheet, both initially and during life,

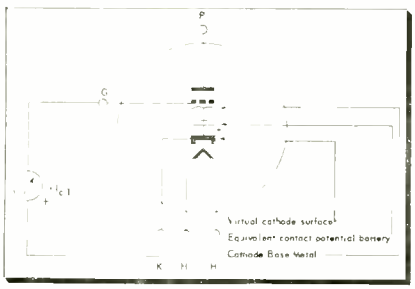


Fig. 10: Conception of contact potential

no assurance of the magnitude or maintenance of this property can be given. Fig. 8 includes the classical plot of secondary grid emission current, together with curves for the normal positive grid primary electron current, and a dotted curve for the combined current. Resistance lines are indicated for resistance values of Ra, Rb, and Rc respectively, originating from a positive supply voltage of both 75 volts and zero volts. If the tubes were operating from the 75 volt supply, a sudden characteristic change in the tube, or between tubes, from the primary current curve to the combined curve would produce a change in grid voltage from point A to A′ etc., for each resistance. In the case of the low resistance, Ra, the change in grid voltage is small, but for a large resistance, such as Rc, the change is considerable. Thus, a positive grid supply voltage, with an appropriately high resistance to keep the normal currents within dissipation

Grid Currents

(*Continued from page* 153)

limits, may prove to be a hazard. This hazard exists when the 75 volts is applied before the cathode of the tube has warmed up enough to produce a primary current curve much higher than shown in this figure. A much higher primary current would mask the secondary emission current and also move Point A to a much lower grid voltage.

The next hazard from this property occurs when the grid is operated from a low or zero voltage supply. The signal grid of a pentagrid converter type such as the 6BE6 might be typical. In this case a signal surge, such as a band switching transient, might momentarily drive the grid 25 volts positive. In that case, the grid will lock at point C_o or B_o indefinitely, and paralyze the equipment with low or zero conversion conductance and destructive screen grid and plate currents. The zero bias low grid resistance line, Ra on this graph, does not intercept the secondary

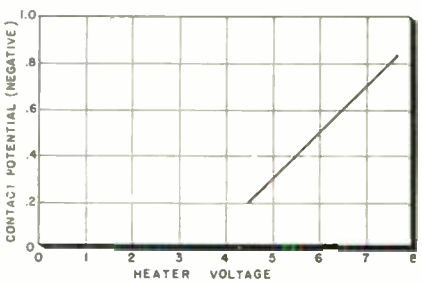


Fig. 11: Heater voltage vs. contact potential

current curve and an equipment failure is prevented.

In the case of Class C operation, secondary grid emission has been known to engender misunderstanding between equipment designers and tube manufacturing people. One case, which happened to be with a filament type triode, is documented in Fig. 9. "Nice" tubes with high primary current would mask the secondary emission current of this graph. "Bad" tubes with low primary current produce the curve identified as "combined currents." If the plate voltage and the RF grid drive voltage are applied before the filament voltage, all tubes are "bad" tubes and have a low primary current curve at some time during filament warm-up, if they happen to have just a little secondary emission! The solid curve of the RF grid voltage waveform and the projected solid line grid current waveform are for the initial strategic time, when no developed bias has charged up condenser C. At this time, the grid is

drive 40 odd volts positive and the resulting average grid current is negative. This average current, after a few RF cycles, charges condenser C in the reverse direction, opposite to the polarity signs on the circuit. Thus, in a few milliseconds, the RF drive voltage is operated from a positive developed grid bias of 25 volts as indicated by the dotted waveform curves. At these high values of positive grid voltage, the cathode current constitutes true temperature limited emission, and the resultant heating of the grid, plate, and localized filament areas soon produces an open filament. In fact, one report of this trouble was a complaint that too many tubes had open filaments. In general, a circuit design problem such as this is helped by a small coupling condenser and higher, rather than lower, grid resistance, since there is the chance that positive grid current in the range of zero to 15 volts will be sufficient to charge the condenser rapidly to a normal negative developed voltage. Appreciable dc resistance in the plate supply also helps since it permits the plate voltage to drop, during such a filament warm up surge of plate current, to a low enough voltage to "extinguish" the secondary emission and "unlock" the grid current.

Negative Grid Current

This title was picked to identify the two common conditions at which electrons are collected by the grid even though the grid voltage may be considerably negative. (Actually these are special cases of positive grid electron currents.) One of these conditions results in a hum modulation of a Class A amplifier. In such a case the heater of a heater-cathode type may have one terminal at cathode potential. The opposite heater terminal of a 6.3 volt type will have a peak negative voltage of about 10 volts at the AC heater supply frequency. If an area of the heater is exposed to the view of one of the grid side rods outside of the micas, a negative grid bias of any value less than ten volts permits the grid to pick up emission from the heater at the heater supply frequency.

Other Conditions

The other common conditions of electron pick-up by the grid at negative bias involves operation with AC plate voltages. There are many "phase detectors" and servo amplifier applications using AC plate voltages. Only a few of the tube types

Grid Currents

(*Continued from page* 155)

used in these circuits have specific ratings and MIL-E-1 specified tests to control the tubes' characteristics for such use. The hazard is not voltage breakdown, but rather plate emission. More of these emissive contaminants get on the inside of the plate of the tube, and they frequently build up during life. The high plate temperature due to operation conditions may readily produce emission. This emission is directly related to plate temperature, but it changes considerably from tube to tube and also changes within the same tube, dependent upon its operating history. In such a triode, the grid is nearer to the inside of the plate than the cathode, and picks up most of this emission during the negative voltage period of the plate voltage cycle. A tube in this application is not very tolerant of high grid resistance. The geometry of most tube types is such that this plate emission current does not saturate much below 100 volts, so that reducing the AC plate supply voltage does not help much unless the peak inverse plate voltage is less than −100 volts.

PERSONAL

Arthur V. Loughren has been elected Vice President in charge of Research at Hazeltine Corp., Little Neck, N. Y. He is also Executive Vice President of Hazeltine Research, Inc., Chicago. Mr. Loughren was presented the David Sarnoff Gold Medal by the Society of Motion Picture and Television Engineers in 1953.

A. V. Loughren

I. Kamen

Ira Kamen has been named v.p. in charge of engineering, research and development for Brach Mfg. Corp. Div. of General Bronze Corp., Newark, N. J. Formerly v. p. in charge of sales, Mr. Kamen will continue to direct contract sales, in addition to the added responsibility of overseeing engineering, research and development facilities at Brach.

Robert F. Cline has been appointed Chief Engineer, Electronics Div., of Mullenbach Electrical Mfg. Co., Los Angeles, Calif.

Dr. E. George Roka has been placed in charge of the newly established Semi-conductor Activity of Delco Radio's Engineering Dept., Kokomo, Ind. Prior to his present association, Dr. Roka was supervisor of the Semi-Conductor Group at Honeywell Research Center in Minnesota.

Robert L. Bell, formerly superintendent of metals at Carboloy Dept. of General Electric Co., has been promoted to the post of manager of mfg. engineering.

Thomas B. Friedman has joined Adler Communications Labs., New Rochelle, N. Y. He will assist in the development and application of satellite TV stations and systems.

Howard L. Broverman has joined the Moduline Outage Monitor Development Group of Sprague Electric Co. as field engineer.

Jack Rosenberg was appointed to the technical staff of Electronic Control Systems, Inc., Los Angeles, Calif., where he will be responsible for the development of specialized computers and control systems.

(*Continued on page 159*)

New "Series-String" Tubes

Twenty new types of "series-string" receiving tubes, employing 600-ma heaters designed to operate in a single, series-connected electrical circuit, have been made available to television set manufacturers by the Tube Div., R.C.A.

The new RCA "series-string" tubes and their prototypes are: 2AF4-A, UHF oscillator triode (prototype 6AF4); 3AL5, twin triode (6AL5); 3AU6, sharp-cutoff pentode (6AU6); 3AV6, twin-diode/high-mu triode (6AV6); 3BY6, pentagrid amplifier (6BY6); 3CF6, sharp-cutoff pentode (6CF6); 4BQ7-A, medium-mu twin triode (6BQ7-A); 4BZ7, medium-mu twin triode (6BZ7); 5AQ5, beam power tube (6AQ5); 5AS8, diode/sharp-cutoff pentode (6AS8); 5X8, triode-pentode converter (6x8); 6AU7, medium-mu twin triode (12AU7); 6S4-A, medium-mu triode (6S4); 6SN7-GTB, medium-mu twin triode (6SN7-GT); 12AX4-GTA, half-wave vacuum rectifier (12AX4-GT); 12BH7-A, medium-mu twin triode (12BH7); 12BQ6-GTB, beam power tube (6BQ6-GT); 12BY7-A, sharp-cutoff pentode (12BY7); 12W6-GT, beam power tube (6W6-GT); and 25CD6-GA, beam power tube (25-CD6-G).

PERSONAL

(Continued from page 157)

Dr. J. E. Hobson has succeeded to the presidency of Eta Kappa Nu, national electrical engineering honor society. Dr. Hobson, who is director of Stanford Research Institute, succeeds **Dr. Eric T. B. Gross** of the Illinois Institute of Technology.

Andrew Friedenthal has been appointed Chief Engineer of WJR radio, Detroit, and **Clarence W. Jones** has been named Chief Engineer of WJRT, Flint, Michigan.

Edward S. Ruth has assumed the position of supervisor of Industrial Signalling Engineering at Gamewell Co., Newton Upper Falls, Mass. Mr. Ruth was formerly Director of Research Engineering and Development for Edwards Co., Inc., Norwalk, Conn.

Dr. C. D. Pierson, Jr., chief engineer of the Electronics Systems section at Martin Aircraft, Baltimore, Md., has been elected president of the Baltimore section of the I.R.E. for the year 1954-55.

C. D. Pierson

H. Schmalz

Henry Schmalz has become manager of color tube engineering and development at Thomas Electronics Inc., Passaic, N. J. Prior to joining Thomas, Mr. Schmalz was chief of color development and engineering with Crosley Div. of Avco Mfg. Corp.

Henry C. Guhl has been named manager of process engineering by National Vulcanized Fibre Co. Formerly manager of engineering for the Micarta Div. of Westinghouse Electric Corp., Mr. Guhl will devote his efforts to process and quality control procedures at the Phenolite Div., Kennett Square, Pa.

Dr. Leonard C. Maier has been appointed manager of engineering at General Electric Cathode Ray Tube Sub-Dept., and will be in charge of all cathode ray tube product engineering for G-E monochrome and color TV picture tubes, and special purpose cathode ray tubes.

Dr. Frederick E. Terman, Dean of School of Engineering, Stanford University, was elected to the board of directors of Ampex Corp., Redwood City, Calif.

New Transducer

(*Continued from page 67*)

excessive current drain or transducer life will be materially reduced.

This configuration is quite simple and readily adaptable to miniaturization techniques. Gas tubes ¼ inch diameter by ¾ inch long have been made and potted transducer elements including the resistors R and the capacitors C_1 and C_2 about the size of a thimble have been built.

A third basic arrangement is shown in Fig. 3. The source S is connected to two movable external elec-

Fig. 5: Ionization transducer applications (above) micrometer comparator and (below) pressure meter with 8 v. output for 1mm Hg

trodes r-f. The output voltage is taken between the internal electrodes A and B through two small resistors R. Any variation of the position of the external electrodes RF varies the output voltage. Output voltages of up to ±40 volts are developed. This is one of the simplest and most sensitive configurations yet developed and one that provides excellent life expectancy (upwards of 5000 hrs.). Many problems arise when using the transducer in this manner, the most difficult of which is that of mechanical stability of the r-f electrodes. Any vibration or structural "relaxation" of these

New Transducer

(*Continued from page 160*)

plates is immediately visible in the output signal. (This suggests the vibration pickup as an admirable application.)

Fig. 4 illustrates an arrangement that combines the application techniques of the system of Fig. 2 with the increased life obtained as shown in Fig. 3. The ionization tube is excited by a source connected to two fixed external r-f electrodes. This arrangement eliminates the two internal electrodes from active participation in the r-f circuit, thereby increasing the useful life of the tube.

The balance of the circuit and the mode of use is the same as that given in Fig. 2. Output voltages as high as ±100 volts may be obtained.

Investigations of transducer performance in its many possible variations has shown that a given element may exhibit radically different output to input performance when used in different applicable arrangements. Further, variation of tube parameters such as gas, gas pressure, electrode dimensions, etc. may also be used to achieve a wide variety of performance characteristics. These two features provide a tremendous latitude for selecting a means for solving any given measurement problem. There are several new transducer tube types under current investigation which will further increase the usefulness and the already widespread fields of application.

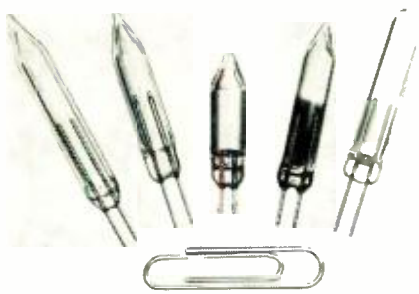


Fig. 6: T-42 Ionization transducer tubes

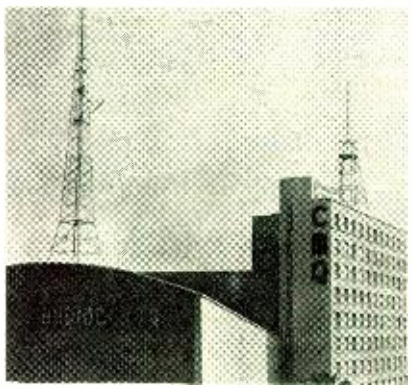
The power requirement for the transducer is very small. Glow discharge tubes have been built requiring as little as 50 milliwatts. Measurement systems have been constructed using a 9 volt "C" battery as the power source, which drives the radio frequency oscillator, and the output circuit (usually a cathode follower). The weight and size not only of the gas tube itself, but also of the associated equipment can be kept correspondingly small. It is possible to use one source for several transducers, each performing unre-

lated tasks, without interaction. Of primary importance in relation to the power requirements, it can be shown that under certain conditions of gas type, gas pressure, geometry, and excitation conditions, the transducer is independent of source voltage and frequency variations of ten to thirty percent of their nominal values.

A sizeable number of applications for the T-42 Transducer have been developed. These include: pressure measurements (high and low pressures), humidity measurements, dielectric investigations, acceleration pickups, linear and angular displacement pickups, conductivity meters, thermometry, tachometers, seismographs, capacitance meters, liquid quantity and level gages, comparator micrometers and others. In addition, there are numerous promising applications that have not as yet been investigated. The development of the T-42 is by no means completed. There remains an extensive program of investigation on this new measurement tool before it may be said that the transducer is performing to the limit of its capabilities. The T-42 Transducer, as with all such devices, has certain types of applications for which it is particularly well suited. Two of these cases for the T-42 are the measurement of dielectric variations and measurements where little or no mechanical force (or inertia) is available for dissipation in the measuring device. A typical application of the latter is the measurement of angular displacement of a gyroscope without the introduction of disturbing torques.

With the T-42 transducer the r-f field can range between 200 kc to 1 mc. The output impedance of the device is high, of the order of about 1 megohm.

CMQ ORDERS MICROWAVE



CMQ Radio and TV studios in Havana showing (Chan. 6) CMQ-TV tower and microwave reflector (left) and (Chan. 7) CMBF-TV tower (right). Both stations are owned and operated by CMQ which has recently ordered Philco equipment for an additional 7 hop microwave relay link.

BULLETINS

(*Continued from page* 151)

Laminated Plastics

A chart released by Synthane Corp., Oaks, Pa., provides a complete tabulation of the latest military and government specifications for 24 grades of thermosetting laminated plastics. (Write for No. B1119)

Instruments, Etc.

A booklet released by Communication Measurements, 350 Leland Ave., Plainfield, N.J., illustrates, describes, and presents technical data covering electronic generators, regulated power supplies, meters, and other associated products. (Write for No. B1120)

"Varicons"

Elco Corp., "M" St. below Erie Ave., Philadelphia 24, Pa., have released a 17-page catalog, V-2, covering the patented fork-like "Varicon" contact and other parts of the new miniature connector system. (Write for No. B1121)

Connector Line

The 4-page bulletin, SR-KM1, released by Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif., presents engineering test data covering the new K miniature series connector line. (Write for No. B1122)

Meters

Instrument data sheets 103-1 and 303-1 cover, respectively, the Model 103 comparator for micrometer for dimensional gauging problems requiring measurements ranging from 0.000001 to 0.0002 in., and a micro-differential, high-sensitivity pressure meter made by Decker Aviation Corp., 1361 Frankford Ave., Philadelphia, Pa. Bulletin 01 covers the T-42 ionization transducer. (Write for No. B1123)

Towers

An illustrated brochure released by Towers Structures Inc., Lodi, N.J., illustrates and presents detailed drawings of guyed and self-supporting towers and discusses their stress analysis. (Write for No. B1124)

Toroidal Inductors

Bulletin TL2-P4, available on request at Lenkurt Electric Sales Co., 1116 County Rd., San Carlos, Calif., describes and presents performance curves covering the TL and TH series toroidal inductors. (Write for No. B1125)

"Worksaver"

Bulletin P-1038A, published by Yale & Towne Manufacturing Co., Philadelphia 15, Pa., pictures and gives dimensions and specifications on the 4,000 and 6,000 lb. capacity "Worksaver" low lift electric platform trucks. (Write for No. B1126)

(*Continued on page* 168)

OBTAIN THESE BULLETINS described here by writing on company letterhead to Bulletins Editor, TELE-TECH & ELECTRONIC INDUSTRIES, 480 Lexington Ave., New York 17, N.Y., listing numbers given at end of each item of interest. Please mention title of position held.

INDUSTRY NEWS

(*Continued from page 58*)

John Ritchie, Jr. has been appointed industrial sales manager, and **Charles Mueller** sales engineer at Link Aviation, Inc., Binghamton, N. Y.

Elton T. Barrett has been elected president of CGS Labs. Inc., and **Carl G. Sontheimer**, majority stockholder of the firm, has become vice-president in charge of engineering.

E. T. Barrett

L. A. Wortman

Leon A. Wortman has joined J. C. Warren Corp., Freeport, N. Y., as sales manager. Prior to joining with Warren, Mr. Wortman was national advertising and sales promotion mgr. for RCA magnetic tape recorders and hi-fi components.

Brig. Gen. James S. Willis, U. S. Army, ret., has joined Hallicrafters Co. as coordinator of research and development. Before assuming this position General Willis was commanding general of the Signal Corps supply agency at Philadelphia.

Jerre V. Manning has been appointed general manager of Marine Equipment Div. of Minneapolis-Honeywell Regulator Co. This division produces the Honeywell Sea Scanar.

H. Jeffrey Mapes has joined the radio-television div. of Stromberg-Carlson Co. as sales promotion mgr. and asst. to **David S. Cook,** advertising mgr.

Slip Ring Co. of America has appointed **Robert W. Grant** sales manager. The firm recently moved into new quarters at 1654 Lincoln Blvd., Santa Monica, Calif.

Theodore H. Heemstra has been appointed Technical Sales Engineer for Federated Metals Div., American Smelting & Refining Co.

New Company Formed

Advertising Promotions Inc., with offices at 184 W. Washington Blvd., Chicago, Ill., will specialize in direct mail and point of sale programs.

TELE-TECH ADVERTISERS — NOVEMBER, 1954

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

BULLETINS

(Continued from page 164)

Cams

A 4-page two-color bulletin released by Ford Instrument Co., Div. of The Sperry Corp., 31-10 Thomson Ave., Long Island City 1, N.Y., describes a wide variety of cam types and sizes. Cams are "3-dimensional" (two inputs) and single input.
(Write for No. B1127)

X-Ray Techniques

The first issue of a new-style industrial house organ, known as the "Radiation Digest," has been published by the X-Ray Dept., General Electric Co., 4855 Electric Ave., Milwaukee, Wis. The publication serves those fields of industry in which x-ray, electron beam and related radiation devices are employed.
(Write for No. B1128)

Tubes

"Characteristics of Magnetron Oscillators," "Characteristics of Klystron Oscillators," and "Characteristics of Special Purpose Tubes," prepared by Raytheon Manufacturing Co., Microwave and Power Tube Operations, and Power Tube Div., Waltham 54, Mass., are available to readers without charge. Contain illustrations and complete technical data.
(Write for No. B1129)

Bobbin Cores

Bulletin BC-102 punched for Catalog TWC-100 issued by Magnetics, Inc., Butler, Pa., explains ultra-thin tape cores with rectangular hysteresis loops under pulse conditions. The 4-page release gives dimensional specification details.
(Write for No. B1130)

Wire

The Technical Information Dept., William Brand & Co., North & Valley Sts., Willimantic, Conn., have released a "Preliminary Report On the Use of Induction Heating to Bond Stranded Insulated Wire During the Cut and Strip Process."
(Write for No. B1131)

Glass Products

Catalog NP-54, released by the Technical Information Dept., Corning Glass Works, Corning, N.Y., includes descriptive and application information covering fixed glass dielectric and trimmer capacitors, resistors, and other glass components.
(Write for No. B1132)

Components

No. 201G Engineering Manual presents detailed drawings and specifications covering the line of brackets, wire harness clamps, bonding clamps, multiple support clamps, shims, tube clamps, etc., made by Thomas Associates, 4607 Alger St., Los Angeles 39, Calif.
(Write for No. B1133)

Resistors

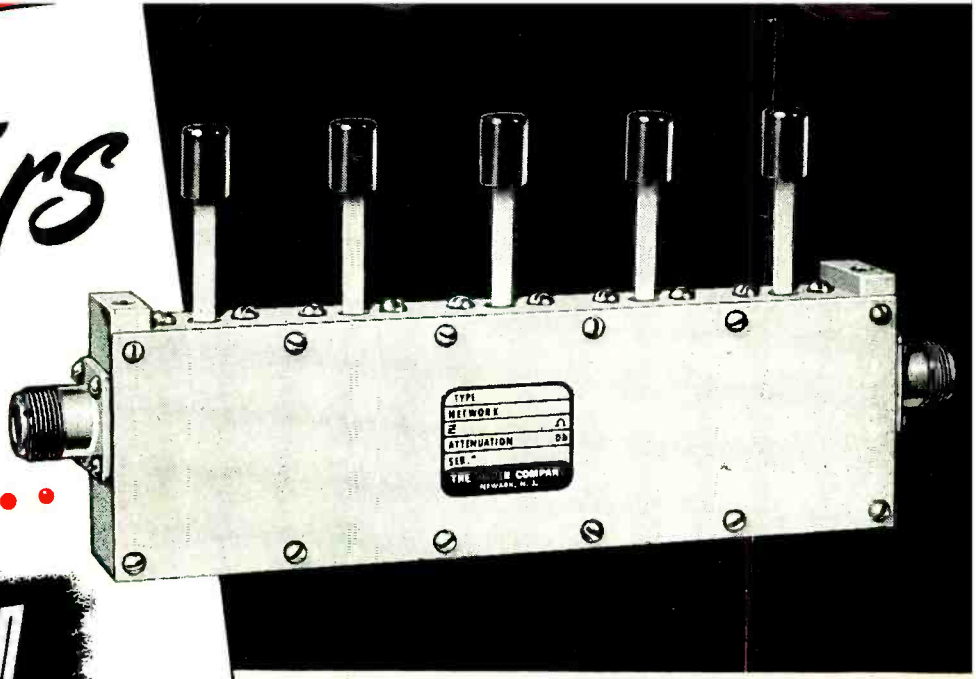
Monson Manufacturing Corp., 6059 W. Belmont Ave., Chicago 34, Ill., have released a catalog page that pictures and describes a new line of lower-cost, smaller-size, bobbinless, non-inductive wire type resistors. Contains complete data.
(Write for No. B1134)

MIL-C Specifications

Bulletin 809A, issued by Sangamo Electric Co., Capacitor Div., Marion, Ill., presents an "Interpretation of Military (MIL-C-) Capacitor Specifications" covering products presently manufactured by the Capacitor Division.
(Write for No. B1138)

IN Attenuators

WHY DOES ONE NAME . . DAVEN STAND OUT?



Series 550-RF Attenuator

In addition to Daven being the leader in audio attenuators, they have achieved equal prominence in the production of RF units. A partial listing of some types is given below.

DAVEN Radio Frequency Attenuators, by combining proper units in series, are available with losses up to 120 DB in two DB Steps or 100 DB in one DB Steps. They have a zero insertion loss and a frequency range from DC to 225 MC.

Standard impedances are 50 and 73 ohms, with special impedances available on request. Resistor accuracy is within ± 2% at DC. An unbalanced circuit is used which provides constant input and output impedance. The units are supplied with either UG-58/U* or UG-185/U** receptacles.

TYPE	LOSS	TOTAL DB	STANDARD IMPEDANCES
RFA* & RFB 540**	1, 2, 3, 4 DB	10	50/50Ω and 73/73Ω
RFA & RFB 541	10, 20, 20, 20 DB	70	50/50Ω and 73/73Ω
RFA & RFB 542	2, 4, 6, 8 DB	20	50/50Ω and 73/73Ω
RFA & RFB 543	20, 20, 20, 20 DB	80	50/50Ω and 73/73Ω
RFA & RFB 550	1, 2, 3, 4, 10 DB	20	50/50Ω and 73/73Ω
RFA & RFB 551	10, 10, 20, 20, 20 DB	80	50/50Ω and 73/73Ω
RFA & RFB 552	2, 4, 6, 8, 20 DB	40	50/50Ω and 73/73Ω

Because DAVEN makes the most complete, the most accurate line of ATTENUATORS in the world!

Series 640-RF Attenuation Network

These units are now being used in equipment manufactured for the Army, Navy and Air Force.

Write for Catalog Data.

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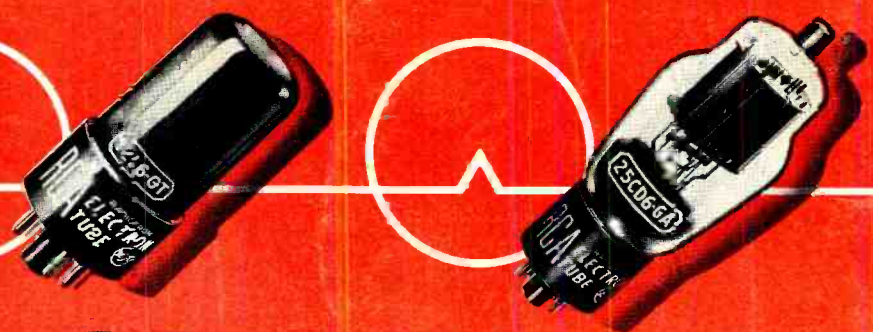
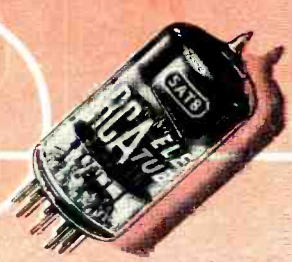
FOR "SERIES-STRING" TV



SPECIFY

RCA TUBES



RCA "SERIES-STRING" TUBES

"SERIES-STRING" TYPE	PROTO-TYPE	"SERIES-STRING" TYPE	PROTO-TYPE
2AF4-A	6AF4	5J6	6J6
3AL5	6AL5	5U8	6U8
3AU6	6AU6	5X8	6X8
3AV6	6AV6	6AU7	12AU7
3BC5	6BC5	6S4-A	6S4
3BY6	6BY6	6SN7-GTB	6SN7-GT
3CB6	6CB6	12AX4-GTA	12AX4-GT
3CF6	6CF6	12BH7-A	12BH7
4BQ7-A	6BQ7-A	12BQ6-GTB	6BQ5-GT
4BZ7	6BZ7	12BY7-A	12BY7
5AN8	6AN8	12L6-GT	25L6-GT
5AQ5	6AQ5	12W6-GT	6W6-GT
5AS8	6AS8	25CD6-GA	6CD6-G
5AT8	6AT8		

If you're making—or planning to make—"series-string" TV receivers, spark your designs with *new* RCA tube types!

Designed to withstand increased heater-cathode ratings where necessary, these new RCA tubes meet the demands of "series-string" TV applications.

Controlled heater warm-up time minimizes voltage unbalance during starting—adds dependability to your receiver designs.

RCA's ever-careful attention to technical detail and product quality assures you of high calibre "series-string" tube performance.

For technical data, call your local RCA Field Representative. Or write RCA, Commercial Engineering, Section K-50-Q, 415 South Fifth St., Harrison, N.J.

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