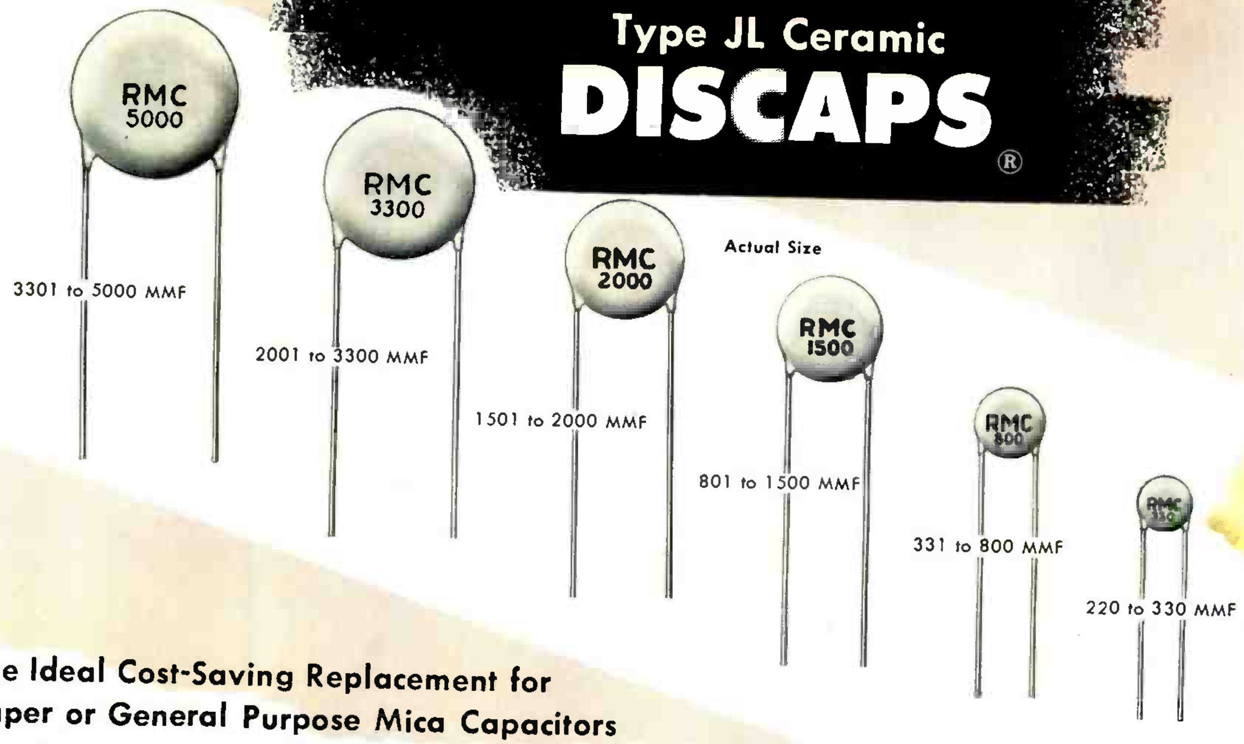
TELE-TECH
& Electronic Industries

Standardizing Printed Circuit Materials
Precision Transistor Test Equipment
Analog Computing by Heat Transfer

Another RMC First

Type JL Ceramic DISCAPS®



The Ideal Cost-Saving Replacement for Paper or General Purpose Mica Capacitors

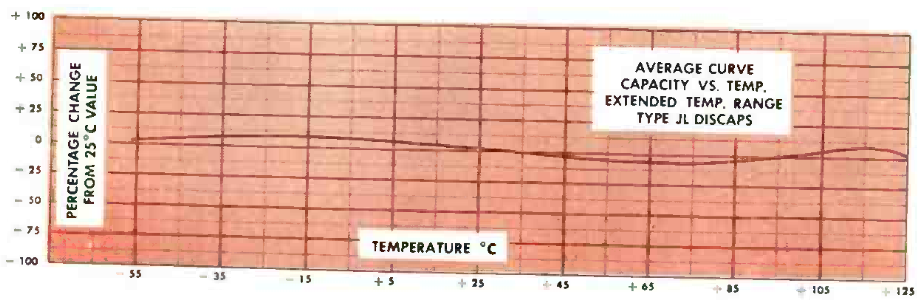
Type JL DISCAPS, the result of extensive research in the RMC Technical Ceramic Laboratories, afford exceptional stability throughout an extended temperature range. The maximum capacity change between −60° C and +125° C is only ±7.5% of capacity at 25° C. Type JL DISCAPS are available in tolerances of ±10% or ±20%. Standard working voltage is 1000 V.D.C.

Manufactured in a wide range of capacities, Type JL DISCAPS offer the advantages of longer life, dependability, and lower initial cost. Their smaller size and greater mechanical strength provide additional economies in assembly line operations.

It will pay you to investigate the advantages of using Type JL DISCAPS as replacements for paper or general purpose mica capacitors. Your inquiry is invited.

SPECIFICATIONS

POWER FACTOR: 1% max. @ 1 K C (initial)
POWER FACTOR: 2.5% max. @ 1 K C, after humidity
WORKING VOLTAGE: 1000 V.D.C.
TEST VOLTAGE (FLASH): 2000 V.D.C.
LEADS: No. 22 tinned copper (.026 dia.)
INSULATION: Durez phenolic—vacuum waxed
INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms
AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms
CAPACITY TOLERANCE: ± 10% ± 20% at 25° C



SEND FOR SAMPLES AND TECHNICAL DATA

DISCAP CERAMIC CONDENSERS

RMC

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

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TELE-TECH
& Electronic Industries

FEBRUARY, 1954

FRONT COVER: COLOR TV IN PRODUCTION—Indicative of the concentrated effort with which the TV industry has undertaken to start color TV on the way to becoming a commercial reality are the representative pictures of equipment being manufactured by four companies. Raytheon assembler (upper right) is shown working on the underside of a color set. Pilot production line at CBS-Columbia (lower right) is turning out TV signal and power chassis for receiving color pictures. For the broadcaster, an RCA color TV camera (lower left) is inspected at end of assembly line. Large-size color picture tubes made by Chromatic TV Labs. undergo final inspection before shipment. For a picture story of how RCA makes color tubes, see page 89. More color news is given on page 13.

DEPARTMENTS

TELE-TECH*, Vol. 13, No. 2. Published monthly by Caldwell-Clements, Inc. M. Clements, President; M. H. Newton, Assistant to President; John J. Borghi, Vice President and Secretary; Marguerite B. Clements, Treasurer. Acceptance under Section 34.64 Postal Laws and Regulations authorized at Bristol, Conn., February 8, 1952 with additional entry at New York, N. Y. 75c a copy. Annual Subscription Rates: United States and Possessions: $7.00; Canada: $8.00; All Other Countries: $10.00. Please give title, position and company connection when subscribing.

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* Reg. U. S. Pat. Off.

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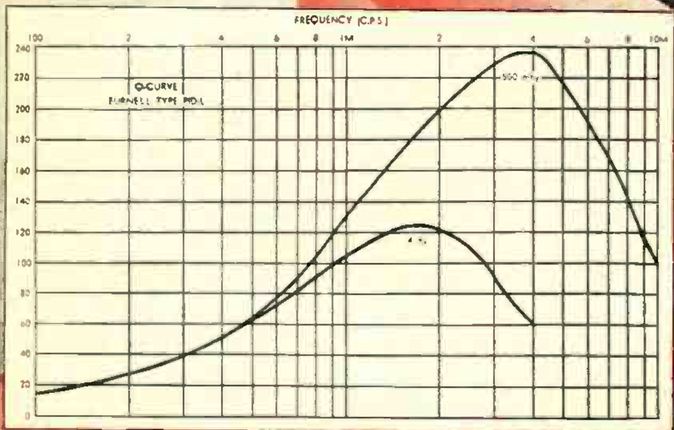
*A New Level in Engineering is Achieved in the Functional Design of Toroidal Decades**

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

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

* Pat. Applied for



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

P.I.D. 1 (MHYS)*
P.I.D. 2 "
P.I.D. 3 "
P.I.D. 4 "
P.I.D. 8 "

P.I.D. 10 (MHYS)*
P.I.D. 20 "
P.I.D. 30 "
P.I.D. 40 "
P.I.D. 80 "

P.I.D. 100 MHYS
P.I.D. 200 "
P.I.D. 300 "
P.I.D. 400 "
P.I.D. 800 "

P.I.D. 1000 MHYS
P.I.D. 2000 "
P.I.D. 3000 "
P.I.D. 4000 "
P.I.D. 8000 "

P.I.D. 10000 MHYS
P.I.D. 20000 "
P.I.D. 30000 "
P.I.D. 40000 "
P.I.D. 80000 "

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

OTHER RECENT *Burnell* ACHIEVEMENTS IN TOROIDS AND FILTER NETWORKS

SIDE BAND FILTERS

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

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

MINIATURE TELEMETERING FILTERS

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

SUB MINIATURE TOROIDS

Toroids for intermediate frequencies of 100KC to 1 megacycle. A wide variety of coils ranging in size from 5/8 inch provides high Q in the frequency range between audio and RF.

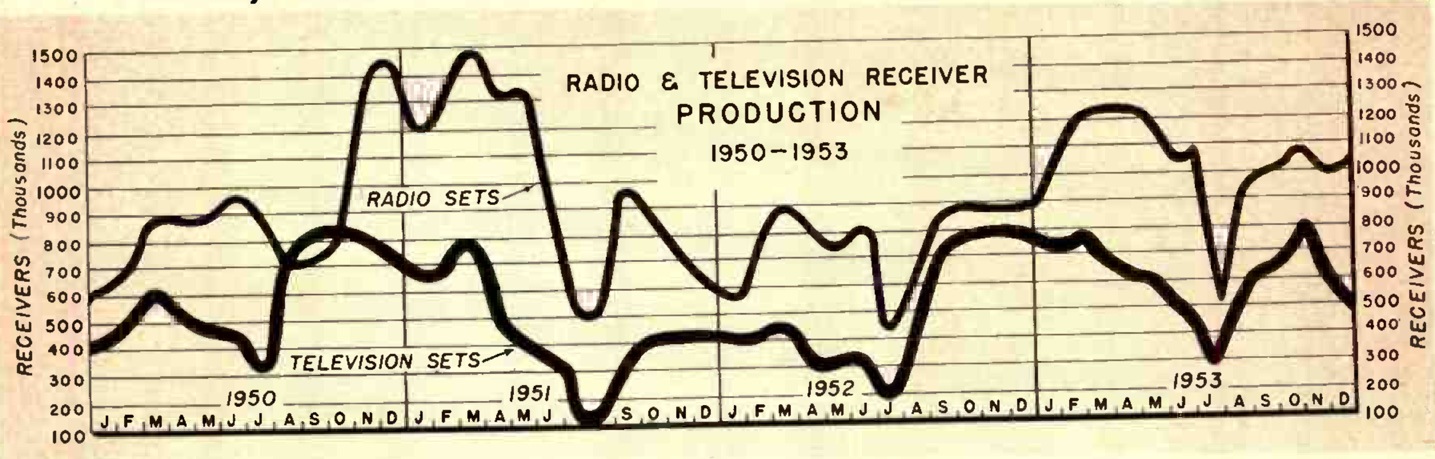
The tiny toroid about the size of a dime has been welcomed by designers of sub miniature electronic equipment for the transistor, guided missile and printed circuit field.

Literature for all the above available on request

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

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

TOTALS



Electronic Engineering Salaries

Salary Distribution of Electronic Engineering Graduates

Salary above	1949 grad.	1950 grad.	1951 grad.	1952 grad.	1953 grad.
$7500	—	9%	—	—	—
$6500	11%	29%	9%	5%	—
$5500	56%	57%	30%	15%	—
$4500	90%	96%	97%	55%	38%
$3400	100%	100%	100%	100%	96%

Salary Range

	1949	1950	1951	1952	1953
Highest	$6700	8400	7400	6000	4800
Average	5500	6000	5350	4750	4250
Median	5600	5900	5100	4500	4400
Lowest	4400	4200	4300	4000	3350

Monthly Starting Salary

	1949	1950	1951	1952	1953
Highest	$295	330	400	430	390
Average	252	270	310	325	355
Lowest	200	200	260	265	285

Type of employer:
- Aircraft (electronics)—25.5%
- Electronic equipment mfg.—21.5%
- Federal and State Govt.—17.8%
- Radio equipment and broadcasting—15.0%
- Instrument mfg.—8.2%
- Armed Services—6.6%
- Utilities and Oil companies—3.3%
- Sales organizations—1.7%
- Non radio-electronics—.8%

Employment location:
- Calif. (Bay area)—20%
- Calif. (LA. area)—36%
- Calif. (other)—19%
- "East" (outside Calif.)—19%

Changed positions once or oftener—17%
Taking or having taken graduate work—16%
Membership in the Institute of Radio Engineers—87%

Prof. Clarence Radius, head of electronic and radio engineering at State Polytechnic College, San Luis Obispo, Cal., sends us some interesting salary figures for electronic graduates in recent years.

"Since all of these engineering graduates are engaged in electronics, these figures may be somewhat more indicative of current trends in the electronics industry, than recently published figures for electrical engineers in general," he explains.

"Of course, we are particularly proud of the fact that 87% of our graduates are interested in their profession to the extent of being members of the I.R.E." he adds, pointing out that Calif. Poly is the third largest undergraduate engineering school in the eleven western states. There are well over four-hundred undergraduate students in the electrical and electronic engineering departments.

Broadcast Stations in U.S.

	AM	FM	TV
Stations on Air	2446	537	233 VHF 120 UHF
Under Construction (CPs)	136	65	69 VHF 145 UHF
Applications Pending	209	9	280 VHF 75 UHF

Radio & TV Receiver Production

		TV	Radio	
December			Home	500,000
			Battery	141,000
			Auto	325,000
			Clock	75,000
	Total	500,000		1,041,000
Year 1953 Jan.-Dec. inclusive			Home	4,510,000
			Battery	1,851,000
			Auto	5,085,000
			Clock	2,095,000
	Total	7,400,000		13,541,000

GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contracts awarded by government procurement agencies in December 1953

Actuators	$42,368
Alternator & Voltage Control	365,849
Amplifiers	345,865
Anodes	111,144
Antenna Assys	164,436
Batteries	259,991
Bells, electrical	106,500
Cable	527,208
Components, autopilot	1,152,413
Components, radio set	153,059
Components, vector magnetometer	114,805
Connector Assys	39,851
Connectors, plug	109,174
Control Equipment	549,683
Crystal Units	29,033
Digitalized Readout Equipment	92,143
Diodes, germanium	47,500
Flight Simulators	4,504,667
Frequency Meters	271,323
Generator Sets	1,756,813
Generators and Regulators	43,793
Ignition Analyzer Kits	45,462
Ignition Harness Assys	105,768
Indicators	250,116
Inverters	804,489
Loudspeakers, Magnetic	48,750
Mobile Trainers	150,000
Motors	1,257,615
Paper, electro-sensitive recording	31,400
Parts, electro-motor	95,276
Parts, turbo-generator	27,641
Plotting Boards	32,500
Power Control Cubicle	32,531
Radio Compass Units	44,179
Radios, portable	31,786
Radio Set Controls	29,640
Rectifiers	205,894
Regulators, frequency	92,400
Resistors, Variable	77,741
Rheostats	28,084
Spectographs	51,681
Transducers, receiving elements	9,191
Transformers	120,809
Transmission System, range data	40,907
Tubes, electron	800,281
Vibration Analyzers	37,732
Welding Units, arc	28,802

Compare!

...in important matters such as the purchase of TV broadcast equipment...

COMPARE BEFORE YOU DECIDE

If your station plans to begin television service, or go to high power . . . Standard Electronics invites you to compare and decide on a basis of cold facts.

Compare circuitry . . . tube replacement costs . . . power consumption . . . ability to transmit color signals . . . operating simplicity . . . eye appeal . . . maintenance . . . deliveries . . . comparative factors that truly decide which transmitter best serves your needs.

Comparison Chart of VHF High Power Transmitters (50 K W)

	SE Transmitter	Transmitter B	Transmitter C	Transmitter D
AMPLIFIER DRIVES WITH 5 KW	★ YES	NO	YES	YES
AMPLIFIER WILL OPERATE WITH ANY MAKE DRIVER	★ YES	NO	NO	NO
TUBE COST { COMPLETE SET FCC SPARES	★ $6,138 $1,495	$11,625 $4,237	$13,230 (est) $6,429 (est)	$9,250 (est) $5,050 (est)
AIR COOLED	★ YES	YES	NO	NO
POWER LINE REQUIREMENTS (at black level)	★ 208/230 V 60 cy, 3 φ 145 KW	460 V 60 cy, 3 φ 193 KW	208/230 V 60 cy, 3 φ 150 KW (est)	208/230 V 60 cy, 3 φ 165 KW (est)
FLOOR AREA (including power equipment, blowers, etc.)	★ 152 sq. ft.	154 sq. ft.	160 sq. ft. (est)	——
ALL TUBES VISIBLE FROM FRONT	★ YES	NO	NO	NO
SELF CONTAINED (no separate enclosures, vaults, pumps, etc.)	★ YES	NO	NO	NO
INDIVIDUAL CHASSIS CONSTRUCTION	★ YES	NO	NO	NO
INTERUNIT CABLING WITHOUT TRENCHES	★ YES	NO	NO	NO

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& Electronic Industries

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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, 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

A New, Rugged, Disc-Sealed TETRODE with...

LOW DRIVE at VHF...

HIGH PERFORMANCE AT LOWER COST PER KILOWATT!

OPERATING DATA

R.F. POWER AMPLIFIER, CLASS B, LINEAR TV SERVICE

TYPICAL OPERATION AT 170-220 mc, TWO TUBES, PUSH-PULL

	CCS	
D.C. Plate Voltage	4000	volts
D.C. Grid No. 2 Voltage	800	volts
D.C. Grid No. 1 Voltage	−150	volts
R.F. Grid No. 1 Voltage, peak to peak		
Synchronization Level	850	volts
Pedestal Level	700	volts
D.C. Plate Current		
Synchronization Level	2.75	amps
Pedestal Level	2.1	amps
D.C. Grid No. 2 Current		
Synchronization Level	110	ma
Pedestal Level	50	ma
D.C. Grid No. 1 Current		
Synchronization Level	100	ma
Pedestal Level	50	ma
Driving Power at Synchronization Level*	300-400	watts
Power Output		
Synchronization Level	5	kw
Pedestal Level	2.8	kw

*Driving power is accounted for largely by circuit losses. The indicated driving power is required to take care of losses in loading resistors, circuit losses and tube driving power.

AMPEREX®

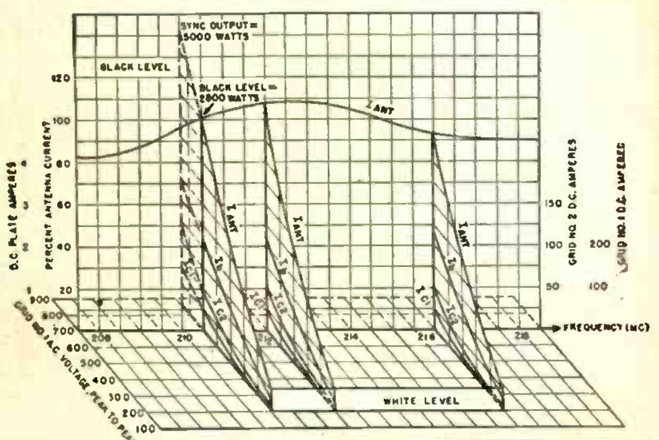
6076/AX-9907R—FORCED-AIR COOLED
6075/AX9907—WATER COOLED

- For communications operation up to 220 mc.
- Ideal for single side band, suppressed carrier operation.
- Low interelectrode capacitances provide wider bandwidth for new color TV requirements.
- Low inductance screen-grid disc-seal adds strength, enables complete shielding of input and output circuits with low losses and reduces necessity for screen neutralization.
- Proven long life.
- High VHF figure of merit $\left(\frac{Gm}{C\ out}\right)$

H.F. CLASS B AMPLIFIER — PUSH-PULL TV SERVICE

PLATE VOLTAGE = 4000 VOLTS • GRID NO. 2 VOLTAGE = 800 VOLTS

GRID NO. 1 BIAS = 150 VOLTS



OPERATING DATA

R. F. AMPLIFIER, CLASS C—TELEGRAPHY

TYPICAL OPERATION	CCS	
Frequency	110	mc
D.C. Plate Voltage	5000	volts
D.C. Grid No. 2 Voltage	800	volts
D.C. Grid No. 1 Voltage	−250	volts
D.C. Plate Current	1.1	amp
D.C. Grid No. 2 Current	100	ma
D.C. Grid No. 1 Current	70	ma
Peak R.F. Grid No. 1 Voltage	480	volts
Driving Power	30	watts
Power Output	3.9	kw

LOW INTERELECTRODE CAPACITANCES

INPUT	23.5	μμf
OUTPUT	8.4	μμf
PLATE TO CONTROL GRID (Max.)	0.35	μμf

AIR-COOLED TUBE HEIGHT—6¾"

LIST PRICES

6076/AX-9907R 275.00

6075/AX-9907 .... 225.00

ACCESSORIES (Amperex Numbers)	Water Jacket	Grid Connector	Pin Connector	Air Flow Chamber
6076/AX-9907R		S-3706	S-3707	S-11882
6075/AX-9907	S-3737	S-3706	S-3707	

Complete Technical Data, including New 3-Dimensional Curves Available from our Application-Engineering Department.

AMPEREX ELECTRONIC Corp. 230 DUFFY AVE., HICKSVILLE, Long Island, N.Y.

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NEW! FOR PRINTED
COMPLETE LINE

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

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

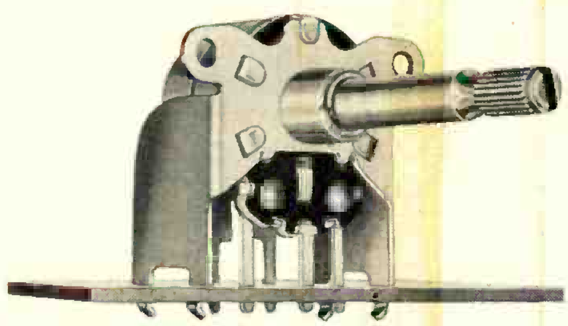
3 **PLUG-IN BLADE-TYPE TERMINALS** for vertical or horizontal mounting of control to printed circuit panel. (See all photos.)

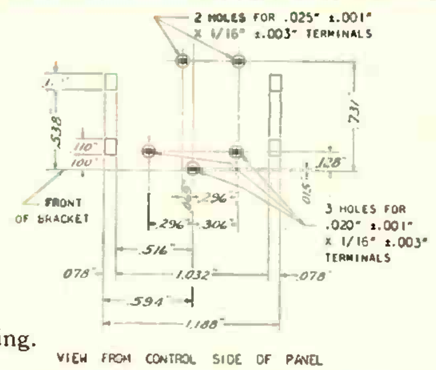
4 Threaded Bushing Mounting. (See Types XGC-45, GC-U45 and *miniaturized* U70.)

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

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

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

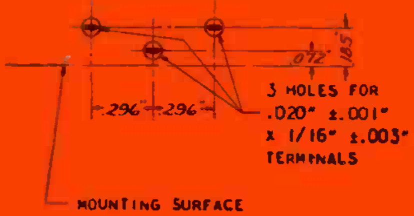




Suggested panel piercing.

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

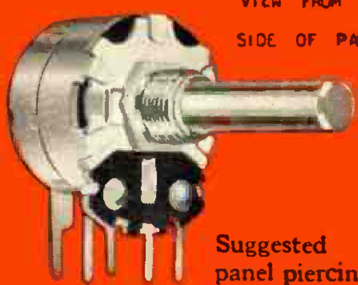
- Snaps instantly into place.
- Stays firmly put during soldering. Solder permanently anchors control to circuit panel.
- Terminal connections cannot loosen; bracket prevents mounting or operating strain on control or switch terminals.
- No mounting hardware, no separate supporting panel needed.
- No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

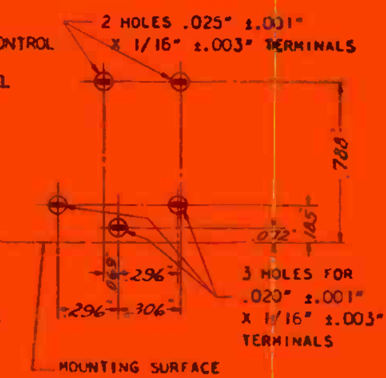


Suggested panel piercing.

Type XP45

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





Suggested panel piercing.

Type XGC-45

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

All controls illustrated actual size.

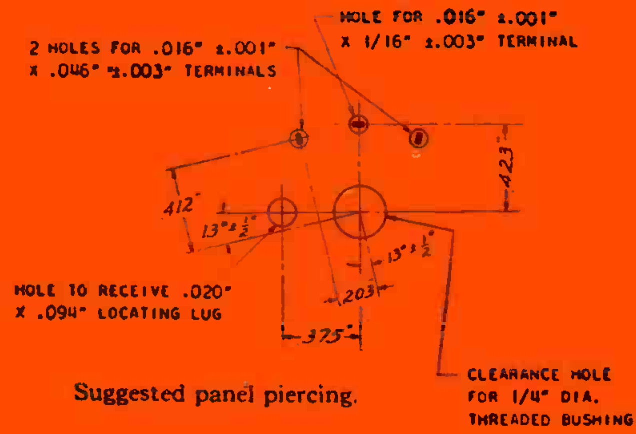
CIRCUITS
OF VARIABLE RESISTORS

HORIZONTALLY MOUNTED

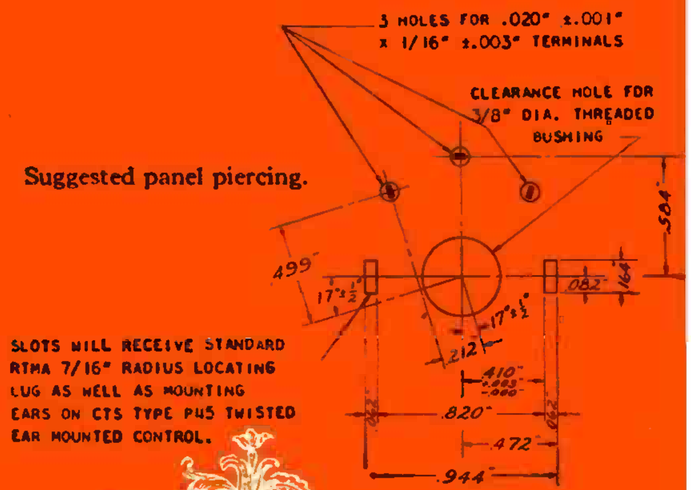
to Printed Circuit Panel. Shaft extends through panel. (Types U70, GC-U45 and UPM45.)

Type U70
(Miniaturized)

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



Suggested panel piercing.



Suggested panel piercing.

SLOTS WILL RECEIVE STANDARD RTMA 7/16" RADIUS LOCATING LUG AS WELL AS MOUNTING EARS ON CTS TYPE P45 TWISTED EAR MOUNTED CONTROL.

Type UPM45

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

Type GC-U45

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

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

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CHICAGO TELEPHONE SUPPLY *Corporation*

ELKHART · INDIANA

Burton browne advertising

General tolerance all decimal dimensions ± .005".

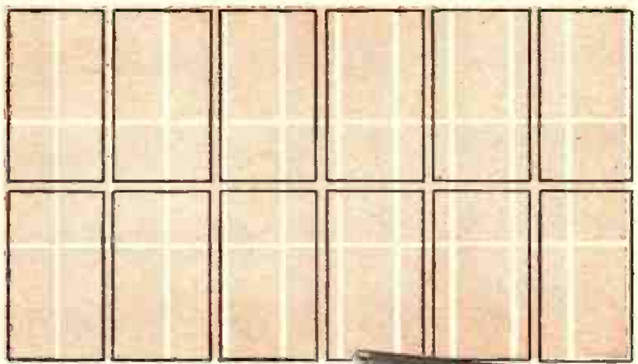
SMALLEST HIGH PERFORMANCE
BROADCAST PRE-AMP, BOOSTER
AMPLIFIER EVER DEVELOPED

Langevin Model 5116

—and it exceeds FCC requirements by a wide margin!

- LENGTH 9"
- WIDTH 1 ⅜"
- HEIGHT 3 ⅛"

Model 5116 is a miniature, plug-in, two stage, low noise, preamplifier or booster amplifier designed for use in radio and TV broadcast systems, recording studios and sound systems. While important space saving has been effected in the design of this amplifier, Langevin sacrificed none of the fine performance and dependability which make the Langevin Model 116-B an industry-wide criterion of excellence. In fact performance characteristics are considerably improved. Included are such quality features as gold-plated plug-in connectors and push-button metering facilities.



SPACE SAVING THAT REALLY COUNTS!

61% reduction in volume permits mounting of 33 Model 5116 units in the space required by 12 of the very popular Langevin Model 116-B amplifiers.

Photo below, illustrates the extremely compact racking possible with the new Model 5116. Note complete accessibility and uncongested appearance. Units at extreme right are Langevin 5117 Program/Monitor Amplifiers.

WRITE TODAY—

for complete data and specifications on the Langevin line of miniature plug-in equipment including program, booster and monitor amplifiers, power supplies, etc. Please address requests on company letterhead.

LANGEVIN MANUFACTURING CORPORATION

37 WEST 65th STREET, NEW YORK 23, N. Y.

A SUBSIDIARY OF THE W. L. MAXSON CORPORATION

EXPORT DISTRIBUTORS: INTERNATIONAL STANDARD ELECTRIC CORPORATION, 50 CHURCH ST., NEW YORK CITY

Polarad

COLOR

TV

equipment for studio and laboratory

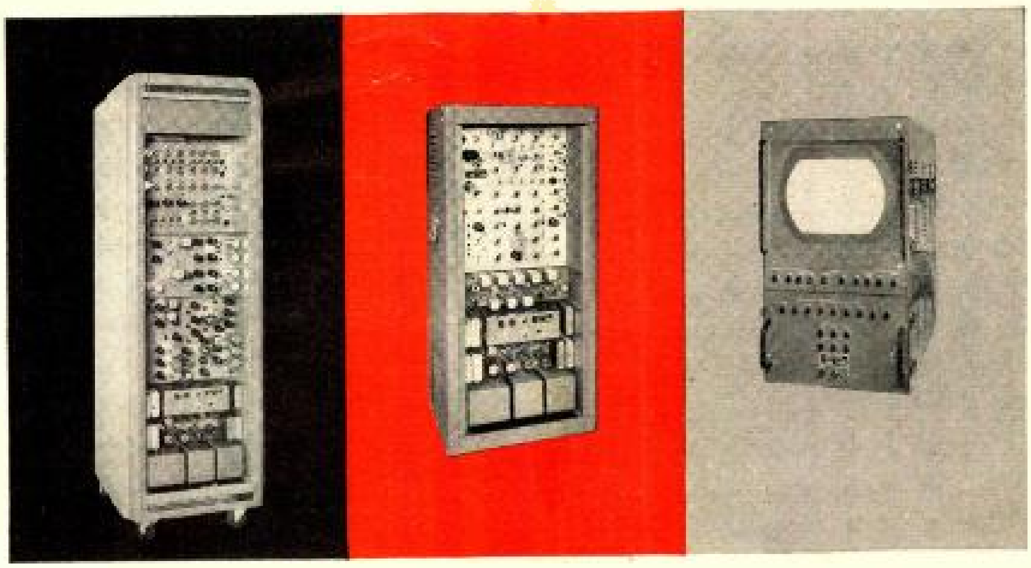
Polarad NTSC Color TV Equipment consists of fully integrated units that combine ease of operation with maximum flexibility.

COLOR BAR GENERATOR—PT-203 Provides color TV test signals, NTSC standards, for color TV equipment, networks and components. Supplies complete composite video signal in the form of seven fundamental color bars simultaneously with seven gradations of gamma bars. White dot pattern superimposed on both color and gamma bars. Color test pattern can be used for adjustment of both color transmitter and receiver circuitry. Internal switching permits 19 different test patterns.

COLOR SYNCHRONIZING GENERATOR—PT-201 Furnishes NTSC color TV subcarrier frequency component and contains divider network to yield 31.5 KC signal. Provides driving, blanking and synchronizing pulses, as well as vertical and horizontal dots for linearity checks. Used to drive color bar generators, or any other NTSC color TV generating equipment. Utmost stability assured by driving all pulses from leading edge of crystal controlled oscillator. Unit may be locked to synchronize with 60 cps line. Also available as a separate unit, PT-202 Subcarrier Frequency Generator to modify any existing standard (B/W) synchronizing generator in accordance with NTSC color TV standards.

COLOR TV VIDEO MONITOR—M-200 Compact, rugged instrument consisting of two portable units. Uses 15 inch RCA tri-color Kinescope. Checks quality of NTSC color video signals in studio, on transmission or in factory. Excellent synchronizing stability. Displays highest definition transmitted pictures with exceptionally good color rendition. All controls on front panel. Instrument may be rack mounted or employed as field test equipment.

ALSO AVAILABLE An NTSC color TV Flying Spot Scanner, furnished as a completely packaged unit supplying a standard color video signal. For further information, contact your nearest Polarad representative or write directly to the factory.



COLOR BAR GENERATOR PT-203
OUTPUT SIGNALS: Composite video (2 outputs) (Sync. negative & positive)
SIGNAL INFORMATION
7 Bars of Color
7 Bars of Gamma Gradations
White Dot Pattern (Vert. and Hor.)
EXT. VIDEO INPUT FOR MIXING
2 Volts neg. polarity

COLOR SYNCHRONIZING GENERATOR PT-201
OUTPUT SIGNALS:
Synchronizing Signal (Neg.)
Camera Blanking Signal (Pos., Neg.)
Horizontal Drive Signal (Neg.)
Vertical Drive Signal (Neg.)
Composite Video Output (Neg., Pos.)
NTSC Color Subcarrier Freq. (3.579545 mc/s)

COLOR VIDEO MONITOR M-200
Signal Polarity—Positive, Negative, Balanced
Input Video—0.25 to 2.0 Volts, peak to peak
Input Impedance—66 mmf across 2.2 megohms
Resolution—250-300 lines (Full Utilization of NTSC Color Signal Bandwidth)
Linearity—Better than 2% across raster Horizontal and Vertical

Polarad ELECTRONICS CORPORATION 100 METROPOLITAN AVENUE, BROOKLYN 11, NEW YORK

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.

MINIATURIZED 5 AND 10 WATT AXIAL LEAD WIRE-WOUND RESISTORS

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

Axial lead Blue Jackets are rugged vitreous enamel power resistors built to withstand the severe humidity performance requirements of RETMA and MIL Specifications. They have been field-tested for a full year—*successfully!* As for *economy*, these newest members of the Sprague Blue Jacket family are low in cost . . . eliminate need for extra hardware . . . save time and labor in mounting!

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

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

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

Standard Resistance Tolerance: ±5%

SPRAGUE Blue Jackets®

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

NORTH ADAMS, MASSACHUSETTS

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

As We Go To Press...

COLOR TV off to Flying Start

Raytheon color set (l) is compared to b & w

Color TV receiver being assembled at CBS

RCA assembles color broadcast equipment

TV manufacturers lost no time following up the Dec. 17 FCC approval of compatible color TV standards, which become effective on Jan. 22, 1954. Tricolor picture tubes, heretofore the big bottleneck, are becoming more available, and several tube makers have firmed down plans for mass production. The RCA-15GP22 production (see page 89) has been stepped up considerably, and the company has converted all facilities in its Lancaster, Penna., plant from black-and-white to color tubes. RCA has also scheduled a demonstration of its 19-in. tricolor kinescope for Jan. 21.

Chromatic TV Labs., makers of the Lawrence tube, is shipping 21-in. sizes, and has sold color tubes to 35 other manufacturers. Their 1954 output of 21 and 24-in. single-gun tubes is expected to increase greatly with the acquisition of new grid-producing facilities with an annual production rate of 25,000 grids.

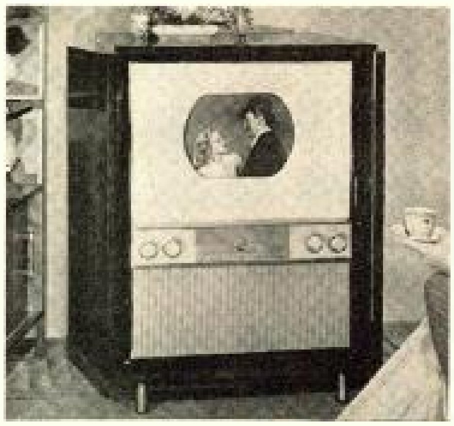
Following a similar agreement by Crosley, Thomas Electronics has signed with Chromatic, and will be mass producing 21-in. Lawrence tubes by summer.

Color receivers are starting to come off pilot production lines slowly but surely. A few companies have announced initial models, and some have actually shipped first "show" sets to dealers. Other manufacturers have not publicized their pioneer models, but are known to be setting up pilot lines and evaluating early designs. By March, dealers should be well supplied with color TV demonstrators.

Receiver circuit simplification continues to plague the industry, with first designs containing 40 to 50 tubes. Along these lines, Hazeltine has come up with a simplification technique (see page 111) for sets using the Chromatic tube which should prove of great interest.

Color broadcasting equipment production is moving along steadily. AT&T is geared to provide network interconnection for color as stations make requests.

Westinghouse color set has 12½-inch screen



"Tinkertoy" Plans Available to Industry

The Navy Dept. is making available to industry the drawings for tools and production processes needed to set up pilot runs of electronic modules developed under "Project Tinkertoy" (TELE-TECH & ELECTRONIC INDUSTRIES, Nov. 1953, page 70). This method of employing mechanized assembly of raw materials with minimum labor is expected to reduce substantially the lead time required to produce new equipment. Production plans may be obtained from the Office of Technical Services, Dept. of Commerce, Washington 25, D.C. In the future, the project will be called "modular design of electronics" and "mechanized production of electronics" instead of the code name "Project Tinkertoy."

Computer Translates Russian into English

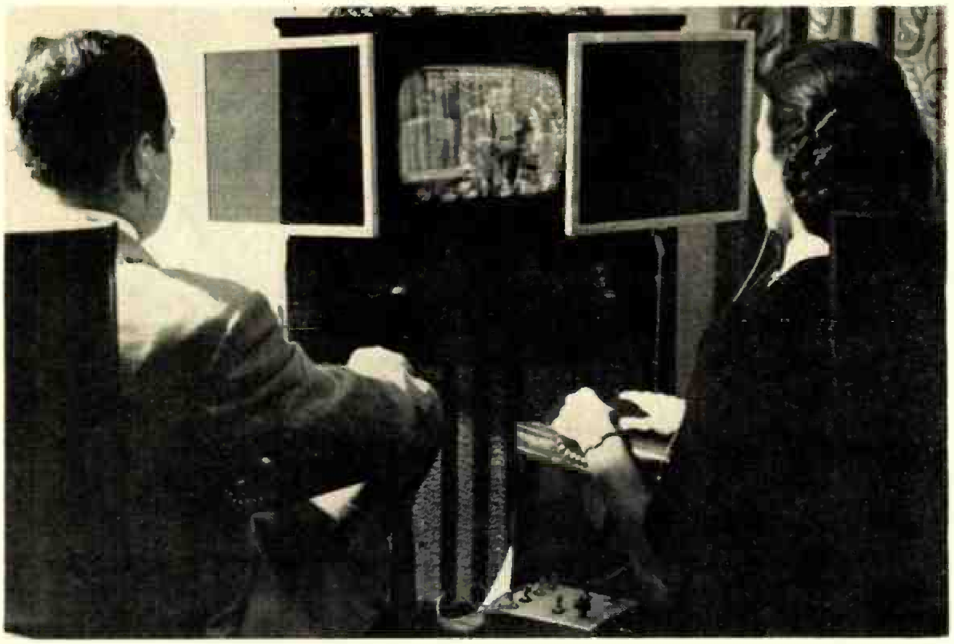
An electronic method of translating languages automatically has been devised by IBM in cooperation with Georgetown Univ. Employing the stock Type 701 Electronic Data Processing Machine, the system is initially set up to translate Russian into English immediately after the Russian is typed on a keyboard for punch card recording. So far the vocabulary contains only 250 basic words. Punch card controlled memory instructs the calculator on how to cope with syntax. Incoherent statements and misprints in the input cause the machine to ring a bell.

GUIDED MISSILE TESTS

Technicians at Bell Labs. set up simulated firing course to study action of Nike, guided missile for aircraft defense. Flight problems are introduced into electro-mechanical simulator and computer through control panel. Unit will be installed at Ft. Meade, Md.

MORE NEWS on page 14

Twin TV Displays Simultaneous Programs



Husband and wife watch and listen to two different programs at the same time on the same TV screen. Polaroid panels separate pictures which are directed at viewers by dichroic mirror

Domestic disagreements concerning which TV program should be tuned in may decline thanks to a novel two-in-one receiver developed by Allen B. DuMont Labs. A limited number of these "Duoscopic" sets have been produced, and if the public welcomes this means of allowing different people in the same room to view two different programs simultaneously on one set, it will go into mass production. The equipment consists of two chassis, each producing a picture on its own screen. The picture tubes are mounted at 90° to each other, and have oppositely polarized filters over their faces. At 45° between them, a dichroic mirror displays the superimposed pictures of the tube below it and the one behind it. Polaroid glasses or panels separate the pictures for different viewers, and earphone do likewise for the audio. Cost is double that of a standard set. The system has possibilities for 3-D TV .

Electronic Controls Developed for Home

Electronic relay which adjusts indoor temperature according to signals from two electronic thermostats, one mounted outdoors, is assembled at Minneapolis-Honeywell. Punched grid circuit is used instead of conventional wiring

The past year has seen the first introduction of electronic controls in the home in significant numbers. Production of such systems to control temperature has increased more than 700%, and, according to Paul B. Wishart, president of Minneapolis-Honeywell Regulator Co., some 50,000 homes will be equipped with the advanced systems by the end of 1954.

The new system provides a single thermostat to control both heating and cooling. Instead of maintaining indoor temperature constant, it is automatically varied according to outside weather conditions.

Cost of Computation Services Announced

Burroughs Electronic Instruments Div., 1209 Vine St., Philadelphia, Penna., has announced the availability of its computer services. Rates are: Machine time, $50/hr.; Programming, $7.50/hr.; Tape operation, $5/hr.

TV Computer Counts Blood Cells

The TV camera has been turned into the eye of a simple and ingenious computer to count microscopic particles such as blood cells, bacterial cultures or grains of photographic emulsion. The system, known in its laboratory stage as the Sanguinometer, was developed by RCA engineers working in cooperation with the Sloan-Kettering Institute.

The Sanguinometer is essentially a closed-circuit industrial system combined with an optical microscope and a novel computer that has the ability to make a count of particles in a given field by means of a unique electronic circuit developed by L. E. Flory and W. S. Pike of RCA Lab. The TV camera at the eyepiece of the microscope, feeds the information it "sees" to both the computer and a monitor viewing screen.

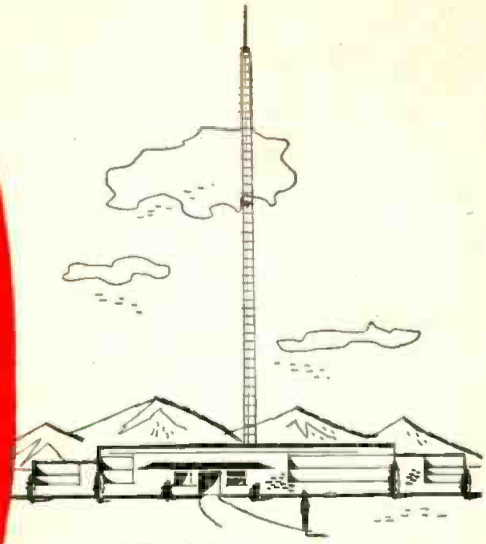
FIRST INSTALLATION OF ELECTRONIC FISH FINDER

Capt. Richard Dobbin of the "Flying Cloud" operates first commercial U. S. installation of "Fischlupe" (top), made by Electroacustic G.m.b.H., Germany, and distributed by Radiomarine Corp. of America. Supersonic signals reflected from fish are displayed on CRT (bottom) showing large school of fish located above sea bottom

MORE NEWS on page 18

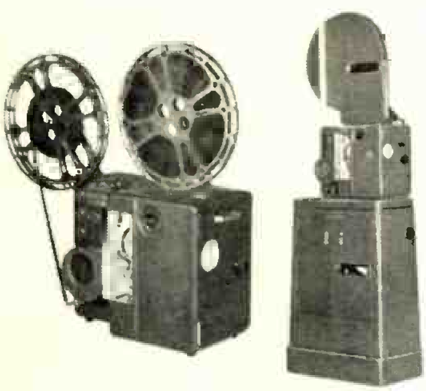
ask for proof!

HOW GPL CAN EQUIP YOUR TV STATION BETTER.. at LOWER COST

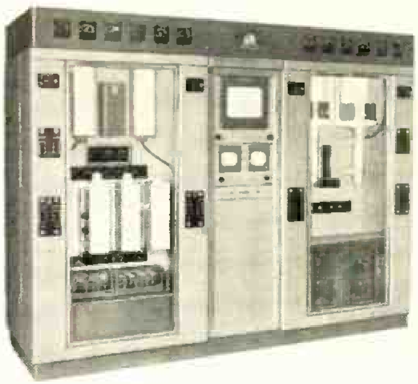


■ In your studios, with your operating cost figures, GPL will gladly put on a double demonstration of proof for you. First, to show you television quality—the reason networks pick GPL for top shows. Second, to show you economy that can't be matched, due to the precision and double-duty utility of GPL equipment. GPL is a complete source of station equipment, from camera chains to transmitters. For quality plus economy, study this equipment in operation.

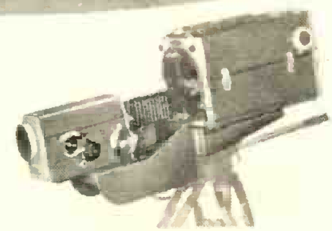
CAMERA CHAINS: The world's finest, precision-built, lightweight, fast-handling. Selected by networks for efficiency and quality. Remote control of focus, lens change, iris. Also remote pan & tilt available. Easy to service, low maintenance costs.



PROFESSIONAL PROJECTORS: Designed for TV, with 4000-foot magazines. Sharp, steady pictures. GPL "3-2" projector may be used in studio or field, for remote commercials, also for rear screen.



GPL-CONTINENTAL TRANSMITTER: 1 KW UHF unit with construction and performance far above standards of today. Space saving, but easily accessible. Air-cooled. No transmitter control console needed. Flexible for power increase.



GPL-WATSON VARI-FOCAL LENS: Turns any camera into twins; one camera can handle entire show. 10:1 change in focal length in two 5:1 steps: 3 to 15 inches, 6 to 30. Motor driven control from camera or control room.

VIDEO SWITCHER: Compact, efficient with full studio flexibility anywhere. Saves control room space, ideal in field. View, preview, fade, dissolve, lap etc. 5 inputs, 2 remotes, outgoing line. Twin fade levers.

General Precision Laboratory GPL

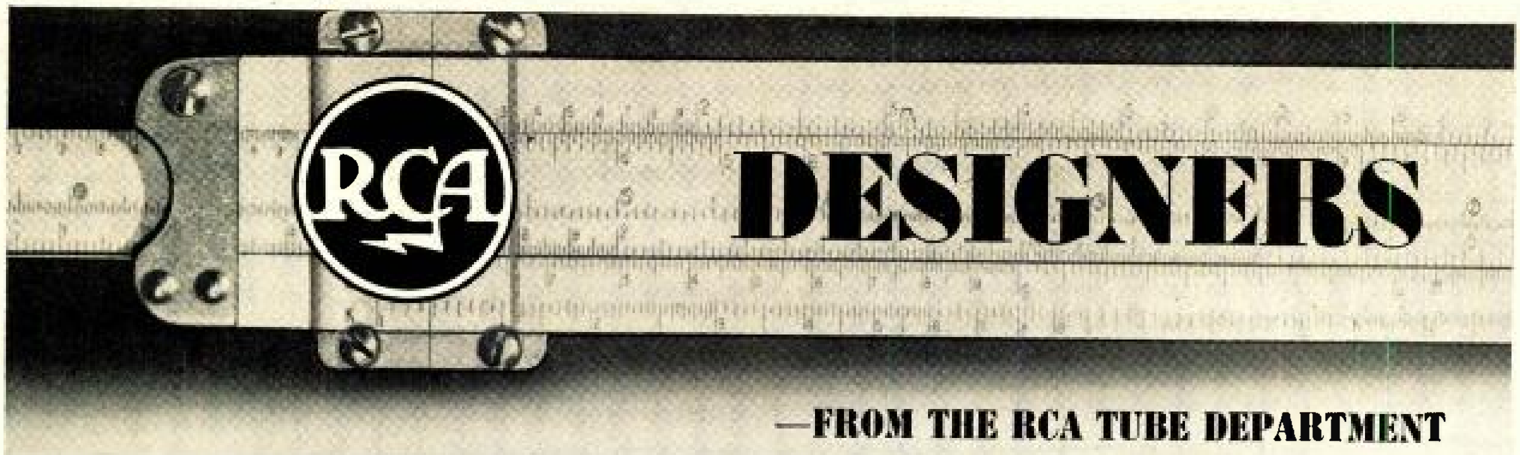
INCORPORATED

PLEASANTVILLE NEW YORK Cable address: Prelab

Export Department: 13 East 40th St., New York City

Cable address: Arlab

Camera Chains by Pye, Ltd. • Film Chains • Field and Studio Equipment • Theatre TV Equipment • GPL-Continental Transmitters

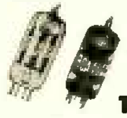


Cut equipment costs with RCA Preferred Tube Types

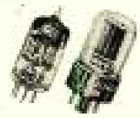
As a guide to cutting costs when choosing electron tubes for the design of new electronic equipment, RCA offers its current list of RCA Preferred Tube Types.

These key tube types—generally preferred for their performance in radio, television, and other widely used circuits—offer the *cost saving* advantages of *volume produced* types. Because they can be manufactured at a more uniform rate, Preferred Tube Types bring special benefits of year 'round availability, stocking economies, uniformly high quality, and initial lower cost which make for low equipment cost to designers, distributors, and consumers alike.

For standardization of your designs and simplification in the manufacture and maintenance of your equipment, consider the importance of Preferred Tube Types. Ask your RCA representative for details on how RCA Preferred Tube Types can actually reduce your manufacturing costs and increase your profit picture.



RCA PREFERRED TUBE TYPES for new Equipment Design



Types For AM and FM Receiver Applications

Amplifiers, Oscillators, & Mixers				
Triodes		Pentodes		
Twin	with Diodes	Sharp Cutoff	Remote Cutoff	with Diodes
12AU7◈	6AV6 12AV6	1U4 6AU6 6CB6	1T4 6BA6 12BA6	1U5

Rectifiers and Diode Detectors	Converters	Output Amplifiers
5U4-G 5Y3-GT 6AL5 6X4 35W4	1R5 6BE6 6X8 12BE6	3S4 3V4 6AQ5 6K6-GT 6V6-GT 35C5 50C5

Types For Television Receiver Applications

Amplifiers			
IF	Video	Audio	Deflection
6AU6 6BQ7-A 6CB6	6AU6 6CL6	6AQ5 6AV6 6K6-GT 6V6-GT	6S4 6BQ6-GT 6CD6-G 6W6-GT

RF Tuner Tubes	Deflection Oscillators	Control Circuits#
6AF4* 6BQ7-A* 6J6 6X8	6SN7-GT 12AU7◈ 12BH7◈	6AU6 6SN7-GT 12AU7◈ 12BH7◈

Rectifiers		Damper Tubes	Sound & Video Detector
High-Voltage	Low-Voltage		
1B3-GT	5U4-G	6AX4-GT 6W4-GT	6AL5

Miniature types are shown in italics   * For UHF   ◈ Tapped heater, for 6.3-volt or 12.6-volt operation   # Including synchronizing functions, AGC, etc.

SMALL TYPES FOR INDUSTRIAL AND COMMUNICATION SERVICES

Home Entertainment Types of Special Interest #		Vacuum Types For Critical Applications		Types For Regulator Service	Glow Discharge Triode
6AK6 6AQ6 6BJ6 6C4	6L6-G 6SC7 6SL7-GT 12AX7	1620 5690 5691 5692 5693 5879	(5690–5693) "Special Red" Types	OA2 OB2 5651 6080	5823

Miniature types are shown in italics   * For UHF   ◈ Tapped heater, for 6.3-volt or 12.6-volt operation
Also see types for AM, FM, & TV Receivers

For Industrial equipment applications. In addition to the Preferred Tube Types listed above, RCA lists Preferred Tube Types in the following categories:

- Vacuum Types for RF and AF Power Applications
- Thyratons • Ignitrons • Rectifiers • Phototubes
- C-R Oscillograph Types • Camera and TV Studio Types

A complete listing of these types is yours for the asking.

For valuable assistance in choosing tube types for industrial applications, consult your RCA Field Engineer.

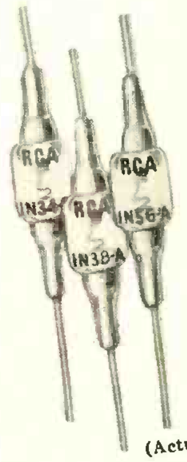
NEWS

New Multiplier Phototube for Headlight Dimming Service

(Actual height) 3⅛″

RCA-6328 is a short, 9-stage multiplier phototube. Instantaneous response of the tube meets the critical timing requirements of headlight-control service. RCA-6328 is capable of providing stable performance over long periods. High luminous sensitivity allows this tube to be used with an amplifier having relatively low-impedance input and fewer stages than required for a less-sensitive tube.

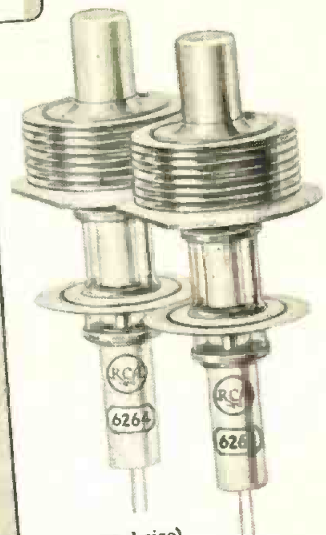
RCA Germanium-Crystal Diodes are now available



(Actual size)

RCA Point-contact Germanium-Crystal Diodes are now available in quantity. Sealed in glass, they include RCA-IN34-A (general-purpose type); IN38-A, IN55-A, and IN58-A (large-signal types); IN54-A (high-back-resistance type); and the IN56-A (high-conduction type).

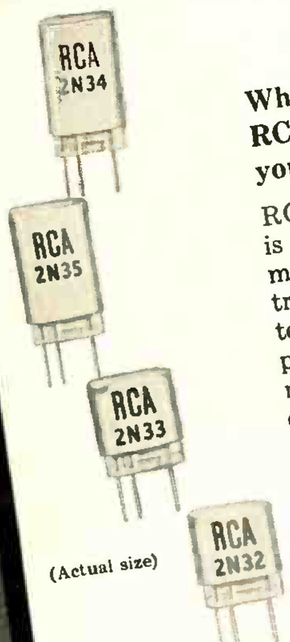
UHF "Pencil" Triodes for Mobile and Aircraft Services



(Actual size)

These new "Pencil" tubes—with external plate radiators—can be operated with full ratings at frequencies as high as 500 Mc—and at reduced input ratings up to 1700 Mc! ICAS plate dissipation is 13 watts. RCA-6263 is intended for rf power amplifier and oscillator services; RCA-6264 is designed for frequency-multiplier service.

Why you can count on RCA Transistors for your designs



(Actual size)

RCA transistor production is geared to the progress made in developing new transistor manufacturing techniques and in improved production-control methods. That is why you can count on RCA for high-quality transistors. They are made in accordance with the best engineering practice known.

RCA—"Headquarters" for

- Receiving Tubes
- Thyratrons
- Rectifier Tubes
- Voltage-Regulator Tubes
- Germanium Diodes
- Transistors
- TV Picture Tubes
- Portable Radio Batteries
- Cathode-Ray Tubes
- Vacuum-Gauge Tubes
- High-Power RF Tubes
- Phototubes
- TV Camera Tubes
- TV Components
- Speakers
- Laboratory Test Equipment

RCA Tube Department
Commercial Engineering, Section B50R, Harrison, N. J.

Please send me technical data on:

- ☐ RCA Preferred Tube List PTL-501D
- ☐ New Multiplier Phototube, RCA-6328
- ☐ RCA Germanium Diodes
- ☐ RCA Transistors
- UHF "Pencil" tubes: RCA-6263 ☐ RCA-6264 ☐

Name____________________

Firm____________________

City__________ Zone_____ State__________

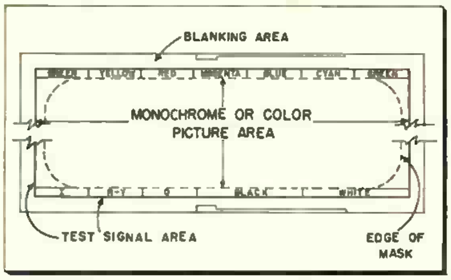
RADIO CORPORATION of AMERICA

TUBE DEPARTMENT HARRISON, N. J.

As We Go To Press . . . (Continued)

Compatible Color TV Test Signals Proposed

Continuous color standard test signals that would be transmitted without interference to regular monochrome or color TV programming has been proposed to the FCC by J. Raymond Popkin-Clurman, president of Telechrome, Inc. As shown in the illustration, 10 to 12 lines at the top and bottom of the video picture would show the major saturated colors, their complementaries, I, R-Y, Q, black and white. In



addition, a color burst and possibly one line of gray scale would be sent. These signals are described as consistent with approved standards, would generally lie in masked-off area, and would provide standard of comparison for receivers whenever needed.

Long-Life Battery Developed by Sonotone

After four years of production for the armed forces, Sonotone has announced the release for commercial usage of a nickel-cadmium storage battery with at least five times the life of ordinary lead batteries. It will operate under climatic extremes of −65° to 165°F, can withstand 15g vibration and 50g shocks, and does not gas on discharge. A cell the size of a deck of cards can supply currents as high as 100 amps. Plate grids consist of sintered carbonyl nickel powder, active positive plate material is nickel oxide, and that of negative plate is cadmium. Potassium hydroxide is the electrolyte. Cell EMF is 1.3v. A five-cell battery rated at 50 amp-hrs. measures only 7¼ x 5 x 11½ in.

New nickel-cadmium battery repeatedly starts auto engine despite battery being frozen in cake of ice. Size is half of regular battery

COMING EVENTS

Feb. 4—ISA 9th Annual Regional Conference, Hotel Statler, New York, N.Y.

Feb. 4-6—6th Southwestern IRE Conference and Electronics Show, Hotel Tulsa, Tulsa, Okla.

Feb. 4-6—1954 Audio Engineering Society, Audio Fair, Alexandria Hotel, Los Angeles, Calif.

Feb. 11-12—AIEE-IRE-ACM West Coast Computer Conference, Ambassador Hotel, Los Angeles, Calif.

Feb. 18-19—AIEE-IRE Conference on Transistor Circuits, Philadelphia, Pa.

Mar. 15-19—NACE Tenth Annual Conference and Exhibition, Kansas City.

March 22-25—IRE National Convention, Waldorf-Astoria Hotel and Kingsbridge Armory, New York, N. Y.

March 30-April 8—62nd Royal Netherlands International Industries Fair, Utrecht, Holland

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

May 24-26—AIEE Conference on Telemetering, Morrison Hotel, Chicago.

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

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

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

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

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

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

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

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

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

Sept. 13-24—SESA First International Instrument Congress and Exposition, Convention Hall and Commercial Museum, Philadelphia, Pa.

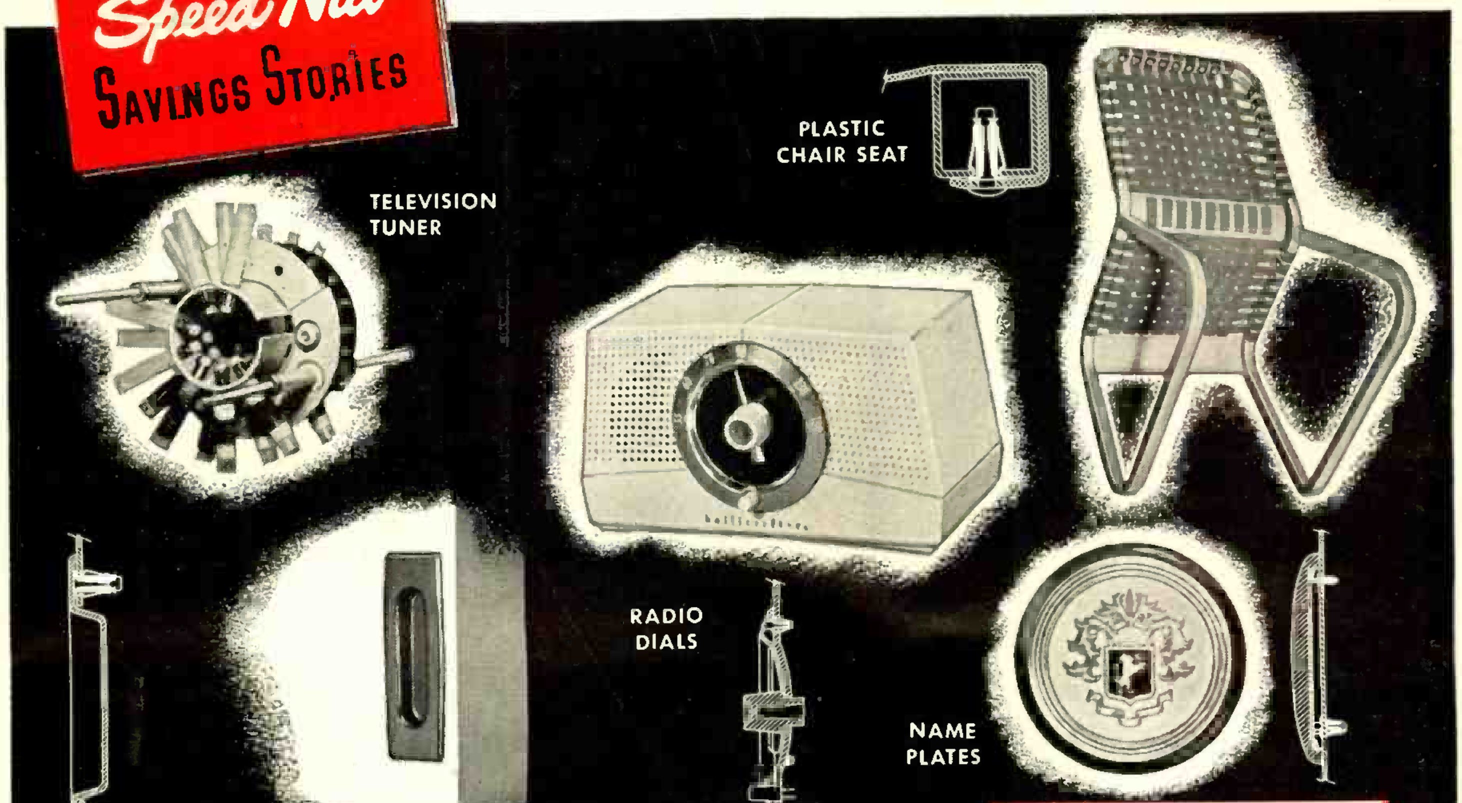
Sept. 30-Oct. 2—High Fidelity Show, International Sight and Sound Exposition, Inc., Palmer House, Chicago.

ACM: Assoc. for Computing Machines.
AFCA: Armed Forces Communications Assoc.
AIEE: American Institute of Electrical Engineers.
AMA: American Management Association.
ASTE: American Society of Tool Engineers.
ASTM: American Society for Testing Materials.
AWS: American Welding Society.
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.
SESA: Society for Experimental Stress Analysis.
SMPTE Soc. of Motion Picture and TV Engineering.
WCEMA: West Coast Electronics Manufacturer's Association
WESCON: Western Electronics Show & Convention.

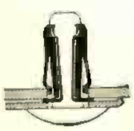
TELE-TIPS on page 20

TINNERMAN **Speed Nut** SAVINGS STORIES

FASTEST THING IN FASTENINGS®



Tubular SPEED CLIPS® Reduce Assembly Costs ...Increase Production...Improve Quality



Hundreds of manufacturers—dozens of industries—save thousands of dollars with Tinnerman Tubular type SPEED CLIPS. These high quality spring steel fasteners snap into place by hand, are self-retained in stud-receiving position. Applicable in punched or molded holes, equally effective on metal or plastic studs, ideally suited to "blind" attachments where only one side is accessible . . . just a few of the reasons these unique fasteners reduce production costs and materials handling.

Tubular type SPEED CLIPS have proven themselves in the electronics field. Production savings exceeding 50 percent and substantial increases in output have been achieved through their use. A wide variety of types and sizes are available to fill most fastening needs.

Your Tinnerman representative has complete information that may lead to improved fastening methods for you—see him soon.

Tinnerman Tubular Type SPEED CLIPS

...heat treated spring steel fasteners available in a wide range of sizes with rust resistant finishes. Design variations include permanent-lock or removable-lock types. Integrally molded studs provide extra savings through reduced parts and parts handling.

Write direct for SPEED NUT "Savings Stories", and your copy of Tubular Type SPEED CLIP Bul. #330. TINNERMAN PRODUCTS, INC., Box 6688, Dept. 12, Cleveland 1, Ohio. *In Canada:* Dominion Fasteners, Ltd., Hamilton, Ont. *In Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *In France:* Aerocessoires Simmonds, S. A.—7 rue Henri Barbusse, Levallois (Seine).

TINNERMAN **Speed Nuts**®

MORE THAN 8000 SHAPES AND SIZES

TELE-TIPS

MOST CREATIVE YEARS in a man's life are usually the thirties, according to a recent statistical analysis. In the physical sciences, major contributions and inventions come from men 30 to 35. Even in philosophy, peak creativity occurs most frequently in the 30 to 44 group. However, the greatest achievement of leaders and statesmen is most likely after 50 or even 60. Leaders tend to be younger in newly-established societies and in times of upheaval.

ELECTRONIC RELIABILITY is the subject of reports by R. M. C. Greenidge of Bell Labs. and Lewis M. Clement, RETMA Chairman of Electronic Applications Committee (Reliability), showing where responsibility rests for component failures in military equipment.

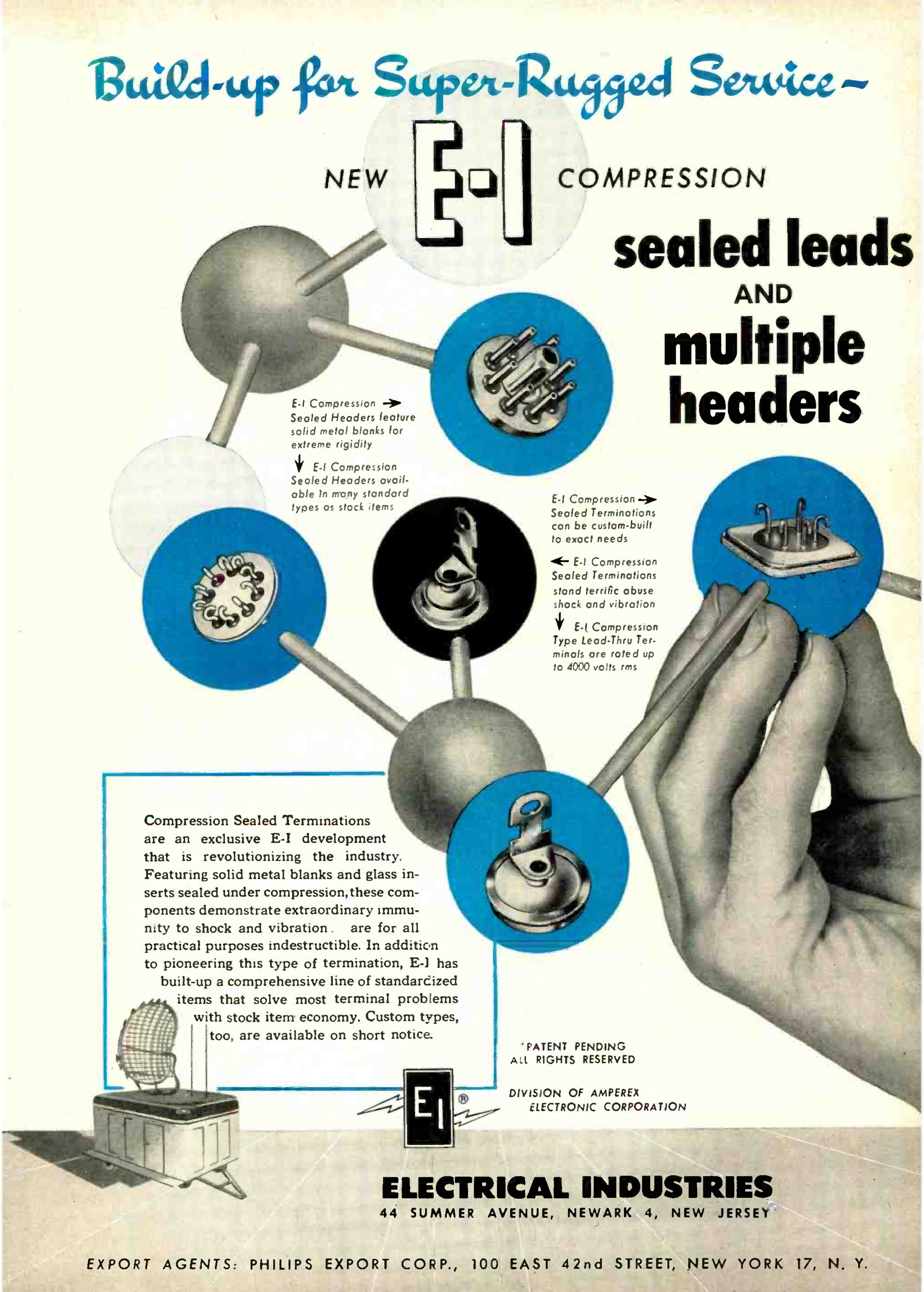
Failures assigned to engineering—43%
- *Circuit and component deficiencies* 11%
- *Inadequate components* 10%
- *Circuit misapplication* 12%
- *Unstable materials* 5%
- *Unsatisfactory parts* 5%

Failures assigned to operational causes—30%
- *Abnormal, accident* 12%
- *Manhandling* 10%
- *Faulty maintenance* 8%

Failures assigned to manufacturing—20%
- *Faulty workmanship, inadequate inspection* 18%
- *Defective raw material* 2%

Failures assigned to other causes—7%
- *Worn out* 4%
- *Cause not determined* 3%

MAGNETIC TAPE is replacing the printed page as a means by which busy doctors can keep up with the specialized articles and reports contained in medical journals. The California Medical Association is now issuing a weekly magazine digest called "Audio Digest," which is nothing more than digested articles on medicine, put on hour-long reels of Scotch sound recording tape. The "new look" digest will enable doctors to catch up with their reading by using the otherwise non-productive hours of driving about in their cars to play back the recordings. (*Continued on page* 34)



Build-up for Super-Rugged Service –
NEW E-I COMPRESSION
sealed leads
AND
multiple
headers
E-I Compression Sealed Headers feature solid metal blanks for extreme rigidity
E-I Compression Sealed Headers available in many standard types as stock items
E-I Compression Sealed Terminations can be custom-built to exact needs
E-I Compression Sealed Terminations stand terrific abuse shock and vibration
E-I Compression Type Lead-Thru Terminals are rated up to 4000 volts rms
Compression Sealed Terminations are an exclusive E-I development that is revolutionizing the industry. Featuring solid metal blanks and glass inserts sealed under compression, these components demonstrate extraordinary immunity to shock and vibration . are for all practical purposes indestructible. In addition to pioneering this type of termination, E-I has built-up a comprehensive line of standardized items that solve most terminal problems with stock item economy. Custom types, too, are available on short notice.
*PATENT PENDING
ALL RIGHTS RESERVED
EI ®
DIVISION OF AMPEREX ELECTRONIC CORPORATION
ELECTRICAL INDUSTRIES
44 SUMMER AVENUE, NEWARK 4, NEW JERSEY
EXPORT AGENTS: PHILIPS EXPORT CORP., 100 EAST 42nd STREET, NEW YORK 17, N. Y.

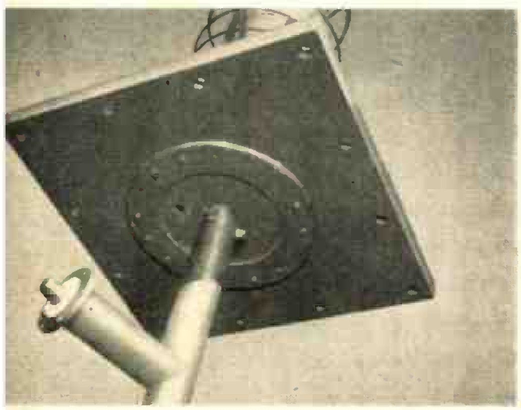
UHF ANTENNA GAINS HIT NEW HIGH!

G-E Helical Antennas at Three New TV Outlets Boost Directed ERP Within 500 KW Mark!

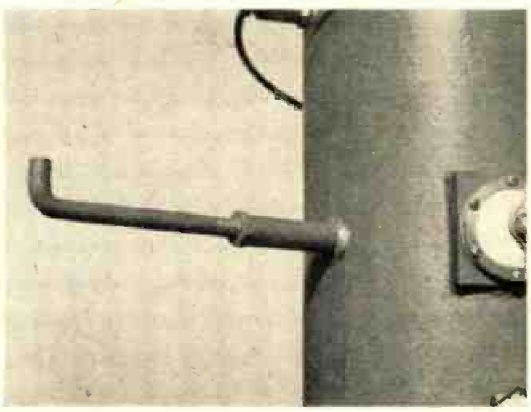
Here's how you can directionalize at lowest cost!

KTVU, Stockton, Calif.—Channel 36 . . . . Antenna Gain 47.6!
KACY-TV, St. Louis, Mo.—Channel 14 . . . . Antenna Gain 46!
KCOK-TV, Tulare, Calif.—Channel 27. . . . Antenna Gain 40!

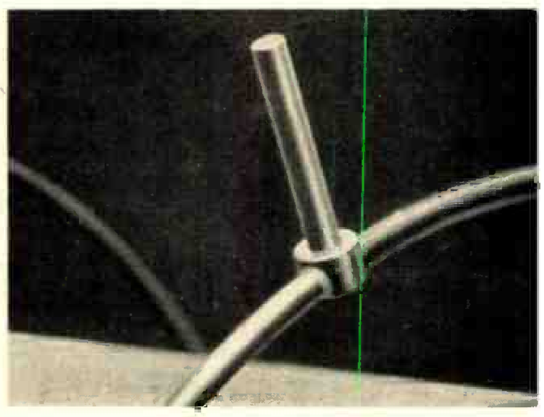
These gains were achieved with patterns which were custom-directionalized to meet specific needs of each broadcaster. Good coverage of your market area may require more intense directionalizing, give you even *higher gains!*



SIMPLIFIED DESIGN for fast transmission line hook-up! Power line may be readily removed or connected to the input feed adapter shown here. Beacon light cable feeds *inside the antenna* to eliminate any potential signal interference.



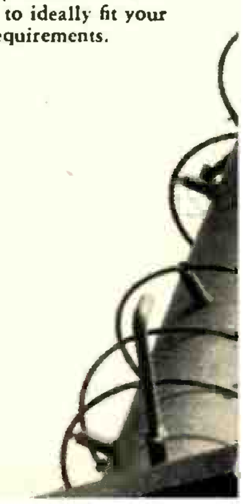
SIMPLIFIED DESIGN for antenna bay accessibility! This pole step with boss welded to bay facilitates beacon light maintenance or adjustments. Also useful as a twist lever for bay rotation when contouring.

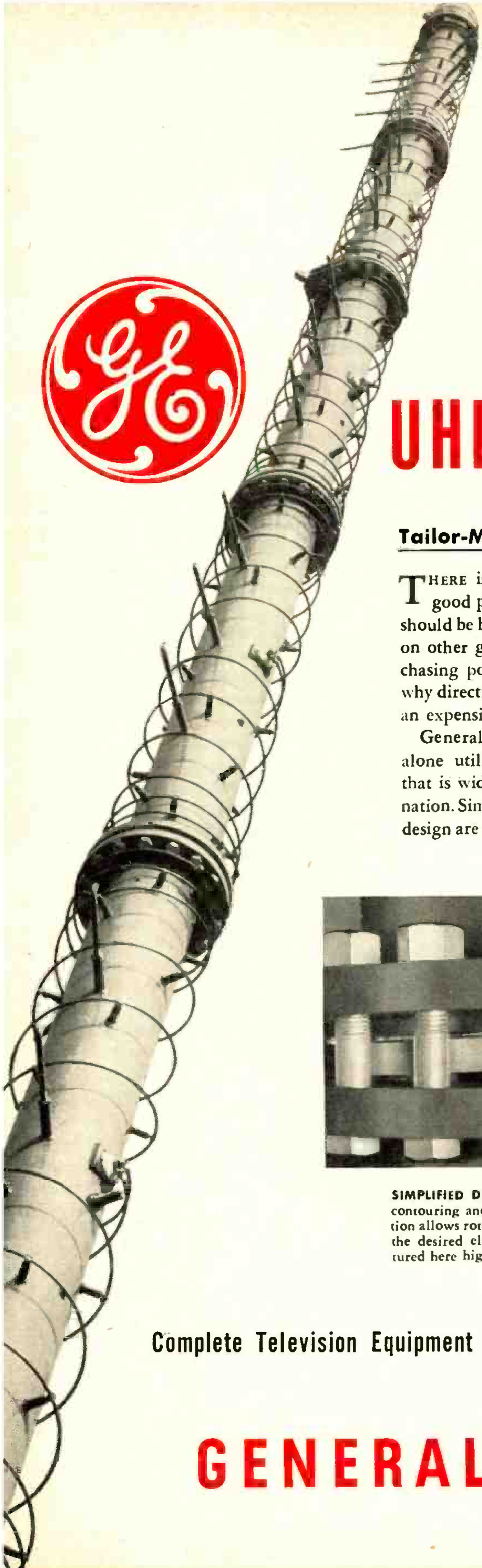


SIMPLIFIED DESIGN for directionalizing with this unique stub attachment! Inexpensive and easily installed on standard helicals (between 4 and 6 per bay) it controls directivity to ideally fit your geographical and population requirements.

Here's how you can get in the high-power class!

Your local G-E broadcast field representative has the answers on a directionalized helical antenna for your market. He'll show you how a 12 KW UHF transmitter will perform in any new TV outlet or how to combine your present small 1 KW unit with a General Electric 12 KW amplifier! See him today and place an order for early delivery of this preferred equipment!





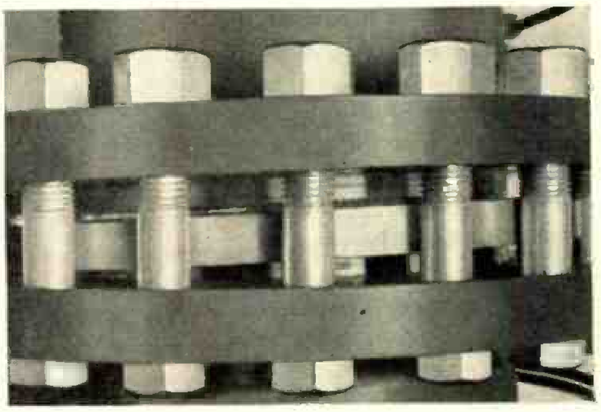
Directionalized UHF HELICAL ANTENNA

Tailor-Made coverage of Every Market with Standard Equipment

THERE is absolutely no reason why a good part of your UHF station signal should be beamed into the ocean or wasted on other geographical areas void of purchasing power. There is still less reason why directionalizing your antenna need be an expensive... custom-equipped process.

General Electric contouring methods alone utilize a standard antenna... one that is widely used today throughout the nation. Simple additions to the basic helical design are speedily made to result in single direction... elongated... close-in... or any ideal coverage your market demands! *And, this is done at a fraction of the cost other manufacturers must impose!*

An examination of this outstanding feature, and all others in the extremely practical, yet simple, G-E Helical design, clearly shows why General Electric leads the industry in *high-power* UHF equipped stations throughout the country! *Section X214-11, General Electric Company, Electronics Park, Syracuse, New York.*



SIMPLIFIED DESIGN permits bay adjustments for contouring and beam tilt! A swivel flange connection allows rotation of bays to any angle to establish the desired electrical phase. (Loosened bolts pictured here highlight this feature.)

SIMPLIFIED DESIGN... Just one feed point per bay! Provides extreme ease of adjustment! Low-impedance, non-resonant construction throughout results in stable antenna performance even in toughest weather—proved under all conditions!

Complete Television Equipment for UHF and VHF

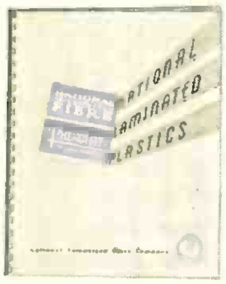
GENERAL ELECTRIC

He doesn't give Phenolite a thought

He doesn't have to. Every piece of Phenolite laminated plastic . . . and there are literally hundreds of them in his plane . . . can be counted on to do the job it was specified to do. This versatile material performs without fail in assignments that range from insulation in passenger reading lights to gears in the automatic pilot.

What makes Phenolite's application so universal? Because there are more than 35 different grades of Phenolite manufactured as standard, and many more special types. These are based on materials such as paper, cotton cloth, asbestos paper and fabric, glass cloth, nylon, etc., scientifically compounded with phenol, melamine or silicone resins under heat and pressure. Each grade has a combination of electrical and mechanical properties that is unique. There's almost always a grade of Phenolite to give the designer—aircraft or otherwise—exactly what he wants.

What can *you* do with a material that has great mechanical strength . . . weighs half as much as aluminum . . . is extremely resistant to moisture . . . is an ideal insulator at both high and low voltages . . . can be machined, shaped, punched, sawed, drilled, worked at will . . . is resistant to heat, solvents, oils, acids, alkalis and other chemical solutions? You can use it to advantage and we'll be glad to help you.

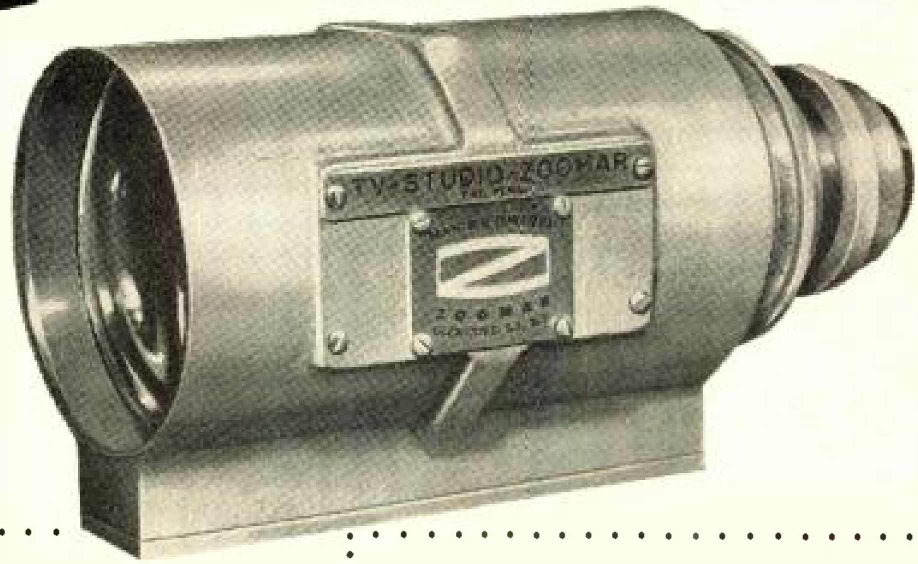


Want the facts and specifications on weights, tolerances, forms and grades available? Or dielectric strengths, colors, suggested applications, machining and forming techniques? Here's the whole story in one thumb-tabbed package. It's a catalog you can't afford to be without, so ask the National representative nearest you for your copy. He's listed in the classified directory. Or write to National Vulcanized Fibre Co., Dept. K-2, Wilmington 99, Delaware.

NATIONAL
VULCANIZED FIBRE CO.
WILMINGTON 99, DELAWARE

What Station Managers and Chief Engineers say about —

THE NEW STUDIO Zoomar



R. D. CHIPP, P. E., *Dir. of Engineering,*
DuMONT Television Network

"We have used the Studio Zoomar at WABD with good results on a number of programs. It is in demand by producers, directors, and clients. We plan one for the new Gateway Studios in Pittsburgh. Its use minimizes camera movement and lens changes, with a resulting increase in flexibility of studio operations. A corresponding reduction in operational cost is possible."

DWIGHT "RED" HARKINS, *Station Manager,*
KTYL, Phoenix, Ariz.

"Studio Zoomar has made possible production techniques and savings hitherto impossible. We use it on all live shows. Its versatility is unending. It saves time required for each set-up, whether it be a title card or a large set. Its instant ability to align correctly is a life-saver."

ROBERT J. SINNETT, *Chief Engineer,*
WHBF, Rock Island, Ill.—Davenport, Ia.

"Studio Zoomar gives us better programming and materially reduces our operating costs. It cuts out a myriad of details associated with the old technique. It means a one camera studio and a one camera show."

"Studio Zoomar imparts a certain enchantment and natural quality to the picture that simply cannot be duplicated in standard single lens multi-camera technique.

BERNARD C. O'BRIEN, *Chief Engineer,*
WHEC, Rochester, N. Y.

"We can assure you that the new Studio Zoomar lens is working perfectly. We are using it to produce single-camera shows and have had wonderful success with it. We wouldn't be without one of these lenses for anything."

JOHN C. MERINO, *Manager,*
KFSD-TV, San Diego, Cal.

"The new Studio Zoomar operates perfectly with three other lenses on the turret. At last it's possible to have the flexibility of a multiple lens arrangement, without switching to another camera. Studio Zoomar makes the one-camera show a reality."

ROBERTO KENNY, E.
XEW-TV, Mexico City

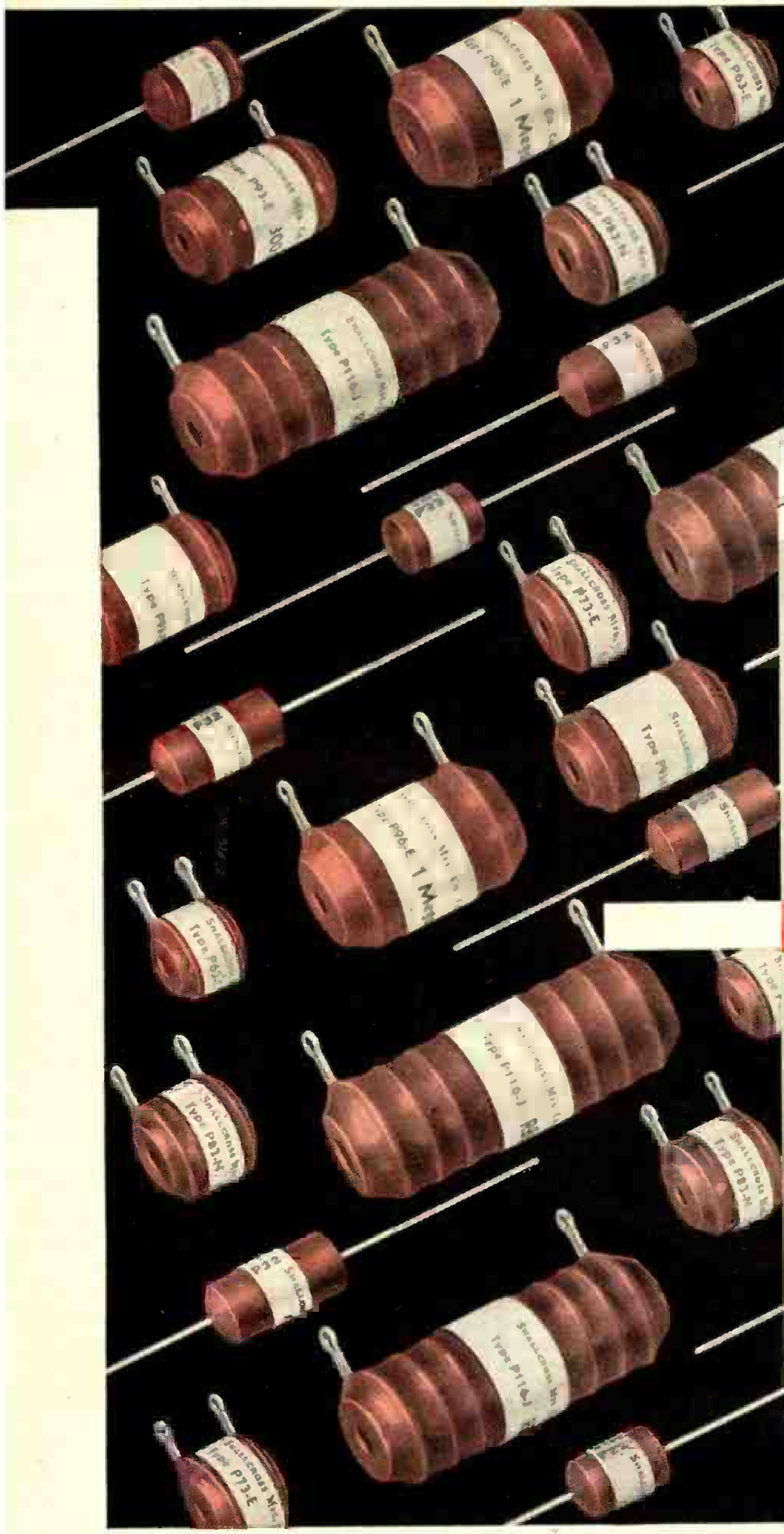
"Studio Zoomar lens works perfectly in daily operations. Our producers like this new Zoomar very much. Congratulations!"

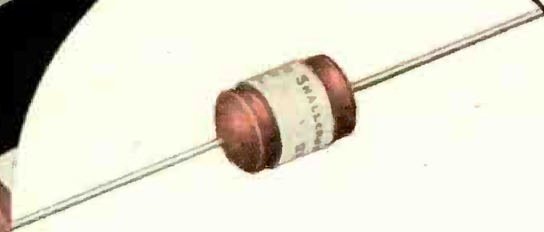
STUDIO ZOOMAR is made by the makers of Television Zoomar, now used by most major TV stations. It is fast (f/2.8), optically balanced, color corrected, and recommended for all color cameras including RCA. Weight, 6 pounds, length, 1 foot, zoom range, 2¼ to 7 inches. Because of the many economies this new lens makes possible, it should pay for itself in short order.

Demonstration on your own equipment without obligation. Write — Wire or Call

TELEVISION ZOOMAR CORP.

500 Fifth Avenue, New York 18, N. Y. • Jack A. Pegler, President





AMPHENOL

Building to the Future of Electronics – AMPHENOL

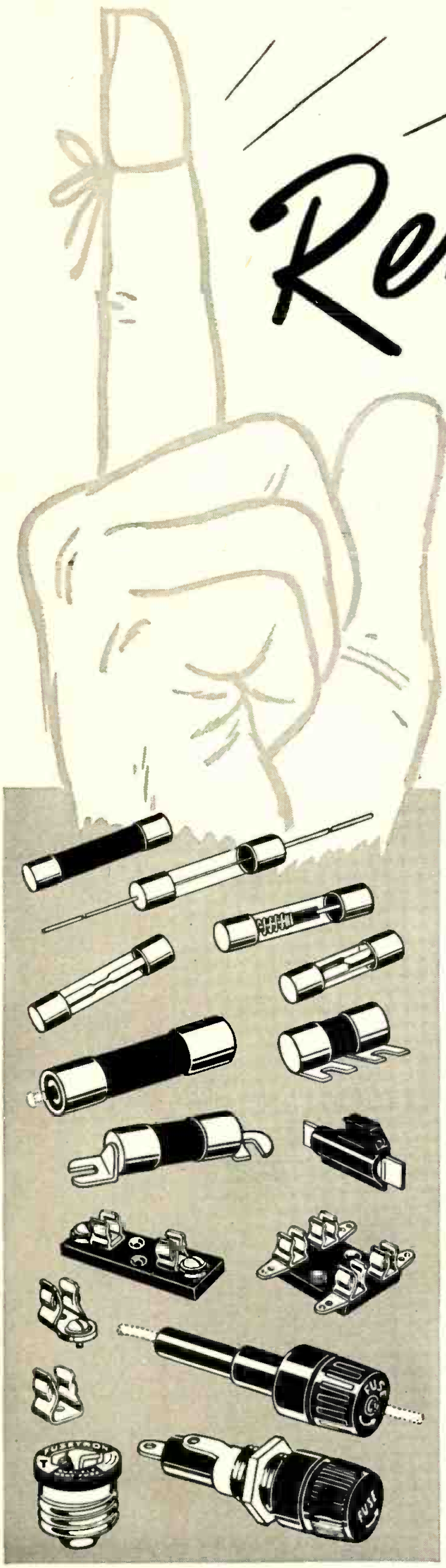
at AMPHENOL
Engineering skill, production know-how build better components

AMPHENOL's famous quality components are designed by skilled engineers whose knowledge of electronics is unequalled in the industry. Their ability and ingenuity enable AMPHENOL to better work for you.

Production of the over 9,000 items now made by AMPHENOL is accomplished in five modern plants. Highly trained employes—strict quality controls insure the fidelity of the finished component to the original design.

A N connectors, R F connectors, coaxial cables, sockets and many other special components are produced by AMPHENOL. All reflect the skill of the engineer and the production know-how at AMPHENOL's five plants.

AMERICAN PHENOLIC CORPORATION • *chicago 50, illinois*



Remember!

For "Trouble-Free" Fuses Use BUSS FUSES

There is a reason manufacturers and service organizations have learned to rely on BUSS fuses to operate properly under all service conditions. Every BUSS fuse normally used by the Electronic Industries is tested in a sensitive electronic device that rejects any fuse that is not correctly calibrated, properly constructed and right in all physical dimensions.

Once properly installed, a BUSS fuse will blow only to protect. If a BUSS fuse does blow, you can be sure there is trouble in the circuit. When the trouble is corrected and a new BUSS fuse installed the job is finished. The user won't be annoyed and your equipment won't be out of service by the fuse failing to operate properly . . . because a BUSS fuse will carry its rated current and it is properly constructed to prevent poor contact heating causing needless blows.

And by standardizing on BUSS fuses, you can fill your exact fuse needs from one source. The line is complete-dual-element (slow-blowing), renewable and one time types . . . in sizes from 1/500 ampere up.

Should you have a special problem in electrical protection —

Our fuse research laboratory and its staff of engineers are at your service to help you select the right fuse for the job — and if possible a fuse already available in wholesalers stocks.

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

For More Information ***Mail this Coupon***

BUSSMANN Mfg. Co. (Division of McGraw Electric Co.)
University at Jefferson, St. Louis 7, Mo.

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

Name ______________________

Title ______________________

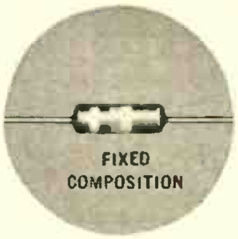
Company ______________________

Address ______________________

City & Zone ______________ *State* ______________

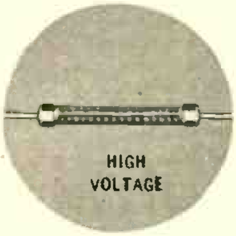
TT-254

high popularity—high stability



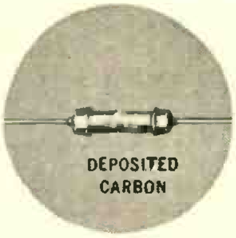
More IRC Filament Type BT Resistors are used in radio and TV sets than any other brand. They meet and beat JAN-R-11 specifications, and have been tested and approved by most producers of government equipment. Exceptionally stable—in ⅓, ½, 1 and 2 watts. Send coupon for Data Bulletin.

high voltage—high stability



IRC Type MV High Voltage Resistors offer outstanding stability even in very high resistance values. Filament resistance coating in helical turns on ceramic tube provides a long, effective conducting path. 2 to 90 watts. Check the coupon for detailed information.

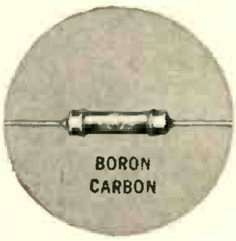
high economy—high stability



Type DC Deposited Carbon Resistors combine accuracy and economy with high stability. Excellent where carbon compositions are unsuitable and wire wound precisions too large or expensive. Available in ½, 1 and 2 watts. Use coupon for further facts.

STABILITY STANDARDS

high accuracy—high stability



The ultimate in *stable* non-wire wound resistors. Type BOC Boron-Carbon ½ watt Precistors are ideally suited for critical circuits where stability and high accuracy under widely varying temperatures are important. Extraordinary load life. Send for Bulletin.

NEW
resistor

MOLDED
boron-carbon precistor

Eliminates Possibility of End-Cap Trouble

Eliminates Danger of Mechanical Damage

Improved Electrical Characteristics

The new Type MBC ½ watt, 1% resistor offers the inherent superiority of a Boron-Carbon resistor plus the advantage of a fully insulated unit. Send coupon for full details.

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

Wherever the Circuit Says

IRC

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

INTERNATIONAL RESISTANCE CO.
407 N. Broad St., Philadelphia 8, Pa.

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

Send me full data on: ☐ DC Deposited Carbon; ☐ BT Insulated Filament Type Resistors; ☐ MV High Voltage Resistors; ☐ BOC Boron-Carbon Precistors; ☐ MBC Molded Boron-Carbon Precistors

Name ____________

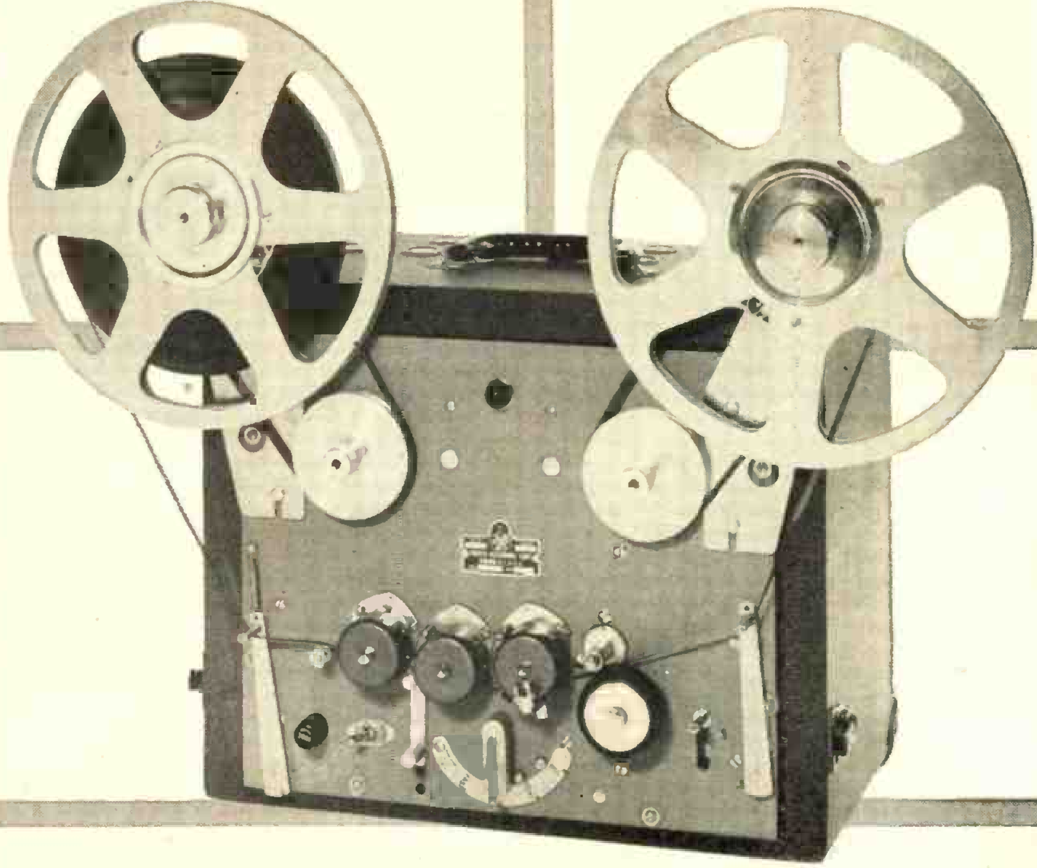
Title ____________

Company ____________

Address ____________

City ________ Zone ____ State ____

Regardless of model . . . Presto has only one quality



Take, for instance, the finely engineered . . .

PRESTO RC-7 TAPE RECORDER

EQUIPMENT SPECIFICATIONS

- Dynamic range better than 50 db at 3% distortion.
- Three-motor drive system.
- No friction clutch or friction brakes.
- Heavy-duty construction throughout.
- Separate erase-recording-playback heads.
- Twin speed: 7½"/sec. or 15"/sec.
- Frequency response 50 to 15,000 cps.
- Reel size: 7" standard, 10½" with RA-1 adapter.
- Flutter: at 7½"/sec., 0.25 — at 15"/sec., 0.20.
- Available in 110 or 220 volts and 60 or 50 cycles.
- Weight: 41 lbs.

The completely portable PRESTO RC-7 is a precision recorder in every detail. Yet it's rugged and durable for heavy-duty field recording, and equipped with every feature this service demands. Built around a sturdy 3-motor drive, the RC-7 contains the same high-quality components found in Presto's fine studio equipment.

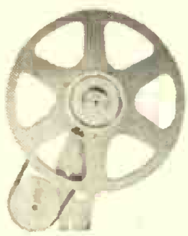
The RC-7 has separate recording and reproducing heads. Monitoring from tape is instantaneous. Mechanical friction devices, which always require constant adjusting, are totally eliminated from the RC-7, and virtually no adjustment is needed throughout the life of the machine. Note the RC-7's other features in the column at the left.

All of PRESTO's engineering experience as the world's foremost producer of precision recording equipment has been devoted to making the RC-7 the outstanding leader in fine tape recorders, in flawless performance, simplicity of operation, and long and thoroughly satisfactory service.

Write for complete engineering data and price

NEW RA-1 REEL ADAPTER

enables owners of the RC-7 and 900-R1 recorders to use 10½" reels. Carries out all normal functions, such as fast forward and rewind speeds. Easily attached.



PRESTO RECORDING CORPORATION

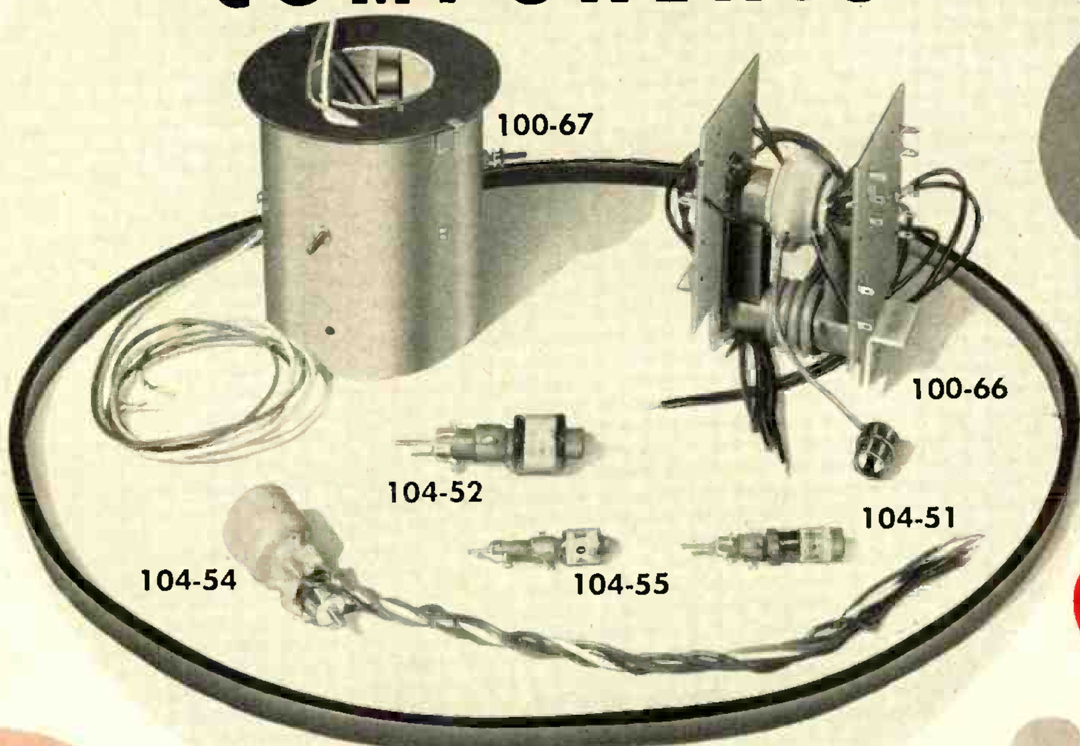
PARAMUS, NEW JERSEY

Export Division: 25 Warren Street, New York 7, N. Y.
Canadian Division: Walter P. Downs, Ltd., Dominion Square Bldg., Montreal

WORLD'S LARGEST MANUFACTURER OF PRECISION RECORDING EQUIPMENT AND DISCS

Another Raypar First...

TV *Color* COMPONENTS



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7800 WEST ADDISON STREET • CHICAGO 34, ILLINOIS

100-66 FLYBACK TRANSFORMER
104-51 HORIZONTAL LINEARTY CONTROL
104-55 HORIZONTAL DYN. CONV. PHASE CONTROL
104-54 HORIZONTAL CONVERGENCE TRANSFORMER
104-52 WIDTH COIL
100-67 PURITY COIL
104-53 FIELD NEUTRALIZING COIL

For further information write for price list and our free catalog and engineering handbook

SERVING AMERICA'S LEADING RADIO & TV MANUFACTURERS

TELE-TIPS

(*Continued from page 20*)

H-F SOUND CUTTING—The hardest possible materials can no longer defy cutting, and that includes diamonds, tungsten carbide, synthetic sapphires, hardened tool steel, and agate quartz. In fact an ultrasonic machine tool called the Cavitron, which uses high-frequency sound waves, can bore holes with up to 0.0003-inch tolerance in such materials. A stack of Driver-Harris nickel plates contracts 1,620,000 times per minute in an electromagnetic field. The magnetostrictive vibrations pass through a monel tool holder to a cutting die brazed to the holder's tip. The die does not actually cut but transmits the vibrations to a stream of water carrying fine abrasive particles. These literally erode out the surface of the material to conform to the shape of the cutting die. The tool is already making parts for the aircraft, electronic and jewelry industries.

CRIME PROGRAMS on TV can help curb juvenile delinquency. A Texas judge ordered parents of teenagers caught carrying firearms to listen to a transcription of a "Dragnet" program, dramatizing a similar case which had resulted in murder. The program is reported to have had "a most lasting effect."

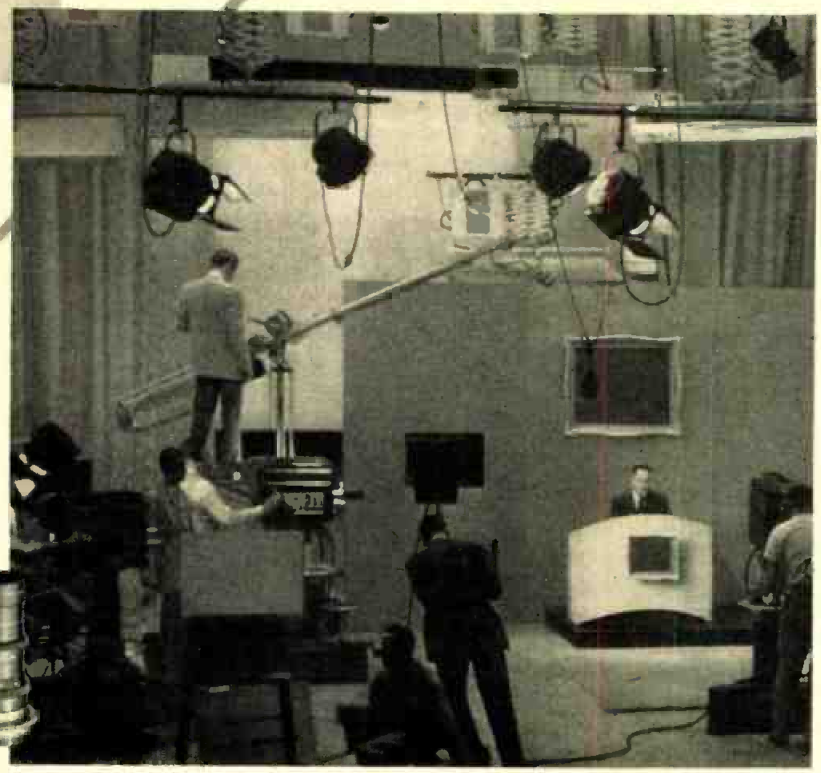
IN A JAM—Despite the use of hundreds of Soviet jamming transmitters, many programs beamed behind the Iron Curtain by Voice of America, Radio Free Europe and BBC do get through. Operation is aided by fact that there are a large number of shortwave receivers in the Soviet Union because the internal broadcast system depends largely upon high frequencies.

HUMOROUS TALE going the rounds tells about a Soviet engineer who is thrown into jail. "Why are you here?" asks his cellmate. "Because I am anti-Smernov," replies the engineer. "Funny," says the other, "I was jailed for being pro-Smernov." Just then a third man is shoved into the cell. "Who are you?" The new prisoner looks at them and replies, "I'm Smernov."

(*Continued on page 42*)

WHEN SHOOTING FILM

OR LIVE TELEVISION



THERE'S A **RAPTAR** LENS FOR EVERY REQUIREMENT

Wollensak TV Raptar Lenses are specially designed for the television industry . . . built for tomorrow's advancements as well as today's requirements. Robert Horn of Station KIMA-TV writes, "We have had extremely satisfactory results from the normal 25mm Wollensak Raptar on our Auricon camera. The extreme wide angle lens has more than paid its way in permitting good coverage in tight quarters."

When televising live you'll also get the finest results with TV Raptars . . . 14 lenses in focal lengths from 2″ to 24″. Write for literature. Wollensak Optical Co., 850 Hudson Avenue, Rochester 21, N. Y.

MASTERPIECES by **WOLLENSAK**

THE BETTER CAMERA HAS A WOLLENSAK LENS

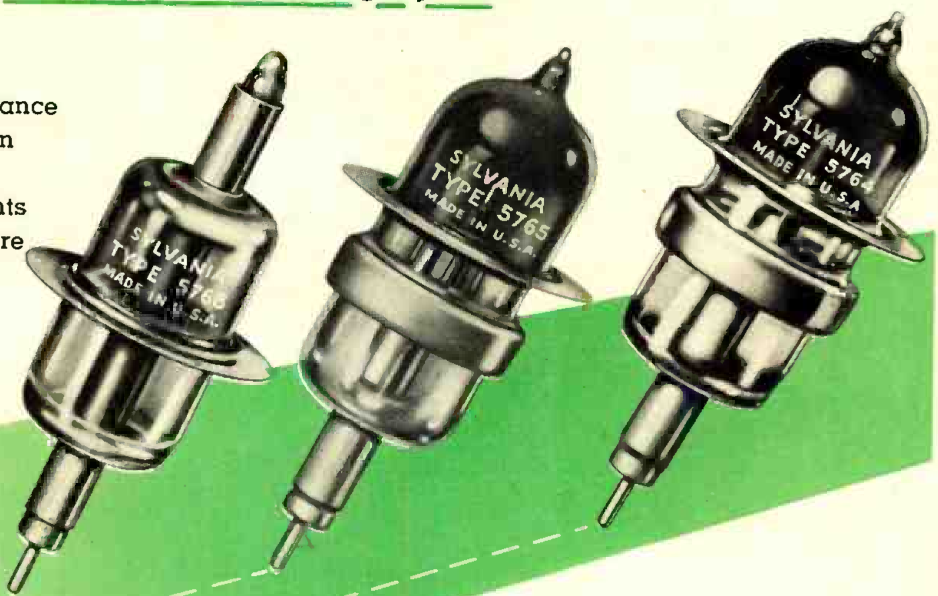
SYLVANIA

ROCKET TUBES

(PLANAR TRIODES)

The Answer to Efficient Power at 1000 to 4000 Megacycles

- Low Lead Inductance
- Low Interelectrode Capacitance
- Rugged Planar Construction
- Small Size
- Moderate Input requirements
- Good frequency-temperature Characteristics



TYPICAL APPLICATIONS

TYPE	SERVICE	FREQUENCY MC	OUTPUT
2C36	Pulsed oscillator	1000	125 Watts
2C37	CW oscillator	1000-3300	450 MW.
5764	Pulsed oscillator	2900	200 Watts
5765	CW Tunable oscillator	900-2900	250 MW. Av over the band
5768	CW Tunable amplifier	1000-3000	10 db. av gain
RT434	CW oscillator for butterfly type circuits	1000-3000	400 MW.

Still more reasons why it pays to SPECIFY SYLVANIA

For complete information concerning Sylvania Rocket Tubes or other electronic tubes write to Sylvania, Dept. 4E-4402.

SYLVANIA

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

LIGHTING · RADIO · ELECTRONICS · TELEVISION

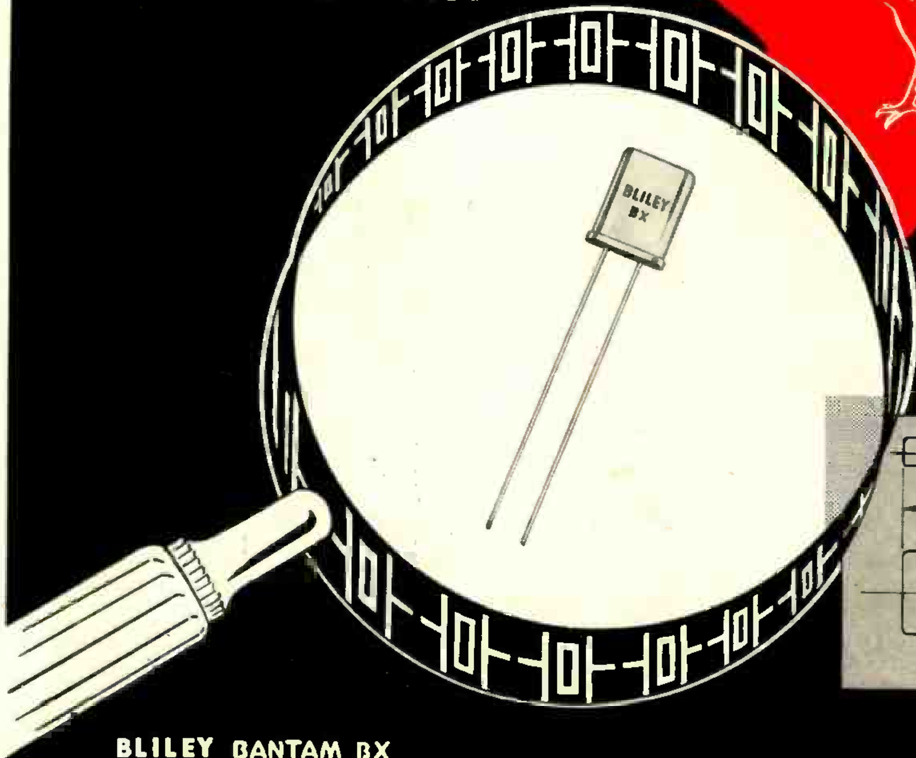
In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg., St. Catherine St., Montreal, P. Q.

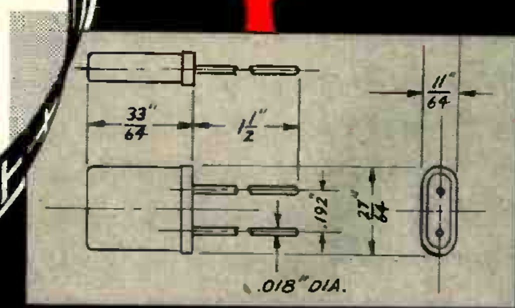
PRECISION *in* PINT-SIZE!

Bliley

BANTAM BX

CRYSTAL UNIT





ACTUAL SIZE

BLILEY BANTAM BX
FREQ: 15mc-100mc

The new **BANTAM BX** has wire leads for mounting in a miniature selector switch or can be soldered to a printed circuit terminal board.

The new **BANTAM BX** does not sacrifice precision or dependability. It meets same performance and tolerance requirements as larger crystal units such as MIL types CR-23 or CR-32.

The new **BANTAM BX** is fully described in Bulletin 46. Now available for prototypes or in production quantities.

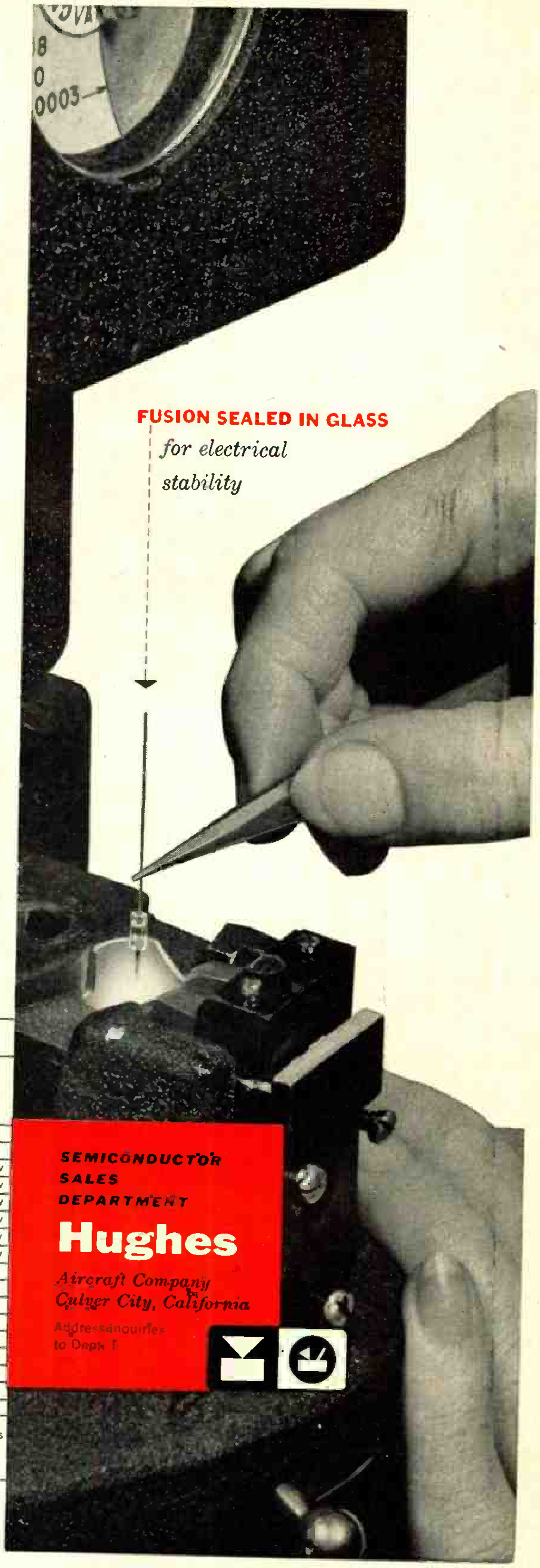
Bliley CRYSTALS

BLILEY ELECTRIC COMPANY
UNION STATION BLDG., ERIE, PA.

HUGHES DIODES

A New Standard of Reliability

Reliability in a germanium diode is determined principally by permanent freedom from the two major causes of diode failure—moisture penetration of the diode envelope, and electrical instability under extreme operating conditions.



HUGHES GERMANIUM DIODES are designed to prevent such failures through two exclusive features:

1. **Fusion Sealing**—The glass-to-metal seal, proved in billions of vacuum tubes, is incorporated to full advantage in diode manufacture by the Hughes-developed process of fusion sealing at high temperature. The result is a rigid *one-piece* glass envelope impervious to moisture.

2. **100% Testing**—Hughes 100% testing procedures *invite* instabilities to occur prior to shipment, assuring rejection of defective diodes. *Each* **HUGHES DIODE** is humidity-cycled, temperature-cycled, JAN shock-tested, and electrically tested under vibration. This testing procedure insures operation of **HUGHES DIODES** under adverse conditions of moisture, temperature, vibration and severe shock.

Reliability of **HUGHES DIODES** has been proved in advanced airborne military radar and fire control systems, and for guided missiles.

HUGHES GERMANIUM DIODE ELECTRICAL SPECIFICATIONS AT 25° C.

Description	RETMA Type	Test Peak Inverse Voltage* (volts)	Maximum Inverse Working Voltage (volts)	Minimum Forward Current @ +1 v (ma)	Maximum Inverse Current (ma)
High Peak	1N55B	190	150	5.0	0.500 @ −150 v
	1N68A	130	100	3.0	0.625 @ −100 v
High Back Resistance	1N67A	100	80	4.0	0.005 @ −5 v; 0.050 @ −50 v
	1N99	100	80	10.0	0.005 @ −5 v; 0.050 @ −50 v
	1N100	100	80	20.0	0.005 @ −5 v; 0.050 @ −50 v
High Back Resistance	1N89	100	80	3.5	0.008 @ −5 v; 0.100 @ −50 v
	1N97	100	80	10.0	0.008 @ −5 v; 0.100 @ −50 v
	1N98	100	80	20.0	0.008 @ −5 v; 0.100 @ −50 v
High Back Resistance	1N116	75	60	5.0	0.100 @ −50 v
	1N117	75	60	10.0	0.100 @ −50 v
	1N118	75	60	20.0	0.100 @ −50 v
General Purpose	1N90	75	60	5.0	0.800 @ −50 v
	1N95	75	60	10.0	0.800 @ −50 v
	1N96	75	60	20.0	0.800 @ −50 v
JAN Types	1N126**	75	60	5.0	0.050 @ −10 v; 0.850 @ −50 v
	1N127†	125	100	3.0	0.025 @ −10 v; 0.300 @ −50 v
	1N128‡	50	40	3.0	0.010 @ −10 v

*That voltage at which dynamic resistance is zero under specified conditions. Each Hughes Diode is subjected to a voltage rising linearly at 90 volts per second.
**Formerly 1N69A. †Formerly 1N70A. ‡Formerly 1N81A.

HUGHES DIODES *are also supplied 100% factory-tested to a wide range of customer-specified characteristics, including high-temperature requirements.*

SEMICONDUCTOR SALES DEPARTMENT

Hughes

Aircraft Company
Culver City, California

Address inquiries to Dept. T

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you need absolute dependability . . .
you need ADLAKE Mercury Relays!

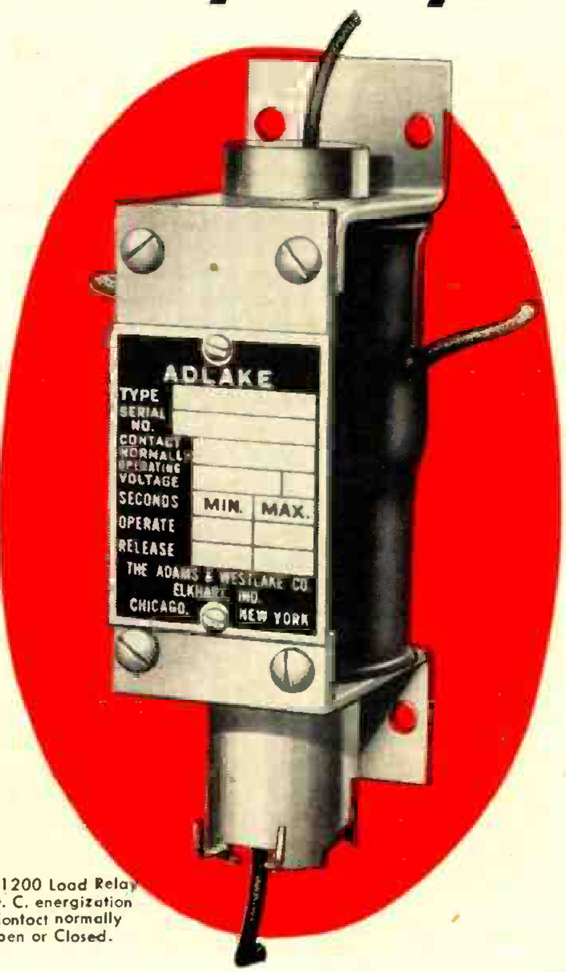
Because they're designed and built to meet the most exacting needs of industry...in jobs that conventional relays can do in an uncertain manner at best...ADLAKE Mercury Relays have won a reputation for *absolute* dependability! And no wonder, because each ADLAKE Relay offers:

Positive leak-proof sealing—assured by the use of properly selected metals and glass components with properly matched thermal expansion characteristics.

Liquid, mercury-to-mercury contacts—completely eliminate failures caused by low contact pressure, contact burning, pitting and sticking. And the inherent high surface tension of mercury imparts an ideal snap action to the contacts.

Arc-resisting ceramics—used to reduce any destructive effect caused by the arc.

Yes, as thousands of enthusiastic users in every branch of industry know, ADLAKE means dependability every way! Write for your free copy of the ADLAKE Relay catalog today. The Adams & Westlake Company, 1175 N. Michigan, Elkhart, Indiana. In Canada, write PowerLite Devices, Limited, of Toronto.



Type 1200 Load Relay for D. C. energization —Contact normally Open or Closed.

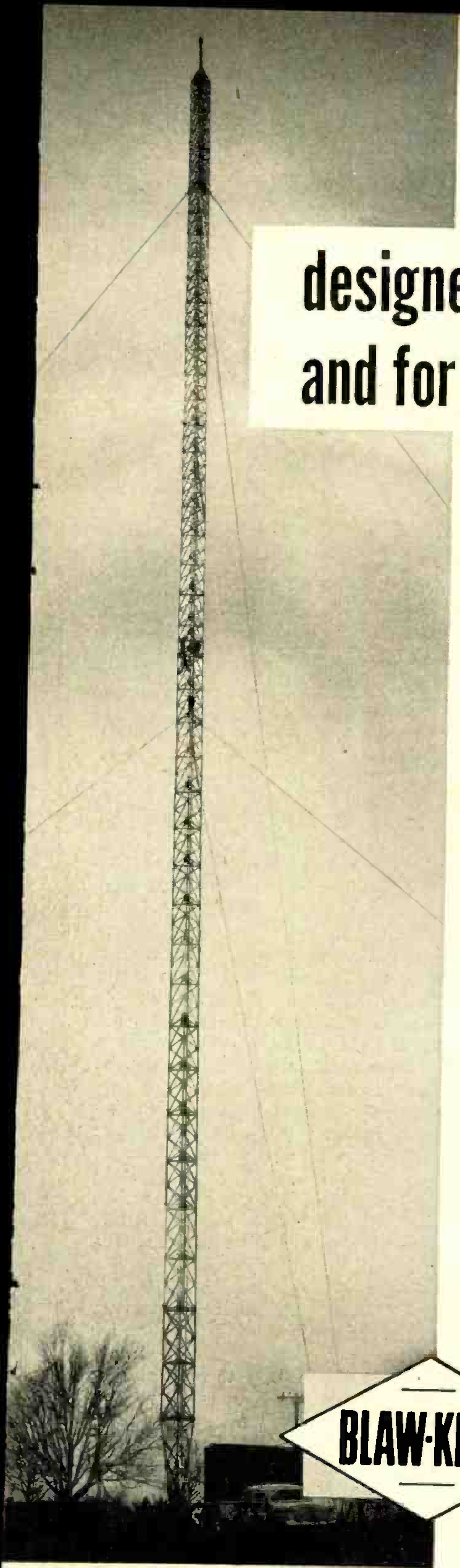
EVERY ADLAKE RELAY IS TESTED —AND *GUARANTEED* —TO MEET SPECIFICATIONS!

THE Adams & Westlake COMPANY

Adlake — 97th year of serving the transportation and building industries

Established 1857 • ELKHART, INDIANA • Chicago • New York

Manufacturers of ADLAKE Hermetically Sealed Mercury Relays



designed for present requirement of 440′ and for extension—when needed—to 600′

When WICC-TV in Bridgeport, Connecticut, erected their tower, they went high enough to meet their present need—but also had an eye for the future.

So any time they need greater height for increased coverage, another 160 feet can be added to their present tower height of 440 feet. For the Blaw-Knox Type TG tower purchased by WICC was originally designed for extension to 600 feet—with a third set of guys to be installed at that time.

This is typical of how Blaw-Knox Towers are designed and constructed to meet specific customer requirements—based on some forty years experience in designing and building towers. Blaw-Knox Type TG towers, for example, are designed to support TV and FM antennas—available in standard heights up to 1000 feet and in special designs for higher structures. All have such features as—

- pivoted or articulated base to avoid excessive bending stresses
- structural angle bracing (with no adjustable members) in a "tension and compression" system to provide extra strong rigid construction
- guys, with all connections permanently attached, factory pre-stressed and proof tested to load greater than ever required in service
- invar rule to insure accurate and simple tensioning of guys
- convenient support for transmission lines
- hot-dip galvanized to protect against all weather conditions

For more complete information on all types of Blaw-Knox Antenna Towers just write or phone to get your copy of Bulletin No. 2417. Or send us your inquiry for prompt service, specifying height of tower and type of antenna.

BLAW-KNOX COMPANY, PITTSBURGH 38, PENNSYLVANIA

BLAW-KNOX EQUIPMENT DIVISION • TOWER DEPARTMENT

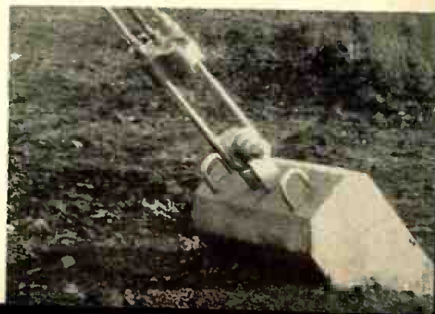
BLAW-KNOX ANTENNA TOWERS

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

Distributed by Graybar

← INVAR RULE **GUY PIER →**

Invar measuring rule, an exclusive Blaw-Knox feature, is used to determine correct initial tension in the factory pre-stressed guys. Erectors use the rule when putting up the tower and can easily duplicate correct tension determined in the factory tests—thereby eliminating any guess work in the field erection.



TELE-TIPS

(*Continued from page 34*)

A TEXAS JAIL is using closed circuit TV to observe prisoners' activities. The inmates don't care for the idea, but officials claim it has improved supervisory efficiency.

NUTS come right out of their shell without fuss, thanks to a new electronic nutcracker. A 65-kv jolt neatly separates the walnut meat from the shell. Nut growers in Pacific Northwest are so pleased with system's high production, they are considering its use on filberts.

ULTRASONIC washing machines are becoming increasingly popular in Australia. A generator feeds an electrical-to-mechanical transducer, which shakes the clothes and water.

DEAD OR ALIVE?—Anyone who ever had a dentist pull the wrong tooth cannot get his tooth back, but he can take comfort in the fact that it is now harder than ever for a dentist to make such a mistake. The Ritter Co. of Rochester, N. Y., has developed an electronic pulp tester for checking teeth suspected of needing extraction. The tester has a neon light in its tip which glows when contact is made. The dentist can increase current with a nichrome-wirewound rheostat. If a patient feels a pulsation when the tester is put in operation, the suspect tooth is alive. By using it in conjunction with X-ray examination, the pulp tester makes it almost impossible for a dentist to extract a live tooth by mistake.

AVERAGE AMERICAN worker is nearly three times as productive as his Western European counterpart, and can buy three times as much with his earnings, reports Stanford Research Institute.

PATENTS are declining in importance, according to a UNESCO study. In 1932, one American in 551 had taken out a patent in the previous decade. Today, the figure is one in 936. Furthermore, half of the patents are destroyed when the first court attempt is made to enforce them, and seven-eighths fail that are appealed to the Circuit or Supreme Court.

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MANEUVERABILITY

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for Film and TV Cameras

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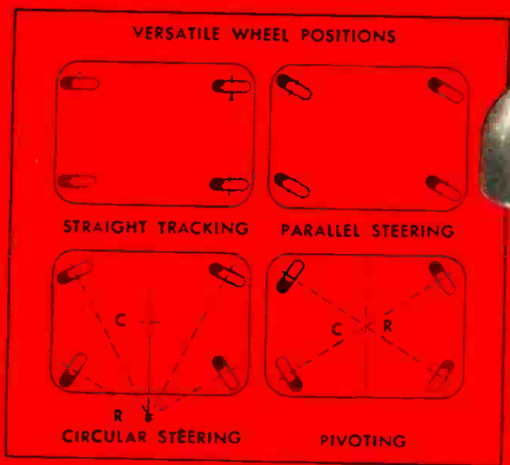
NEW! CIRCULAR STEERING

Entirely new steering mechanism makes possible easy, smooth, sharp turning on own axis or in any desired arc. Wheels can also be locked parallel for straight tracking in any direction.



NEW! HYDRAULIC BOOM LIFT

Camera boom is raised and lowered smoothly, quietly, effortlessly, automatically by hydraulic system. Extreme high and low lens heights are readily achieved even when dolly is in motion.

NEW! MANEUVERABILITY

The extreme flexibility of the steering mechanism makes possible fast positioning in small, crowded studios.

NEW! HANDLING EASE

Weighs only 500 pounds. Cameramen and grips appreciate easy dollying, turning, raising and lowering boom.

NEW! LOW SLUNG CHASSIS

Cinemobile is built low down for better balance, greater stability and smoother rolling.

NEW! VERSATILITY

Makes possible a wide range of camera effects formerly achieved only with larger, heavier equipment. Priced to fit the budget of smaller studios.

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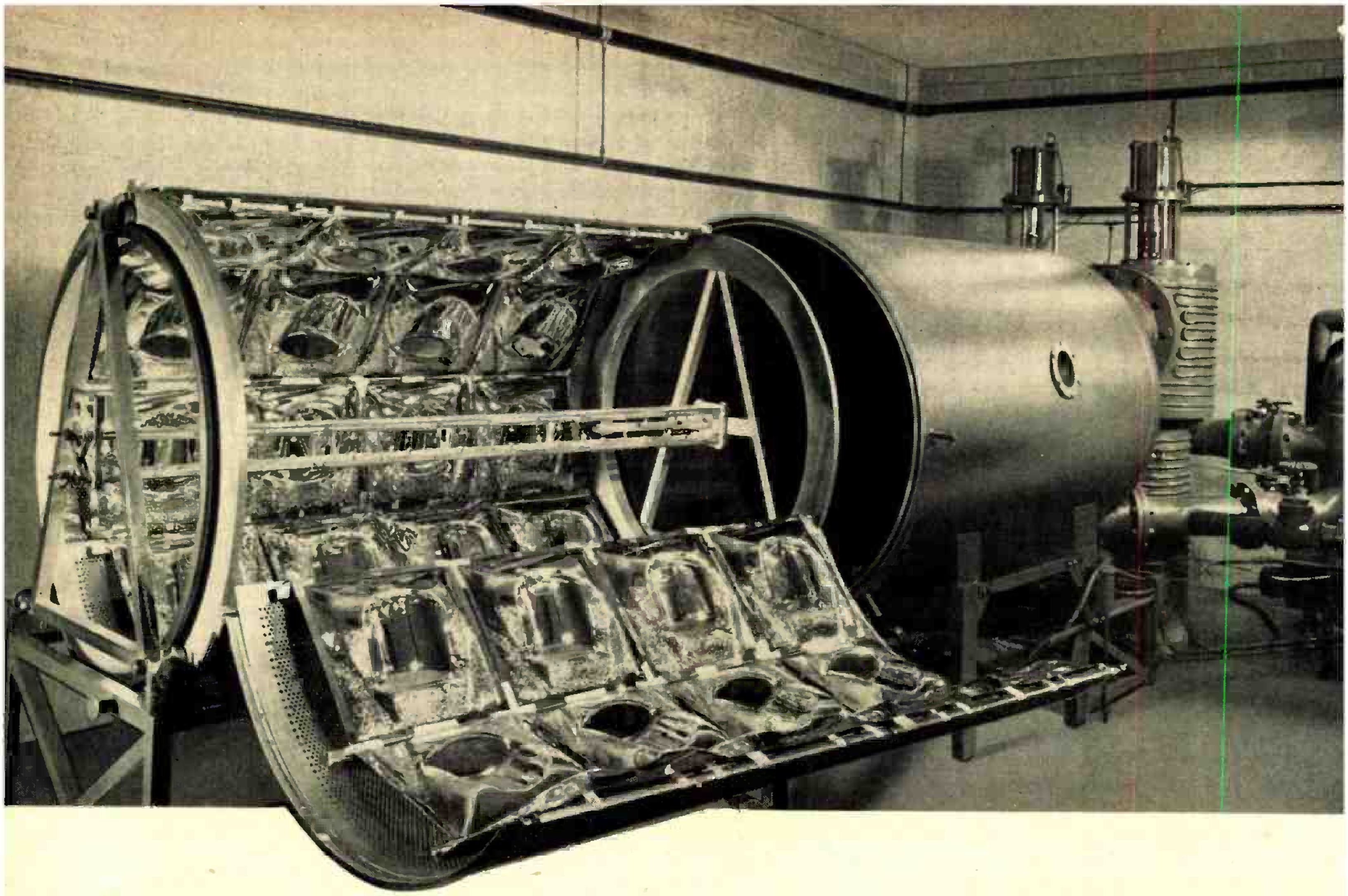
"WORLD'S LARGEST MANUFACTURER OF MOTION PICTURE PROCESSING EQUIPMENT"



Now available for aluminizing color TV tube components . . .

CVC high vacuum coaters

Large *CVC* high vacuum coaters, similar to those used for metallizing plastics, are now available for aluminizing color TV tube faceplates and faceplate inserts.

Units such as the *CVC* LC1-48A, illustrated above, are easy and economical to operate. Pieces are loaded on an extra-long cylindrical fixture which opens to permit easy attachment at a convenient working level.

The entire fixture is rolled into the vacuum chamber, the door closed, and, in a matter of minutes, the load is coated with aluminum. Three cycles per hour are easy, four are possible.

To help you get ready for color TV tube production on a mass production basis, we can furnish you with this type of equipment, with inline aluminizing systems, or with stationary individual unit systems.

For information on any application of high vacuum to color TV tube production, write to *Consolidated Vacuum Corporation, Rochester 3, N. Y.* (a subsidiary of Consolidated Engineering Corporation, Pasadena, California.)

CVC

Consolidated Vacuum Corporation

Rochester 3, N. Y.

designers and manufacturers of high vacuum equipment

SALES OFFICES: PALO ALTO, CALIF. • CHICAGO, ILL. • CAMDEN, N. J. • NEW YORK, N. Y.

for POWER RESISTOR needs

COME TO . . .

Greenohm*
HEADQUARTERS

Power Resistor Decade Box — any resistance from 1 ohm to 999,999 ohms—in working circuit.

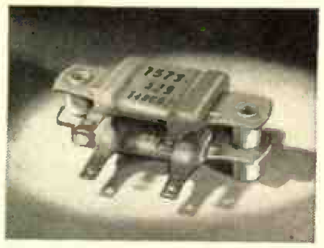
"Standees"* or above-chassis-mounted power resistors in ceramic casings, with Greenohm cement filling.

The toughest power resistors made! That's why you find Greenohms in radio-electronic and electrical assemblies noted for dependable performance and longest life.

These green-colored power resistors are available in *standard* and *special* types. Protected by the exclusive cold-setting inorganic cement, these units withstand severe overloads and extreme temperature changes without altering their resistance values or appearance. Resistance windings remain unimpaired in the manufacturing process.

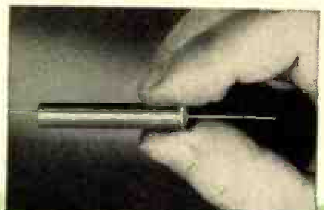
Your needs most likely can be met by the extensive selection of fixed and adjustable Greenohms. But if your needs are extraordinary, then Clarostat is prepared to design your special power resistors and to deliver any quantities to meet any assembly schedules.

Engineering Bulletin on Greenohms, sent on request. Let us have your power resistor requirements for engineering collaboration, quotations, delivery schedules.



Stacked Greenohms for banking several power resistor sections.

Typical of special Greenohms — a screw-base resistor with handy knob for fast replacement, in changing resistance values.



Greenohm Junior or miniature resistor in ceramic casing filled with Greenohm cement.

STAND PAT WITH

CLAROSTAT Controls & Resistors

CLAROSTAT MFG. CO., INC., DOVER, NEW HAMPSHIRE

In Canada: Canadian Marconi Co., Ltd., Toronto, Ontario

*Trade-marks

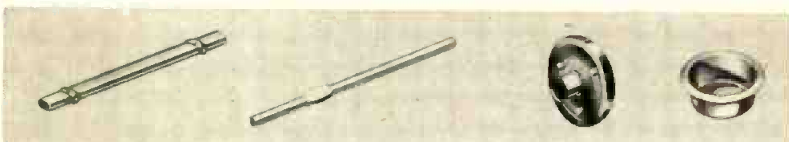
Behind the radar curtain that guards our shores

Magnetron illustrations courtesy of Raytheon Manufacturing Company

Source of UHF waves that make possible the radar screen guarding our continental perimeter is the magnetron.

Essential elements of the magnetron, and the anodes and cathodes of the companion direct-reading oscilloscope are produced by Superior Tube Company. For example, in the Raytheon magnetron above, Superior furnishes: A. The cathode (heart of the magnetron); B. The anode; C. The sleeve on the wave trap (or choke) assembly.

All of these parts are made from Superior seamless nickel tubing. As a matter of fact, there is Superior tubing *in every one* of the 400 different types of Raytheon magnetrons—a record possible only because of great satisfaction with Superior alloys, fabrication, deliveries and service. Put *your* chief dependence upon Superior. Superior Tube Company, 2508 Germantown Ave., Norristown, Pa.



Seamless Nickel Cathode. Oval, double bead, .025" x .048" x .003" Wall. 12mm long.

Lockseam* Nickel Cathode Round, vertical emboss, .045" OD x .0021" Wall. 26.5 mm long.

Disc Cathode* .121" OD, .312" long.

No. 2 Grid Cup, 305 Stainless Steel, Rolled edge. .499" OD x .010" Wall x .262" long.

Superior
THE BIG NAME IN SMALL TUBING

All analyses .010" to ⅝" OD.

Certain analyses in Light Walls up to 2⅛" OD.

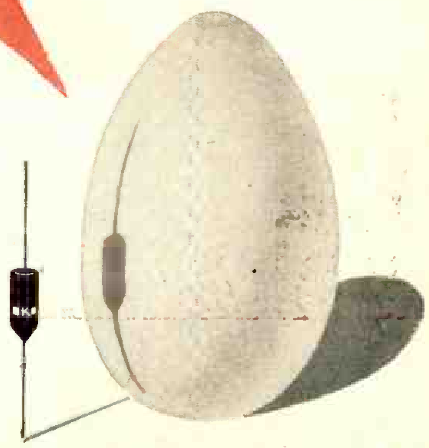
Many other types of nickel cathodes—such as Lockseam*, made from nickel strip, disc cathodes, and a wide variety of stainless anodes, grid cups and other tubular fabricated parts are available from Superior. For information and free literature on these products as well as Cathaloy A-30, A-31**, our latest Cathode Alloys, address Superior Tube Company, Electronics Division, 2500 Germantown Avenue, Norristown, Pa.

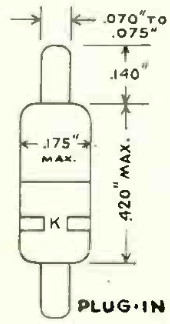
*Manufactured under U.S. Patents
**U.S. Trademark applied for

NEW RAYTHEON hermetically sealed GERMANIUM DIODES

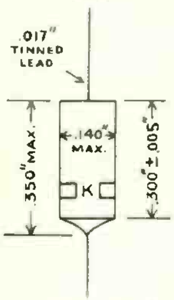
a new sealed package worth crowing about

- Completely sealed against atmospheric conditions
- 100% testing of all diodes
- *Every* diode temperature-humidity cycled for 32 hours; also held for 12 hours at 105°C, 4 hours at –25°C
- Samples of every production lot put through JAN-193 humidity test
- Oscilloscope tests for hysteresis and the various types of instability
- *Smaller size* for solder-in design
- NEW plug-in design
- Extra rugged and shock resistant
- Coated with protective insulating lacquer





PLUG-IN



SOLDER-IN

TYPE	TYPICAL APPLICATION	MAX. DC INVERSE VOLTAGE	MAX. PEAK ANODE CURR. ma.	MAX. AVG DC ANODE CURR.	MIN. FORWARD CURRENT AT +1V	MAXIMUM INVERSE CURRENT AT –5V ma.	AT –10V ma	AT –50V ma.	AT –100V ma.	MIN. INVERSE VOLTAGE	AVG INVERSE CURRENT –50V
1N67 1N67-P	50V DC Restorer	80	100	35	4.0	0.005		[illegible]		100	0.1
CK705 CK705-P	Gen. Purpose Diode	60	150	50	5.0		0.05	0.8		70	[illegible]
CK705A CK705A-P	Gen. Purpose Diode	[illegible]	[illegible]	50	5.0		0.01	0.8		70	0.43
CK707 CK707-P	50V DC Restorer	[illegible]	[illegible]	35	3.5	[illegible]		[illegible]		100	0.1
CK708 CK708-P	100V DC Restorer	100	100	[illegible]	[illegible]				[illegible]	[illegible]	[illegible]
CK713 CK713-P	Computer Diode	65	150	50	30 at +2V			0.25 at –40V	(DC characteristics at 50°C)		

P Indicates plug-in type — DC Characteristics measured at 25°C

These types are available in production quantities through Newton, Chicago and Los Angeles sales offices. They are also stocked by over 500 Raytheon Special Tube Distributors.

RAYTHEON

Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

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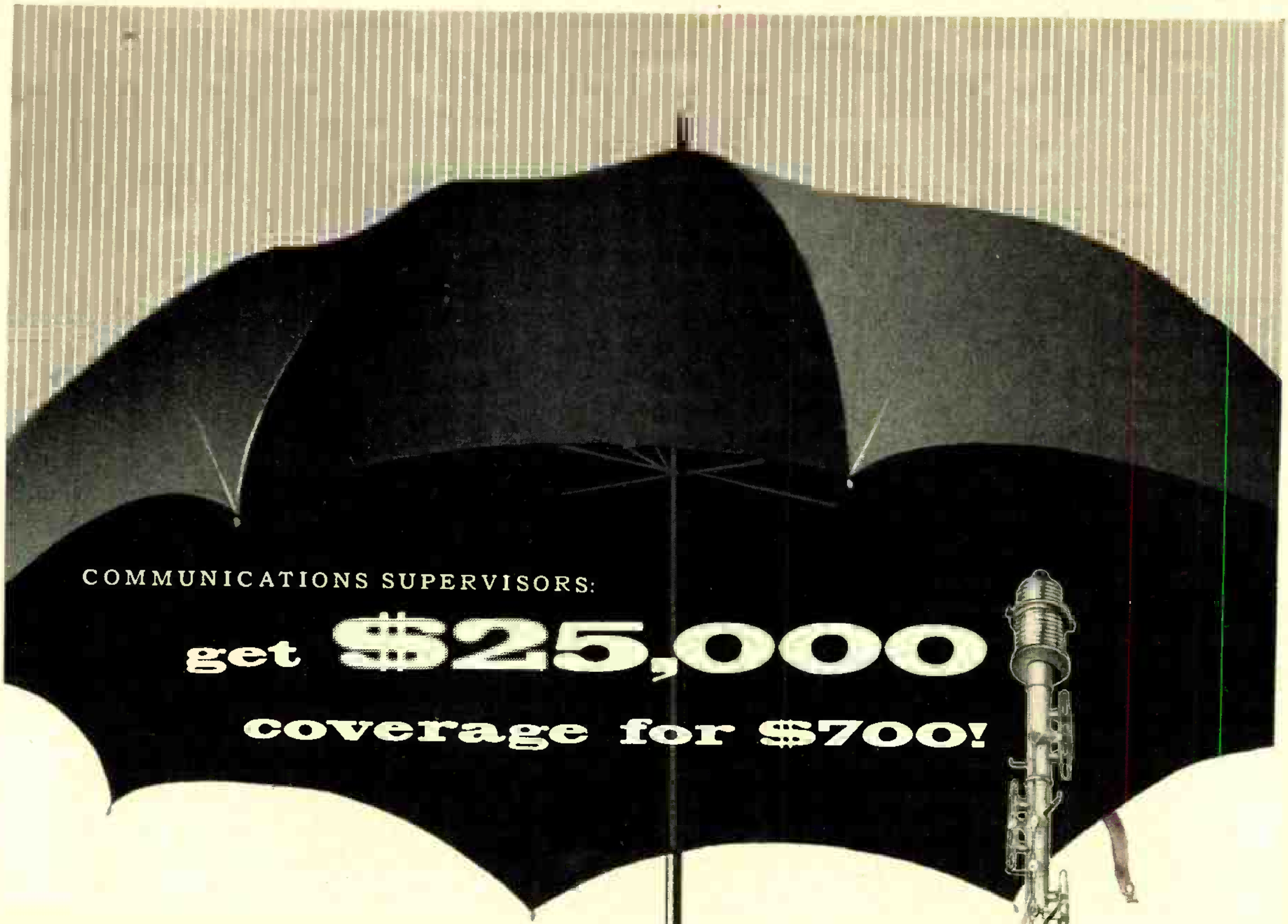
RELIABLE SUBMINIATURE AND MINIATURE TUBES • SEMICONDUCTOR DIODES AND TRANSISTORS • NUCLEONIC TUBES • MICROWAVE TUBES • RECEIVING AND PICTURE TUBES



Here are the plain facts that speak for themselves of $24,300 savings.

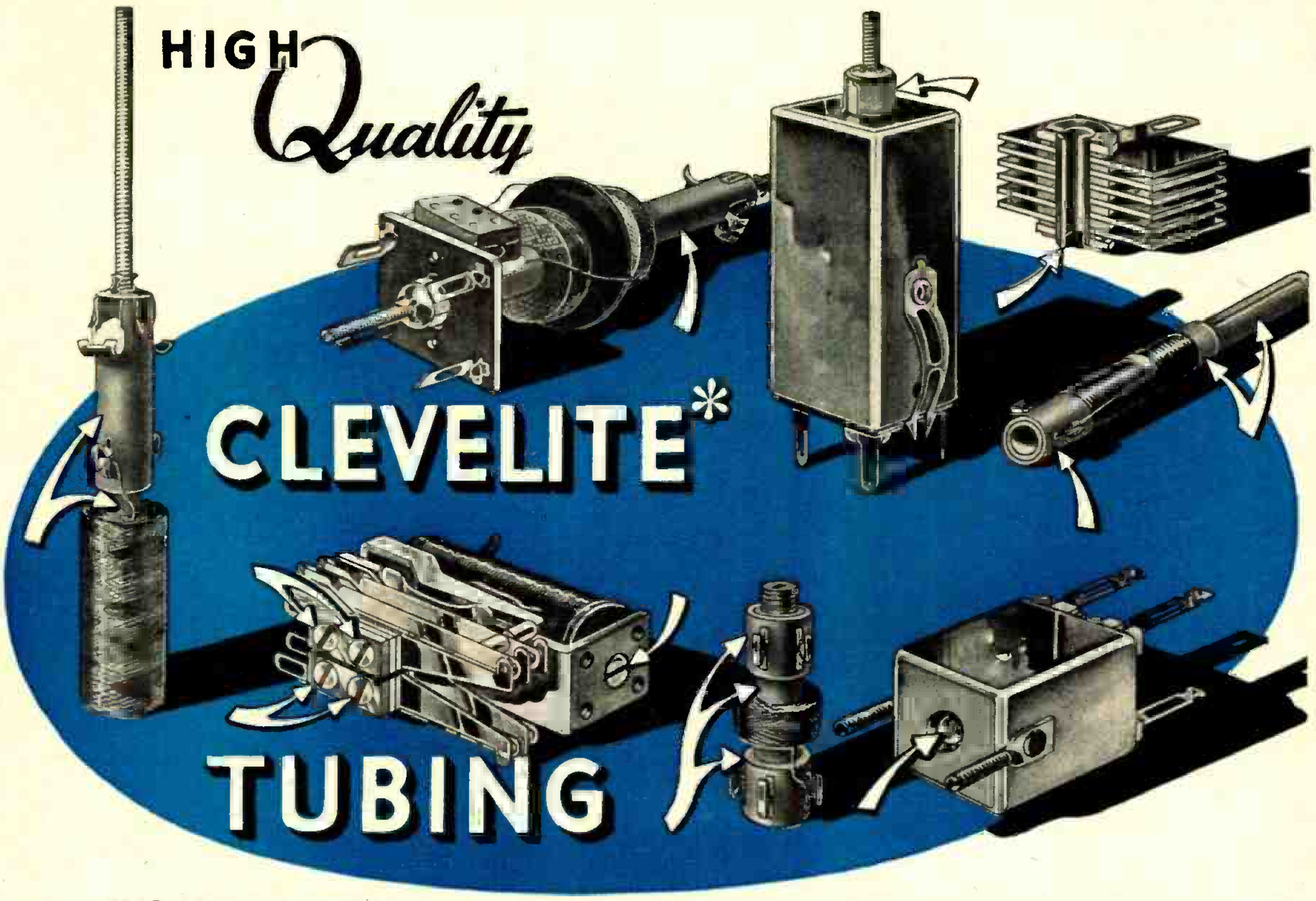
To increase the "talk-back" range of one-hundred cars from 20 miles to 25 miles—corresponding to an increase of 50% in area coverage—one-hundred 15 watt transmitters must be replaced with 60 watt transmitters . . . at an approximate cost of $25,000.

You can get the same coverage by installing an Andrew 3000-type antenna for only about $700.

One postcard can save you over $24,000. Before you buy, write us for a complete analysis of costs and antenna types to meet your needs.

Andrew
CORPORATION

363 East 75th Street · Chicago 19



ENSURES BETTER PERFORMANCE AT LOWER PRODUCTION COSTS

ITS CHARACTERISTICS INCLUDE:

High Dielectric Strength . . .

★

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Mechanical Strength . . .

★

Low Loss and Good Machinability.

★ ★ ★

Ask for our new Clevelite Folder.

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

Prompt deliveries are ensured by our large production facilities.

Tell us Your needs. Our Research and Engineering Laboratory is at your service.

WHY PAY MORE? For the best . . . call Cleveland!

*Reg. U. S. Pat. Off.

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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

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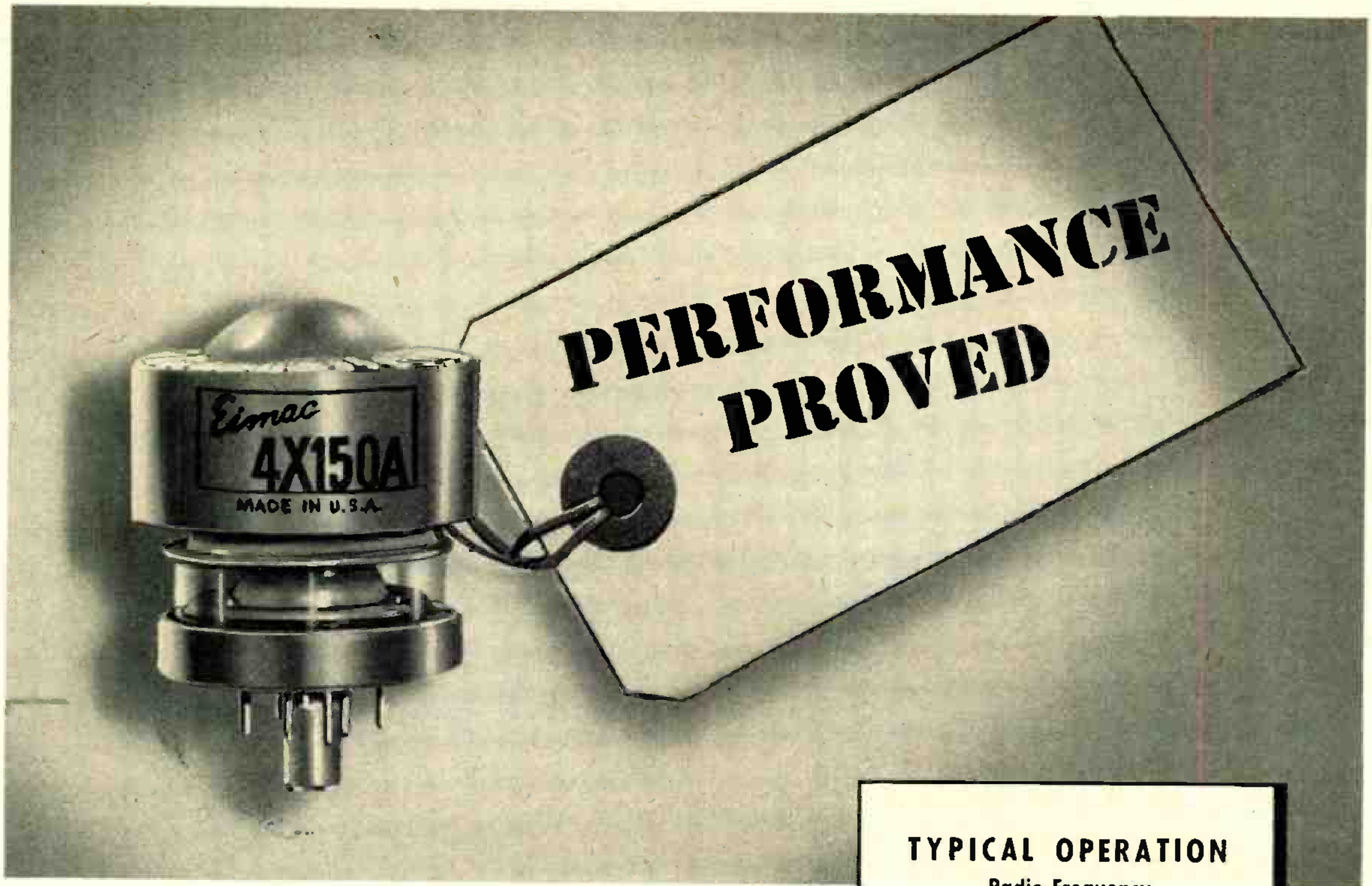
WEST COAST IRV. M. COCHRANE CO., 408 S. ALVARADO ST., LOS ANGELES



TYPICAL OPERATION

Radio-Frequency
Power Amplifier or Oscillator

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

Frequencies up to 165 Mc.

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

500 Mc. Coaxial Cavity

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

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

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

For further information contact
our Application Engineering Department

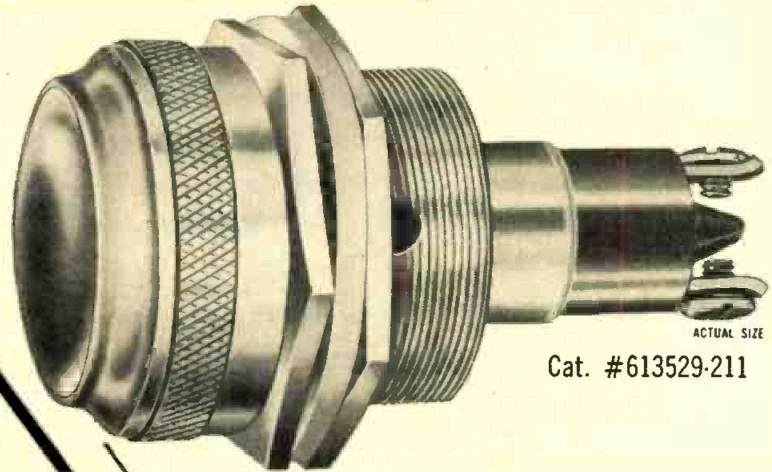
Eimac TUBES

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA
Export Agents: Frazer & Hansen, 301 Clay St., San Francisco, California

for **YOUR** *product*

WHICH PILOT LIGHT DO YOU NEED?

DIALCO



Cat. #613529-211

THE BIG ONE

This Pilot Light Assembly was first made to accommodate the *S-11 lamp* and was intended for use in the cabs of great diesel locomotives.

This BIG one

or

this LITTLE one

Dialco HAS THE COMPLETE LINE OF INDICATOR and PANEL LIGHTS

THE LITTLE ONE

The miniaturization program on defense products required the development of this *sub-miniature* light. It is used on communication equipment and aircraft. Midget flanged base bulbs to fit are rated 1.3, 6, 12, and 28 volts.

Cat. #8-1930-621

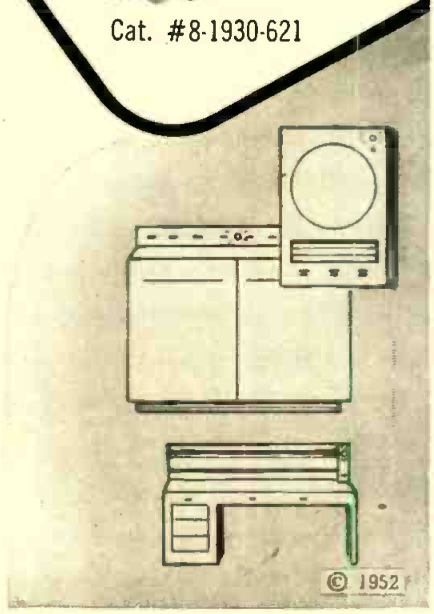
Samples to suit your own special conditions and requirements will be sent promptly and *without cost*. Just outline your needs. Let our engineering department assist in selecting the *right lamp* and the *best pilot light* for YOU.

Write for the Dialco HANDBOOK of PILOT LIGHTS

Foremost Manufacturer of Pilot Lights

DIALIGHT CORPORATION

60 STEWART AVE., BROOKLYN 37, N. Y. HYACINTH 7-7600



Lab Samples from STACKPOLE

. . . assure accurate engineering plus efficient production

QUALITY-CONTROLLED COMPONENTS

- FIXED RESISTORS
- VARIABLE RESISTORS
- SPECIAL RESISTORS
- POWDERED IRON CORES
- CERAMAG® FERROMAGNETIC CORES
- MOLDED COIL FORMS
- FIXED COMPOSITION CAPACITORS
- TUBE ANODES
- CARBON DISCS (Voltage Regulators)
- LINE SWITCHES
- SLIDE and ROTARY-ACTION SWITCHES

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

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

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

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

Electronic Components Division

STACKPOLE CARBON COMPANY

St. Marys, Pa.

PATENT NEWS

The patents described in the following list are some of the many patents, presently available for licensing or sale, which may be of interest to TELE-TECH & ELECTRONIC INDUSTRIES readers. Register numbers are those given in the Official Gazette of the Patent Office. Inquiries should be addressed to the owner of the patent rights or other party specified. Complete copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., for $.25 each.

Pat. 2,638,510. **Duplex Loudspeaker,** patented May 12, 1953. Loudspeaker with sectional reflex horn is converted into a wide-range duplex loudspeaker by replacing one of the horn sections with a large bell-like diaphragm of a separately operated direct radiator. (Owner) C. D. Zeitouni, c/o H. M. Kilpatrick, 11 Park Pl., New York 7, N.Y. Reg. No. 51,460.

Pat. 2,587,568. **Manufacture of Electric Circuit Components,** patented Feb. 26, 1952. Process for automatic production of parts using printed circuitry. Pattern printed on metal foil remain after unprinted portions are removed in etching bath. (Owner) Technograph Printed & Electronics, Inc., 185 Valley St., Tarrytown, N.Y. Reg. No. 52,122.

The following 12 patents, owned by General Electric, are available for non-exclusive licensing on reasonable terms. Write to Manager, Patent Services Dept., General Electric Co., 1 River Road, Schenectady, N.Y.

Pat. 2,629,803. **Titanium Electrode,** patented Feb. 24, 1953. Reg. No. 52,139.

Pat. 2,629,922. **Method of Brazing Resistor Terminals,** patented March 3, 1953. Reg. No. 52,140.

Pat. 2,630,472. **Method and Apparatus for Inspecting Cavities,** patented March 3, 1953. Reg. No. 52,149.

Pat. 2,632,866. **Velocity Modulation Electron Discharge Device,** patented March 24, 1953. Reg. No. 52,162.

Pat. 2,624,875. **Pulse Echo System With Time Sensitivity Control,** patented Jan. 6, 1953. Reg. No. 51,489.

Pat. 2,625,603. **Television Pulse Separation Circuit,** patented Jan. 13, 1953. Reg. No. 51,491.

Pat. 2,625,678. **Radiant Energy Navigational Device,** patented Jan. 13, 1953. Reg. No. 51,492.

Pat. 2,627,551. **Ultrahigh-Frequency Transmission Structure,** patented Feb. 3, 1953. Reg. No. 51,494.

Pat. 2,627,588. **Electromagnetic Scanning Amplifier Circuit,** patented Feb. 3, 1953. Reg. No. 51,495.

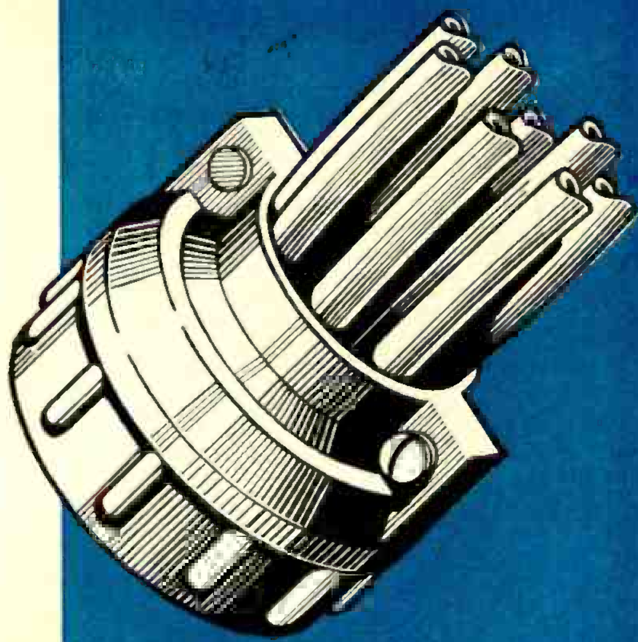
Pat. 2,629,819. **Load Compensating Network,** patented Feb. 24, 1953. Reg. No. 51,496.

Pat. 2,631,240. **Sweep Voltage Generator,** patented March 10, 1953. Reg. No. 51,497.

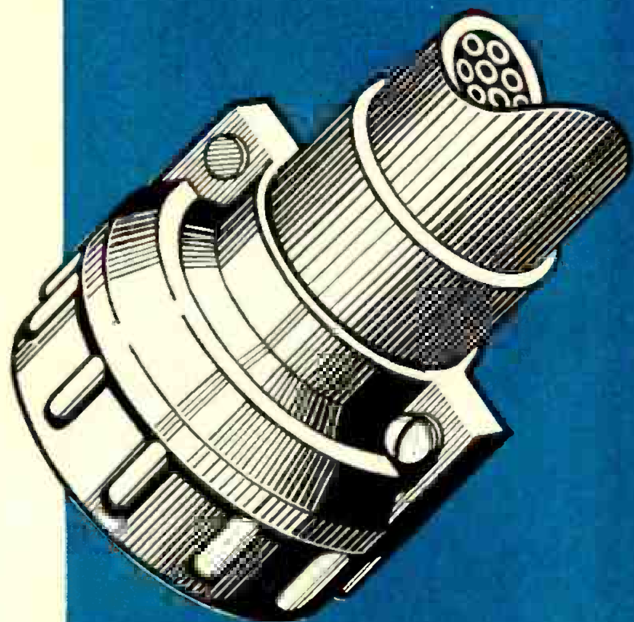
Pat. 2,629,050. **Variable Electronic Capacitance Device,** patented Feb. 17, 1953. Reg. No. 51,570.

(*Continued on page* 60)

Bendix Builds a Better *cable clamp* — *the* AN3057B



Inexpensive
Efficient
Versatile



The new Bendix AN approved AN3057B cable clamp is now available. Engineered by Bendix to the highest quality standards, this cable clamp offers major design improvements. The clamping action is radial and completely eliminates wire strain and chafing by holding the wire bundle firmly in rubber. This clamp will accommodate a wide range of wire bundle sizes, but an even greater range can be handled through the use of the Bendix AN3420A accessory telescoping sleeve.

The new AN3057B cable clamp will also waterproof multi-conductor rubber covered cable on the rear of a connector, or where moisture-proof entrance through a bulkhead or into an equipment box is required.

This versatile clamp is a product of the Scintilla Magneto Division of Bendix Aviation Corporation and is a companion AN accessory to the world famous Bendix Scinflex line of electrical connectors. Write our Sales Department for details.

Outstanding Features

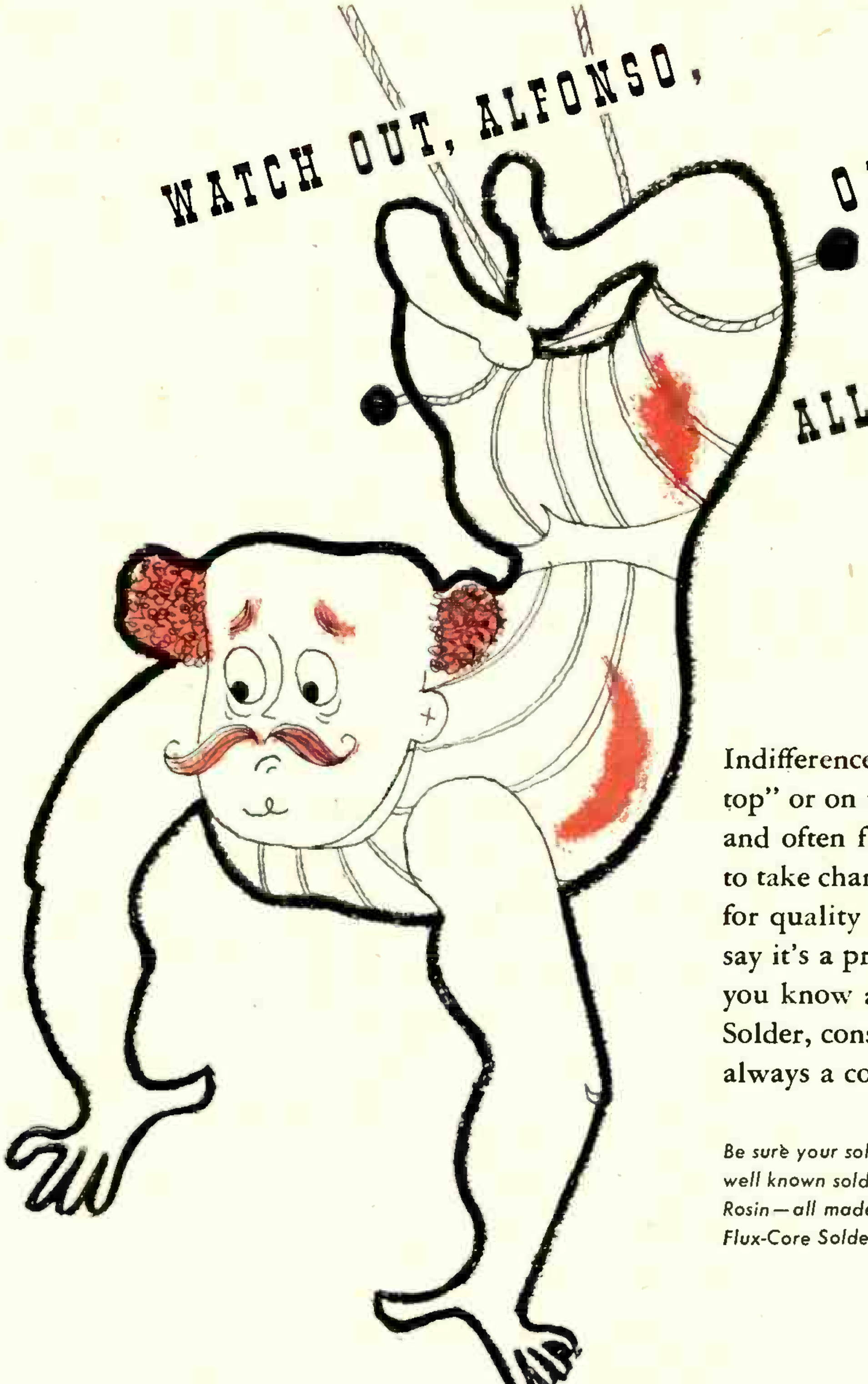
- Neoprene gland.
- Centered clamping action.
- Increased close down.
- Positive grounding feature.
- Cadmium plated die-cast aluminum nut.
- Shorter over-all length.
- Waterproofs multi-conductor cable.
- Immediate delivery.

Bendix

SCINTILLA DIVISION of Bendix AVIATION CORPORATION
SIDNEY, NEW YORK

FACTORY BRANCH OFFICES: 117 E. Providencia Ave., Burbank, Calif. • 582 Market Street, San Francisco 4, California • Stephenson Bldg., 6560 Cass Avenue, Detroit 2, Michigan • 512 West Avenue, Jenkintown, Pa. • Brouwer Bldg., 176 W. Wisconsin Avenue, Milwaukee, Wisconsin. *EXPORT SALES:* Bendix International Division, 205 East 42nd St., New York 17, N. Y.

WATCH OUT, ALFONSO, ONE TUMBLE'S ALL IT TAKES...



Indifference—whether it's under the "big top" or on the production line—is inexcusable and often fatal. You simply can't afford to take chances with a hard won reputation for quality performance. That's why we say it's a pretty good rule to stick to a solder you know and trust . . . time-proved Kester Solder, constant in solder alloy and always a consistent flux formula.

Be sure your soldering is satisfactory with one of these well known solder products: "44" Resin, "Resin-Five" and Plastic Rosin—all made only by KESTER . . . Key Name in Flux-Core Solder for More Than 50 Years.

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QUALITY CAN COST LESS

Available sizes:
4 watt........1 to 1000 ohms
5/16" dia. x 1" long
7 watt........1 to 5000 ohms
5/16" dia. x 1¾" long
Standard Tolerance............10%

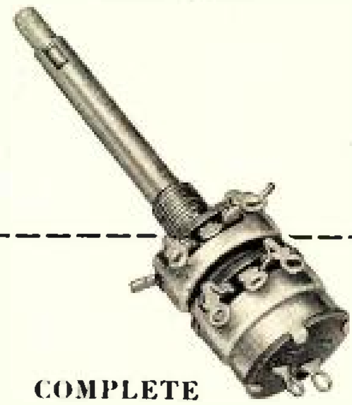
...And MALLORY Ceramic Resistors Prove It!

Wherever you need fixed resistors in television and other electronic circuits, you can get an ideal combination of quality and economy in Mallory Ceramic Resistors. They're low in cost—and their axial lead construction cuts production expense by eliminating mounting brackets, permitting point-to-point wiring and saving under-chassis space.

These features assure top quality performance:

- ***Accurate resistance up to rated wattage through the use of exclusive Mallory Yard-Ohm wire.***
- ***Long life: Fiberglas core contains no organic materials; high grade non-corrosive inorganic cement, injected under pressure to give high heat dissipation, holds resistance element securely. Resistors are built to take 100% overloads.***
- ***Moisture protection: Resistor ends are sealed by special heat and moisture resistant compound.***
- ***Rugged construction: tinned leads are securely clinched to prevent opens, high resistance and pull-outs. Non-porous steatite tubes protect against mechanical and thermal shock.***

For complete facts, write for the new catalog on fixed wire-wound resistors and carbon and wire-wound controls.



COMPLETE LINE OF CARBON CONTROLS

Factory assembled carbon controls are supplied in single, dual concentric and dual tandem constructions, with or without switch. High density, smooth surfaced element gives exceptionally low noise level, long life and minimum resistance drift. Available in standard tapers from 200 ohms to 10 megohms.

Expect more ... Get more from **P.R. MALLORY & CO. Inc. MALLORY**

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

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Serving Industry with These Products:
Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

PATENT NEWS

(*Continued from page 56*)

The following eight patents, owned by the AEC, are available on a non-exclusive, royalty-free basis. Apply to Chief, Patent Branch, Office of the General Counsel, U.S. Atomic Energy Commission, Washington 25, D. C.

Pat. 2,649,571. **Bridge for Resistance Measurement**, patented Aug. 18, 1953. Improved ratio arm bridge method is well adapted to measuring high resistances. Reg. No. 52,102.

Pat. 2,651,751. **Apparatus for Measuring Resistance**, patented Sept. 8, 1953. Invention is for measuring resistance of electrolyte materials employs voltage source across serially connected electrolyte and resistor. Reg. No. 52,106.

Pat. 2,654,840. **Pulse Generator**, patented Oct. 6, 1953. System comprises sawtooth electronic generator of the gas relaxation type. Pulses have instantaneous rise time and hyperbolic decay. Reg. No. 52,114.

Pat. 2,656,527. **Signal Deviation Warning System**, patented Oct. 20, 1953. Using electromagnetic field, system gives warning upon intrusion of any body into protected zone. Reg. No. 52,119.

Pat. 2,632,103. **Stabilized Pulse Circuit**, patented March 17, 1953. Circuit is adaptable where rectangular output pulses with uniform characteristic regardless of changes in circuit parameters are desired. Reg. No. 51,524.

Pat. 2,640,949. **Electron Source**, patented June 2, 1953. Activating material disposed about heater produces intense electron beam emitted in a controlled direction with minimum power expenditure. Reg. No. 51,529.

Pat. 2,642,531. **Multichannel Analyzer**, patented June 16, 1953. Pulse analyzer is employed to sort pulses according to magnitude, and is useful in proportional counters. Reg. No. 51,532.

Pat. 2,644,922. **Magnetic Flux Direction Determining Apparatus**, patented July 7, 1953. Portable unit quickly and accurately determines magnetic flux direction in presence of electrostatic field. Reg. No. 51,539.

CEC Instruments Moves Western Office

CEC Instruments, Inc., sales and service subsidiary of Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif., has opened new and enlarged quarters for its Western Regional Office at 1025 East Green St., Pasadena. Occupying approximately 2,000 sq. ft. of office space in a new building, an eleven person sales and service organization will serve Consolidated Instrument users in nine western states and in the Canadian provinces of Alberta, Saskatchewan and British Columbia.

the Chief Engineers' Best Friend

EVEN BEFORE GETTING ON THE AIR!

The G-R Type 1183-T TV-Station Monitor is one of the most reliable frequency-indicating devices commercially available. It is, in addition, an *accurate measuring tool* which is indispensible to station operating personnel . . . even before the transmitter is on the air.

Chief Engineers, who have had this TV Monitor at their disposal during preliminary transmitter setting-up stages, are its most enthusiastic supporters. They are impressed by its adaptability to a wide variety of station measuring problems during the early periods of operation. These men stress the importance of having one of these monitors available at the station at the earliest possible time.

Current deliveries are within 60 days from date of order.

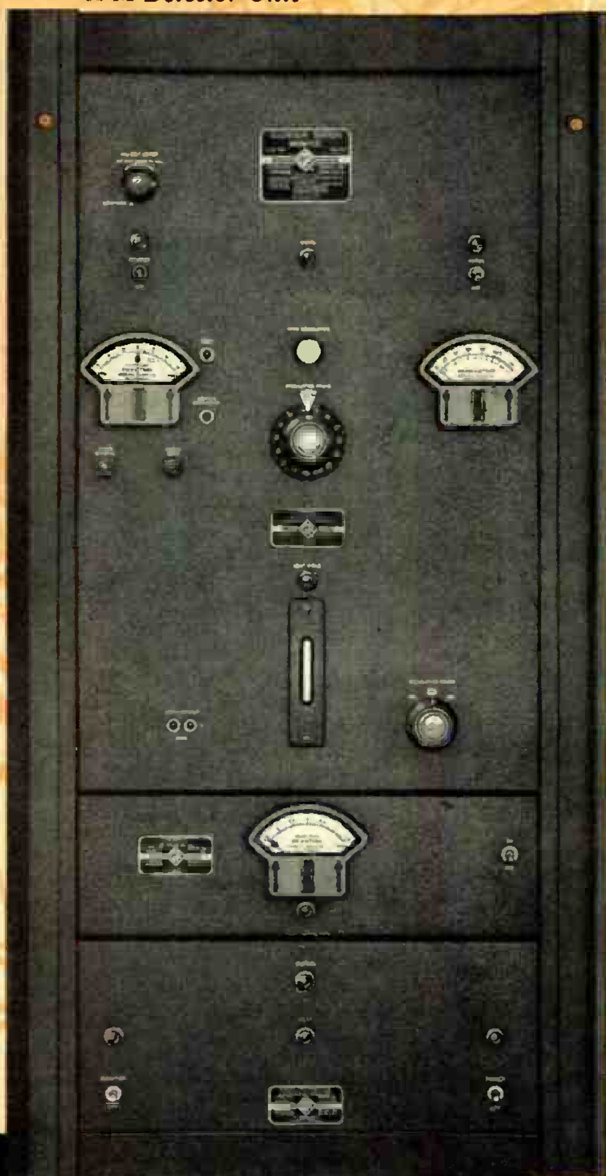
A few of the many ways in which the Type 1183-T TV-Station Monitor will aid you, in the adjusting and testing period preceeding commercial operation:

★ *By indicating correct tuning of aural and visual transmitter frequencies and insuring correctness of inter-carrier spacing*

★ *Providing reliable indications of modulation percentage, useful for calibrating transmitting-station audio circuits*

★ *Helping locate, analyze and eliminate distortion and noise in transmitter aural channel*

★ *Measuring a-m noise in f-m channel when used in conjunction with the Type 1932-A Distortion Meter and Type 1932-P1 A-M Detector Unit*



The Type 1183-T TV-Station Monitor has evolved over a quarter century of G-R leadership in the development and manufacture of precision frequency-measuring instruments. It indicates carrier-frequency deviations with an accuracy of much better than one part in one million, and faithfully monitors distortion, noise and modulation level for "proof of performance" testing.

This instrument meets every requirement of the FCC for offset carrier operation. It will indicate correct intercarrier spacing within 300 cycles for 30 days and within 500 cycles for 6 months — more than accurate enough to meet FCC specifications for NTSC color broadcasting.

Type 1183-T
T-V Station Monitor
now in use by nearly every television station
$2830 to $2905
depending on frequency

FEATURES

★ Sound and video carrier frequencies are compared with multiplied frequency of highly-stable crystal oscillator invented and patented by G-R — two large scale, illuminated meters indicate frequency deviations of carriers

★ Aural modulation in both percentage and db is shown on third meter; panel switch provides for indication of positive peak, negative peak, or both peaks simultaneously — for convenience, over-modulation-alarm-lamp flashes when aural modulation exceeds predetermined level set by dial

★ Visual carrier indications accurate within ±500 cycles. Aural carrier indication within ±1000 cycles

On all v-h-f channels, the above accuracy is guaranteed for at least thirty days—at the lower u-h-f frequencies, the period is over sixteen days—at the higher u-h-f frequencies, the period is ten days or more

★ High fidelity audio output provided for distortion and noise-level measurements, and for audio monitoring — residual noise level is down 70 db or better for 25 kc deviation

★ Overall monitor distortion is less than 0.1% for ±25 kc swing, allowing measurement of very low-level transmitter distortion

★ VHF Monitor has high impedance and sensitivity of 1-volt or better — 500 mw sensitivity for low-impedance UHF input

★ Signal to noise ratio is excellent through channel 83

★ Complete remote metering facilities — terminals are provided for connecting remote center-frequency meters and additional modulation and over-modulation indicators

★ Center-frequency indications and distortion measurements are accurate even under heavy modulation — counter-type discriminator has excellent linearity over ±100 kc range

★ Separate power input for crystal-oven heaters enables direct connection to station standby power

★ Convenience in operation — pilot lamps on front panel indicate adequate input power — input-level meters at rear are immediately adjacent to input-level adjustments

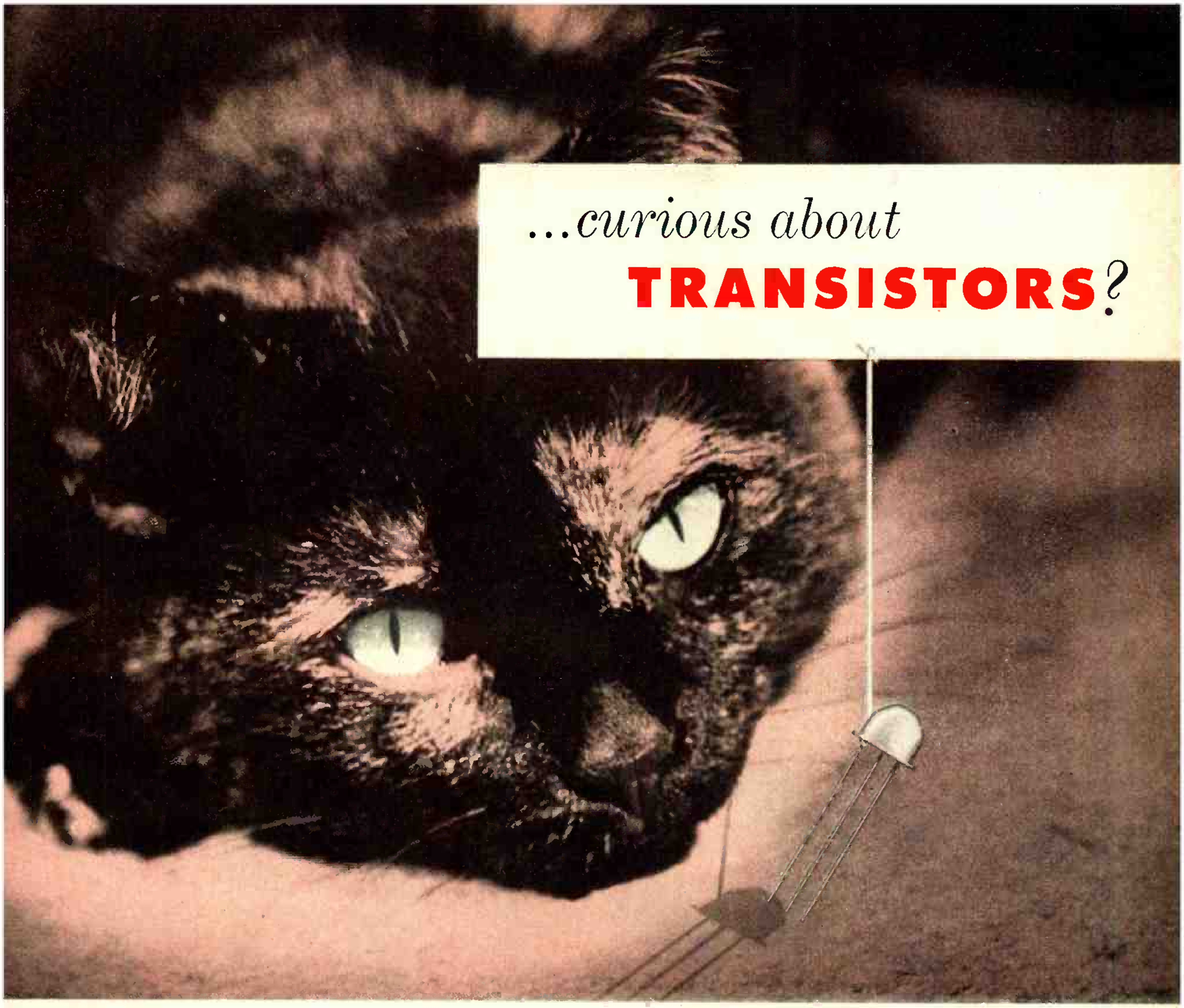
★ For safety, all a-c power leads are fused on both sides of the line — short to ground cannot cause fire — fusible link in crystal oven prevents accidental overheating

★ Cabinet is arranged for maximum heat dissipation and easy installation — interior is readily accessible for servicing

GENERAL RADIO Company

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

90 West St. NEW YORK 6 · 920 S. Michigan Ave. CHICAGO 5 · 1000 N. Seward St. LOS ANGELES 38



We're long past the "Cat's Whisker stage" with Transistors.
Contact Hydro-Aire for consultation NOW!

The day has come when the Electronics Industry must examine all vacuum tube applications for the possibility of substituting Transistors. Of course, it will not be a matter of simple replacement; each application must be designed around the Transistor. But the advantages of the Transistor are overwhelming. You get small size and light weight, long life and low cost. In addition, there is an endless potential of entirely new applications still unexplored.

Hydro-Aire is ready to co-operate with you in exploring this fascinating new field. The specialized know-how of our experienced Transistor Development and Application Division is yours for the asking. Our research engineers are waiting to consult with you.*

* *Please address your inquiries:*

CHIEF CONSULTING ENGINEER

Transistor Development and Application Division

HYDRO-AIRE *Inc.*

3000 Winona Avenue, Burbank, Calif.

Subsidiary of Crane Co.

CONSULTANTS ON TRANSISTOR APPLICATIONS

HIGH VOLTAGE

molded ceramic filter CAPACITORS

Specifically engineered for reliable service in the high voltage supply filter circuits of modern television receivers and cathode ray instruments are Sprague's new molded jacket "doorknob" capacitors.

These moderately priced units incorporate an improved ceramic dielectric element encased in a thermosetting, non-flammable housing for maximum protection. Fifteen different terminal combinations are standard to meet practically every mounting requirement.

Standard capacitance rating is 500 mmf. Voltages are 30,000, 25,000, and 20,000 volts d-c to fit all applications in television receivers from 27-inch down to 17-inch screen size.

Complete engineering information on these capacitors is contained in Bulletin 606A, available on letterhead request to Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

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

SPRAGUE

WORLD'S LARGEST CAPACITOR MANUFACTURER

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

TELE-TECH
& Electronic Industries

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

The Great Job Done by NTSC

Chairman W. R. G. Baker's announcement that the National Television Systems Committee is to be dissolved, now that the FCC has adopted NTSC standards for color-TV, gives occasion for an industry and public tribute to this hard-working committee of engineers. They have laid the groundwork for standards on which the color-TV industry of the future can operate successfully.

Great credit goes to Dr. Baker for his indefatigable leadership, and to the vice-chairmen Elmer Engstrom, Dave Smith, Arthur Loughran and Donald G. Fink for marshalling their divisions, as well as to individual members who worked tirelessly to round out the color-TV standards, their definitions and their interpretation, culminating finally in the successful presentation of the standards to the FCC.

Creating Color-TV Standards

Many engineers in our industry seem not to understand clearly just what the functions and accomplishments of the NTSC have been. Despite its misnomer title, incorporating the word "Systems," the NTSC distinctly has *not* created a *system* of color TV. That will be left to individual manufacturers to build their own "systems" and parts of systems,—but all designed to work together in providing the public with satisfactory color-TV service.

The functions of the NTSC can probably best be explained by a railroad analogy. If the United States were just beginning to set up a continental system of railroads (as it did back in 1840), with claims of broad-gauge, super-wide gauge and narrow-gauge equipment makers, a great service would have been rendered by a coordinating committee undertaking to adopt an *interchangeable standard* of track-width and clearance specifications for tunnels, bridges and adjoining structures, on which all equipment of whatever make would operate.

Something like this, though of course infinitely more complicated, was the task of the NTSC. By the same railroad analogy, it would leave to individual manufacturers, the invention and design of their own locomotives and cars. But its job would be to set up mutual *standards of track and clearances* on which all locomotives and all cars could operate interchangeably—a Baldwin locomotive pulling AC & F cars, or an American Locomotive Works engine working well with a string of Pullmans.

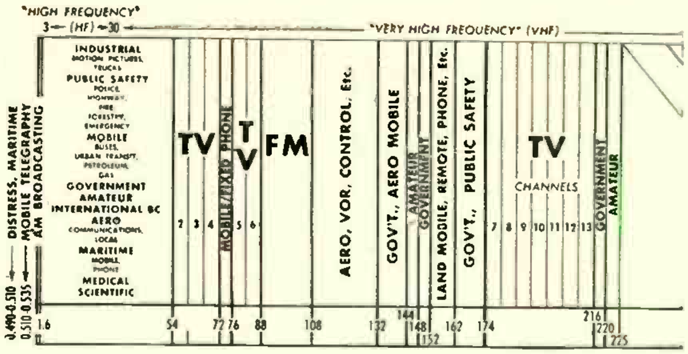
An Invaluable Public Service

Engineers representing the whole TV industry worked long and earnestly to set up similar standards for color TV. These NTSC members created no "system" as such. They left the invention and building of color TV systems to individual manufacturers. And by coordinating and defining the standards to which all of these equipment makers should conform in building their competitive transmitters and receivers, they made it possible for all color-TV systems to work together interchangeably.

In coordinating and defining such interchangeable standards and seeing their adoption by FCC, NTSC has rendered a matchless public service to future millions of color-TV users.

RADARSCOPE

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



BIG PATENT SCRAMBLE is in the wind for 1954, with several manufacturers rushing to sign up as many licensees as possible. Continuance of industry's "patent pool" is being seriously questioned in influential quarters. More attorneys gearing for court fights.

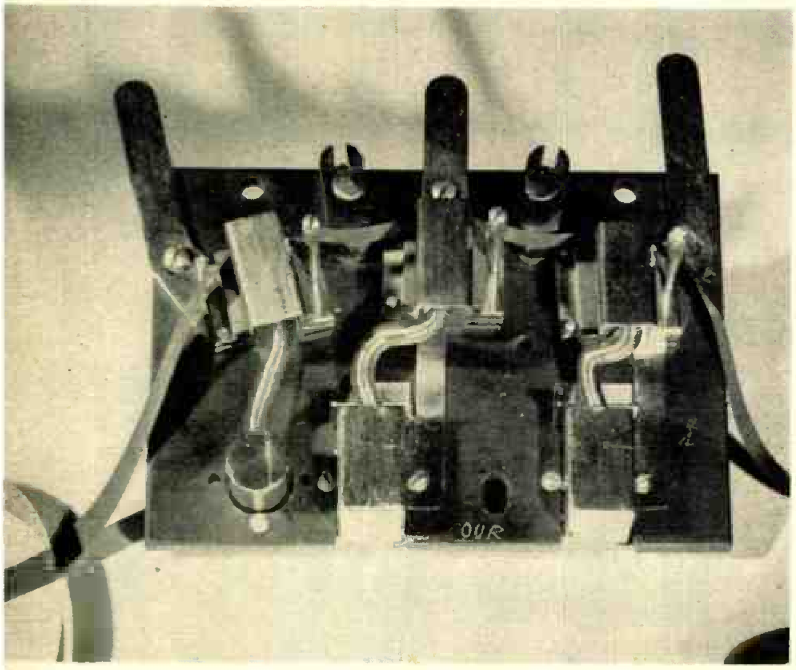
NEW COLOR PHOSPHOR developed to give bright TV pictures in shadow mask type of tube with under 20 kv anode potential.

MOBILE RADIO division is being set up by prominent TV-electronic manufacturer, and will be ready to start producing very soon.

BINAURAL DISC RECORDING will get an added shot-in-the-arm when a new pick-up is announced. Unit plays two sound tracks from single record groove by having stylus vibrate vertically as well as laterally.

CREDIT, CREDIT, who deserves the credit? TV circles buzzing about national advertising battle between several companies, aimed at convincing the public on who deserves the credit for developing color TV.

VIDEO TAPE RECORDING



Heart of RCA's magnetic tape system for recording video signals is the recording and reproducing head. The half-inch tape travels at 30 ft./sec, and has five channels for recording color TV. Three heads shown in photo are (l to r) audio record, quadruple video record for four tracks, and quadruple video reproduce. Audio reproduce is not shown. Spacing of only 2 in. between video record and reproduce heads allows instantaneous playback not achievable with film. The system is described in detail in Jan. 1954 TELE-TECH & ELECTRONIC INDUSTRIES, p. 81

GROSS NATIONAL PRODUCT is continuing to climb. This yardstick of prosperity reached a record $370 billion in 1953.

RECEIVING TUBE specially designed as a dc restorer for three color signals in TV has been announced by GE. It's the 6BJ7 miniature triple diode, with characteristics similar to the 6AL5 twin triode.

ELECTRICAL WORKERS UNION will push for guaranteed annual wage in 1954.

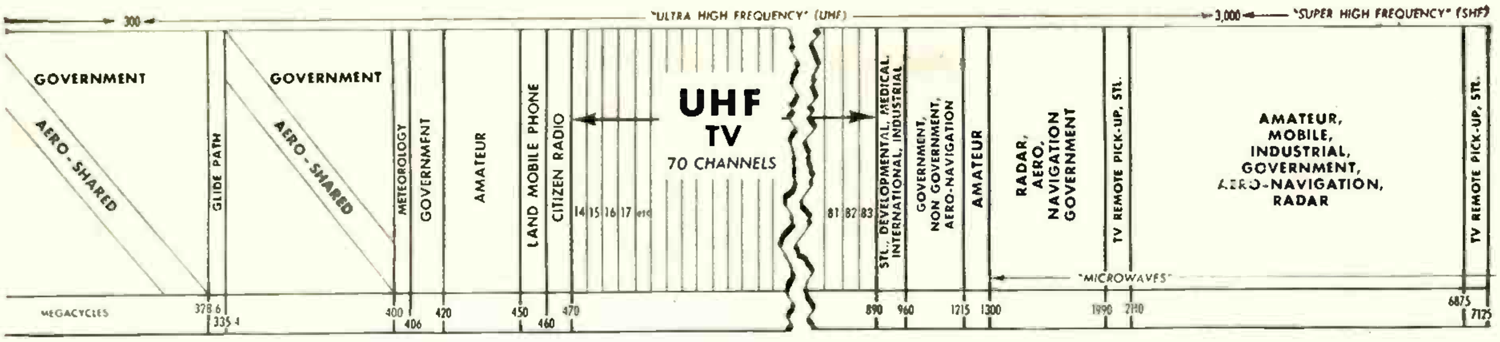
50,000 MILES OF VIDEO CHANNELS have been placed in service by the Long Lines Dept. of AT&T. Facilities are now serving some 261 stations in 159 cities interconnected with the networks.

CORPORATE PROFITS for 1954 are expected to be 5% to 10% under the 1953 figure of $20.3 billion, which was the nation's third highest. This was after payment of $24.6 billion in taxes. During last year, industrial plant expansion totaled $28 billion, and 62 million people were employed.

MILITARY COMMUNICATIONS will come under the broad authority of the recently created Office of Transportation & Communications in the Office of the Secretary of Defense. It is the first time that organizational responsibility for communications have been placed in a single office at top Defense Dept. level.

SUBMINIATURIZATION

POWER SUPPLIES are one of the prime bottlenecks in efforts to achieve full equipment subminiaturization. While complete transmitter-receiver units have been reduced to the size of a pack of cigarettes, the power section has often been found to occupy an equal space and be of greater weight. This is particularly true in portable communications equipment powered by batteries. Result is that a considerable sum of money is now being allocated by the armed forces for research projects to increase the life and reduce the size of conventional batteries, and to develop new types. Along these latter lines, researchers have come up with several new silver, cadmium, mercury and "atomic" types with amazing capabilities. Many of these are still under security restrictions, but eventual release to the public will open up new commercial vistas.



COMMUNICATIONS

FCC LICENSE FEES—Broadcasting and TV licensees are certain to bear the largest proportion of the fees for filing and license processing under the fee plan which the FCC submitted to the Budget Bureau Feb. 1. The fee plan is to be promulgated by the Commission after its approval by the Budget Bureau into proposed rules. The broadcasting industry and other segments of that field, together with the communications companies and users of mobile radio services, then will have the opportunity to present their comments and views about the proposed fees for the respective services. Following FCC Commissioners' review of the views of the industries, an oral argument before the FCC will be available before a final order is issued. Actually the fees will not be excessive but will be largely similar to court costs.

INDUSTRIAL ELECTRONICS

WELCOME NUMBER FIVE—During the past several decades, the expanding electronic art has developed into four major fields: TV, radio, communications, and special military applications. During the last few years, a fifth major category has evolved—industrial electronics—for factory controls and accounting. Watch for a sixth group to develop from number five during the next ten years—home electronics—to reduce household drudgery and increase home comforts.

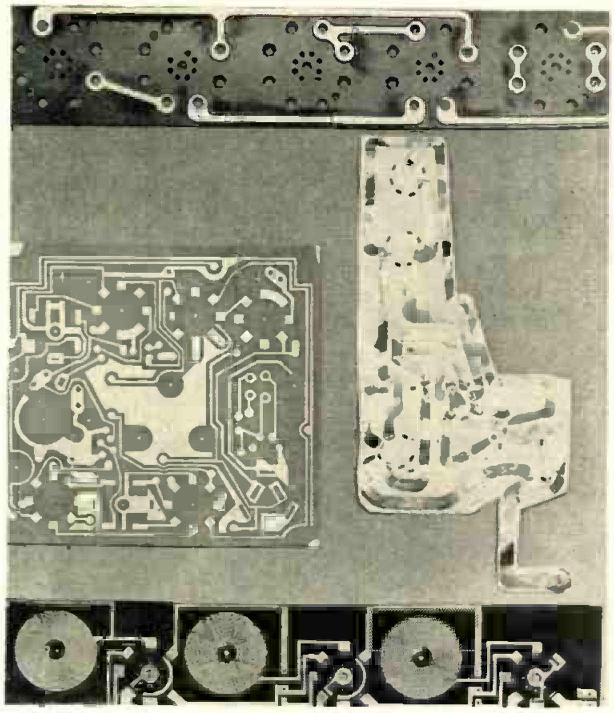
BATTLEFRONT TV

TACTICAL TV in future wars may mean the differences between safety and destruction for battalions of soldiers and equipment. Military leaders have been hampered by their inability to see what was taking place on the battlefront. Plans had to be based on fragmentary and often contradictory reports from scouts and patrols. Starting with signal fires and flages and progressing to telegraph, telephone and radio, some measure of control grew with the slow, steady development of battlefield communication systems. The ultimate, to see immediately and control the battle situation, may be in the future of TV. Several concrete tactical applications have suggested themselves in the military application of TV.

In four broad applications, TV maybe used to save lives, money, and time, or reasonably increase a military advantage: As a Tactical Adjunct in intelligence and reconnaissance work, fire control, data transmission, briefing of tactical commanders, guidance of pilotless vehicles and the close-up observation of the action and effect of our weapons. As a Training Medium to incorporate or be incorporated into present methods of training, where applicable. As an Educational Force, which is the one most closely allied to the use of TV in the commercial or entertainment field and the present use by the Military Services of Information and Education films. A special category in this field is the use of TV for morale, special service, and public relations activities. As a Technical Tool to be used primarily for viewing objects in inaccessible places or objects with which direct contact would be dangerous, such as contaminated or radioactive substances. Exploratory work is being done by the Signal Corps in all of the above fields and TV now is used by Signal Schools as a training medium.

HIGH-VOLTAGE RADIOGRAPHY

Electron gun of 6,000,000-volt linear accelerator undergoes tests. Apparatus developed at Stanford University is junior version of its billion-volt, 200-ft. accelerator. Gun shown will be attached to 6-ft. copper tube, through which electrons will be accelerated by SHF waves from klystron. Device is suitable for industrial radiography and medical X-ray and cancer treatment. It will be produced by General Electric, and made available in next few years



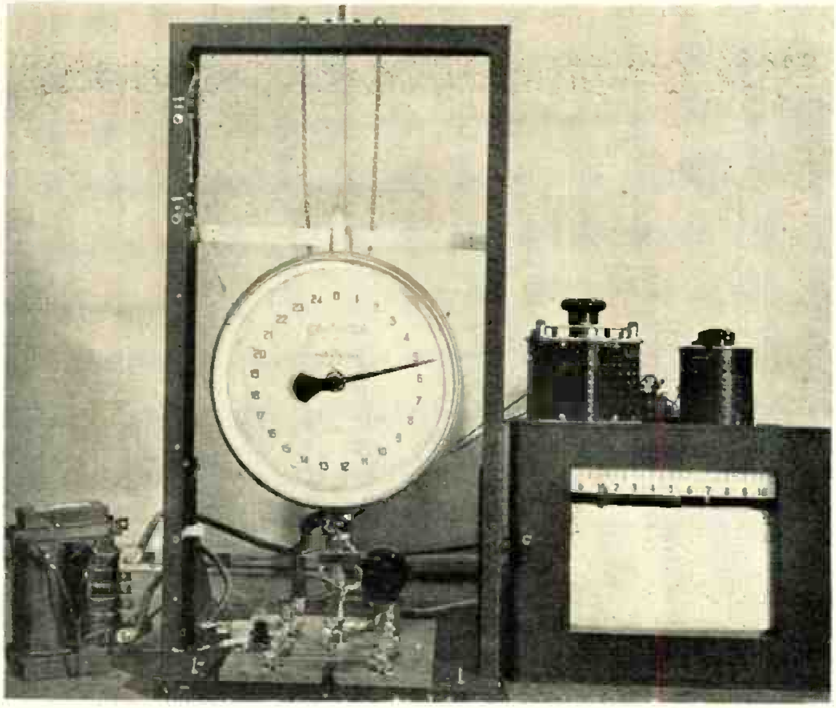


Fig. 1: (l) Samples of plated, etched and stamped wiring for radios. Fig. 2: (r) Extensometer set-up for stripping tests of clad laminates

Standardization of Printed

Lack of technical standards hinder equipment designers as well as plant production and inspection teams. Test procedures for foil-to-laminate adhesion given.

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Sylvania Electric Products, Physics Laboratories, Bayside, L.I., N.Y.

NOW that several brands of receivers incorporating some form of "printed" wiring are being released to the public for field evaluation, production and inspection departments are faced with the necessity of evaluating raw materials for which few standards have been established. Likewise the set designer, in replacing conventional point-to-point wiring by a more readily reproducible pattern of foil-like metal conductors on a plastic base, needs new standards of good practice and the means of evaluating printed constructions far in advance of Underwriters' inspection or public reaction.

The most common approach to improved assembling at this time is the etching of metal-clad plastic laminate and this important, but variable, material must be at the focus of standardization. However, in any consideration of standards and conditions of tests of printed circuits for radio use, the range of viewpoint must equally encompass the similar products of etching, stamping, plating or other processes. And it must likewise provide for judgment of flexible as well as rigidly supported foil conductors. The present viewpoint may reasonably be limited to connective harness joining all, or a major part, of radio or TV sets, as this promises to be of principal interest to the industry for the foreseeable future, components employing printed parts and small silk-screened unit assemblies generally being amenable to evaluation under existing criteria.

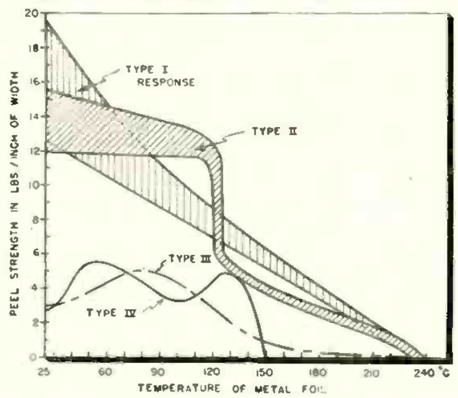
Tests of Adhesion

In earlier papers by Danko[1] and by Swigger,[2] reference is made to tests of adhesion in clad-laminates and to tentatively utilized instantaneous measures of electrical properties. Now, however, engineers want a more perceptive look at these raw materials, which will enable prediction of their endurance under field service conditions. Also needed is an understanding of the effects of dust, corrosion and other long term conditions upon variations of printed designs used in commercial radio and TV. Samples of typical plated, etched, and stamped connective harness for radios are shown in Fig. 1. Both rigid and flexibly based types are represented.

Since shorting between conductors is obviously dependent on adhesion to the insulating member, delamination resistance is of primary concern. Details of two tests for this purpose —1) a straight "pull" test, and 2) a "peel test"—were reported by the author.[3] Recording of the stress required to peel a 1-in. wide conductor at room temperature has come into rather general use, but agreement upon method is non-existent.

The essence of the peel test is well known in the adhesive and plating industries and several test procedures have been evolved.[4-8] Variations in the stripping rates and angles of force application are depend-

Fig. 3: Peel strength of foil clad laminates



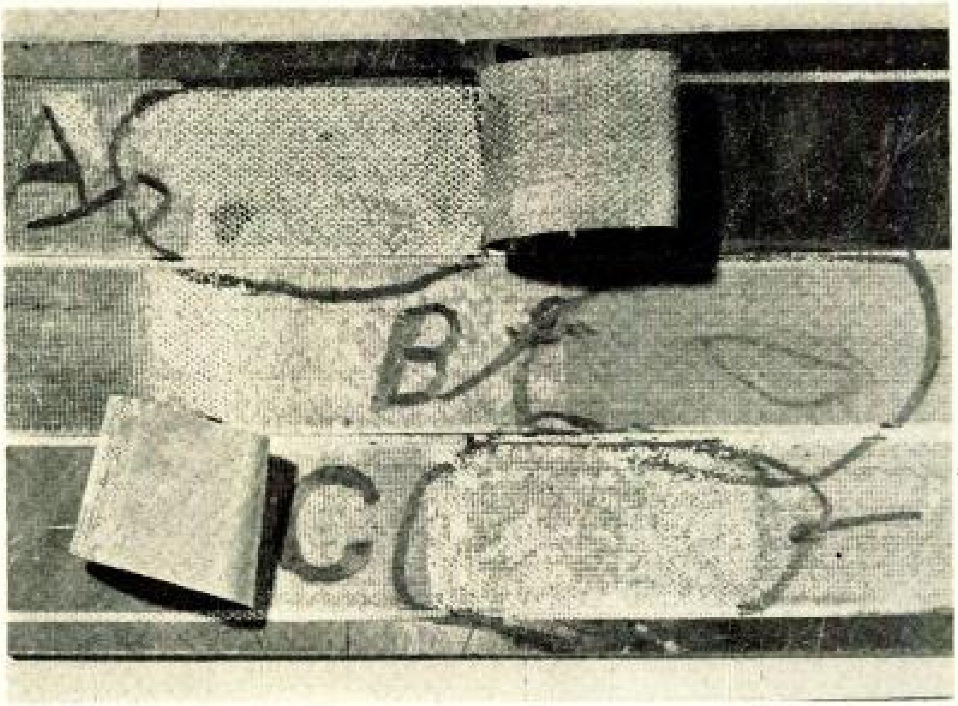


Fig. 4: Peel test samples show separation (a) at the copper-adhesive interface, (b) below the main interface, and (c) alternating between (a) and (b). (c) is strongest type of bond

Circuit Materials

ent upon the specific material to be tested. Published stripping rates vary from 1 in. per minute with the force applied at 90°, to 6 in. per minute at 180°, to dead weights.

Rate of Stripping

The rate of stripping for clad-laminates has been found uncritical up to 6 ft. per minute, but gives results not correlatible with static (dead weight) type tests. Values reported in this paper have been taken on the specially constructed extensometer shown in Fig. 2 at 3 ft. per minute (exceptions noted) at which speed the dynamometer gave a smoothest response.

A right angle pull has been found to give closer agreement between specimens having different foil thickness and probably also more closely simulates actually encountered conditions where the tag end of a conductor has begun to "lift." Tests performed under such conditions were in close correlation with similar tests performed on a low range commercial tensile testing machine.

As adhesives of varying thermal character may be used for foil bonding, cold adhesion strength becomes a questionable index to endurance at higher temperatures. In Fig. 2 it may be noted that provision has been made to heat the specimen under test by passing current from a welding transformer lengthwise through the foil strips. A thermocouple cemented to the foil provides a complete thermal history on the recorder at the right.

A first objective of this study has been to determine the thermal endurance of foil circuits under simulated conditions of manufacture. The short-term hot peel strength represents the resistance to delamination of conductors while heated by soldering and under the stress of handling and thermal deformation, without the presence of hardened solder to interfere with measurement. The graph of Fig. 3 is compiled from tests on many samples, all brands obtainable, and the several grades offered by some suppliers. Fresh samples were used to obtain each temperature interval. All, however, were 2 oz. copper on 1/16-in. paper base phenolic, and were raised in 10 seconds to the temperatures shown. The (initial) room temperature adhesion may be seen to range from about 2.5 lbs. to 19.5 lbs. per inch of width.

Response to Heating

It has been found that four generalized types of response to heating may be recognized among specimens. which are all within the same NEMA class. Specimens having the highest cold adhesion declined in strength as the temperature was raised in a gradual and easily predictable manner represented by the curve for Type I. A second group of clad-phenolics, initially strong, were found to stand up well under mild heating, but to suffer a sudden 50% loss of bond strength at a critical temperature level. This response has been labeled Type II.

Many of the poorer materials show improvement of strength upon heating up to 50—70°C. Some then fail completely at 150° and others continue then to show some adhesion even up near the limit of short-term thermal endurances of the best specimens. These are typified by curves III and IV. A surmise of in-

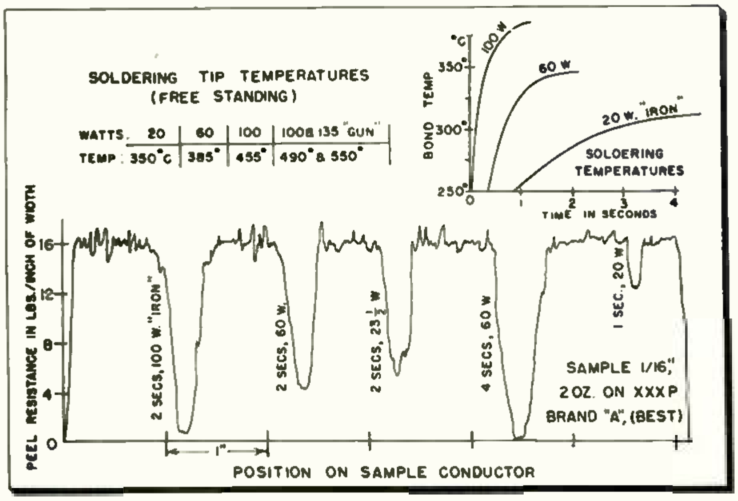


Fig. 5: Main curve depicts impairment of bond under hand soldering conditions. Temperature level reached by etched conductors being soldered can be judged from graph in upper right.

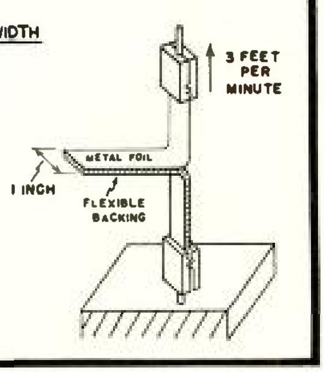
Fig. 6: (r) Application of stripping test to flexibly backed foil

TYPICAL TEST RESULTS

BACKING	LBS./INCH WIDTH
003 FISH PAPER	8.7
.010" COTTON, 80 x 80	9.9
.004" NYLON, 109 MESH	1.85
.004" GLASS CLOTH ECC-60x58 (SINGLE COPPER FACE)	7.7
.004" GLASS CLOTH ECC-60x58 (DOUBLE *COPPER FACE)	5.9

* NOTE: ONE FACE REMOVED BY FERRIC CHLORIDE ETCHING

TEST METHOD



BASE LAMINATE (2 OZ. COPPER-CLAD EXCEPT WHERE NOTED)	ULTIMATE COLD AT 25°C	BOND STRENGTH *** IN LBS/INCH WIDTH — DURING SOLDERING: SHORT TERM HOT STRENGTH — 210°C **	230°C **	AFTER SOLDER DIPPING — 4 SEC. AT 240°C*	2 SEC. AT 275°C*
XXXP LAMINATE-AVERAGES					
BRAND "A" - BEST	16.2	3.0	1.4	16.2	15.4
BRAND "B" - MEDIAN	7.6	2.0	BLISTERED	8.4	EXPLODED
BRAND "C" - POOREST	2.4	0.2	BLISTERED	2.4 SL. BLISTERED	EXPLODED
EDGE OF A SHEET	1.6				
CENTER SAMPLE	3.3				
POLYTETRAFLUOROETHYLENE	6.8	13.6	9.2		
MELAMINE FF-55	12.6	5.0 (125°)	BLISTERED (200°)		
SILICONE-GLASS G-7	1.1	5.2 (125°)	BLISTERED (200°)		
NYLON YN-25	15.5				
COTTON, FINE LE-41	8.7				
CANVAS CE	2.5				
ETHOXYLENE-GLASS	5.1				
STAMPED TO XXXP - AVERAGE	8.8 (1/4" WIDTH)			4.5 (1/4" WIDTH)	
ALUMINUM-CLAD XXXP-AVERAGE	8.3	2.0 (150°)		6.6	EXPLODED

* TEMPERATURE OF SOLDER IN POT.
** BOND INTERFACE TEMPERATURE (MOLTEN SOLDER MAY RUN 30° HOTTER).
*** ALL TESTS MADE ON 1" WIDTHS EXCEPT WHERE NOTED.

Table I: Variation in strength of samples from center versus samples from edge of sheet.

complete curing has been supported in some cases by examination of the bond layer. Notably, all materials have failed in the 10 seconds required to reach 240°C; faster heating, if obtainable, might enable differentiation at the upper level. This test, while yielding useful information about the behavior of laminates under soldering and hot-punching conditions is too difficult for control use, because it is necessary to adjust experimentally the temperature rise program for each sample to a standard recorder diagram.

The method of sampling for adhesion testing was in accord with ASTM Specification D634-44 which essentially requires the rejection of material within 3 in. of any edge in order to minimize edge effects introduced in processing. Some data was taken to show the variation of strength in samples taken from the center versus samples taken from the edge of a sheet. This data may be found in Table I. Some sheets have also been found to have the best adhesion along the edges. Variations from sheet to sheet and from shipment to shipment of the same brand were in some cases quite pronounced.

Along with the averages for clad XXXP which may be considered typical, there have been included a few values of more expensively based materials for comparison. The bond quality of clad laminates has notably improved over the past three years so that minimum acceptance levels might well be raised several hundred percent over those mentioned in the references cited.[1,2] This is warranted also by the further finding, reflected in the tabulated data, that those clad-phenolics having the best cold adhesion also best survived solder dipping.

The values in the second and third columns of Table I were taken on rapidly heated samples (as for the previous graph) and show a large, temporary, loss of bond strength during soldering. If a temperature —critical for each type—is not exceeded, a strong bond strength returns upon cooling.

Solder Dipping Tests

Results of actual solder dipping tests are given in the last two columns and the temperatures shown are those of the solder on which the samples were floated. The solder temperatures were, on the average, 30°C above temperatures recorded by thermocouples placed within the samples at the metal-plastic interface. The 240°C level represents the lowest temperature considered practical for commercial solder dipping. These measurements were made on 1-in. strips in a bath of low melting point solder, which permitted wiping the sample free of solder. Control checks with 50-50 solder baths and the use of narrower strips revealed no discernable differences.

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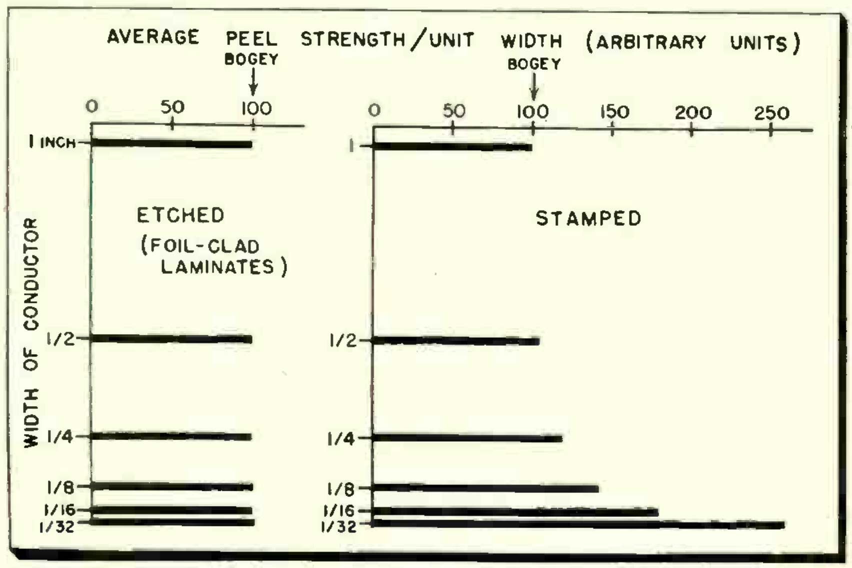

Fig. 7: (l) In standardizing stripping tests, correlation within 1-2% is obtained on etched conductors less than 1-in. wide.

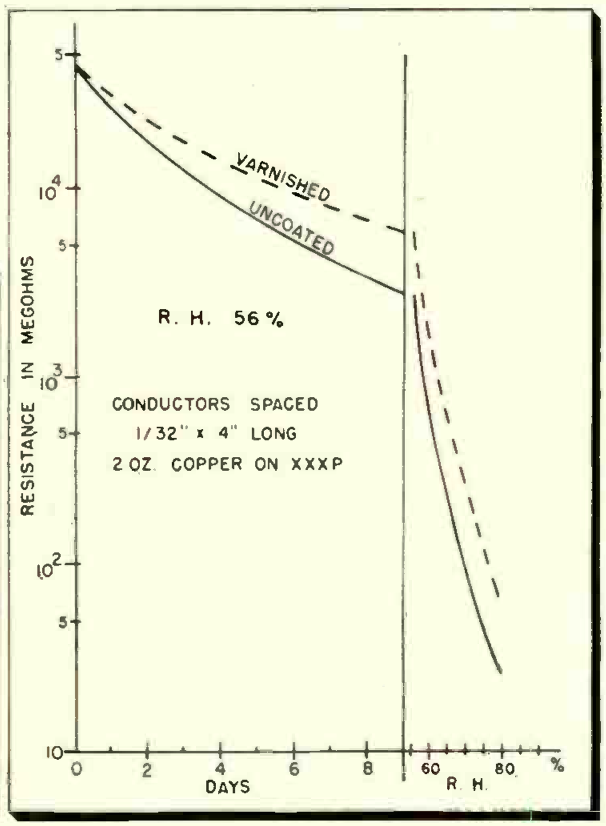

Fig. 8: Surface resistance is markedly lowered by dust accumulation which absorbs moisture.

Power Rating of R-F Coaxial Cables

Experimentally determined power handling capacities are shown to be higher than present ratings. Measurement techniques permit better evaluation of temperature.

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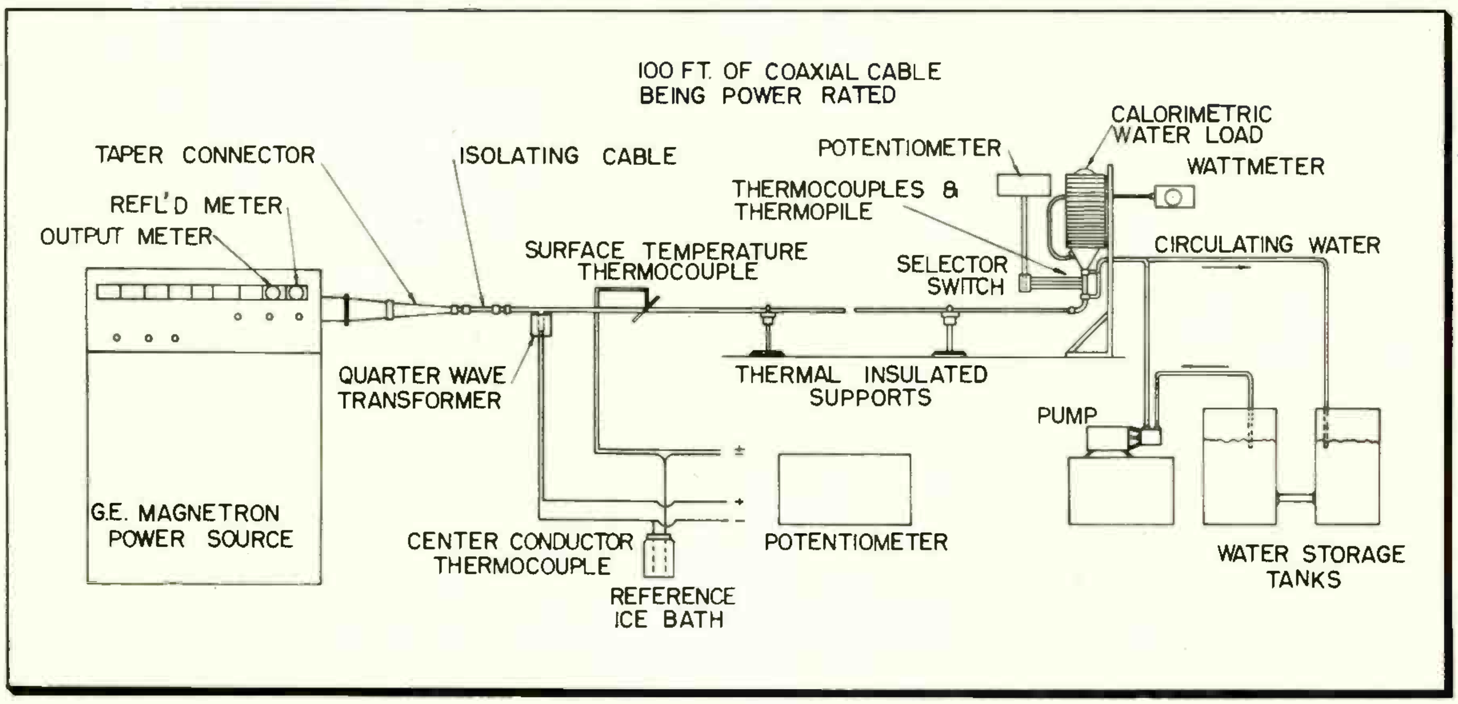
THE determination of the power ratings of r-f, solid dielectric coaxial cables is of basic importance to the Armed Services and the electronic industry for the efficient design, utilization and performance of these cables in accordance with the recent demands for greater power handling capacities in all types of electronic equipment. A study of the existing literature showed that several methods have been proposed both in this country and abroad for theoretically determining the power ratings of r-f coaxial cables, and that present power ratings are based on these considerations rather than on experimental values.

Of the several theoretical methods that have been proposed, the results of Mildner[4] and Macalpine[2] yield the most concise and usable sets of equations from which the power rating of r-f cables can be theoretically established based on r-f power and heat transfer theory. The power rating in the most general case, with the heat dissipated due to the three heat sources (inner conductor, dielectric, and outer conductor) combined with the periodic heat sources produced by the standing wave when mismatching occurs, is developed by Macalpine. This derivation may be simplified to the case where the cable is properly terminated and no standing waves produced. The power rating of r-f coaxial cables terminated by a matched load is also given by Mildner in which the heat dissipated by the three sources in the cable is derived in terms of the components of attenuation and the thermal constants of the materials used in the construction of the cable. Power ratings were determined for various British cables using this procedure. The derivation presented by Mildner has been further elaborated by Swicker[6] in which experimentally determined thermal constants and components of attenuation were utilized in calculating the power ratings of American cables. The power ratings of r-f cables recommended by the Armed Services Electro Standards Agency are based on these theoretical formulae supplemented by empirical constants. Since up to the present no actual experimentation has been performed to measure the power ratings of coaxial cables while actually transmitting r-f power, this investigation was conducted to confirm the previous theoretical analyses, to check the present calculated power ratings for polyethylene dielectric coaxial cables, and to determine accurately the power ratings of coaxial cables constructed from recently developed high temperature materials.

Transmission Limitations

The limitations of r-f power which can be transmitted by coaxial cables are dependent first on the heat generated by the normal electrical losses in the cable which cause deterioration of the dielectric and jacket by chemical (softening) and mechanical (thermal expansion) action, and secondly on the heat generated by excessive electrical stress which causes local overheating from discharges and deterioration of the insulation until electrical breakdown occurs. Since the heat generated inside r-f cables is the most predominant factor, the safe operating temperature of the center conductor has been established as the criterion for the power handling capacity, and therefore, the standard power rating of a coaxial cable is defined as the

Fig. 1: Apparatus arrangement for measuring the power ratings of coaxial cables



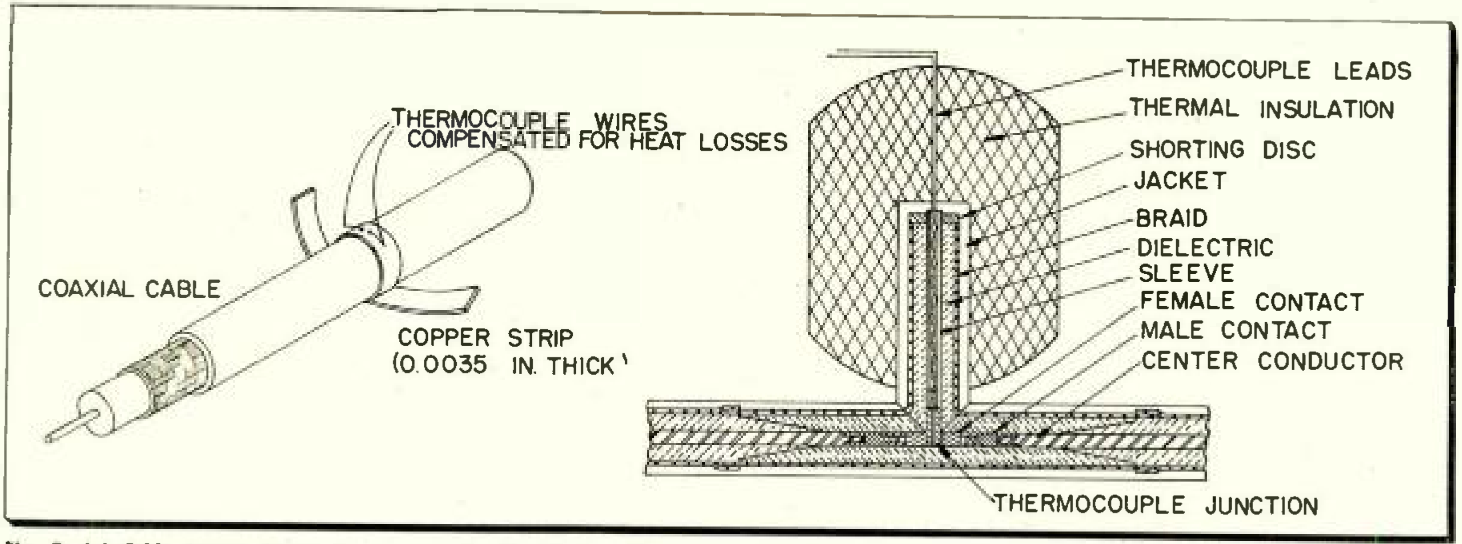


Fig. 2: (a) Cable surface temperature measured with thermocouple on copper strip. (b) Transformer isolates thermocouple from center conductor

input power to the cable terminated by a matched load with a specified temperature rise of the cable center conductor under steady state and given environmental conditions.

Recent knowledge and experience has permitted raising the maximum allowable operating temperature of coaxial cables as is evidenced by the published data.

Maximum Temperatures

Maximum operating temperatures for polyethylene cables were established in England in 1943 limiting the center conductor temperature to 149°F at a specified ambient of 122°F. The center conductor temperature was subsequently raised to 158°F while maintaining the same ambient temperature. In 1948 the maximum operating temperature was increased to 185°F while increasing the ambient temperature to 131°F thus raising the allowable temperature rise from 36°F to 54°F. In this country ratings have been established for a maximum center conductor temperature of 175°F for polyethylene dielectric coaxial cables with an ambient temperature of 104°F. Natural or free convection conditions are assumed to prevail at each of the above ambient temperatures. The experimental power ratings of the present investigation are based on a center conductor temperature of 175°F and a method presented for obtaining the power rating at any required ambient temperature under natural convection conditions. A certain factor of safety is provided in choosing a maximum operating temperature of 175°F as the flow point for polyethylene occurs at 224°F[7]. It is also necessary to measure the power ratings of the cables while they are transmitting r-f power, rather than dc, since heat sources exist in the center conductor, dielectric, and outer conductor.

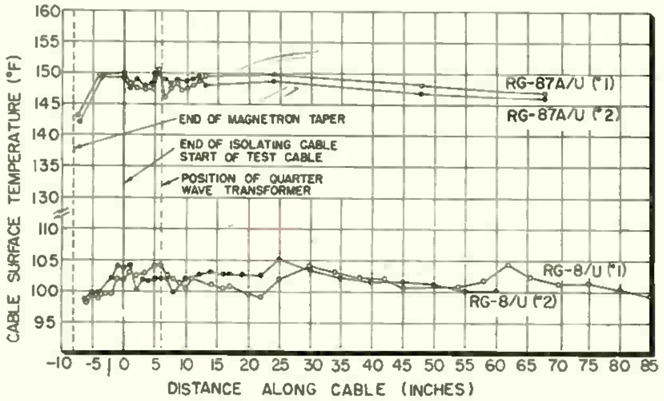
By a similar analysis, the maximum operating temperature for cables utilizing a Teflon dielectric has been taken as 482°F. Although chemical failure is not a problem at these elevated temperatures, mechanical difficulty has been experienced because of the large relative expansion of the dielectric in comparison to that of the inner conductor and braid when long lengths of cable are used.

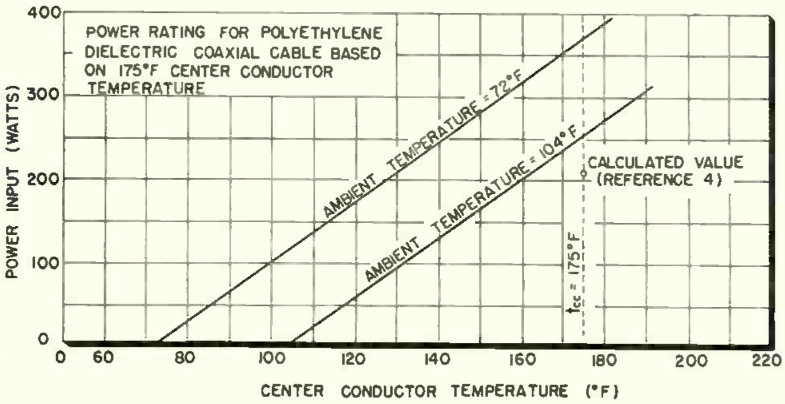
A schematic diagram of the apparatus utilized for measuring the power handling capacities of coaxial cables is shown in Fig. 1. It was necessary to accurately measure the input and output power, the cable center conductor temperature and the ambient temperature in establishing the power rating. A General Electric magnetron heater, capable of delivering 5,000 watts continuously at 915 Mc, was used as a power source. Its power output could be varied from 25 watts to full power while matching various loads to the output. Special connectors were designed to interconnect the r-f power source and terminating matched load with the various coaxial cables to be tested.

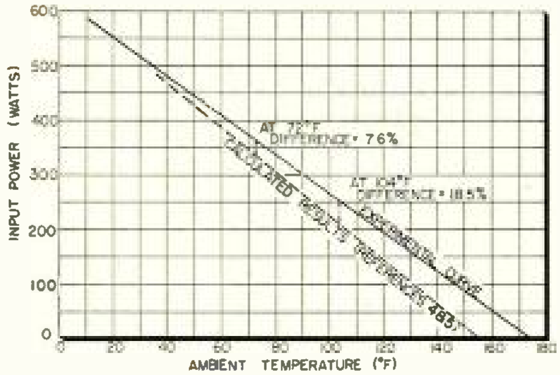
Test Installation

A Termaline r-f wattmeter load was calibrated and used as a calorimeter that both terminated the coaxial cable and dissipated the transmitted power. The test installation consisted of the wattmeter-load, differential thermopile installation, potentiometer and a circulating water system to cool the load during the

Fig. 3: (l) Surface temperature variation along coaxial cable axis. Fig. 4: (r) Power handling capacities and rating of RG-8/U and RG-9/U







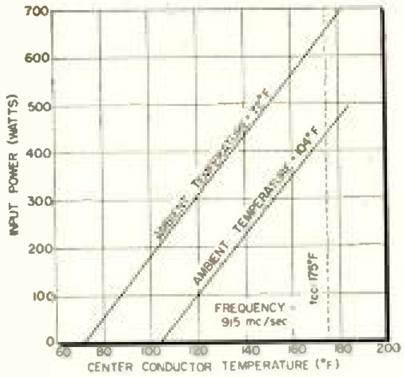


Fig. 5: (l) Experimental and calculated RG-8/U power ratings at various ambient temperatures.

Fig. 6: (r) Experimental power rating of RG-14/U coaxial cable

high power measurements. Since a constant pressure water supply was necessary to insure a constant water flow rate, a closed system was designed in which a positive displacement pump, having a capacity of 2 gpm and driven by a 1/3 hp electric motor, was utilized to circulate the cooling water. Sufficient capacity was available with two 55 gallon drums coupled together to permit the water to cool to room temperature before being recirculated through the calorimeter, thus permitting an accurate calibration of the calorimeter under constant environmental conditions.

The coaxial cable samples, 50 to 100 ft. long, were suspended horizontally in still air by means of thermal insulating supports every 3 ft. along the axial length. The entire cable sample under test was placed under a supported cheesecloth structure to eliminate air currents while an air-conditioning system maintained a constant 72 ±1°F ambient air temperature during the testing. A 5-junction thermopile measured the environment air temperature in the test chamber.

Surface Temperature

Cable surface temperatures were measured as shown in Fig. 2a with a thermocouple mounted on a copper strip that was tightened firmly around the cable to assure a good thermal contact and an accurate average temperature around the cable circumference.

The center conductor temperature was accurately measured with a thermocouple while the cable was transmitting r-f power by utilizing a quarter-wave transformer to isolate the effect of the thermocouple insertion, as shown in Figure 2b. The quarter-wave transformer was designed to be thermally and electrically equivalent to the cable into which it was inserted. The quarter-wave transformer was thermally insulated so that the heat losses from the cable at the point of insertion were the same before and after the transformer insertion. Surface temperature measurements and the reflected power meter measurements before and after the transformer insertion showed that no mismatch occurred. Although space does not permit the presentation of the electrical and thermal calibration of the transformer, it was possible to obtain a calibration allowing the direct reading of the true center conductor temperature.

The quarter-wave transformer is connected to the center conductor of the component being tested by means of a double female contact having the same dimensions as the component center conductor. The quarter-wave stub, consisting of a brass sleeve, 2.25 in. long, is screwed into a double female contact. The thermocouple (No. 30 A.W.G. wire) is inserted through a 0.028-in. axial hole in the sleeve and soldered at the junction along the axis of the center conductor. The stub is then assembled identically as the component in which it is inserted, provision being made for a shorting disc which is screwed to the sleeve and adjusted to the proper quarter wave length.

Care was exercised to insert the quarter-wave transformer into the cable at the point of maximum center conductor temperature. Theoretically, the curve of the temperature distribution along the cable should have been similar to the logarithmic distribution of the dissipated power and the maximum temperature should occur at the input end of the cable under test. However, because of the periodicity of the coaxial cable, a series of measurements on various cables indicated that the actual graph was distorted by the periodically occurring temperature peaks, an example of which is shown in Fig. 3. In addition, the point of maximum cable temperature (proportional to maximum center conductor temperature) was displaced approximately 6 in. from the input end because of the end heat losses. The quarter-wave transformer was therefore inserted at a point 6 in. from the input end where the maximum center conductor temperature occurred. It is recommended that the maximum center conductor temperature be determined for each particular test setup since the location of the point of maximum center conductor temperature is dependent upon the end losses and will vary accordingly.

Test Results

The results of a series of power rating tests for RG-8/U and RG-9/U polyethylene dielectric coaxial cables are shown in Fig. 4 in which the variation of the input power with center conductor temperature is plotted at an ambient temperature of 72°F. Although there are slight dimensional variations between the two cables and the RG-9/U cable has an additional layer of braid, no measureable difference was observed between the power ratings of these

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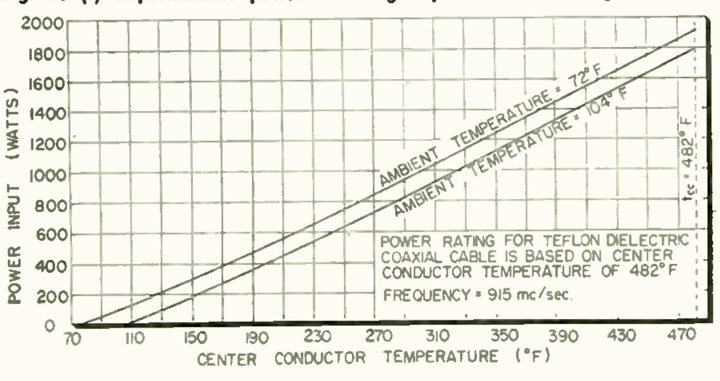
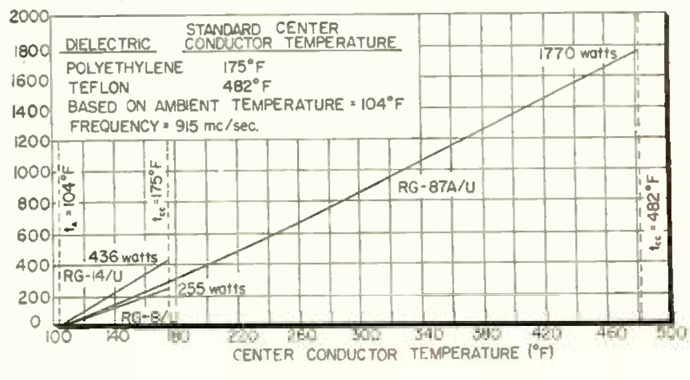
Fig. 7: (l) Experimental power handling capacities and rating of RG-87A/U and RG-116/U. Fig. 8: (r) Comparison of experimental power ratings





Precision Transistor

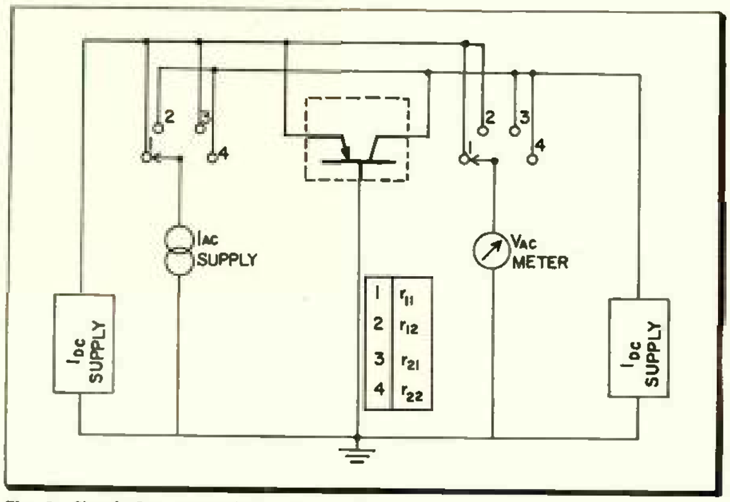


Fig. 1: Circuit for measuring r parameters

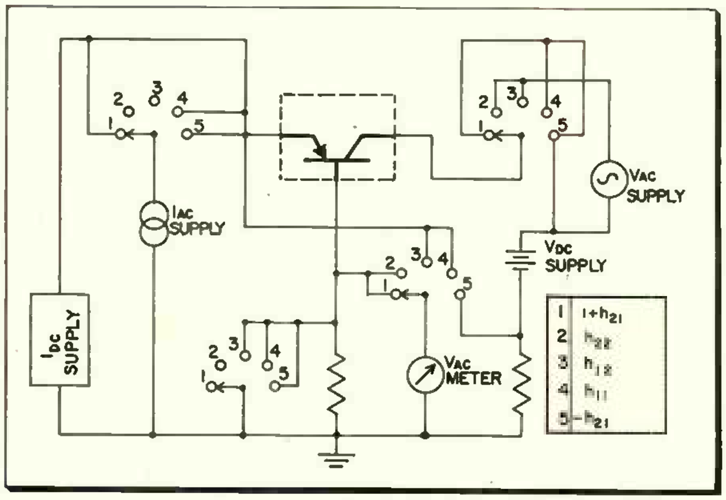


Fig. 2: Circuit for measuring h parameters

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ALONG with the recent wide interest in transistors as a potentially important tool of electronics, there has also been considerable interest in the measurement of transistor characteristics.

Most of the commercially available types of measuring equipment previously described in the literature have been curve tracers which plot families of transistor static characteristics on the screen of an oscilloscope. The chief advantage of this method is the ability to present an entire family of characteristics simultaneously. However, the accuracy with which values, especially slopes, can be read from an oscilloscope is necessarily limited and in many cases may be too low for quantitative work. In addition, it is inconvenient and time consuming to compute each slope to be measured.

The "Transtester" to be described has been developed to meet the needs of engineers who require higher accuracy and greater convenience than can be obtained by reading an oscilloscope. It measures directly on meters both the dc characteristics, which are of particular interest for switching applications, and a complete set of low frequency small signal parameters, which are of interest for linear amplifying and related applications. Each of these measurements can be made with an accurary greater than 3% over an unusually wide range of values. Recently one of these units has been modified slightly to permit the attachment of an X-Y recorder and a number of families of dc characteristics and plots of small signal parameters as functions of independent variables have been obtained.

Small Signal Parameters

The small signal method of measuring dynamic characteristics used in the Transtester may be summed up briefly as follows. If the transistor is considered as a general four terminal network, various relations between the network voltages and the network currents can be written. For example, if the currents are taken to be the independent variables of the network, the voltages can be expressed as functions of these currents;

$$V_1 = V_1 (I_1, I_2)$$
$$V_2 = V_2 (I_1, I_2)$$

If these functions are expanded in a Taylor's series and if only the linear parts of the series are retained, they become

$$v_1 = r_{11} i_1 + r_{12} i_2$$
$$v_2 = r_{21} i_1 + r_{22} i_2$$

where the lower case v's and i's represent ac signals and the r's are slopes of the curves obtained by plotting each dc voltage as a function of each dc current with the other dc current held constant. These r's are the parameters customarily used to characterize the ac circuit action of a point contact transistor.

On the other hand, if the input current and the output voltage of the network are taken to be the independent variables of the network, a different set of linear equations is obtained, namely:

$$v_1 = h_{11} i_1 + h_{12} v_2$$
$$i_2 = h_{21} i_1 + h_{22} v_2$$

where the h² or hybrid parameters are in some ways a more appropriate description of a junction transistor than are the r parameters.

The Transtester is designed primarily to measure the r parameters for point contact transistors and the h parameters for junction transis-

TABLE I: SUMMARY of PARAMETER MEASUREMENT by the TRANSTESTER

Parameter	Input Signal (Calibrated)	Condition Established	Output Signal (Read)	Full Scale Meter Reading
r_{11}	i_1	$i_2 = 0$	v_1	C+ ohms
r_{12}	i_2	$i_1 = 0$	v_1	C ohms
r_{21}	i_1	$i_2 = 0$	$v_2/100$	10^2C ohms
r_{22}	i_2	$i_1 = 0$	$v_2/100$	10^2C ohms
h_{11}	i_1	$v_2 = 0$	v_1	C ohms
h_{12}	v_2	$i_1 = 0$	v_1	10^{-5}C
$-h_{21}$	i_1	$v_2 = 0$	$10\ i_2$	10^{-1}C
h_{22}	v_2	$i_1 = 0$	$1000\ i_2$	10^{-8}C ohms
$1 + h_{21}$	i_1	$v_2 = 0$	$1000\ (i_1+i_2)$	10^{-3}C

+The value of the constant C depends on the input signal magnitude and meter sensitivity, both of which may be varied by switches. For the equipment described C may be varied from 10^{-1} to 10^{+4} with 3 steps per decade.

Test Equipment

New instrument indicates dc characteristics as well as low frequency ac measurements directly on meters. Higher accuracy over similar oscilloscope readings a feature.

tors, a choice that now appears to be favored by the majority of those who are concerned with transistors.

The small-signal parameters defined above can be measured with an ac voltmeter (or ammeter) by connecting calibrated ac current and voltage sources together with appropriate dc supplies as indicated in Figs. 1 and 2. For example, if i_2 is held constant, r_{11} will be equal to the ratio of v_1 to i_1. In practice, small errors will be introduced by the non-zero internal impedance of the voltage supplies and current meters and the non-infinite impedance of the voltmeters and current sources. Other errors may be introduced if the signal is so large that the linear approximations given above are invalid or if the frequency is so high that reactive components affect the measurement of the parameters. In the Transtester, they are much less then the error in reading the meter for typical transistors. A frequency of 270 CPS is used for the ac measurements as a compromise between frequencies so low that transistor noise (and 60 CPS pickup) are bothersome and frequencies at which the reactive components of the transistor parameters are important.

Table I summarizes the conditions which are established for the measurement of the various parameters and indicates the values of these parameters which can be read with the Transtester. Selection of the parameter to be measured is made by a single switch which also connects the appropriate dc supplies. The magnitude of the input ac signal is controlled by the range switch and has the value 200 μa/R for the ac current-source or 20 volts/R for the voltage-source. Here R denotes the setting of the range switch which has the following positions: 1.0, 2.5, 5.0, 10, 25, 50, 100, 250, 500, and 1000. Typically, measurements are made with R between 100 and 1000 corresponding to signal levels of about 1μamp or 100 mv. The constant, C, in the last column of Table I depends on the input signal level and the ac voltmeter sensitivity. More specifically, C is equal to R x M where R is defined above and M is the setting of the meter multiplier switch (Values: 0.1, 1.0, and 10).

(*Continued on page* 179)

Evaluating Shielded Enclosures

By ***RICHARD B. SCHULZ***

Ace Engineering & Machine Co. 3644 N. Lawrence St. Philadelphia 40, Pa.

THE term commonly used as a criterion of the performance of shielded enclosures is "attenuation." In the loose sense in which it is frequently used the manufacturer may mean either "attenuation" or "insertion loss." For clarification, the paraphrased engineering definitions are:

Attenuation of a periodic wave is the decrease in amplitude with distance in the direction of wave propagation, expressed in db.

Insertion Loss at a given frequency caused by the insertion of apparatus (wall of a shielded enclosure) in a transmission system (air) is the ratio, expressed in db, of the powers at that frequency delivered to that part of the system beyond the point of insertion before and after insertion.

As an example of the way in which these terms are applicable to the measurement of the performance of a shielded enclosure, consider first the term "attenuation."

In accordance with the definition, a measurement should be made of powers associated with the wave at points 1 and 2 (Fig. 1a) and the ratio of these measurements should be expressed in db. Instead, it is common practice to measure only the electric field intensities E_1 and E_2 at these points and to use the expression

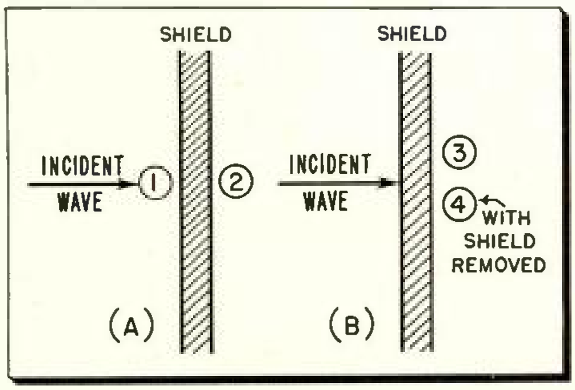
$$\text{Attenuation (db)} = 20 \log (E_1/E_2)$$

For a plane wave striking the shield at normal incidence, a correct measurement may be obtained only where there is negligible reflection to point 2 from other surfaces of the enclosure. However, it is practically impossible to meet plane-wave conditions at the lower ratio frequencies in use today, and reflections inside shielded enclosures are generally large.

Insertion Loss

A measurement of "insertion loss" is based upon the illustration of Fig. 1b. Here, both measurements 3 and 4 are made at the same point, but respectively without and with the shielding barrier in place. The power ratio of these measurements should be taken and expressed in db, but again, it is common practice

(*Continued on page* 166)



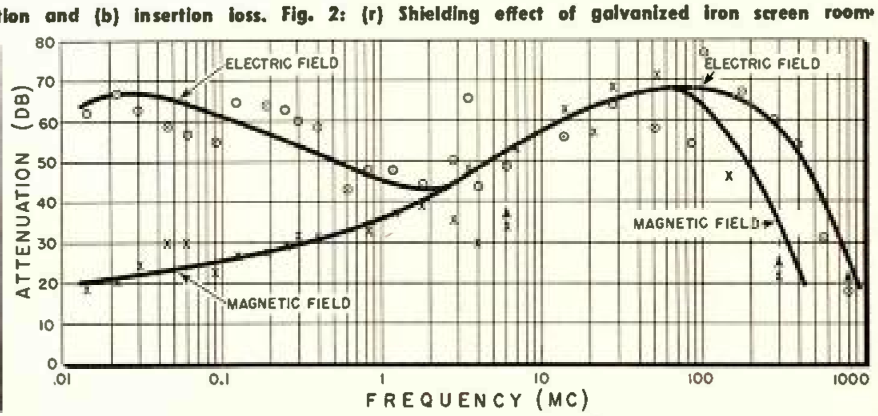


Fig. 1: (l) Location of points for measuring (a) attenuation and (b) insertion loss. Fig. 2: (r) Shielding effect of galvanized iron screen room

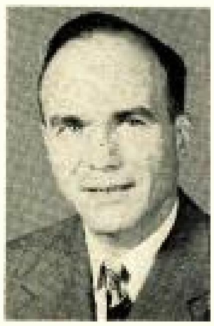
Low-Pass Duplexing System for

Use of lumped constants enables placement of open-wire TR systems in relatively small metal cases. Design also functions as filter to eliminate harmonics and spurious emissions

By ***WILLIAM L. HARTSFIELD*** *and* ***RICHARD SILBERSTEIN***
National Bureau of Standards, Washington 25, D. C.

RESEARCH in oblique-incidence ionospheric propagation by the use of a high-frequency pulsed transmitter is being conducted by the Central Radio Propagation Laboratory of the National Bureau of Standards at its field station at Sterling, Va.[1,2,3] The transmitting and receiving systems employed for studying round trip propagation

W. Hartsfield



R. Silberstein

phenomena by means of a beacon and for back-scatter studies (scatter-sounding) resemble radar systems, except that frequencies used in these studies are those propagated by the ionosphere. As in radar, it is highly desirable to take advantage of the gain and orientation of a single antenna in transmitting and receiving. This can be accomplished without too much difficulty because of the fact that the echoes return to the antenna after the transmitted pulse has terminated.

Fig. 1 illustrates the familiar simple type of duplexing or TR system originally developed for radar use, employing sections of open-wire transmission line. During transmission, gaps G_1 and G_2 break down and conduct. When this occurs points AA, being at a quarter wavelength from the gap, have such a high impedance placed across them by virtue of resonance of the line terminated by the gap that they are essentially isolated from it. The same is true of points BB, so, assuming that all sections of line have the same characteristic impedance, the line from the transmitter to the antenna remains matched. At the same time the receiver is protected by the conduction of gap G_2.

Receiving Conditions

After the transmitter pulse has terminated the gaps open and the system is in condition for reception. Now the section of line terminated at G_1, acts like a short circuit on AA. The short circuit on AA causes the quarter-wave section between AA and BB to act like a high impedance across BB so that now a direct matched line appears between the antenna and the receiver.

Initially a duplexing system like that of Fig. 1 was used at an operating frequency of 13.8 MC. Since the quarter-wave sections were about 18 feet long they were supported on poles outdoors between the transmitter building and the antenna.

With the system in operation interference to VHF reception was reported from a nearby location. Interference decreased as the gaps were shortened, leading to a belief that the gaps might have been the cause of some broadband VHF radiation. The problem was that of filtering interference caused by either the transmitter or the gaps. Any filter placed close to the gaps would upset the existing circuit relationships established by making the lines from the gaps a quarter-wavelength long, and in addition would not stop direct radiation from the gaps.

Design Considerations

It was observed that lumped-constant quarter-wave sections could be constructed which would also be low-pass filters. This made it possible to place the entire duplexing system in a metal case, with the gaps exposed, and install the metal case inside the transmitter building, which was itself shielded. The chief difficulty in the construction of such a system lay in preventing breakdown due to the high voltages present at the powers used, even when the system was matched. For one megawatt into a 600-ohm line, and with reasonable mismatches, peak voltages up to 50,000 may be encountered. This difficulty led to a design in which all circuit elements except the gaps were immersed in mineral oil.

In the interest of simplicity it was decided to use constant-K filter sections. The M-derived type hardly appeared necessary since there was no one harmonic which it was desired to suppress and also since the operating frequency was far below the spectrum in which interference would begin. The final design is shown in Fig. 2.

In Fig. 2 the circuit diagram is analogous to that of Fig. 1 for linear sections except that an extra filter section is used between point BB and the antenna for additional attenuation of higher frequencies, and also a matching section is used between the gap G_2 and the receiver output to match the balanced, shielded 95-ohm line to a 600 ohm line.

For uniformity of design, except in the matching section, one value of capacitance and one value of inductance were chosen for all filter sections. It will be seen that, fortuitously the values in the T section beyond BB came out the same as

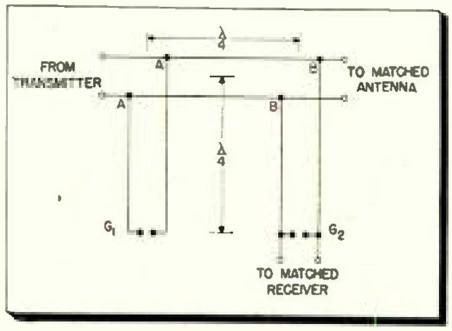


Fig. 1 Conventional Duplexing System

in the pi sections used in the other positions

Fig. 3a shows the prototype, constant-K section used. For this the familiar equations hold

$$L = R_o/\pi f_o \qquad (1)$$

$$C = 1/\pi f_o R_o \qquad (2)$$

where L is inductance in henries
C is capacitance in farads

High-Frequency Pulse Transmitters

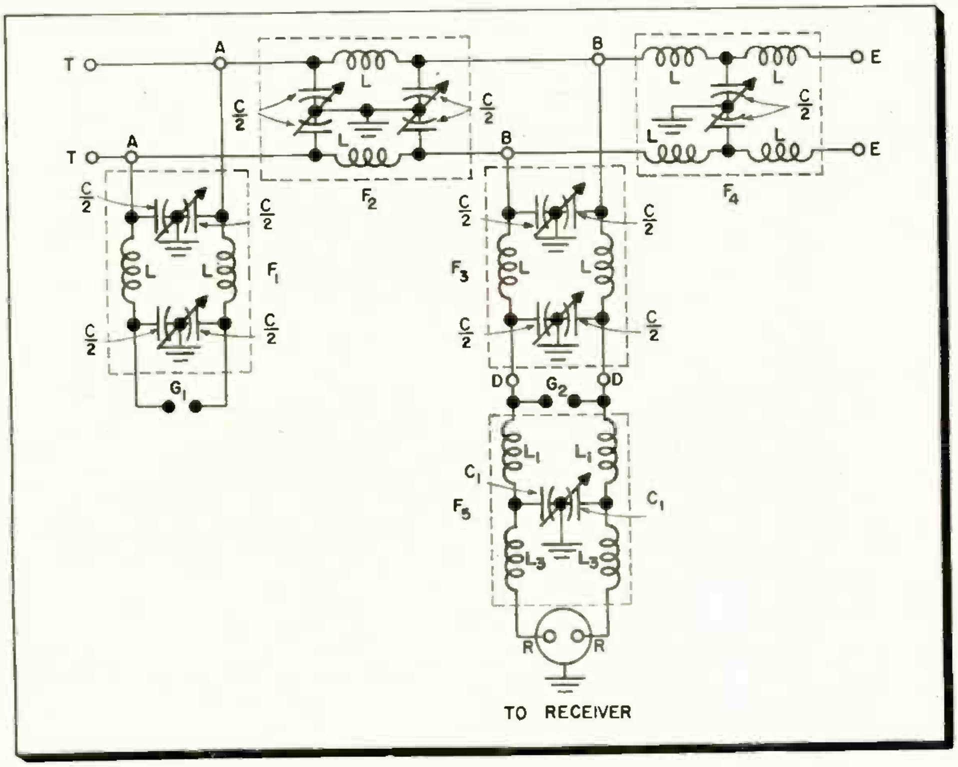


Fig. 2: Circuit diagram of duplexing system

R_o is $\sqrt{L/C}$, the nominal characteristic impedance in ohms f_c is cutoff frequency.

Filter Function

A typical desired function of the filter is that of F_3 in Fig. 2. Referring to Fig. 3b which shows F_3 alone, when the gap is not conducting the impedance looking into BB and DD must be the line characteristic impedance. When the gap G_2 fires, L in shunt with C/2 must resonate so that the impedance across BB is very high. As will be seen below, these conditions may be realized provided that a restriction be imposed on the ratio of the operating frequency f to the cutoff frequency f_c.

For the gap firing: $\omega L = 2/\omega C$

From (1) and (2)

$$f/f_c = 1/\sqrt{2} \qquad (3)$$

The restriction imposed by (3) was not serious in our case since the cutoff frequency thus obtained is appreciably lower than the second haromnic of f.

Antenna Considerations

Since, because of antenna considerations, the operating frequency was to be within about ±2% of 13.8 MC, the possibility existed of matching the load to the exact characteristic impedance of the network.

For a pi network[4]

$$Z_{o\pi} = \frac{R_{o\pi}}{\sqrt{1 - f^2/f_c^2}} \qquad (4)$$

where $R_0\pi$ is the nominal characteristic impedance of the pi network and $Z_0\pi$ is the actual characteristic impedance of the pi network at the frequency f.

The corresponding equation for the T network[4] is

$$Z_{oT} = R_{oT}\sqrt{1 - f^2/f_c^2} \qquad (5)$$

It was apparent that, in designing for a given selected characteristic impedance $Z_o\pi$, the best match in the case of the pi network could be obtained by making the nominal characteristic impedance, from (4),

$$R_{o\pi} = Z_{o\pi}\sqrt{1 - f^2/f_c^2} \qquad (6)$$

since, below filter cutoff, $Z_o\pi$ is, by definition, the terminating resistance which will give the same value of resistance at the filter input.

For a line impedance of 600 ohms, 300 ohms from each side to ground, putting $Z_o\pi$ equal to 300 ohms in (6), $R_o\pi$ has a value of 212 ohms. Using this value and an operating frequency f of 13.8 MC, the following values were obtained for the circuit elements, using (1), (2) and (3).

f_o = 19.5 M_c

L = 3.46 μh

C/2 = 38.5 μμf

The pi network composed of these elements used at F_3 in Fig. 2 matches 600 ohms at DD. At this point the matching section F_5, to be described later, was used to match 600 ohms to 95 ohms, which is the impedance of the balanced shielded cable from the receiver.

The same network was used in the position of F_1. When the gap G_1 fires during transmission a high impedance is placed across AA, as in the case of F_3. However, with the gap open there is no load across the filter corresponding to that at DD so the inductances and lower pair of capacitors resonate to throw a short circuit across AA exactly as in the case of the linear TR systems.

In the position of F_2, during transmission, the network acts like a section of 600-ohm line between the antenna and transmitter. The reason for this is that the gaps conduct and F_1 and F_3 act as very high impedances across AA and BB.

The section F_4 was made a T network, thus saving one pair of capacitors Since the actual impedance of the T network is given by (5) the elements were designed for a best match by making

$$R_{oT} = \frac{Z_{oT}}{\sqrt{1 - f^2/f_c^2}} \qquad (7)$$

where $Z_{oT} = Z_{o\pi}$, the load impedance to be matched.

In accordance with simple constant-K filter theory, the shunt arm of the T equivalent of a given pi has the calculated value of C and the series are the value of L/2, and since $\sqrt{1 - f^2/f_c^2}$ is in our case equal to $1/\sqrt{2}$, R_{oT} has twice the value of R_o Eq. 6 and 7). Calculations lead to the interesting result that the arms of the T are identical in value with those of the pi previously calculated.

The section F_5 of Fig. 2 is a T matching section designed to match the 600-ohm line to a balanced, shielded 95-ohm cable which goes to the receiver. In the design of F_5, Eqs. (11) and (12) of Ref. 4, p. 248, were used. An inductor of value 8.55 μh was available for L_1 and the other circuit elements came out as follows:

L_3 – 3.62 μh

C – 49.2 μμf

The physical elements of the filter presented a problem in addition to that of voltage breakdown. It was desired to tune the various sections of the filter for optimum perform-

(*Continued on page* 118)

FOSDIC—Sensing Device

Optical instrument reads marks on micro es data for direct input to large-scale com

Fig. 1: Microfilmed copies of marked documents are read in FOSDIC cathode-ray scanning unit (r). Scanning generator (c) to drive CRT also receives photocell signals from scanning assembly. Answer information is fed to output unit (l) where it is converted into coded pulse form for magnetic tape recording. Power to all units are supplied from a fourth cabinet

An instrument that provides rapid, automatic processing of information into a form suitable for direct input to large-scale electronic computers has been developed by M. L. Greenough, H. D. Cook, M. Martens and associates of the National Bureau of Standards at the request of the Bureau of the Census. See Fig. 1. Named FOSDIC (Film Optical Sensing Device for Input to Computers), the machine reads marks on microfilmed copies of documents that have been marked with an ordinary pencil or pen, and then processes the information into electrical pulses which are recorded on magnetic tape for direct input to an electronic computer such as the Census Univac. FOSDIC is designed to reduce the work that is now involved in converting written records into a medium acceptable as input by data-processing machines. This is particularly true since FOSDIC allows considerable freedom in design of the documents and does not require the use of any special writing instrument.

It is anticipated that ultimately the use of this machine will reduce appreciably the massive amount of paper-work entailed in summarizing Census information on the entire population. Although designed for census operations, FOSDIC may be generally applied to the processing of other types of information that must be handled in large quantities.

Pre-Input Apparatus

With the development of many large-scale electronic computers in the past few years, there has been an increasing need for equipment to bridge the gap between the machines and their sources of information. This is especially true for computing systems which perform relatively little computation on a large mass of data obtained from many sources. Considerable attention has been given to computers and their input-output equipment but relatively little to "pre-input" apparatus or instrumentation permitting the computer to have direct contact wih sources of information. When human beings are considered as sources of information, only two even partially automatic means of communication are in general use. These are (1) typewriters of various forms and (2) special marking instruments such as punches or conductive pencils. An alternate method is through the manual preparation of punched cards. To these methods has now been added FOSDIC, a completely automatic machine which processes marks made by an ordinary pencil or pen into a form directly usable by the computer.

Sensing Equipment

The method of mark sensing used by FOSDIC is the detection of specific blacked-in areas or ovals in a large field of possible answers arranged on a sheet of paper. A "yes-no" answer is given two ovals while a numerical answer is supplied with a vertical column of 10 ovals for each decade. The desired information is indicated by the locations of the marks. It then becomes the task of the sensing equipment to tell the computer precisely which ovals the enumerator has marked to signify his available information. See Fig. 2. Since FOSDIC senses the presence or absence of a mark by optical means, readings are not affected by the electrical conductivity of the mark or the paper, or by any mechanical indentation of the paper due to lack of stiffness. In practice, the interrogating agency need not supply special pencils since any common marking device is satisfactory.

The scanning process is carried out on a frame-by-frame basis. Each frame is a microfilmed picture of one side of a sheet which may be as large as 14 by 16 in. The film is placed in an optical assembly between a cathode-ray tube with a moving spot that scans the image and a photocell that produces a varying electrical signal from the light beam that has passed through the film. The current maximum capacity is about 2800 marks per sheet, since this is the present limit of adequate legibility of marks on the document. An individual film is scanned in 0.5 to 0.9 seconds. Allowing for film change and other functions, the total time per frame is about 1¼ seconds. The average information rate is approximately 2000 binary digits or 250 decimal digits per second.

The chief problem in the design of mark sensing equipment lies in the developing of a method to locate the individual ovals with the necessary degree of precision. In a mechani-

for Computers

***filmed documents and automatically process-
puters. System greatly reduces paper work***

cally registered system, such as that used for detecting conducting-pencil marks, the pickup heads are located at fixed distances from the edge of the document. The assumptions are made that the edges are well-defined and that the paper stock has dimensional stability. In FOSDIC, however, the paper edge is replaced by a printed index mark below each column. See Fig. 3. When located by the scanning process, the index mark furnishes an exact guide to the column position. Column height, or distance from top to bottom oval, is not as critical as in a mechanical system since each answer is searched for over an area several times the size of the oval. Thus, with these degrees of freedom over ordinary scanning methods, the use of multiline documents on ordinary bond paper stock is feasible.

The amount of information per document is considerably increased over punched cards.

The NBS-developed instrument is housed in four 42-in. high cabinets. In addition, there is a unit containing magnetic tape handling equipment and recording heads. The input cabinet contains the flying-spot scanning assembly. The main electronic unit generates scanning voltages which drive the cathode-ray tube beam, and receives in return the photocell signals from the scanning assembly. Answer information is fed into the output cabinet where it is converted into coded-pulse form suitable for recording on 8-channel magnetic tape. Power is supplied to all these units from the fourth cabinet.

FOSDIC's electronic equipment is composed of many separate and dis-

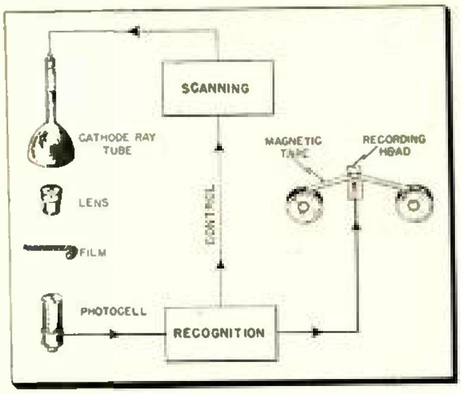


Fig. 2: In operation, scanning control directs CRT beam to appropriate area on microfilm. Information is picked up by photocell, converted into coded pulse form and recorded on tape

tinct circuit groups, each designed to carry out a unique function. For example, the Index Recognition circuit determines when the scanning beam is at the top edge of a solid mark between 0.24 and 0.36 in. high to make this decision, however, it must previously have been informed that a number of other conditions have been met. Among these conditions are: (1) a frame to be scanned must be present, (2) the degree of tilt of the document must have been

(Continued on page 140)

Transistorized Wrist Radio

A TRANSISTORIZED wrist radio has been designed by Lt. Paul Cooper and Joseph O'Brien at the Signal Corps Engineering Labs., Ft. Monmouth, N. J., to demonstrate the feasibility of constructing a small radio receiver with transistors. This model, utilizing a printed circuit, was fabricated by Harry French of SCEL. The reduced power requirements of transistors as compared to vacuum tubes made it possible to use a very small battery which is included in the wrist case.

Regenerative Stage

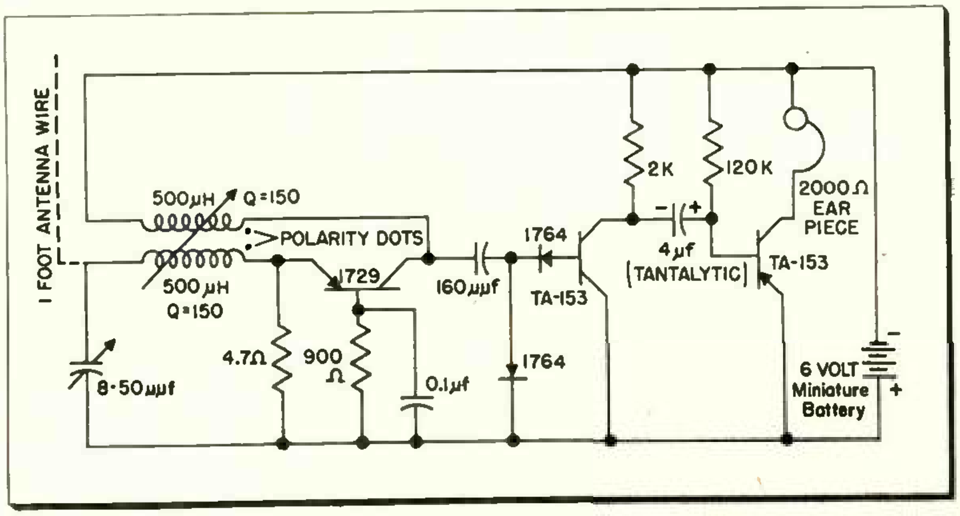
The receiver, employing three transistors, consists of one regenerative r-f stage and two audio stages. The schematic diagram is shown in Fig. 1. A point contact transistor (Type 1729) is used in the regenerative stage. Regeneration is obtained utilizing a transformer with the amount of feed back controlled by the proximity of the two coils. A miniature capacitor is used for tuning. The audio amplification is performed by two PNP junction transistors (Type TA-153). A bead diode (Type 1764) is used as a detector, and another one is used as a dc return. The power supply is a 6.5 v. battery (½ x ⅝ in.) consisting of five RM 412 mercury cells (1.3 v. each). Battery drain is about 20 mw and battery life about 10 hours. Although in strong signal areas no antenna is needed, usually a one foot wire should be used. The earphone is the small hearing aid type made by Telex and has an impedance of 2000 ohms. The transistors can be replaced without making any circuit adjustments.

The receiver tunes from 1000 KC to 1600 KC, has sharp selectivity, and a sensitivity of 50 μv. A number of New York stations (45 miles from Ft. Monmouth) can be heard quite satisfactorily. When the receiver is in the vicinity of radiators, such as telephones, the reception is greatly improved—to the extent that the reception can be heard by an observer standing 30 ft. from the earphone.

In the evolution of the receiver, it was found that with a 60-ft. outside

(Continued on page 140)

Circuit shows application of transistors and bead diodes in wrist radio



CUES for BROADCASTERS

Practical ways of improving station operation and efficiency

Remote Antenna Current Meter

LOUIS N. SELTZER, Chief Engineer, WCOJ, Coatesville, Pa.

AT WCOJ, we have eliminated a minor headache in remote meter calibration, eliminated an ac switch which had to be thrown when we went on the air, and improved the accuracy of our remote meter readings.

We use a Gates MO-3294 diode-type remote meter, with the circuit shown in Fig. 1. This unit is typical of those found in most stations which meter their tower current remotely. It requires a line-and-ground or a pair of lines from the transmitter shack to the tower to supply ac to the filament, and a switch-box-and-fuse on the wall to energize the filament.

We found that replacing the 6H6 rectifier several times during the winter on a day when the snow is three feet deep is an unwelcome bother. We also found that just about every week during our remote meter check the circuit required readjustment of resistor "R" as the tube aged, which meant having to open up the antenna tuning unit to insert a long screwdriver past several hot leads.

An analysis of the circuit indicates that the only purpose served by the right-hand section of the rectifier is to supply a reverse current to make the remote meter read zero when no r-f is flowing (to neutralize the static current of the left-hand (working) section.)

We took an octal tube base and soldered the pigtails of a 1N34 germanium diode between pins 3 and 4 and inserted the tube-based germanium diode in place of the 6H6, thus changing our diode meter circuit to that of Fig. 2.

In almost a year of use we have found that adjustment during our weekly remote meter checks has been eliminated, since the unit now shows far greater stability. We have one less ac. switch to throw when we go on the air, and we are now using the line which was released from service (850 ft. of it in our case) as an intercom line.

$$$ 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.

Eliminating Coupling of Erase Heads

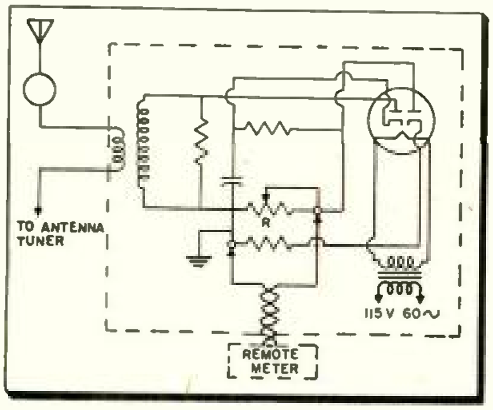
JAMES M. WELDON, Amtel Productions, 1325 N. St., Lincoln, Neb.

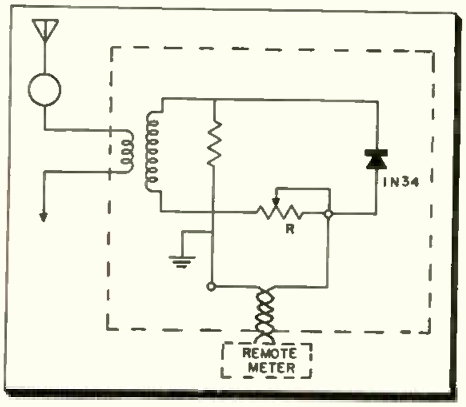
IN our recording-studio operation, we often have occasion to use several tape recorders simultaneously. In doing so, we recently encountered a problem which might well occur to other users of PT-6 Magnecorders.

We are using two PT-6AH Magnecorders, rack-mounted, along with an Ampex 400. We found that, when copying tapes from one Magnecorder to the Ampex and simultaneously recording from another channel with the other Mag, the erase head of the recording Magnecorder was radiating enough energy to be picked up by the erase head of the playback Mag. In the PT-6, bias is furnished by a coil, in series with the erase head, and coupled with the record-playback coil. Through this mutual coupling, the erase voltage appears in the audio of the playback circuit. Ordinarily, this high-frequency signal might cause no grief; however, when it is mixed with the bias of the Ampex, which is of a different frequency, the result is a very audible hiss in the background of the Ampex recordings.

Obviously, complete shielding of both Magnecorder erase heads would remedy the situation, but the construction of the PT-6 does not lend itself to such a modification without drastic rearrangement of the front panel of the puller. Consideration of the erase-bias circuit of the Magnecorder does, however, suggest another simple solution to the problem. We removed the lead which connects the erase and bias coils, pin four of the erase head to pin four of the record-playback head. This lead was replaced by a toggle switch, mounted through a convenient hole at the rear of the puller chassis, and connected to the head socket lugs with a short length of shielded pair. This operation was performed only on the machine which is used for playback and copying most of the time. Since making this modification we have experienced no trouble from interference, and with the switch closed for recording with this machine, there are no detectable changes in its performance.

Fig. 1, left, shows original circuit of remote antenna current meter using 6H6
Fig. 2, right, gives simplified circuit with 1N34 for reliable operation



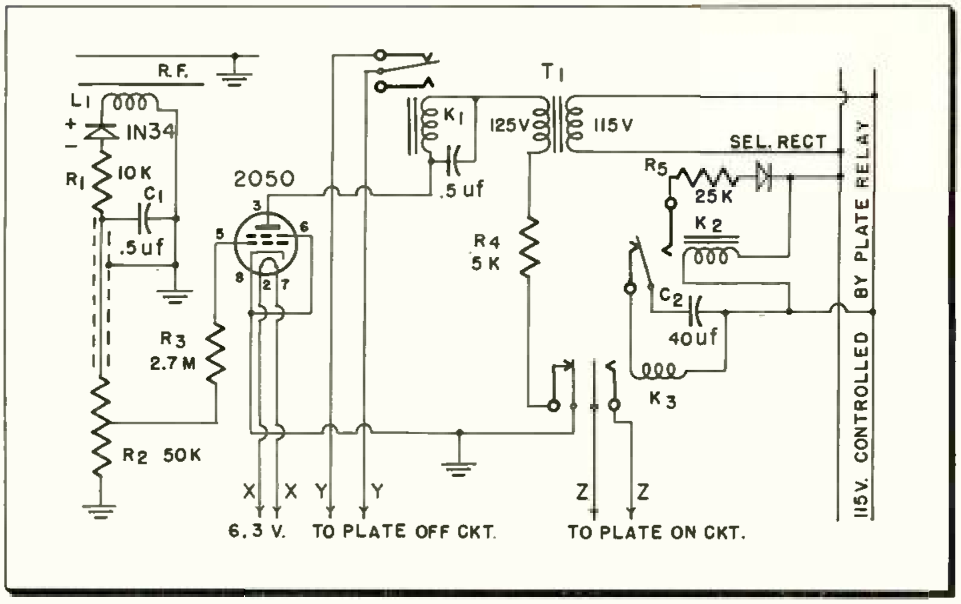


Protection from Lightning and Static Discharge

EDGAR C. SMITH, Chief Engineer, WFIN, Findlay, Ohio

THIS circuit is used to extinguish arcs caused by static discharges across the loading capacitor in our Collins 20-K transmitter. Other devices were tried, such as static drain chokes and gaps, but none were as effective.

The circuit operates as follows: When plate power is applied to the transmitter, K2 is energized, and C2



Rapid cycling lightning protection obtained from self operating thyratron relay

charges through the selenium rectifier and R5.

L1, consisting of about 15 turns of well insulated hookup wire wrapped with plastic insulating tape, is taped to the r-f buss. All r-f picked up by L1 is rectified by the 1N34 diode, filtered by R1 and C1 and applied across R2. The negative voltage across R2 is applied to the 2050 grid through R3 to prevent the tube from firing. The back contact on K1 is closed with the 2050 in this condition, keeping the transmitter on.

Should an arc occur across the line, it acts as a short and removes the negative voltage on the 2050 grid causing it to fire. Relay K1 closes and removes the high voltage from the transmitter. Relay K2 opens, discharges C2 through K3 causing it to close. When K3 closes, plate voltage to the 2050 is removed and high voltage is applied to the transmitter. The complete on-off-on cycle is fast and hardly noticeable over the air.

The filter, consisting of R1 and C1, is important because it prevents the 2050 from firing on high negative modulation peaks when the carrier approaches zero amplitude.

Program Selection for Tape Recorder

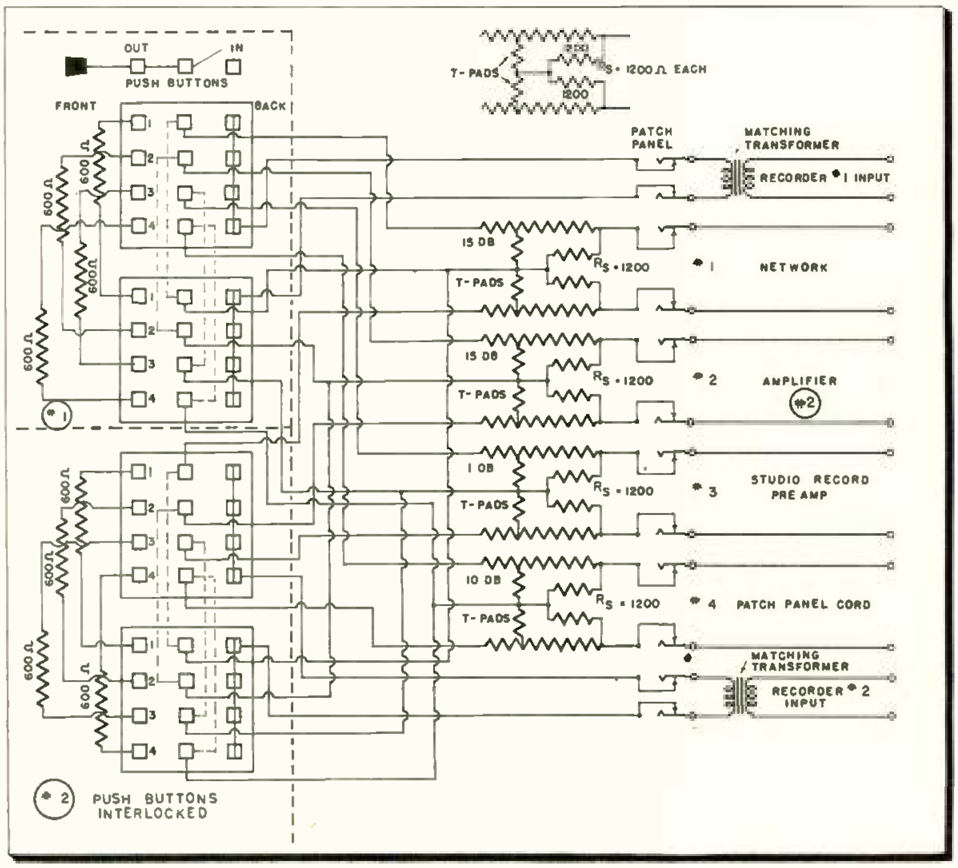
CECIL P. CLARK, Chief Engineer, KBTM, Jonesboro, Ark.

THIS method of program selection is recommended for small stations where only two or three recorders are available and announcers also run the control board. Most material may be found in the scrap box. Push button sections, taken from old radio receivers, are DPDT switches with wiping contacts (for reliable operation) and interlocked so that only one program at a time can be applied to the recorder.

When the button is pushed "in," the 600 ohm transformer is across the input. When it is in the "out" position, the 600 ohm resistor is across the input so that the load is always the same. This is also true if both recorders are across the same input or each on a separate input. Besides facilitating selection, programs may be overlapped so that busy announcers can select their cue when time permits.

The pads are regular 600 ohm T pads with db desired loss figured in each case. R_s is obtained from the formula $R_s=[N_s/N_s-1]Z_1$ with Z_1 being the impedance of the program line and N_s the number of recorders to be fed (in this case, two). This gives nearly a 600-ohm match to the program line. All recorder inputs and program lines are available from the patch panel in case the push-buttons should fail.

Simplified tape selection for announcers obtained by push button console



Simulating Telephone with Filter Mike

ELTON B. CHICK, Chief Engineer, WQXI, Atlanta, Ga.

IT is often necessary to simulate the effect of a telephone on one side of a conversation. Audio filters seemed the simplest solution to WQXI's problem. The possibilities of the war surplus aircraft range filters were investigated. A little experimenting, using a 500 ohm signal source and a 500 ohm load, gave all the information needed. The type FL30 was selected several others had been tried, including the FL8, and all produced about the same results.

The FL30 is a band pass and a band rejection filter. In the range position it passes a band of frequencies around 1020 cps, in the voice position it rejects a 1020 cps signal. Passing a signal through the filter in the range position approaches the

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Diode Noise Generator for

Compact generator facilitates receiver noise measurements

THE desirability of low noise factor receivers for TV in the VHF range has become increasingly evident in the past few years. As tuner noise factors have been decreased and transmitter effective radiated power increased, the so called "fringe" area or marginal reception area has been extended farther and farther from the transmitting site. Unfortunately, at UHF, the combination of propagation characteristics and the presently low effective radiated power of UHF transmitters makes the attainment of low noise factors even more important than at VHF. At the same time, present limitations of tubes and crystal diodes make low noise factors extremely difficult to obtain in the UHF band. Consequently, the measurement of noise factor assumes great importance in UHF receiver design.

Total Noise Power

To measure the noise factor of an amplifier or receiver, it is necessary only to determine the total noise power introduced by the various receiver circuits, and refer this power to the input of the receiver. Noise factor is defined simply as the ratio of the noise power (referred to the input for convenience) of the actual receiver under measurement to the noise power of an "ideal" receiver. The "ideal" receiver is defined as one having no noise sources except the unavoidable input source resistance thermal noise. Thus, once the actual noise power of a particular receiver is known, the noise factor can be obtained by simple computation.

While several methods are available to measure the receiver noise power, one of the simplest involves the use of a noise generator connected to the receiver input terminals which produces an adjustable but known amount of noise power. The measurement then requires that the relative output power of the receiver be indicated, for example by a voltmeter at the output terminals. The reading of the indicator with the noise generator off, but with the receiver operating normally is noted; this reading is due to the receiver and source resistance noise only. The noise generator is then adjusted to change the output reading by some convenient amount. This new output reading will be due to the sum of receiver, source resistance and the noise generator output. If the noise generator power is known, the computation of the receiver noise power and subsequently noise factor is simple and direct.

The design of a noise generator revolves, therefore, about the necessity not only to produce some noise power, but to produce a definitely known noise power. The fact that the mean squared shot noise current produced by a temperature limited diode is directly proportional to the direct current of the diode offers a very convenient source. Diode noise generators have been extensively employed at low frequencies and at VHF. At higher frequencies, the problems of transit time and tube reactances seriously affect the performance of conventional diodes, and it is necessary to resort to new tube designs such as the coaxial noise diode. While it appears that the coaxial diode, which is particularly designed for UHF use, is a highly satisfactory device, the peculiarities of the contemporary UHF situation in regard to tube procurement and the pressure due to the increasing number of UHF transmitters indicate that there are certain advantages to be gained from a somewhat different approach.

Virtually all present UHF tuners are designed with 300-ohm balanced input circuits in emulation of VHF

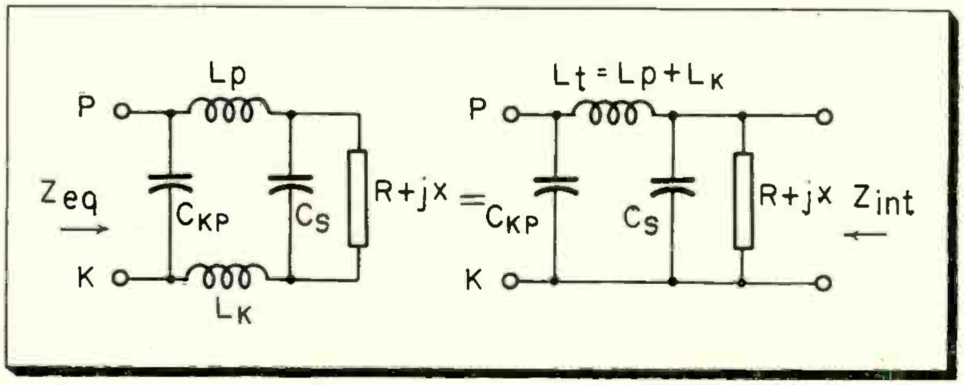

Fig. 1: Four-terminal network connected to diode results in desired current in external load

Table of Equations

$$Z_1 = \frac{-jX_{cs}\,(R+jX)}{R+j(X-X_{cs})} = X_{cs}\frac{X-jR}{R+j(X-X_{cs})} \qquad (1)$$

$$Z_2 = Z_1 + X_{1t} = \frac{XX_{cs}-X_{1t}(X-X_{cs})+jR(X_{1t}-X_{cs})}{R+j(X-X_{cs})} \qquad (2)$$

$$Z_{eq} = X_{cpk}\frac{R(X_{1t}-X_{cs})-j[XX_{cs}-X_{1t}(X-X_{cs})]}{XX_{cs}-X_{1t}(X-X_{cs})+X_{cpk}(X-X_{cs})+jR[X_{1t}-X_{cs}-X_{cpk}]} \qquad (3)$$

$$R^2(X_{1t}-X_{cs})(X_{1t}-X_{cs}-X_{cpk})-[XX_{cs}-X_{1t}(X-X_{cs})][XX_{cs}-X_{1t}(X-X_{cs})+X_{cpk}(X-X_{cs})]=0 \qquad (4)$$

$$RX_{cpk}\frac{(X_{1t}-X_{cs})[XX_{cs}-X_{1t}(X-X_{cs})+X_{cpk}(X-X_{cs})]-(X_{1t}-X_{cs}-X_{cpk})[XX_{cs}-X_{1t}(X-X_{cs})]}{[XX_{cs}-X_{1t}(X-X_{cs})+X_{cpk}(X-X_{cs})]^2+R^2[X_{1t}-X_{cs}-X_{cpk}]^2}=R_o \qquad (5)$$

$$R' = (R^2+X^2)/R \qquad X' = (R^2+X^2)/X \qquad (6)$$

UHF Measurements

Interesting design approach results in test instrument which overcomes problem of transit time and tube reactance without resorting to scarce tube types

practice. If a coaxial diode is employed in a noise generator, some impedance transformer (such as a balun) must be used to change the low and unbalanced diode impedance (usually 50 ohms) to 300 ohms balanced. An additional problem is posed by the fact that many tuners have quite poor noise factors, often in excess of 20 db. This implies that for the noise generator to produce appreciable change in receiver output, the diode should supply its current to the highest possible impedance to attain maximum noise generator output.

With these factors in mind and motivated by the practical problems of coaxial diode procurement and pressure of rapid UHF expansion, the design of an UHF noise generator which could utilize an inexpensive and readily procurable VHF noise diode such as the 5722 was considered. In addition, a relatively large amount of noise power at 300 ohms balanced to ground was felt to be essential.

Transit Time and Inductance

Two major problems appeared in operating the 5722 in the UHF band. Both are typical of conventional tube problems at these frequencies: transit time effects and tube lead inductances become important. Unfortunately, both tend to reduce the noise current output of the diode for a given direct current plate flow. The effects of lead inductances are the most serious; for example, if a resistive load of 300 ohms were simply connected between filament and plate of the diode at 500 MC, almost 60% of the diode noise current would flow through its own interelectrode capacitance due to the fact that the diode lead inductances appear in series with the external load resistor.

A typical solution to this problem which appears hopeful on initial examination is to make the interelectrode capacitance and series lead inductances parts of a transmission line terminated in the desired load resistance. In the case of the 5722, if the transmission line impedance is selected to be 300 ohms, the high capacitance of the tube results in a cutoff frequency for the line of about 200 MC, which is clearly unsatisfactory for use in the UHF band. If, on the other hand, the line impedance is reduced to increase the frequency cutoff point, satisfactory response is not obtained until the line has an impedance of about 160 ohms. This not only reduces the available noise output but requires the use of some impedance transformer to arrive finally at 300 ohms. Consequently, it appeared that some other approach would be more successful.

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It was clear that there was some four-terminal network which, when connected to the diode terminals, would result in the desired diode current in an external load resistance. This would be a network which would also present a resistive load to the diode itself, but not necessarily of the same magnitude as the external resistance. The main disadvantage of such a network would be that it would permit the desired impedance transformation at only one frequency. However, considering the values of loading which would appear in the circuit, the bandwidth would be of the order of several television channels. This approach was adopted and the network was arranged as shown in Fig. 1. In this circuit C_{kp} is the cathode to plate capacitance of the diode, while L_k and L_p are cathode and plate lead inductances. The other constants are unknowns which are determined as follows:

The circuit is reduced by combining C_s (socket and wiring capacitance) and $R + jX$ to form an equivalent impedance Z_1, as in Eq. (1).

Z_1 and the reactance of L_t (the sum of L_k and L_p) can be combined into an impedance. See Eq. (2).

Now, Z_2 and $-jX_{c_{pk}}$ can be combined to form an equivalent impedance across terminals $P-K$, as in Eq. (3).

In order that all the diode noise current will flow in the external resistance, it is desired to make Z_{eq} equal some $R_o + j0$. Therefore the right hand side of Eq. (3) must be rationalized and the real part equated to R_o and the imaginary part to zero. This yields the two simultaneous

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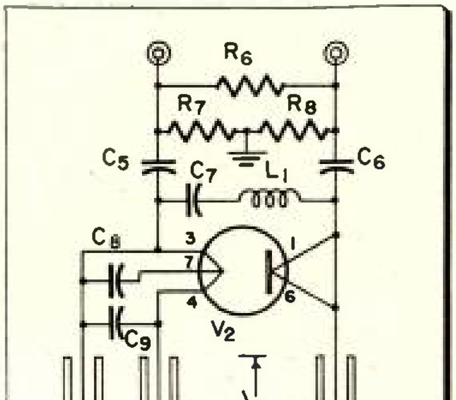

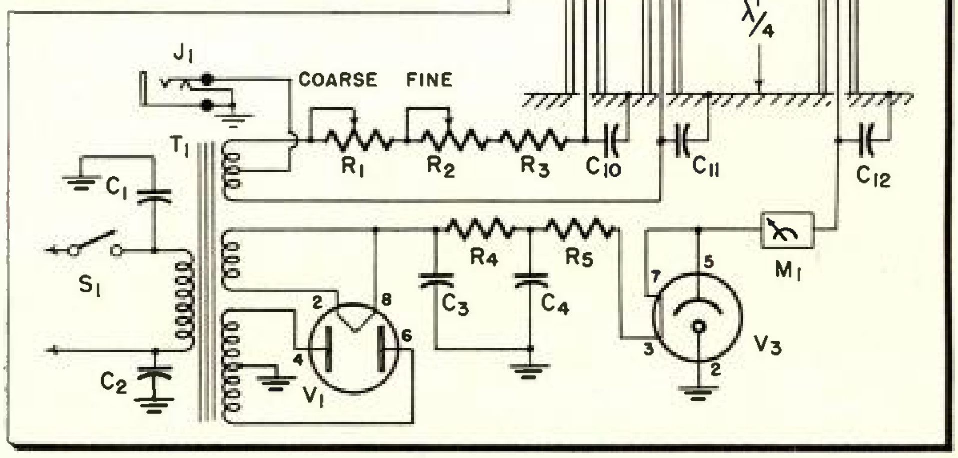

Fig. 2: Complete circuit diagram of generator. Use of good shielding minimizes regeneration

Effective Permeability of

How to design and measure cores with low hysteresis loss. Analysis of effect of dimensions, distributed capacitance, and grounding on coil inductance

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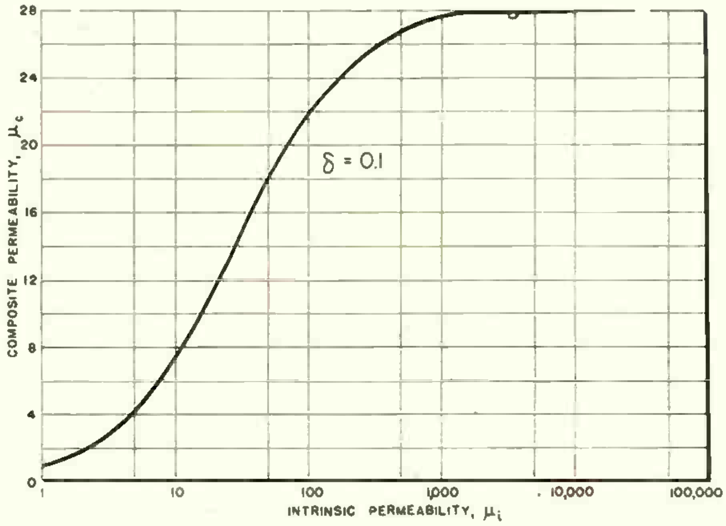


Fig. 1: Curve shows how high intrinsic permeability does little to increase composite permeability beyond the knee

WHEN powdered iron is placed in the magnetic field of an r-f coil, both the inductance and resistance of the coil increase. The Q of the coil may either increase or decrease depending on the relative changes of inductance and resistance. We are only concerned in this paper with the increase of inductance.

The theory of finely divided iron for r-f inductors has been thoroughly treated in the literature[1-4] and will be mentioned only briefly here for the purpose of defining a few of the more important terms.

The permeability of a material is the ratio of β, the flux density in the material, to the magnetizing force, H. Written as an equation, $\mu = \beta/H$. The dimensions are chosen to make the permeability of air unity.

HF Applications

Ferromagnetic materials suitable for high frequency applications are generally alloys of nickel and iron. These materials are distinguished for high permeabilities and unusually low hysteresis loss at low flux densities. When molybdenum is added to the mixture, the eddy current loss is reduced and the initial permeability further increased while retaining a low hysteresis loss.

These alloys are divided into extremely small particles and mixed with an insulating binder before being formed under high pressure. The permeability of the particles is called the intrinsic permeability, μ_i, and of the mixture, the composite permeability, μ_c. For cubic particles of identical size that are uniformly distributed in the binder, Howe[1] has shown the relationship to be

$$\mu_c = \frac{\mu_i - 0.667\delta(\mu_i - 1)}{1 + 0.333\delta(\mu_i - 1)} \quad (1)$$

where δ is the relative volume of the insulating binder

Fig. 1 is a curve plotted from Eq. (1) for a mixture of 90% magnetic alloy and 10% binder (δ=0.1). This is a theoretical guide only; the actual composite permeability of a mixture depends on many factors such as particle configuration and distribution. Fig. 1 serves to show, however, that high values of intrinsic permeability do little to increase composite permeability once the knee of the curve is reached.

Composite Permeability

Composite permeability is gener ally measured by the classical toriodal method. The frequency of measurement is usually 1,000 C.P.S. The value of μ_c for most mixtures can be obtained from core manufacturers.

When cylindrical cores are used to increase the inductance of solenoids, the magnetic flux path consists of both iron and air. The coil functions, therefore, in a medium that has an effective permeability, μ_{ce}, less than the composite permeability of the powdered iron. The effective permeability of a cylindrical iron core may be defined as the ratio of the inductance of a coil, first with, and then without the iron core. The coil in this instance is assumed to be wound of infinitely thin wire on the surface of the core throughout its entire length.

W. J. Polydoroff[2] has shown the effective permeability to be related to the composite permeability as a function of core-length to core-diameter. Polydoroff's curves are reproduced in Figs. 2 and 3. It is interesting to note that unless large ratios of core-length to core-diameter are used, only a small fraction of the composite permeability is realized as effective permeability. Thus we can start with a magnetic alloy whose intrinsic permeability is 200 and a 10% volume of insulation will reduce the composite permeability to 23. Then if we assume the ratio of core length to diameter is unity, the effective permeability will be only about 3.9. Moreover, when the core is used with a coil wound on a form of finite wall thickness, the increase of inductance will be substantially less than 3.9 times that of the coil in air. This last reduction of apparent permeability is due to the difference between core area and mean coil area. In an excellent treatment of the subject, Foster and Newlon[3] developed an equation that relates the effective permeability and the ratio of core to coil diameters to L_i/L_o.

$$L_i/L_o = 1 + \left(\frac{d_i}{d_o}\right)^2 (\mu_e - 1) \quad (2)$$

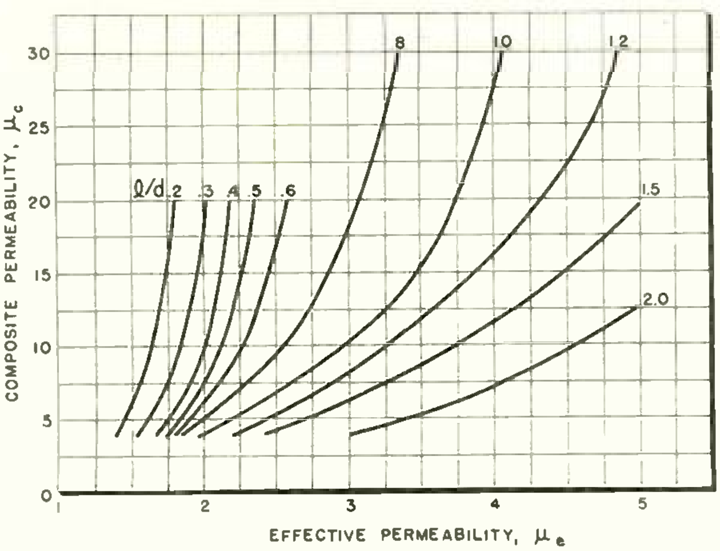
Rearranging to solve for μ_e,

$$\mu_e = \frac{(L_i/L_o) - 1}{(d_i/d_o)^2} + 1 \quad (2a)$$

where L_o=inductance of the coil in air
L_i=inductance of the coil with an iron core (core length=coil length)
d_o=mean diameter of the coil (any units)
d_i=diameter of the core (same units as coil)
and μ_e=effective permeability of the core

Foster and Newlon mention neglecting Nagaoka's constant when they derived this expression. They note, however, that if the geometry of the coil is not changed when the core is added to the coil, the equation yields satisfactory results. Thus,

Cylindrical Iron Cores



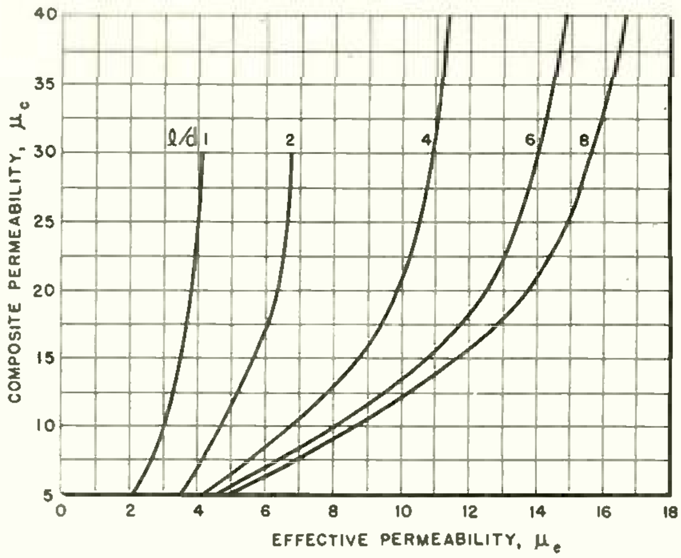


Fig. 2: (l) Relation of effective to composite permeability as a function of core length to diameter. Fig. 3: (r) Same curves for high values

if two coils of identical length but different diameters are compared with the same core, Eq. (2) can be used to predict the change in the L_1/L_o ratio with good agreement. Fig. 4 shows a comparison between measured and calculated values of inductance using Eq. (2) for five coils of different diameters.

Q-Meter Measurement

The L_1/L_o ratio for a given coil can be measured on a Q-Meter without actually computing the values of inductance. From the general equation for series resonance,

$$L_o = 1/(2\pi f)^2 C_1$$

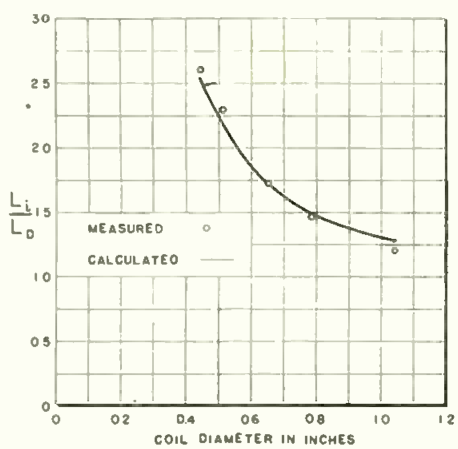
$$\text{and } L_i = 1/(2\pi f)^2 C_2$$

Taking the ratio L_1/L_o by dividing the second equation by the first,

$$L_i/L_o = C_1/C_2$$

Thus, the ratio of L_1/L_o may be found by simply taking the ratio of Q capacitance required to resonate the coil for both conditions, i.e., without and with the core, respectively.

Fig. 4: Comparison between measured and calculated values of inductance for five coils

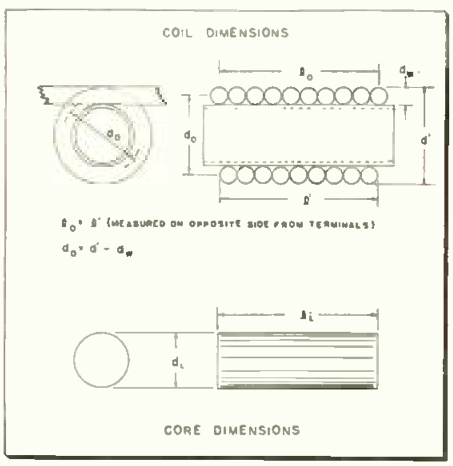


In many cases the length of a sample iron core may differ from the length of the core required in a final design. Similarly, the coil used to test the iron may be longer or shorter than the finished coil. Other equations are obviously needed to compensate for the change in Nagaoka's constant when coils and cores of various lengths are compared.

Polydoroff[2] has described a suitable method of doing this whereby the effective permeability of a cylindrical iron core whose length is equal to the length of the test coil is called effective permeability, μ_e. Polydoroff denotes the effective permeability of longer cores as μ'_e. In this paper the method is expanded and μ'_e will be used for effective permeabilities of cores which are either longer or shorter than the test core used to determine μ_e.

Having once established the effective permeability, μ_e, of a test core,

Fig. 5: Drawings show how dimensions of solenoid coils and cylindrical cores are made



there are four physical changes other than coil diameter that can alter the L_1/L_o ratio. They are:

(I) Using the test coil[5] with a longer core (see Eq. 3)
(II) Using the test coil with a shorter core (see Eq. 4)
(III) Using the test core with a longer coil (see Eq. 5)
(IV) Using the test core with a shorter coil

An equation was empirically developed by Polydoroff for condition (I) which relates μ'_e to μ_e.

$$\mu_e' = \mu_e \sqrt[3]{\frac{\text{core length}}{\text{coil length}}}$$

In a series of measurements made by the writer, better agreement was obtained however, by decreasing the value of the root in Polydoroff's expression from 3 to 1.8. Hence,

$$\text{(I)} \quad \mu_e' = \mu_e \sqrt[1.8]{\frac{\text{core length}}{\text{coil length}}} \qquad (3)$$

As a close approximation, a root value of 2.0 can be used. The results are reasonably good and the square root is easier to handle.

Second Equation Developed

On the basis of the measurements mentioned above, a second equation was empirically developed for condition (II). Thus, when the core is shorter than the coil,

$$\text{(II)} \quad \mu_e' = \mu_e \sqrt[1.14]{\frac{\text{core length}}{\text{coil length}}} \qquad (4)$$

Eq. (4) may be approximated with a root of unity.

An empirical equation was also developed for condition (III).

$$\text{(III)} \quad \mu_e' = \mu_e \sqrt[4]{\frac{\text{core length}}{\text{coil length}}} \qquad (5)$$

Unfortunately, when the coil

length is made less than the length of the test core, the relationship between μ'_e and μ_e can not be explained with a simple expression.

To calculate the ratio of L_1/L_0 for the three conditions considered above, the values of μ'_e for each particular case must be substituted in Eq. (2). Example measurements for these and other conditions appear later.

In Fig. 5 are two drawings showing how the dimensions of solenoid coils and cylindrical iron cores are obtained.

The effective permeability of powdered iron cores is not constant with frequency. Although the variations are not usually extreme, they are sometimes important to design engineers. Several curves of effective permeability plotted against frequency are presented in Fig. 6. These curves are representative and show that permeability is constant in the low frequency region but varies at the higher frequencies. Therefore, when iron cores are assigned for use at high frequencies, their properties should be measured at those frequencies. Precautions for high frequency measurements should be observed, of course, and the usual Q-Meter corrections made in their proper order.[3,6,7]

These variations of permeability are sometimes neglected with consequent design errors. Surprisingly enough, high frequency effects can influence the low frequency measurement of iron cores. Consider the case of a coil (and its core) with sufficient distributed capacitance to affect the true measurement of inductance and effective permeability at low frequencies. To calculate the true properties of both the coil and core from the measured values, the distributed capacitance of the coil must be measured with and without its core and correction equations applied accordingly.

Measurement with Core Inserted

The measurement of this capacitance with the core inserted in the coil usually requires excitation of the coil and core at the natural resonant frequency of the coil, viz., the frequency at which the distributed capacitance resonates with the inductance of the coil. If this occurs at a frequency where the effective permeability of the core is at variance with its low frequency value, the inductance that resonates with the distributed capacitance will differ from the inductance measured at low frequencies. What inductance, then, can be used to compute distributed capacitance? Erroneous results obtain if the low frequency inductance is used and certainly the inductance of the coil can not be measured at its natural resonant frequency.

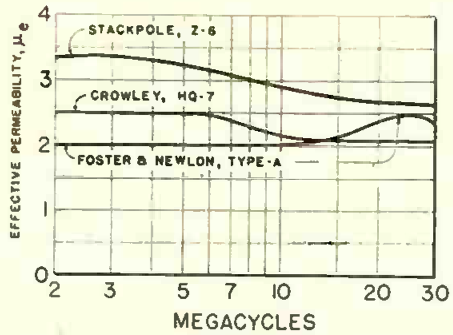
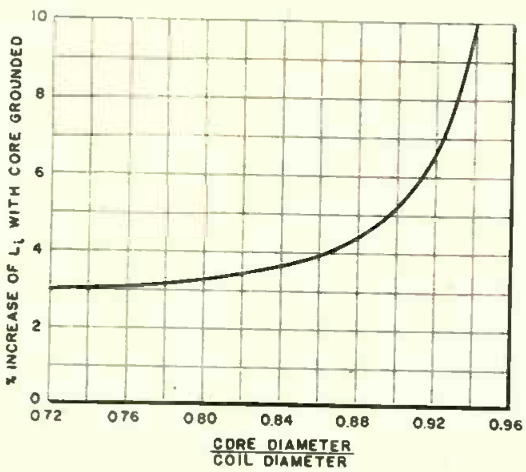


Fig. 6: Permeability-frequency characteristics

In practice, the change of permeability is often overlooked and the effective permeability is calculated on the basis of low frequency inductance measurements. Fortunately, this procedure is generally acceptable for two reasons: 1) the change in permeability is normally of a low order of magnitude, and 2) the resultant error after final corrections are made for distributed capacitance is considerably less than the error produced by the change in permeability, viz., say the measured inductance of a coil with 5 μμf of distributed capacitance equals 150 μh. If the tuning capacitance is 100 μμf the true inductance is 143 μh (150 μh x 100/105). Now assume the distributed capacitance has been incorrectly measured (because of a change of effective permeability at high frequencies) as 4 μμf (a 20% error). The true inductance would have been calculated as 144 μh; an error of less than 1%.



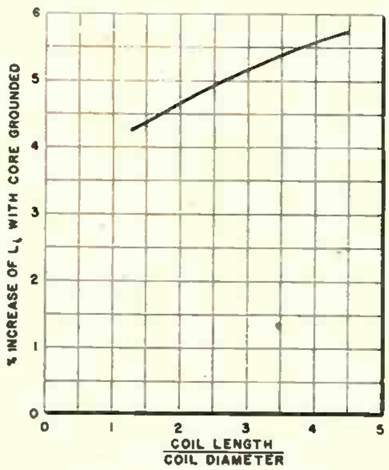
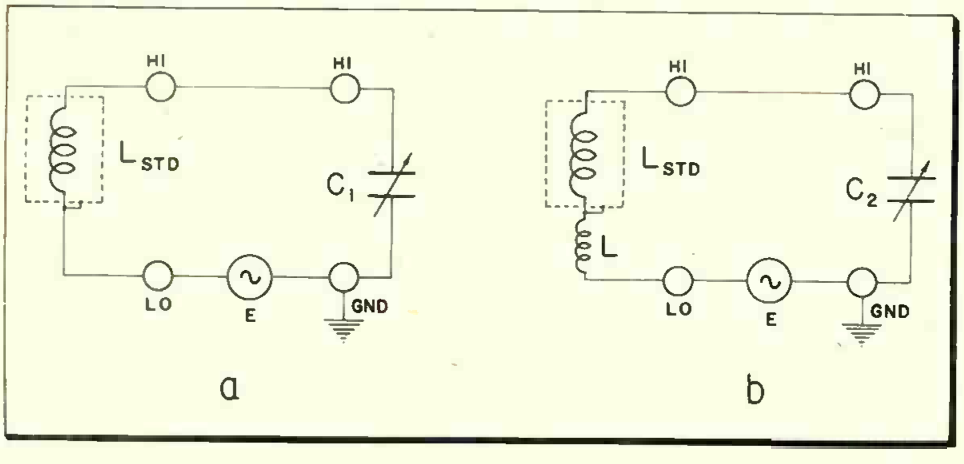


Fig. 7: (l) Coil's apparent inductance when core is grounded. Fig. 8: (r) Curves for high ratios

Fig. 9: Q circuit for measuring coil L. Unknown is inserted in series with standard, C varied



Exact Measurement Procedure

However, when exact measurements of distributed capacitance are needed, the inductance of a coil at its natural resonant frequency may be determined by measuring the effective permeability of the core at this frequency with the aid of another coil—one that will tune with the core in question at the required frequency in the Q circuit. This test coil should preferably have the same mean diameter and length as the original coil. If the dimensions differ, corrections must be made using appropriate equations from those previously given, i.e., Eqs. (2) through (5). The high frequency inductance

(*Continued on page* 170)

Page from an Engineer's Notebook

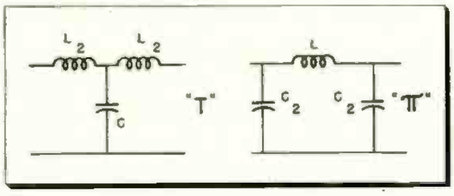
No. 24 — Filter Element Nomographs

By RALPH DAVIDSON, Dynamic Electronics, P.O. Box 188, Forest Hills, N.Y.

THE following nomographs were developed to provide a fast and accurate method for calculating the reactive elements of a high-pass or low-pass constant "K" type filter. These values can also be used in determining reactive elements for "M" type filters by substituting in the appropriate formulas. The frequency ranges of the nomographs are practical for nearly any constant "K" type filter problem in the audio and radio frequencies.

These nomographs solve the following formulas:

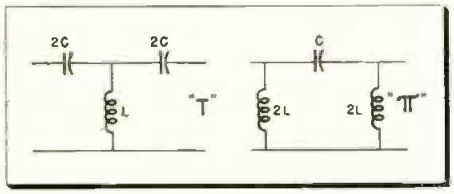
Low-Pass Constant "K" type:



$$C_k = \frac{1}{\pi f_c Z_0} \qquad L_k = \frac{Z_0}{\pi f_c}$$

where C_k is the shunt capacitance
L_k is the series inductance
f_c is the cut-off frequency
Z_0 is the characteristic impedance

High-Pass Constant "K" type:



$$C_k = \frac{1}{4\pi f_c Z_0} \qquad L_k = \frac{Z_0}{4\pi f_c}$$

where C_k is the series capacitance
L_k is the shunt inductance
f_c is the cut-off frequency
Z_0 is the characteristic impedance

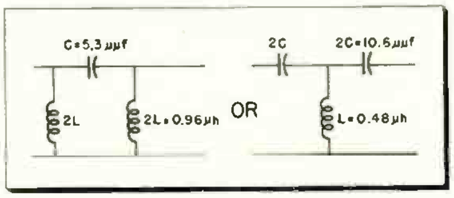
The two nomographs on the next page cover the following frequencies and constant "K" filter types for characteristic impedances of 10 ohms to 100 K:

1. High-pass filter, 1 MC to 10 KMC.
2. Low-pass filter, 1MC to 10 KMC.

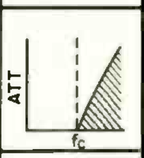
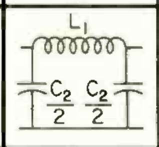
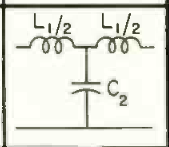
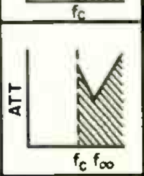
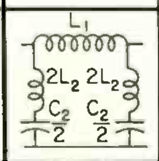
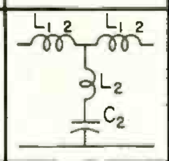
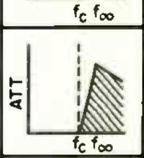
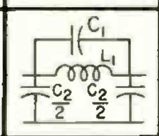
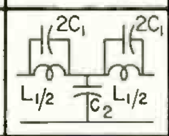
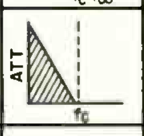
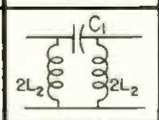
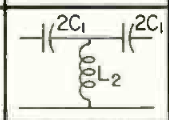
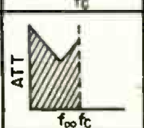
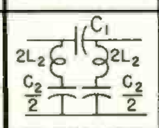
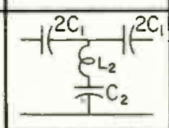
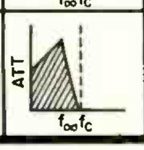
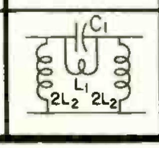
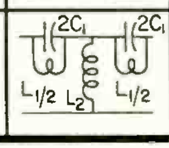
It will be demonstrated how these frequency scales may be extended to cover the entire spectrum.

How to Use Nomographs

For example, suppose a high-pass filter is needed to remove all interfering signals below 50 MC from a TV receiver with 300-ohm input impedance. Turning to Nomograph 1, a line is drawn from 50 MC, the "critical freq. for capacity" on the extreme right scale, to 300 ohms on the left "characteristic impedance" scale. The desired capacitance is where this line crosses the "series capacity" scale, in this case 5.3 μf. Similarly, by drawing a line from 300 ohms to the "critical freq. for inductance" scale at the right, the shunt inductance value of 0.48 μh is obtained from the left-center scale. Combining these reactive elements in a "π" or "T" structure results in the following filter:

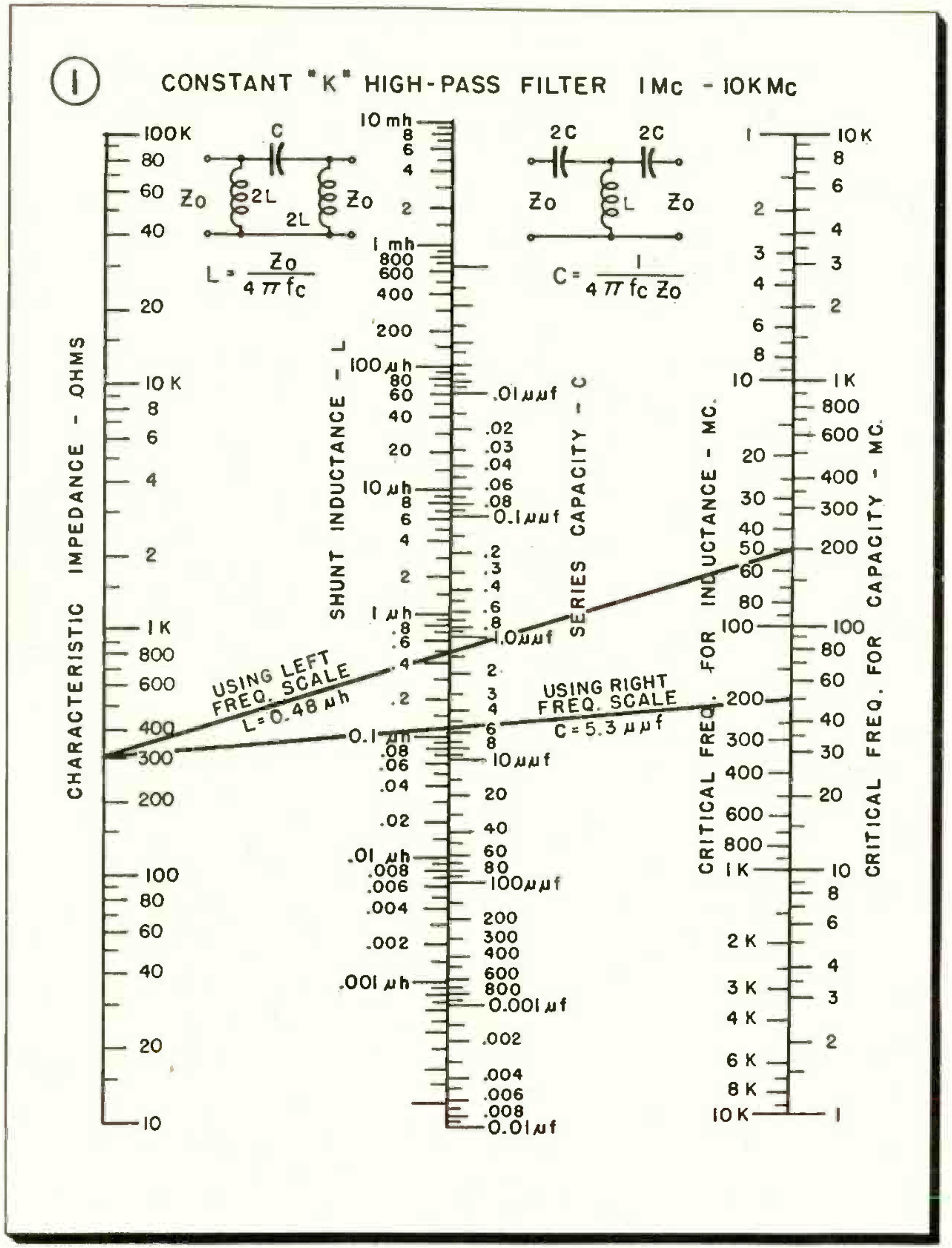


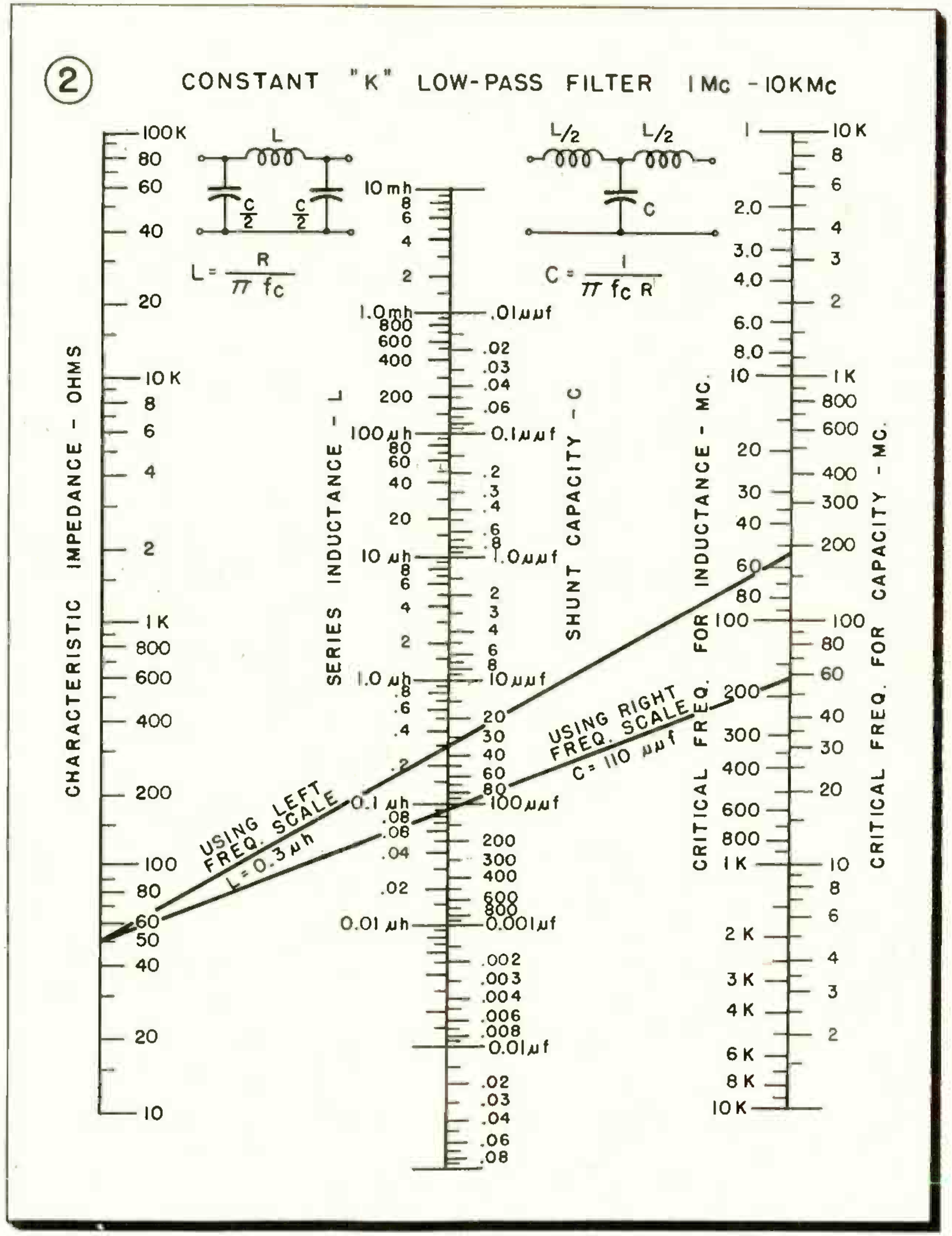
(*Continued on page 157*)
NOMOGRAPHS ARE ON NEXT PAGE →

TYPE	REQUIRED CHAR.	STRUCTURE π	STRUCTURE T	ELEMENT CONSTANTS C_1	L_1	C_2	L_2	CHARACTERISTIC POINTS PASSBAND Z_0	f_∞	f_c	$\frac{f_\infty}{f_c}$
"K"					$\frac{Z_0}{\pi f_c}$ — L_K —	$\frac{1}{\pi f_c Z_0}$ — C_K —		$\sqrt{\frac{L_1}{C_2}}$	∞	$\frac{1}{\pi\sqrt{L_1 C_2}}$	∞
"m_1"					mL_K	mC_K	$\frac{1-m^2}{4m}L_K$	$\sqrt{\frac{L_1}{C_2}}$	$\frac{1}{2\pi\sqrt{L_2C_2}}$	$\frac{1}{\pi\sqrt{C_2(L_1+4L_2)}}$	$\sqrt{1+\frac{L_1}{4L_2}}$
"m_2"				$\frac{1-m^2}{4m}C_K$	mL_K	mC_K		$\sqrt{\frac{L_1}{C_2}}$	$\frac{1}{2\pi\sqrt{L_1C_1}}$	$\frac{1}{\pi\sqrt{L_1(C_2+4C_1)}}$	$\sqrt{1+\frac{C_2}{4C_1}}$
"K"				$\frac{1}{4\pi f_c Z_0}$ — C_K —			$\frac{Z_0}{4\pi f_c}$ — L_K —	$\sqrt{\frac{L_2}{C_1}}$	0	$\frac{1}{4\pi\sqrt{L_2C_1}}$	∞
"m_1"				$\frac{C_K}{m}$		$\frac{4m}{1-m^2}C_K$	$\frac{L_K}{m}$	$\sqrt{\frac{L_2}{C_1}}$	$\frac{1}{2\pi\sqrt{L_2C_2}}$	$\frac{1}{4\pi}\sqrt{\frac{1}{L_2C_1}+\frac{4}{L_2C_2}}$	$\sqrt{1+\frac{C}{4C_1}}$
"m_2"				$\frac{C_K}{m}$	$\frac{4m}{1-m^2}L_K$		$\frac{L_K}{m}$	$\sqrt{\frac{L_2}{C_1}}$	$\frac{1}{2\pi\sqrt{L_1C_1}}$	$\frac{1}{4\pi}\sqrt{\frac{1}{L_2C_2}+\frac{4}{L_1C_1}}$	$\sqrt{1+\frac{L_1}{4L_2}}$

High-Pass and Low-Pass Constant "K" Filter Nomographs

(See previous page for instructions on use and method of extending frequency range)

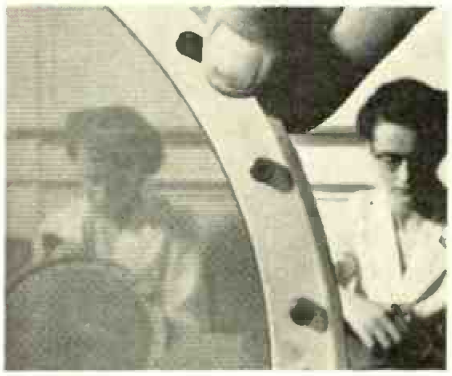




Manufacturing Color TV Tubes

Start-to-finish production operations for making RCA tricolor kinescopes in plant at Lancaster, Penna. Three-gun type 15GP22, now available to manufacturers of home receivers, employs electrostatic focusing and magnetic deflection

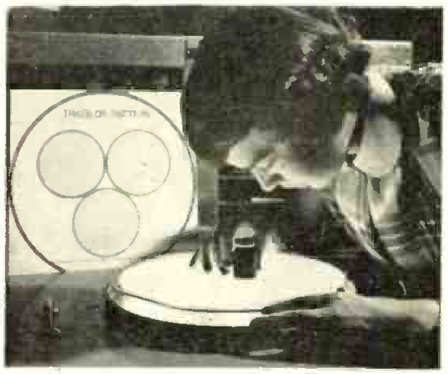
1 Glass negative of shadow mask undergoes inspection. Negative is required to produce gelatin stencil for dot placement on screen



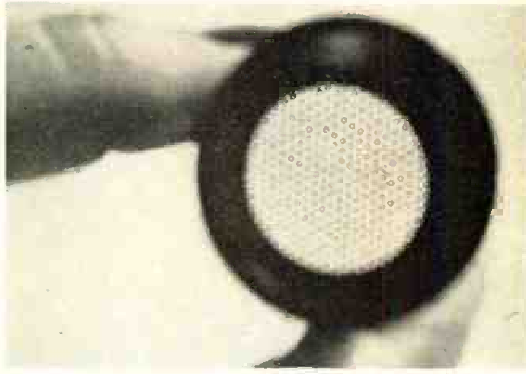
2 Shadow mask containing 200,000 microscopic holes permits electron beam from red, green and blue guns to strike phosphor

3 Quality control inspection of shadow mask (r) assures that specifications are met. Tube's 15-in. faceplate (l) is also checked

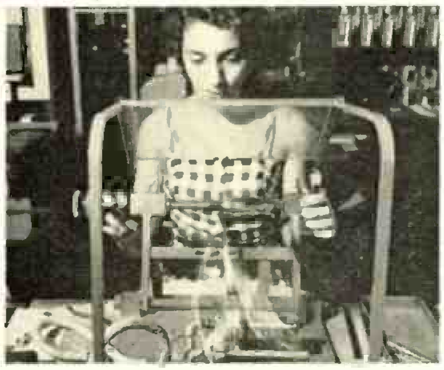
4 Phosphor material of whipped cream consistency is silk screened through gelatin stencil and deposited as dots on plate



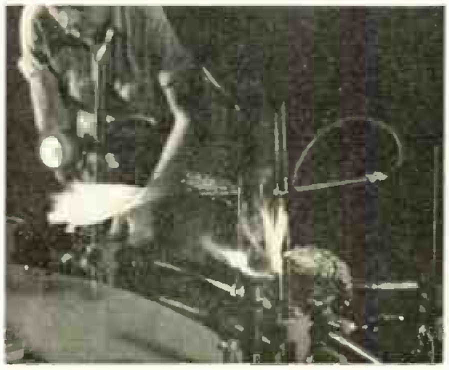
5 Color-dot structure on phosphor glass plate is carefully inspected by technician. Accurate spacing assures correct "angle shot"



6 Color-dot pattern as seen through magnifying lens. The 600,000 dots are arranged in triangular groups, each group containing RGB



7 Parts of tricolor electron gun are assembled on a jig and lowered into flame-covered bed which allows simultaneous joining



8 Tri-barrel electron gun is sealed into the neck of 26⅛ in. long picture tube. Each gun activates one of the three phosphors

9 Shielded by a welding mask, technician joins faceplate section of color TV picture tube to main cone, providing rugged air seal

10 Tricolor tubes await their turn for a trip through the exhaust machine. This provides vacuum same as black-and-white tubes

11 As part of rigid quality control, tube is placed under leak test to check effectiveness of vacuum seal at the welded joint

12 Toward end of the production line tubes undergo test for phosphor-dot brightness in electronically controlled testing machine

Curve-Tracer Test Set

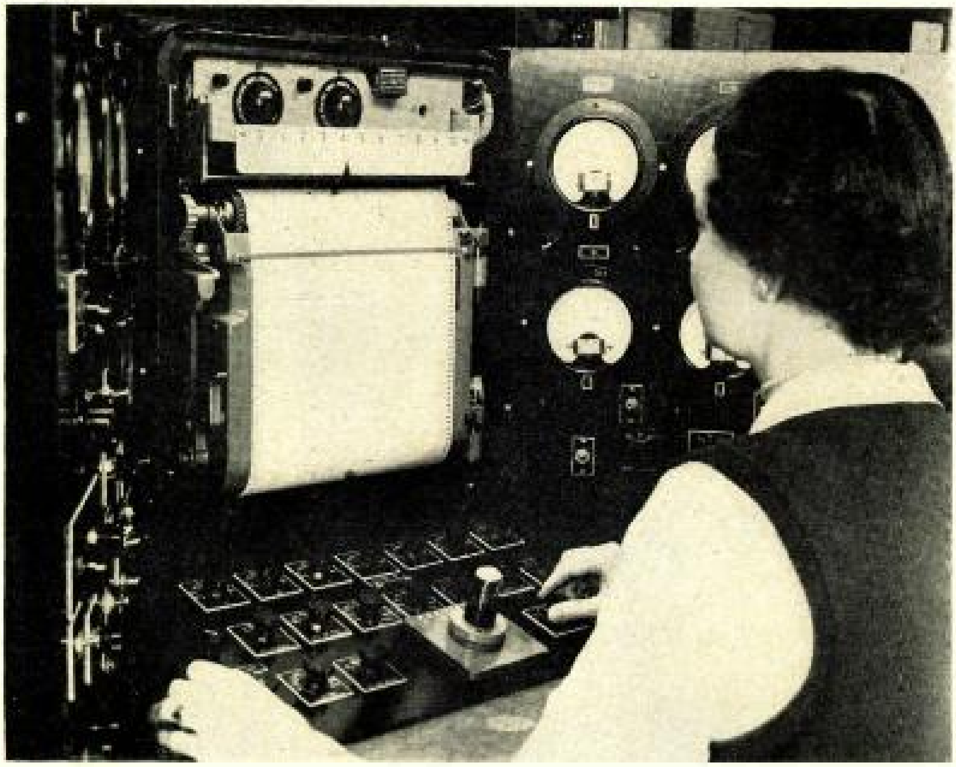


Fig. 1: Operator at controls of curve-tracer set observes tube characteristic curves being recorded

By ELMER H. NIEHAUS
Tube Dept., General Electric Co.
Owensboro, Kentucky

A Curve-Tracer Test Set has been developed, employing an X-Y recorder, for the rapid and accurate plotting of vacuum tube characteristics. In the past, characteristic curves were obtained by taking point-by-point data throughout the range of the curves. These points were then plotted on graph paper and the curves drawn. This method was very time consuming and involved errors in interpolating meter readings and transferring the readings to graph paper. There was also the possibility that the characteristics of the tube would actually change, due to excessive heating or slumping, in the process of taking data.

Another technique that has been commonly employed in obtaining characteristic curves is the oscillographic method. Curves can be obtained more rapidly with the oscillographic method than they can be obtained on a point-by-point basis, but greater errors are involved in transferring the curve to graph paper because of the small scale and relatively large trace.

With the Curve-Tracer Test Set (Fig. 1) it is possible to plot and record any current against any voltage applied to a tube and plate resistance or transconductance against any voltage or current. A chopping arrangement in the grid circuit permits the recording of characteristics in regions where plate or grid dissipation is excessive. The tube can be set up, and a complete plate family of curves recorded at 1% accuracy within five minutes. Other curves and families of curves can be made with equal rapidity.

Current & Voltage Ranges

Ten voltage ranges are provided in the set ranging from 5 v. full scale to 1000 v. full scale. Eight current ranges are provided which range from 500 µa full scale to 100 ma full scale. When the chopping circuit is used, the current ranges are multiplied by the factor of ten. The transconductance measuring circuit has five ranges which vary from 2,500 to 50,000 micromhos full scale, and the plate resistance measuring circuit has five ranges which vary from 5,000 to 100,000 ohms full scale.

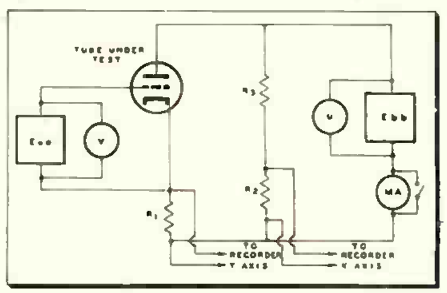
The recorder used in the test set is the Leeds and Northrup Speedomax Type G, X-Y Recorder. It has a full scale sensitivity on each axis of 10 mv, and the chart size is 100 sq. in. The recorder is an accurate instrument with excellent retracing capabilities. After many successive full-scale reversals the chart paper returns to within ±0.3% of its original position. The chart paper can be torn from the roll and copies made by ordinary duplicating methods.

One of the most important uses of the set has been the recording of curves to be used for published data. The set is frequently used by the tube engineer in designing a new product because complete characteristic curves convey more information than a number of point checks. The investigation of customer complaints is expedited by recording complete characteristics which often show whether the fault is in the tube. Another useful application of the Curve-Tracer Test Set is recording characteristics of vacuum tube circuits which can be built in an adapter. The curves of any number of tubes can be recorded on the same sheet of chart paper to show the spread in characteristics or the average of the characteristics.

Basic Circuit

Probably the simplest characteristic curves to record are triode current characteristics with negative bias and within plate dissipation limits. The basic circuit used in recording these simple characteristics is shown in Fig. 2. The circuit as shown would be used to record triode plate characteristics with E_{bb} continuously variable and E_{cc} variable in steps. R_2 and R_3 form a voltage divider of a ratio such that there will be ten

Fig. 2: Basic circuit used with the recorder



for Vacuum Tubes

Recently developed instrument does away with point-by-point plotting. Complete family of curves are recorded within five minutes at 1% accuracy

millivolts across R_2 when E_{bb} is at the desired full scale value. Ten millivolts across R_2 will produce full scale deflection on the recorder X axis. R_1 is of such a value that the current desired for full scale deflection on the recorder Y axis will produce a voltage drop of 10 mv across it. The plate family of curves is recorded by successively varying E_{bb} from zero to full scale for different values of the parameter E_{cc}. A plate transfer family of curves could be made by changing the divider, R_2 and R_3, to the supply E_{cc} and then successively varying E_{cc} from zero to full scale for different values of the parameter E_{bb}. The milliammeter shown in the plate circuit is for monitorial purposes and is shorted out when the curves are recorded.

Sweep Circuit

In order to make smooth curves some method was needed to vary E_{bb} or E_{cc} continuously. The sweep circuit (Fig. 3) was devised as a method to vary, at a controllable uniform rate, the output voltage of a regulated power supply. A voltage is developed between the points A and B. The magnitude of the voltage AB is determined by the bias on the tube V_1. When the sweep switch S_3 is in the return position, the bias on V_1 is set by the potentiometer P_1. When S_3 is in the sweep position the bias on V_1 increases as the capacitor C charges. The charging rate of C is determined by the variable resistor R_1.

The power supply output voltage is proportional to the voltage AB which is applied to the power supply error amplifier tube V_2 by the sweep select switch S_1. The sweep select makes it possible to use the power supply with or without the sweep circuit, and the addition of more sections and positions to the switch would make it possible to use the sweep circuit on more than one supply. The sweep direction switch S_2 allows the power supply output to be varied in an either increasing or decreasing direction. The sweep circuit produces a smooth change in regulated power supply voltage over a range of from 0 to 1 v. or 0 to 1000 v., and the rate of change can be adjusted to suit the curve being plotted.

Characteristic curves with positive-grid bias or with dissipation above maximum limits are frequently desired. The chopper makes it possible to record these curves without damaging the tube under test.

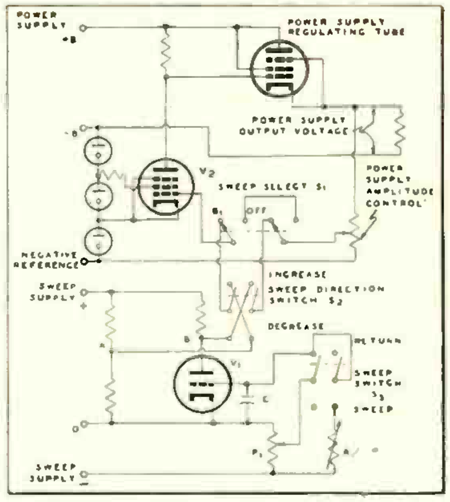


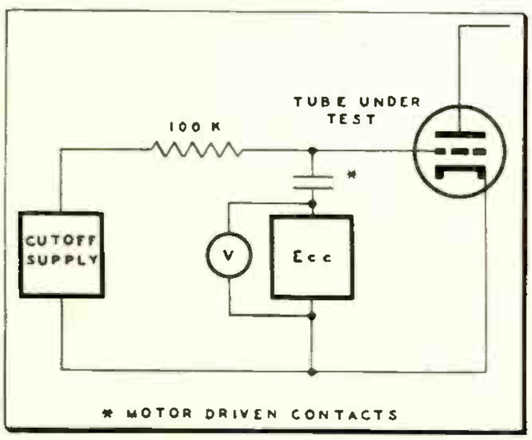
Fig. 3: Sweep circuit varies output voltage of regulated power supply at a uniform rate

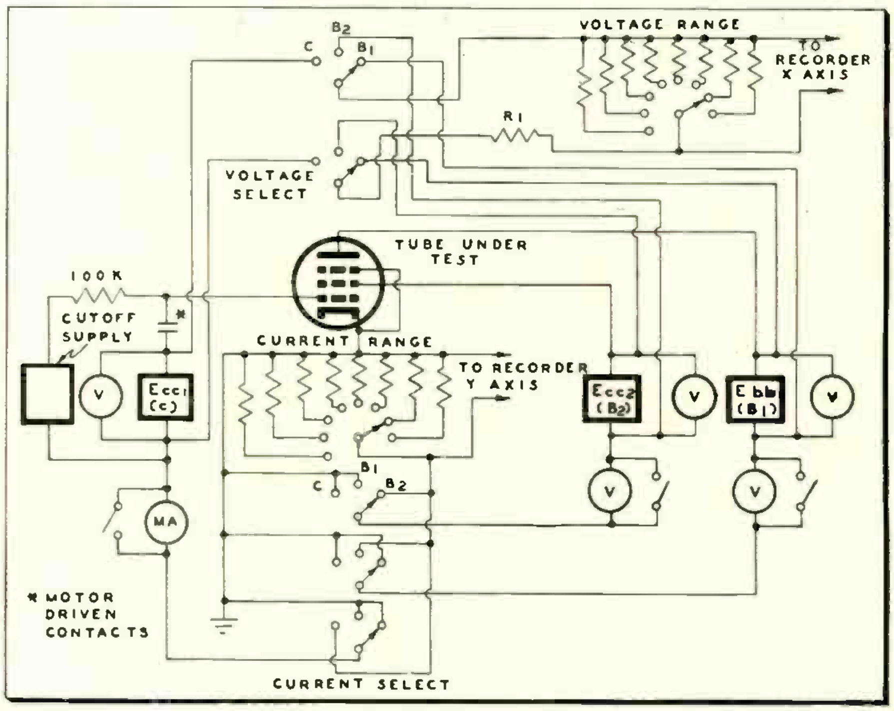
The chopper is located in the grid circuit as shown in Fig. 4 and consists of a set of contacts which are cam-driven by a synchronous motor. The contacts are adjusted to be closed ten percent of each revolution. When the contacts are open, the cutoff supply biases the tube under test beyond cutoff. When the contacts are closed, the cutoff voltage appears across the 100 K resistor. (the E_{cc} supply has a very low output impedance), and the voltage E_{cc} is applied to the tube. The tube under test is conducting 10% of the time and cutoff 90% of the time. Therefore, the average current and the average dissipation are 10% of their normal values.

A calibrating circuit for the chopper is provided in the set. A switch connected the contacts a milliammeter, and a precision resistor all in series with E_{cc}. The contacts are set so the milliammeter reads ten per-

Fig. 4: (l) Chopper located grid circuit consists of a set of contacts which are cam-driven by a motor

Fig. 5: (r) Circuit for plotting vacuum tube characteristics contains voltage select switch which connects power supply voltage to a voltage divider





cent of the current calculated from E_{cc} and the resistance of the circuit.

The essential requirements in power supplies and switches for plotting static characteristics are shown in Fig. 5. The voltage select switch connects the power supply voltage to be recorded to a voltage divider formed by R_1 and the voltage range switch. The ratio of the divider is changed by the voltage range switch making several different full scale ranges available. The current select switch connects one side of the supply from which the current to be recorded is drawn to the current range switch. One side of all other supplies is connected to ground by the current select switch. Several different current ranges are made available by various size resistors on the switch. Current meters are provided monitorial purposes and are shorted when the curves are recorded. To record curves without using the chopper the contacts are shorted and the cutoff supply removed.

A voltage divider circuit was developed to facilitate making curves in families with some parameter changing in equal increments. A dc voltage is inserted in the grid circuit of the error amplifier tube of a power supply in the same manner as the sweep voltage (Fig. 3). When the dc voltage is divided in equal increments, the regulated power supply voltage will also be divided in equal increments. This circuit increases the speed with which curves can be made, particularly when curves are being made on more than one tube.

Transconductance Measuring Circuit

The transconductance measuring circuit was derived from the constant current equivalent circuit of an amplifier. See Fig. 6.

If $R_L << r_p$,

then $E_o = g_m e_g R_L$ (1)

and $K = E_o/e_g = g_m R_L$ (2)

Eq. (2) shows for a constant load (R_L), the voltage amplification of an amplifier is directly proportional to transconductance when R_L is much smaller than r_p.

In the transconductance measuring circuit shown in Fig. 7, the tube under test is in the circuit as an amplifier with a small load resistor. The 1000 CPS oscillator output is amplified and coupled to the tube under test by an output transformer with a five-ohm secondary. The low impedance drive is used to prevent errors when the tube under test is near zero bias. The output voltage, which appears across the load resistor R_L and is proportional to transconductance, is amplified, rectified, and applied to the recorder.

Facilitating Calibration

For ease in calibration the circuit was designed so that a gain of unity in the tube under test would give full-scale deflection on the recorder. Therefore, the full-scale range is determined by the load resistor R_L. As an example:

From Eq. (2):

For a full scale range of 5000 micromhos

$$R_L = \frac{K}{g_m} = \frac{1}{5{,}000 \times 10^{-6}} = 200 \text{ ohms}$$

For 10,000 micromhos full scale

$$R_L = \frac{K}{g_m} = \frac{1}{10{,}000 \times 10^{-6}} = 100 \text{ ohms}$$

The circuit is calibrated by connecting point A to point A (Fig. 7) and adjusting the output of the rectifier to full-scale deflection on the recorder.

Transconductance curves can be made with approximately ±2% accuracy. The shunting effect of the plant resistance of the tube under test causes an error of approximately 1% at the maximum value of transconductance. This error can be reduced by increasing the load resistor (R_L) by 0.5%.

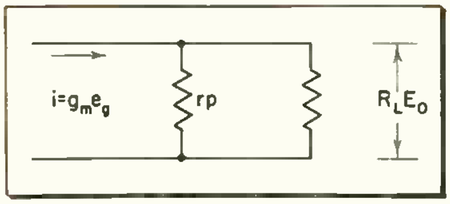


Fig. 6: Amplifier constant current equivalent

Plate Resistance Circuit

Plate resistance, by definition, is the slope of a curve of plate voltage versus plate current.

$$r_p = \Delta E_p / \Delta I_p \quad (3)$$

If ΔI_p is held constant, then

$$r_p = k(\Delta E_p) \quad (4)$$

where k is a constant of proportionality. The plate resistance measuring circuit shown in Fig. 8 uses this relation to measure plate resistance continuously as bias voltage or plate supply voltage is varied.

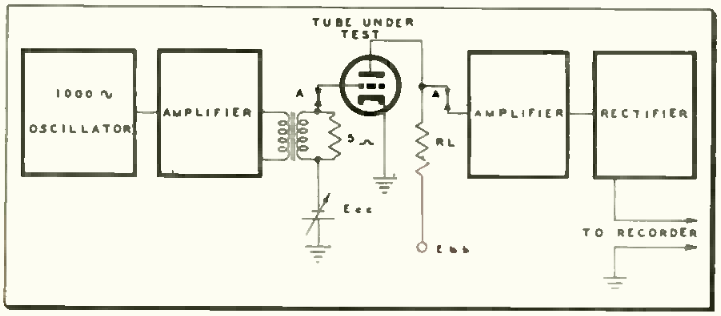
A voltage, proportional to ΔI_p, is developed across the resistor R. This voltage is amplified by the feedback amplifier and then rectified. The output of the rectifier is applied in series with the reference battery to the variable gain amplifier as bias. The output of the oscillator is amplified by the variable gain amplifier, further amplified and transformer-coupled to the tube under test circuit. A change in ΔI_p is reflected to the variable gain amplifier which corrects the drive to hold ΔI_p constant. Therefore, the drive is proportional to plate resistance. A voltage proportional to the driving voltage is amplified, rectified, and applied to the recorder.

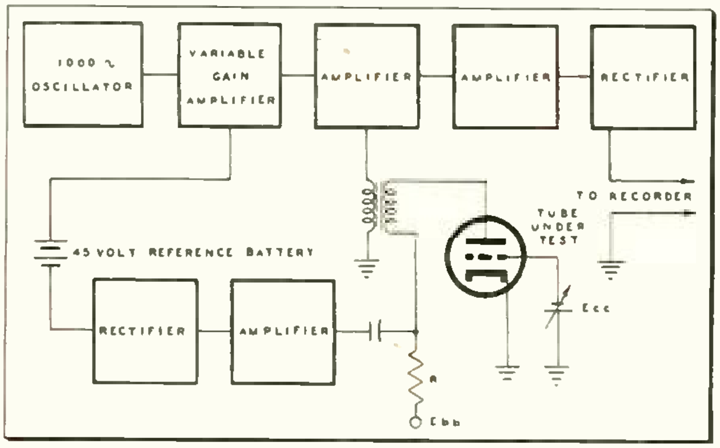
Calibration of the circuit is accomplished by substituting a precision resistor for the tube under test and adjusting the voltage applied to the recorder. Full-scale ranges are changed by changing the resistor R.

Curves of plate resistance can be made to ±2% accuracy on all ranges up to 100,000 ohms. Above 100,000 ohms, capacitive currents become appreciable and impose a limit on the circuit.

(*Continued on page 169*)

Fig. 7: (l) Tube under test acts as amplifier in transconductance measuring circuit. Fig. 8: (r) Plate resistance measurement





Self-Shielding PM Focus Units

Elimination of stray fields is big step forward in obtaining best results with 90° deflection tubes. Advantages include reduced raster rotation and higher drive efficiency

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and

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A MAJOR limitation on the use of the conventional PM focus unit lies in the stray fields from these devices. Cathode-ray tubes requiring 70° deflection systems can use a conventional type of PM focus unit with a fair degree of success. However, in the case of the 90° deflection tube, the errors recognized and considered tolerable in the 70° tube can no longer be accepted.

The most pronounced effect of this stray field is seen in the initial rotation of the deflection yoke to compensate for the raster rotation due to the stray field from the PM unit. To a large degree this initial rotation has not been considered serious in the 70° tube. However, in addition to the initial rotation, the 90° tube also shows an appreciable amount of raster rotation as the strength of the focus unit is varied in focusing the picture. In a conventional PM unit this total rotation may be of the order of 13° as the flux is changed from maximum to minimum. This is of course undesirable.

Local Nonlinearity

Another effect in the 90° tube and its associated deflection system is noted. Where the yoke is operating at very high peak flux densities this stray field can react with the field from the yoke windings so that there can be a local nonlinearity in both the vertical and horizontal sweep. Also, in the case of the yoke for the 90° tube, this stray field can cause a decrease in drive efficiency due to interaction with the yoke fields. The decrease in horizontal drive efficiency can be of the order of 2%.

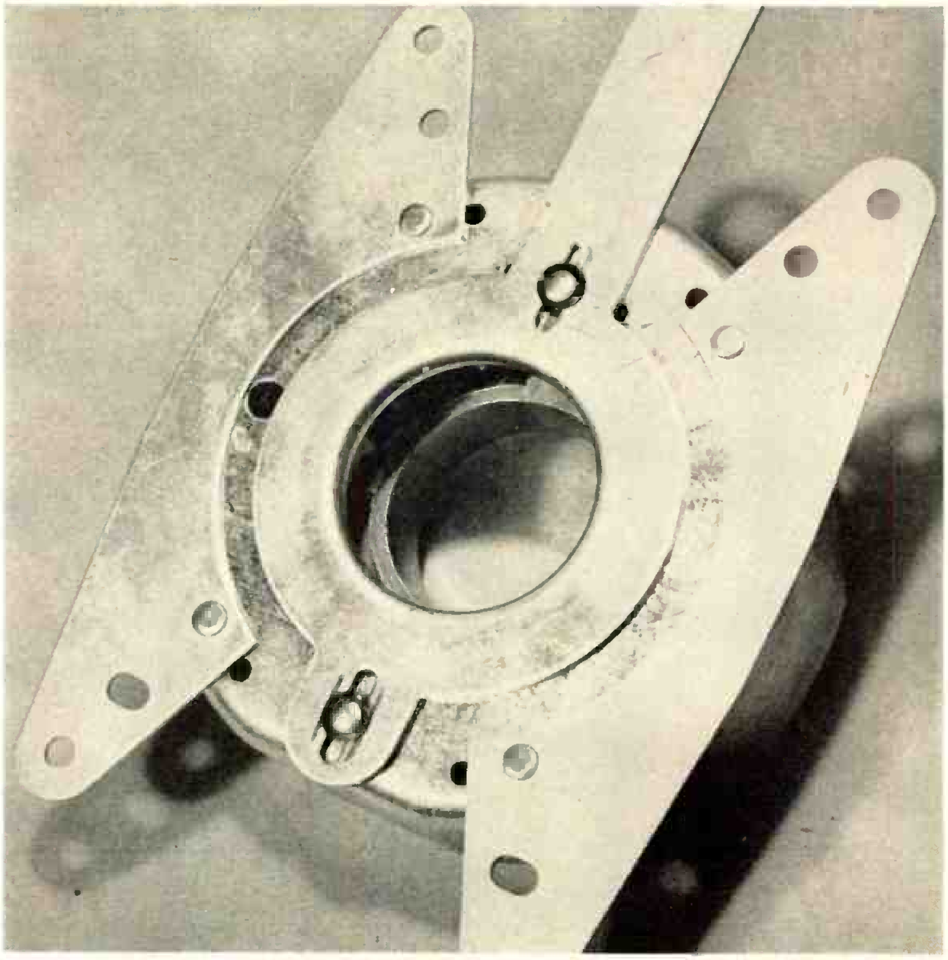
In addition to the raster rotation as the flux is varied, it is found that the same rotation occurs with variations in beam accelerating voltage due to changes in line voltage. This rotation of the raster as the unit is focused or as the line voltage varies is not satisfactorily solved by initially correcting the yoke rotation for the position of focus at nominal line. If it is assumed that the focus unit will not be changed from a given factory setting there still remains the problem of line voltage variation in the home producing an undesirable tilt of the raster which changes with the line variation. When pincushion correctors are used it is seen that any deviation from the original position of the raster from the position at which the pincushion correction magnets were adjusted will cause distortions of the raster shape.

The conventional PM unit design wherein the magnets are axially positioned, inefficiently utilizes the available magnet material. Because of this, larger magnets are needed and the focus unit must be as close to the face of the tube as possible in order to make the unit seemingly stronger. Generally, in this position the area of picture in focus is appreciably less than full screen with the best of deflection yokes.

It has been known for some time that if the magnetic lens producing focus is placed in the same relative position with respect to the crossover of the gun as is the focusing anode of the electrostatic tube, the area in focus on the face of the tube in each case is the same but with the magnetic focus being superior, particularly at higher beam currents. Since the power of the axial type PM unit is limited, it has not been economically feasible to do this in the past, and consequently the ES tube has enjoyed an unwarranted reputation for having full focus attributes not possible with the magnetic tube.

The above problems and limitations of the conventional PM unit led to the development of the self-

Fig. 1: Production model of self-shielding PM focus unit



shielding PM focus unit. A photograph of a production unit is shown in Figs. 1 and 2. As will be seen from the photographs, the basic arrangement of the magnetic circuit is quite different from the conventional or axial type PM unit. In this new unit the magnets are placed radially with respect to the axis of the neck of the tube. This allows one pole piece used to produce the focusing gap to be in the shape of a cup. Because of this structure, and also proper choice of material, the stray field forward is greatly minimized.

Yoke Not Rotated

With this new unit the deflection yoke is no longer rotated in order to square away the picture. The magnetic vertical of the deflection yoke is now at almost right angles to the picture vertical. Also it follows that the picture does not rotate as the unit is brought to and through focus nor as the line voltage varies. Due again to the construction, it is found that the focus unit is fairly efficient in its magnet use, and with 5 oz. of Alnico 5, focus on a 27-in. tube can be reached at 23.5 kv with proper picture brightness.

Fig. 3 shows the focus range available from production units. This data is based upon the focus unit being positioned at approximately 1-3/32 in. from the front edge of the G_1 anode which is used instead of the crossover as a reference point for the object distance. This position is not too critical and may be varied appreciably either side in receiver production. This position is chosen because at this point, with a reasonable tube and reasonable deflection yoke, full focus over the entire face of the 90° tube is achieved.

The rotational orientation of these units has been found to be completely uncritical, indicating that the main focus field and the stray field are symmetrical. This is demonstrated by providing a mount for the focus unit that will hold it positioned in a lateral direction, but leave it free to rotate about the neck of the tube. Generally a piece of cardboard sleeving is adequate. After the tube has been focused, the unit can be rotated through a full 360° without any particular change in the quality of the focus.

The unit also shows good focus quality as a function of line voltage. When focused at about the center of line voltage, focus will hold to a high degree over the line voltage range of 108 to 122 rms. This is a rather interesting effect since it is believed that this comes about more due to the position of the unit on the neck of the tube than to the small stray field and symmetrical stray field.

Centering is provided in the usual manner by a slide pole incorporated as part of the cup forming the front pole piece. While centering of the order of 4½ in. is available in the horizontal direction it may be proper to again caution against using systems that require excessive amounts of centering correction. In addition

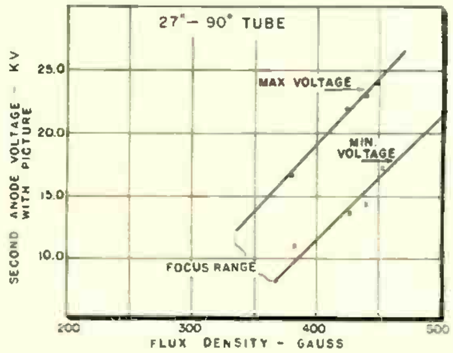


Fig. 3: Focus range available with unit positioned 1 3/32 in. from edge of G_1 anode

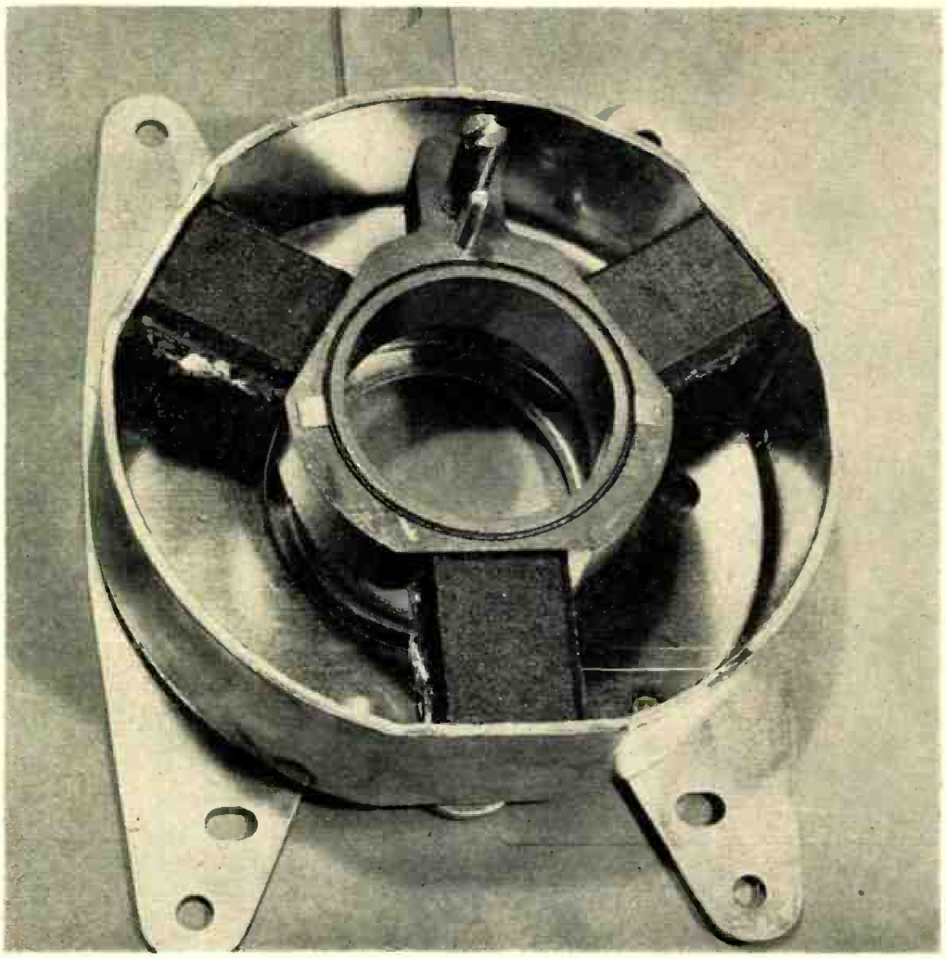
to dot distortions that are produced, excessive centering causes raster line bends in the same manner that is found when the beam bender is incorrectly positioned in its rotational adjustment. The causes for this are identical because in each case there has been too great a misalignment between the various lens axes.

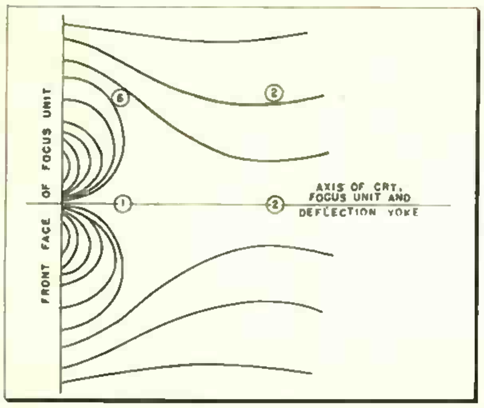
Stray Fields Toward Screen

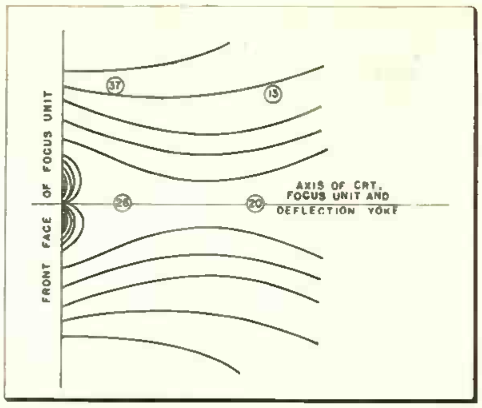
The stray fields toward the screen of the picture tube are shown in Figs. 4 and 5 for the self-shielding focus unit and a typical axial magnet type respectively. It has been determined that the field that strays 1 in. or 2 in. from the front face of the focus unit and returns to the center of the unit which is essential for focusing does not cause raster rotation. This is true since the velocity vector of the beam is in the same direction as the field. The stray flux still further from the face of the focus unit looks similar in shape for both units but are much different in magnitude. The self-shielding unit in Fig. 4 has only 10% to 20% as much stray as the conventional unit.

Fig. 6 shows the effect of the magnetic core material of the deflection yoke on the stray magnetic field. Note that the lines of force become somewhat more parallel to the axis

Fig. 2: Magnets are placed radially with respect to axis of tube neck in new PM focus unit







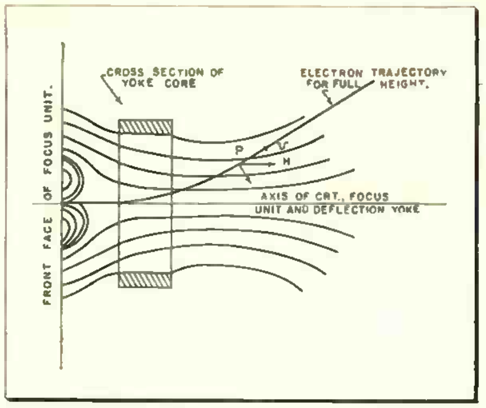


Fig. 4: (l) Flux plot of self-shielding focus unit with radial magnets. Field intensity in gauss shown by circled number. Fig. 5: (c) Flux plot of typical PM focus unit with axial magnets. Fig. 6: (r) Field and electron trajectory using typical axial magnetic focus unit

of the system due to the core material of the yoke.

By making a few simplifying assumptions, the order of the magnitude of the raster rotation can be computed. In Fig. 6 the electron trajectory for the beam to the top center of the picture is shown assuming no rotation of the raster. The movement of the top center of the raster will be determined and from that the angular rotation of the picture may be calculated.

In Fig. 4, it is shown that the angle

(*Continued on page* 156)

System for Making 3-D Vectorcardiograms

To study the third dimensional vectorcardiogram it has usually been necessary to record vectorcardiograms in at least two planes and then construct a third dimensional one in the form of a wire model. Now the Department of Physiology and Biophysics of the University of Mississippi, under the chairmanship of Dr. Arthur C. Guyton, has developed and is using a stereovectorcardiograph for instantaneous registration of third dimensional vectorcardiograms.

As shown in the accompanying diagram, Fig. 1, the stereovectorcardiographic apparatus utilizes a 5-in. cathode-ray tube with two beams, on left and right of the screen. Cardiographic impulses picked up by electrodes A, B, C, and D control the electron beam passing between deflection plates 1, 2, 3, and 4, and record vectorcardiogram I. Similarly, vectorcardiogram II is recorded from plane A, B, C, and E, with electron beam controlled by deflection plates 5, 6, 7, and 8. Two vectorcardiograms are thus recorded simultaneously on the oscilloscopic screen from two separate planes angled at each other at approximately 10° to 15°. An observer viewing vectorcardiograms I and II with left and right eye respectively and fusing the images appropriately thus gets the third dimensional effect.

A sawtooth time signal, to time the vectorcardiogram and to determine the direction of impulse, is applied to the Z axis of both beams simultaneously, giving each pip a comet-like appearance, with the impulse moving toward the comet's head.

The stereovectorcardiogram can be viewed either by direct observation or by photographing the images, to obtain the third-dimensional effect. Best fusion in direct observation is by means of glasses with approximately plus[7] diopters strength. An oscillographic camera can photograph single heart cycles, and at the Univ. of Mississippi laboratory a Polaroid-Land camera is used, so that positive prints can be developed in one minute's time.

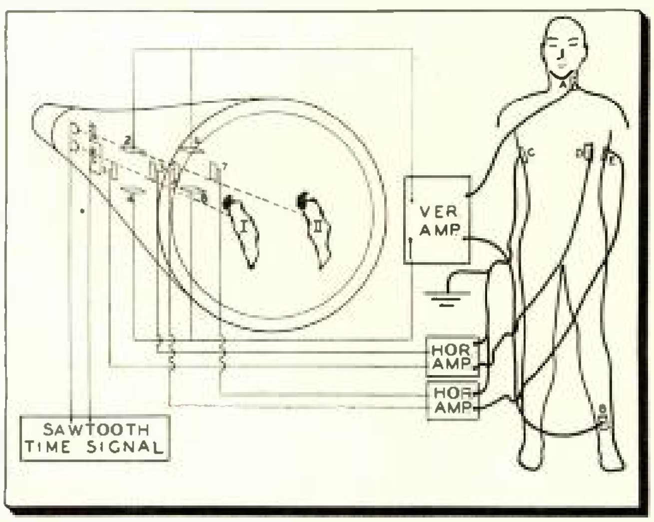
Fusing Images

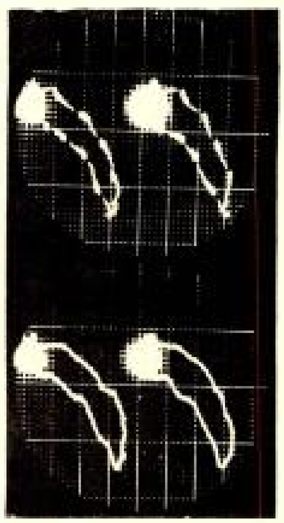
Actual stereovectorcardiograms from a normal individual are shown in Fig. 2, the top one with a sawtooth time signal, the lower without. With practice an observer can learn to fuse images to see a central third dimensional vectorcardiogram, either with the naked eye or with the benefit of special optical aids.

Included in the apparatus described is a DuMont Type 322 dual beam oscilloscope, and three low-frequency amplifiers, for use as vertical amplifier and two horizontal amplifiers. Placement of electrodes A, B, and C is not critical, but slight shifting of electrodes D and E can change the vectorcardiograms tremendously. As standard procedure in this particular apparatus, electrode D is placed directly over the apex of the heart, and electrode E is placed in the midaxillary line.

A second method of recording the stereovectorcardiogram is to use a single-beam oscilloscope tube and to employ a switch between the two horizontal amplifiers and the oscilloscope so that the electron beam is split every 1/2000 of a second. Thus, first a portion of vectorcardiogram I is generated, then a portion of II, then a further portion of I, and so on.

Fig. 1: (l) Apparatus employs dual-beam CRT. Fig. 2: (r) Recorded stereovectorcardiograms





High-Efficiency AM Radiation

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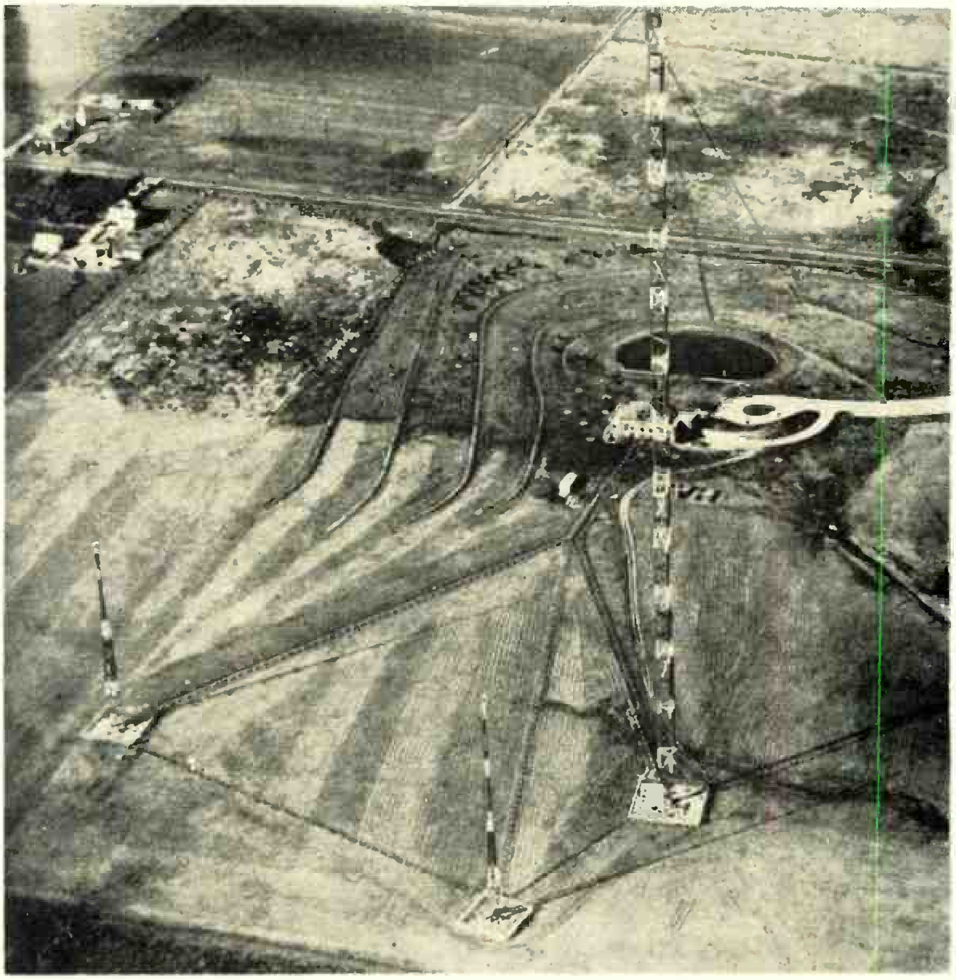


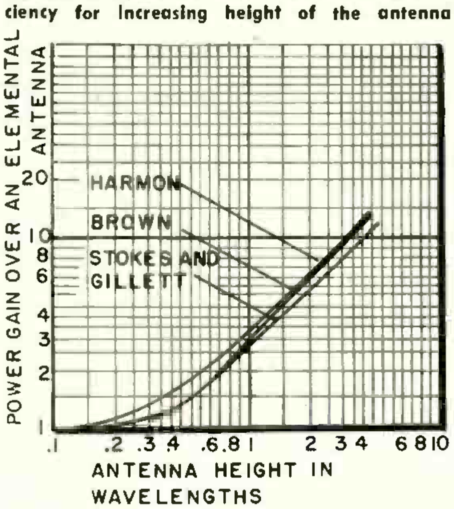
Fig. 2: Three-tower directional antenna system of station WKY, Oklahoma City, Okla.

WHILE any height antenna may be used as an AM radiator, we are all familiar with the increased radiation efficiency and the reduction in fading that results from increasing the antenna height from a quarter-wave length to around 0.6 wave length. However, it apparently is not so generally known that a continuing proportionate increase in radiation efficiency with a corresponding reduction in skywave radiation and fading can be effected for almost any height antenna above the 0.6 wave length.

The basic theory for this was developed independently at about the same time by Mr. Ralph Harmon of Westinghouse and KDKA, Mr Howard Stokes and the author, and Dr. Brown of RCA. Mr. Harmon had developed his theories so that in the Spring of 1933 it was possible to conduct a series of tests at KDKA using a balloon to support a multiple section antenna several wave lengths in height.[1] Our own work started at about the same time, and in 1933 Mr. Howard Stokes, then of the CAA, kindly offered to help in the development of the mathematical theory. The results of our work were never published. Dr. Brown's theoretical study of the various possible permutations of high efficiency antennas was reported in 1936.[2]

The results of these various computations for the increase of radiation efficiency with antenna height are shown in Fig. 1. On this logarithmic chart there has been plotted the antenna gain in the horizontal plane for the various antenna heights, all referred to an elemental antenna with a radiation efficiency of 186 mv/m for 1 kw as a base. The values calculated by Mr Harmon are for a continuous uniform current and, therefore, represent the maximum theoretical possible. The values developed by Mr. Stokes and myself are for a series of quarter-wave sections, whereas the data for Dr. Brown's paper is based on the use of a series of half-wave antennas. None of the curves are linear until a height in excess of a half-wave length is reached. Each shows that thereafter the antenna gain increases with approximately the 0.9 power of the antenna height.

Fig. 1: Computed increase of radiation efficiency for increasing height of the antenna



Increased Efficiency

Fundamentally, these antennas get their increased radiation efficiency in the horizontal plane because they operate as a vertical broadside antenna array focusing the energy in the horizontal plane. As the height is increased, the aperture of the antenna as an array is increased so that a larger and larger percentage of the total energy radiated can be focused in the horizontal plane.

Of notable interest is the high tower at WKY, Oklahoma City, Okla., together with the two quarter-wave towers comprising the reflectors for the directive antenna which is used only at night. See Fig. 2. The main tower is 969 ft. high insulated at the base and at 425 ft. above the base. Fig. 3 shows the base and the means of bringing down the concentric line which feeds the TV and FM antennas at the top, so that they can be used as a center conductor and the tower as the outside shield of a concentric line for tuning the impedance of each section. The use of this type of tuning gives a very high Q circuit which has proven to be extremely stable in operation.

This tower has a physical height of approximately 310° which is a bit higher than is necessary, because the additional height was desired for support of the FM and TV antennas. However, the measurements show that we were able for 1 kw in-

from High Television Towers

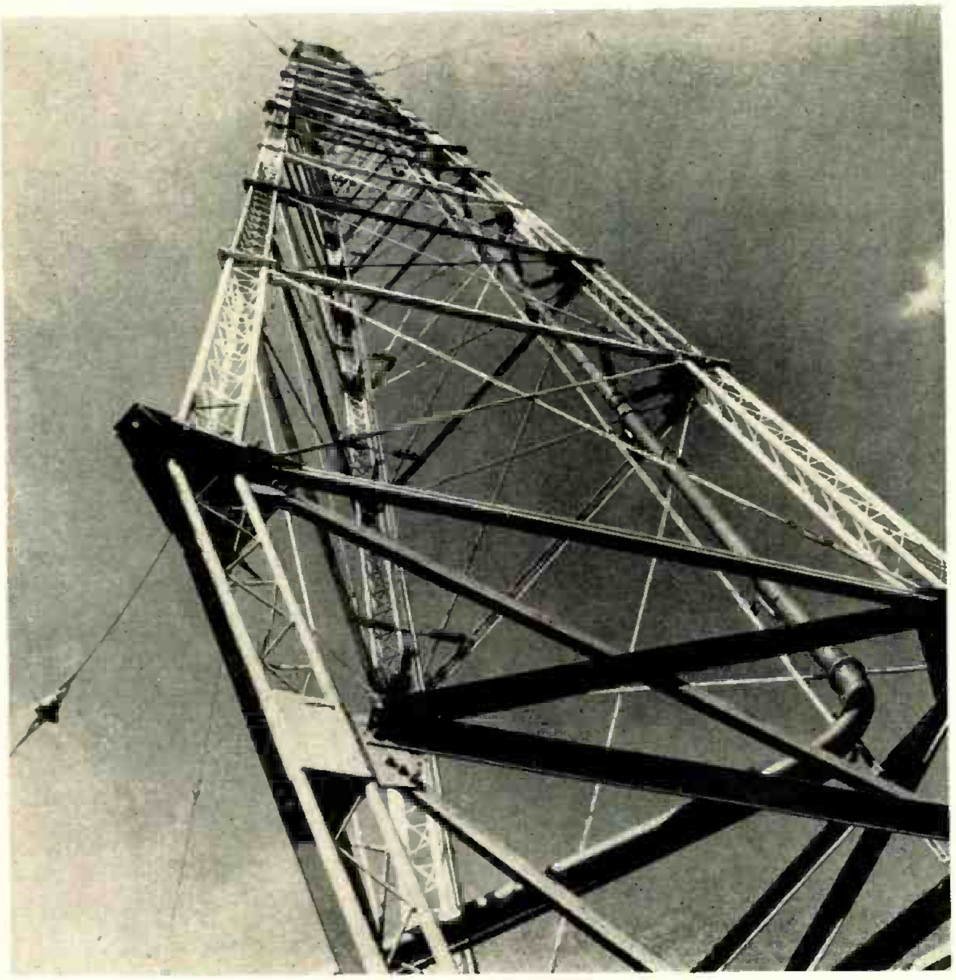


Fig. 3: Base view of WKY's Franklin antenna shows lines feeding TV and FM radiators at top

Reduced skywave radiation and fading effected with antennas above 0.6 wavelength. Small capital expenditure achieves substantial increase in service area

put to get a horizontal field equivalent to 301 mv/m at 1 mile. This value was measured at 3 miles since the field does not get oriented properly in 1 mile.

This value is typical of what can be obtained from a two-unit Franklin antenna from 285° to 310° in physical height. This is equivalent to an effective power gain of 2.4, or 12 kw for 5 kw input. For a four-unit Franklin about 540° in physical height, the effective power gain is 4, or 20 kw for 5 kw input, and 200 kw for 50 kw input. For a six-unit Franklin, which represents perhaps the probable maximum since it corresponds to 1500 ft. at 1500 kc, the power gain is 6. This is the equivalent of 300 kw effective for 50 kw input, or 6 megawatts radiated for 1 megawatt input. These are very substantial gains indeed.

While we had no difficulty adjusting or operating the high tower with the two quarter-wave towers as a directive array at night, there are problems involved which must be considered with some care. We found at WKY that the existence of one of the two quarter-wave reflecting towers of the array at a distance of only 82.5° from the high tower upset slightly the current distribution in the big tower, so that the radiation efficiency of the tower and hence the array was slightly less than had been computed on the basis of the radiation efficiency of each of the three elements operating alone. The actual measured nighttime RMS field was found to be about 5% less than that which had been computed. However, this was not enough to make any substantial difference in the vertical radiation patterns of the high tower, and the measured vertical radiation patterns were in close agreement with the computed as will be shown later.

At WKY the use of the high tower added nearly 300,000 people to their daytime service area, while at the same time increasing by more than 50% the signal strength which would have been received by the people who would have been served from their old station using the quarter-wave antenna. The use of the high tower also allowed similar proportionate gains in the nighttime service.

Directive Characteristics

It is interesting to note that the use of such a high tower in conjunction with much lower towers as reflectors permits the design of a directive antenna which, in many cases, can radiate several times as much power along the ground without causing interference to nearby stations on the same frequency as could be done if all the towers were of low height, or even if all the towers of the array were Franklins. Thus, at WKY, in the case of WTAD at Quincy, Ill., which is but 453 miles away, it was possible to radiate approximately 250 mv/m on the ground without causing anything like the amount of interference to WTAD that had resulted from the station's previous operation with 1 kw with 190 mv/m radiated from a quarter-wave antenna. Actually, the use of the high tower with the two low towers permitted a design which provided a complete null at an angle of only 15° above the horizon even though there were 245 mv/m radiated along the ground. The vertical radiation pattern in the direction of WTAD was measured from an airplane and is shown in Fig. 4 together with the theoretical. More recently, this firm has designed for use in Europe two more of these high efficiency antennas similar to that installed at WKY and which were also used as parts of directive antennas. One of these has been completed, and the measured efficiency has been found to agree very closely with that predicted. The other one, due to circumstances not connected with the design, has not yet been built.

There are a very considerable number of antennas projected for the support of TV antennas with heights of 1000 ft. or more. Many of these

Continued on page 184)

Application of Integrator Type

Radio direction finding equipment shows up to 16 db signal-to-noise ratio improvement with use of signal integration and positive feedback. Rotating capacitor drum and magnetic storage systems employed

By CHARLES A. STROM, JR. & JOSEPH A. FANTONI
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INFORMATION theory studies made during and shortly after World War II indicated that repetitive type signals might be greatly enhanced by trading bandwidth for time. An analysis of the output voltage of a radio Direction Finding system indicated that the Direction Finding voltages fall into this category and that considerable improvement in the Direction Finding bearing S/N ratio might be achieved by proper operation on the information or output voltage. Such operation, if successful, would go a long way in improving the operational sensitivity of the Direction Finding equipment and permit useable Direction Finding bearings on any signal that could be heard by a radio communications station.

While the work done shortly after World War II indicated that both correlation techniques and integration techniques would enable great improvements in S/N ratios, the post detector integration technique was selected for the Direction Finding studies because of the greater apparent simplicity of the associated equipment. Also, this approach appeared to offer some advantages in simplicity of operation and greater stability. The objective of the study at the Rome Air Development Center (started at Watson Laboratories, Red Bank, N. J.) was to investigate some of the possible methods of accomplishing a field type unit which would be useable with existing Direction Finding Equipments and to develop a technique which would be available for use in new Direction Finding equipment. To further simplify the problem, it was assumed that the signals received by the Direction Finding station would be from a friendly transmitter and would be of sufficient duration to permit good use of the integration technique. Signals, such as these transmitted from an aircraft under tower or GCI surveillance were assumed as the normal type transmission.

S/N Improvement

Before proceeding with a description of the post detector integration approaches investigated, it might be well to briefly review the S/N improvement by integration techniques and redefine the terms used throughout this paper.

First, assume a Direction Finding antenna in azimuth at a constant

Fig. 1: Signal enhancement unit used with direction fiinder

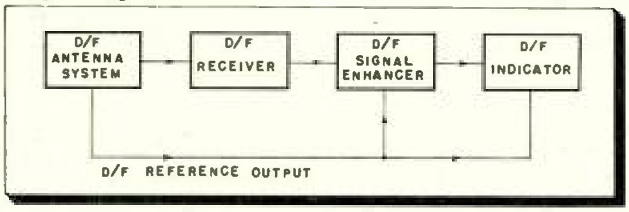


Fig. 2: Delay line enhancer delays and adds desired signal

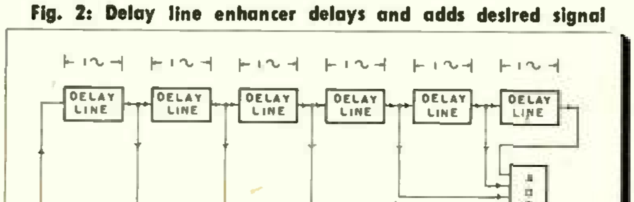


Fig. 3: Integration with magnetic storage drum and playback

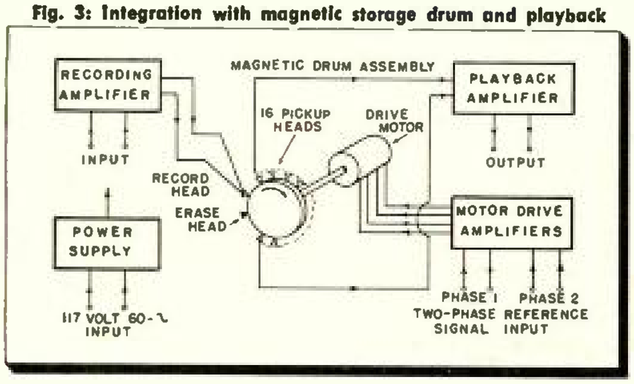
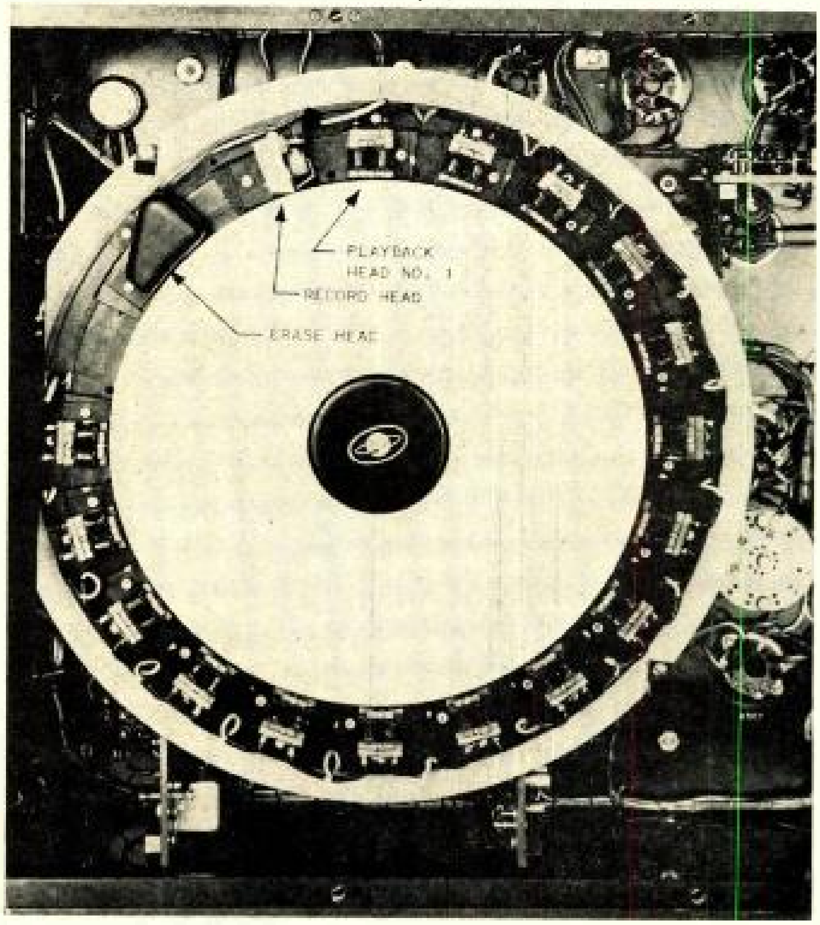


Fig. 4: Magnetic storage drum and playback, record and erase heads



Signal Enhancers

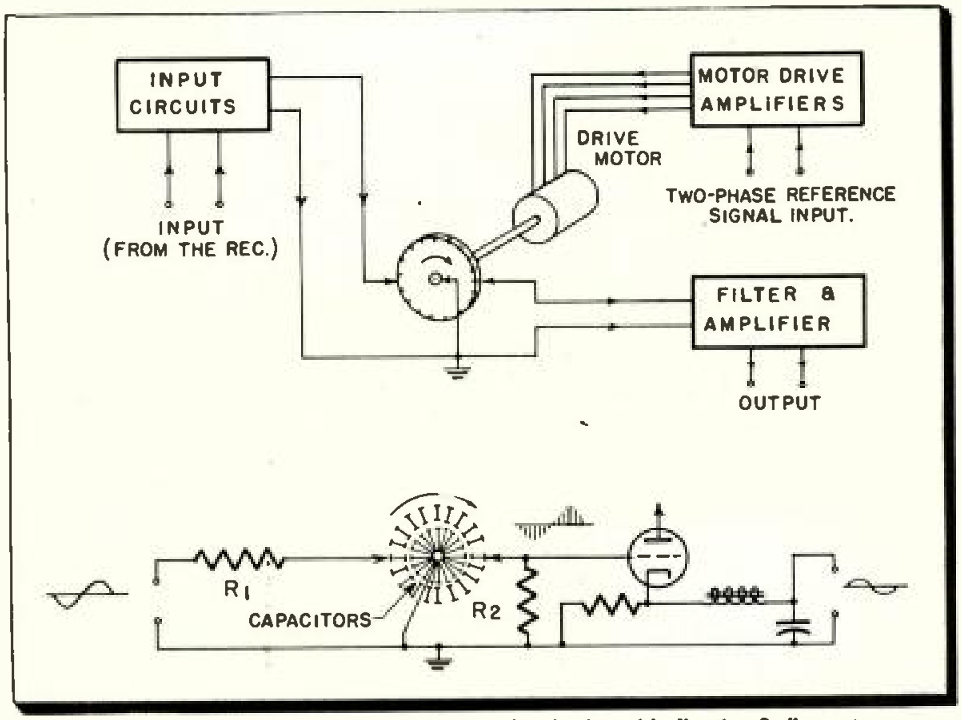


Fig. 5: Rotating capacitor drum is driven in synchronization with directing finding antenna

speed, and connected to a radio receiver. Any r-f energy at the input to the receiver will be amplitude modulated by the azimuth pattern of the antenna. Since we are dealing with a cooperative transmitter, the signal will remain on for several rotations of the antenna and the output wave form from the receiver will have a fundamental period equal to the rotational time of the antenna, even though the fourier analysis of this signal may show it to be very complex and include many harmonics of the fundamental frequency. Since we are performing post detector integrations, only the audio (detected) output of the receiver is of interest and will be fed into the integrator. The integration process requires this addition (cycle by cycle in exact phase and amplitude) of the audio output of the receiver. The signal being in phase and amplitude agreement from cycle to cycle should add directly as (n) the number of additions, while noise, being of a random nature, should add only as $\sqrt{n}$.

Techniques Investigated

In order to investigate the applicability of integration as a means of signal enhancement, three separate approaches were undertaken. They were: (A) Magnesium Delay Line (B) Magnetic Storage Drum and (C) Capacitive Storage Drum. Each was connected to an automatic Direction Finding station and operated in the system to determine the operational improvement of the station. With the exception of the magnetic drum, these units were experimental models and no attempt was made to miniaturize or package these into a field design. Fig. 1 shows a block diagram of the signal enhancement unit used with a Direction Finding station.

A. One of the first units considered was the delay line type of signal enhancer. In this unit the signal is delayed in time by multiples of one cycle, and the delayed signals are added in phase and amplitude coincidence, to form the enhanced signal output. Fig. 2 is a block diagram of this system. One line may be made to do the work of several lines by using different carrier frequencies.

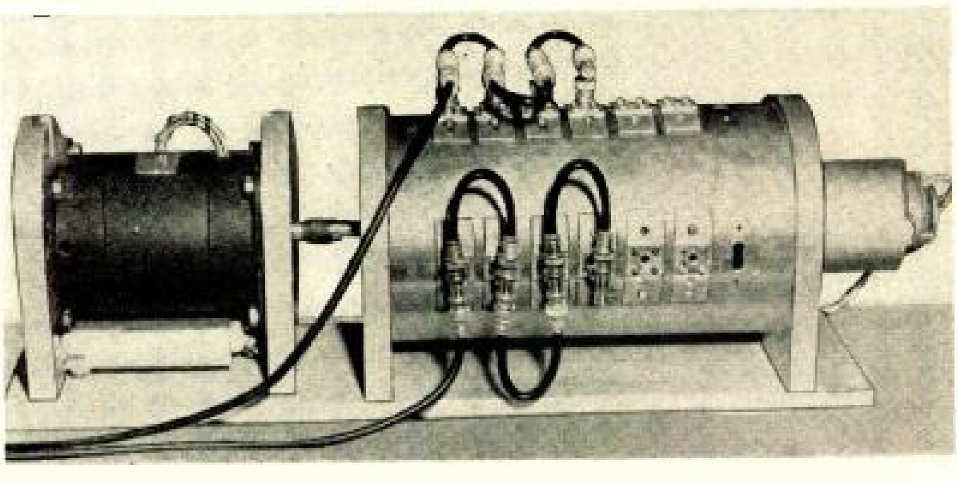
The experimental model made use of a magnesium supersonic delay line and a carrier frequency of approximately five megacycles. The signal output from the receiver modulates the 5 MC carrier and this modulated signal is applied to a crystal at one end of the delay line. The crystal changes the electrical signal into a 5 MC mechanical vibration which is propagated down the delay line. At the receiving end of the line, these vibrators excite another crystal which converts the mechanical vibrations back into a 5 MC electrical signal. An amplifier is used to raise the signal up to a workable level. The output of several delay lines is then added in phase to produce the enhanced signal.

B. The second approach investigated at Rome Air Development Center for improving the S/N ratio by integration resulted in the fabrication of a magnetic storage drum with multiple read-out heads. The output voltage from the receiver is recorded on the drum and the simultaneous output from all playback heads is used to give an integrated output. Fig. 3 shows a block diagram of this equipment.

Magnetic Storage Drum

The model constructed for Rome Air Development Center makes use of an iron oxide coated drum which is driven at 1/20th of the Direction Finding rotational speed. The 16 read-out heads spaced at intervals of one cycle around the perphery of the drum are connected in series and the output voltages which are in phase and amplitude coincidence are the enhanced signal output. An erase head is used ahead of the recording head to remove the old signal prior to recording the new

Fig. 6: Experimental model of capacitor storage integrator for improving signal-to-noise ratio



INTEGRATOR (Continued)

signal. The motor driving the drum is operated in synchronization with the reference voltage and is geared to the drum so that it is driven at exactly 1/20th the speed of the antenna system. Fig. 4 shows the engineering model of this unit fabricated by Engineering Research Associated of St. Paul, Minn. Excellent phase and amplitude linearity had to be maintained in the recording system to prevent distortion of the Direction Finding intelligence at the frequencies employed.

C. The third type of post detector integrator consists of a capacitor drum as the storage unit, suggested by Mr. H. Busignies and M. Dishal.[1] In this storage system a drum is made up of several large capacitors and driven in synchronization with the Direction Finding antenna. The signal output of the receiver is applied directly to the capacitors on the drum through one brush and, the integrated output is read off at a later item through another brush. Fig. 5 shows the circuit and block diagram.

Each of the capacitors is the same size, and the time constant of the read-out circuit selected so the capacitor will not discharge completely each time it contacts the read-out brush. The voltage assumed by the individual capacitors on the drum will be proportional to the amplitude of the signal at the moment of sampling. As the drum is rotated, the output on the read-out brush will be a series of short pulses equal to the individual charges stored on the capacitors on the drum. A filter is used to remove the commutating Continued on page 158)

Fig. 7: Radio D/F results. Without Integrator: A, good signal; B, poor; C, very poor; D, fair. With magnetic Integrator: same as B; F, same as C

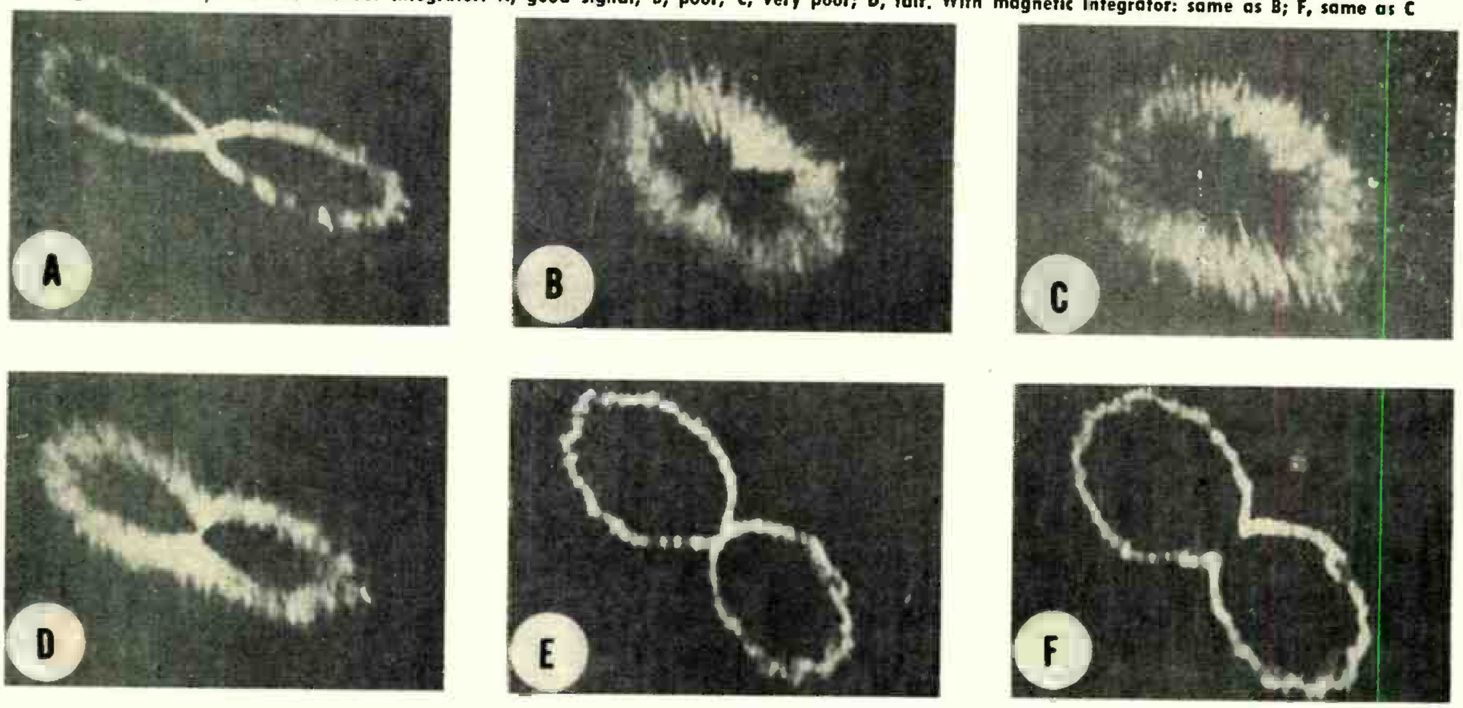
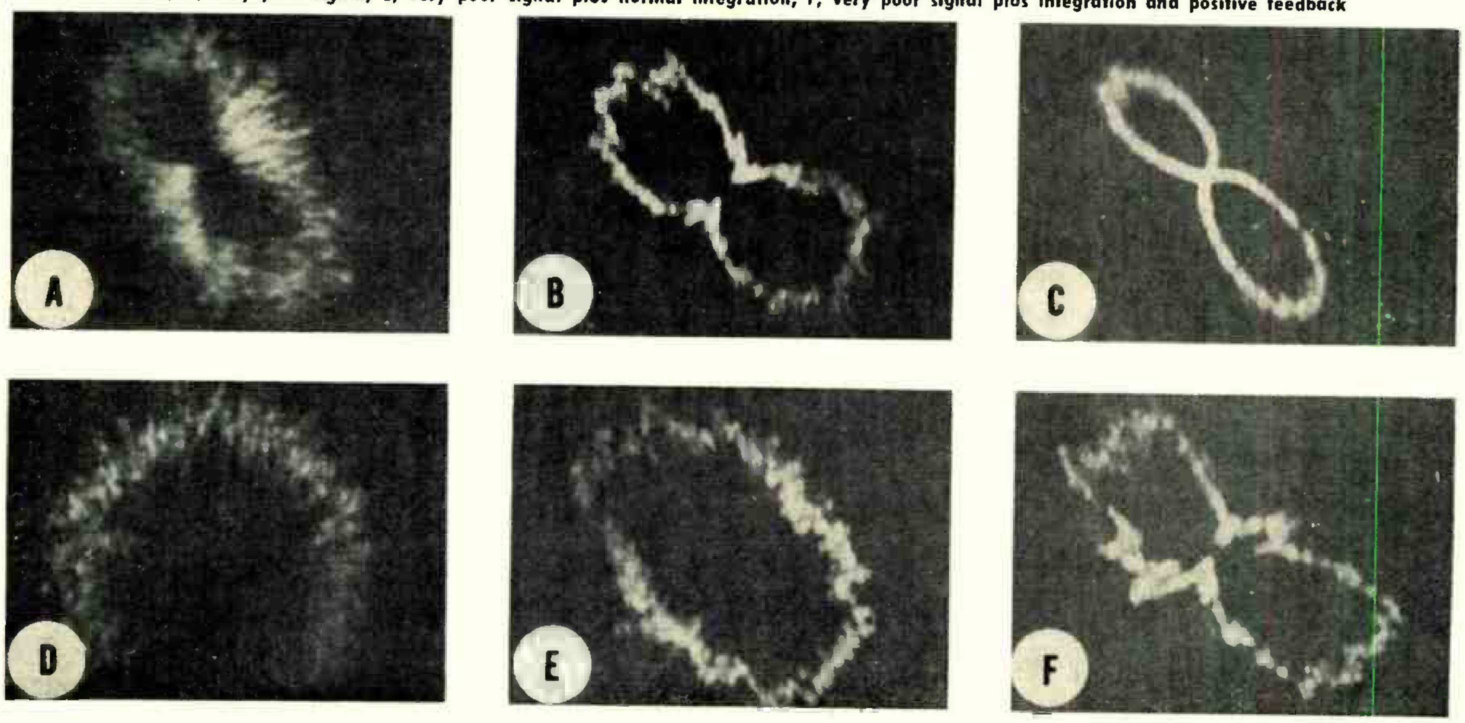


Fig. 8: Bearing presentations. A, poor signal; B, poor plus normal integration; C, poor signal plus integration and positive feedback; D, very poor signal; E, very poor signal plus normal integration; F, very poor signal plus integration and positive feedback



Analog Computing by Heat Transfer

New concept in application of heat-electrical transducers permits design of extremely simple units for computers, servo controls and instrumentation

By PAUL H. SAVET
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THE class of analog computers to be described essentially makes use of a transducer in which an incoming electrical signal is dissipated into heat. The temperature differential thus created is communicated to a pair of temperature sensitive conductors mounted in a Wheatstone bridge. The output of the transducer is a direct function of the amount of unbalance caused in the Wheatstone bridge; it is also proportional to a reference signal, supplied to the bridge for the sake of detecting said unbalance.

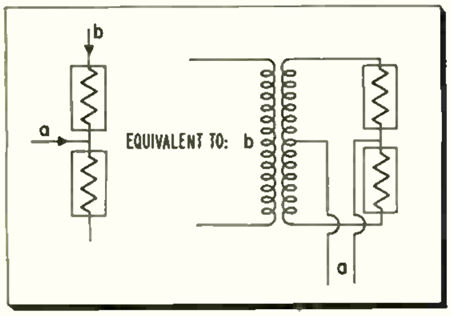


Fig. 1: Notation of equivalent circuit

The idea of such simple analog computers is new. Its principal components, the transducer and the Wheatstone bridge, of course are well known. Ideas in this area at Arma were summarized first in the group working on the miniaturization of the gyro-compass by Joseph Statsinger. Later those ideas were crystallized into a development project and assigned to the research group which it is my privilege to head. There Gareth M. Davidson, Sol Levinson, Sidney Davis and Henry Hammerstein contributed other basic ideas and inspired an entirely new design which has been successfully developed.

In all the figures, the abbreviated notation as shown on the left side of Fig. 1 will be used. In Fig. 2 a and b denote electrical signals. Consider a basic transducer as represented within the dashed lines of Fig. 2. Heater element (1) is in thermal (but no electrical) contact with sensing element (1), while a similar situation prevails for element (2). No heat may be transferred from pair (1) to (2) or vice versa. In principle, the thermal contact could be achieved through conduction, convection or radiation. For practical purposes, convection should be ruled out, however, because of stability considerations.

The construction of the thermal unit is sketched in Fig. 6. It consists of two pyrex rods in a miniature glass or metal envelope the size of a 6AK5. Vacuum is not required. Wound on each rod is the bifilar heater consisting of #40 teflon-insulated nichrome, and one or more sensing elements consisting of #40 teflon-insulated nickel or similar wire. Temperature range is about 60 to 250°C. and frequencies of 60 cps to 1 kc have been employed. Computer elements can be produced for ½ to ⅕ of the cost of regular vacuum tube types. Accuracy below 0.5% may be economically achieved.

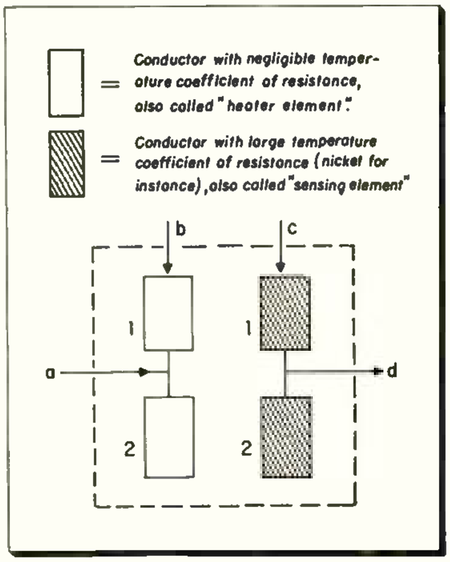


Fig. 2: Basic transducer and conductor symbol

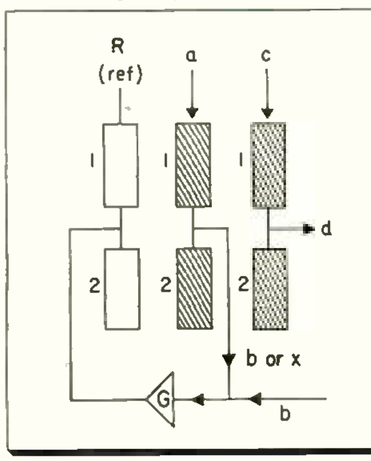
Suppose that a and b are two in phase signals. Fig. 1 and 2 suggest that the difference of heat dissipated between heater elements (1) and (2) is proportional to

$$(a+b)^2 - (a-b)^2 = 4\,ab$$

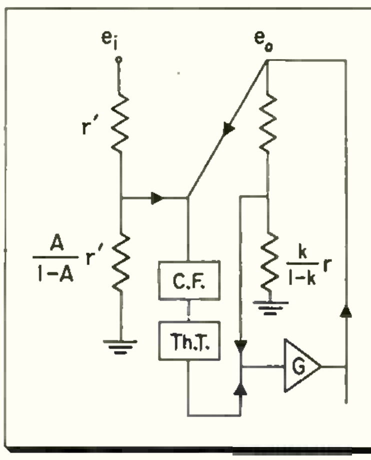
i.e., to the product of incoming signals a and b. If there is a carrier phase difference ϕ between a and b, said heat differential would be 4ab cos ϕ; in particular it would be reduced to zero if ϕ were equal to 90°. As to the sensing elements, shown as the shaded areas on the right side of Fig. 2, the differential of their resistance is a direct (though not forcibly linear) function of the heat differential produced in the transducer. The output (d) is proportional to the reference signal (c) (provided the latter is moderate enough

(*Continued on page 122*)

Fig. 3: (l) Two pairs of sensing elements are used in multiplier and divider. Fig. 4: (r) Embodiment of integrator instrumentation



$$X = \frac{b}{1+\frac{1}{aR}\,\frac{1+p\tau}{k'G}} \approx \frac{ad}{c}$$



$$T(p) = \frac{k}{1+p\tau}$$

$$\left[ke_o - (e_o - Ae_i)\,\frac{k}{1+p\tau}\right] G = e_o$$

$$\frac{e_o}{e_i} = \frac{-A}{p\tau}\left[\frac{1}{1+\frac{1+p\tau}{p\tau Gk}}\right] \approx -\frac{A}{p\tau}$$

C.F. = Cathode Follower

Th.T. = Thermal Transducer

New Test and

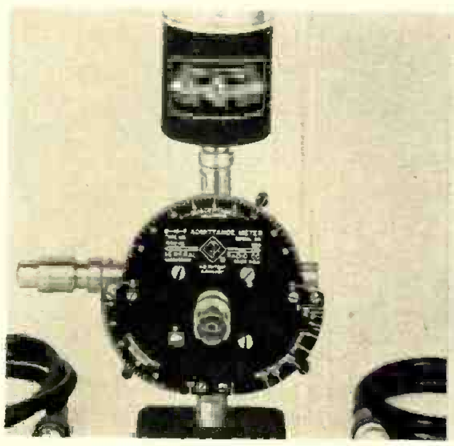
VHF INTERPOLATOR

When supplied with a standard 100 kc signal and auxiliary measuring equipment in the range of 1 to 2 MC, the Model AM-1 VHF interpolator enables the generation and measurement

of frequency in the range of 20 to 1,000 MC with an accuracy of better than 1 part in 10^7—depending on the accuracy of the 100 kc source. The unit can be operated directly from a 105-130 v., 60 cps, ac line, and its safety factor allows continuous operation for indefinite periods. **Gertsch Products, Inc., 11846-48 Mississippi Ave., Los Angeles 25, Calif.** —TELE-TECH & ELECTRONIC INDUSTRIES.

ADMITTANCE METER

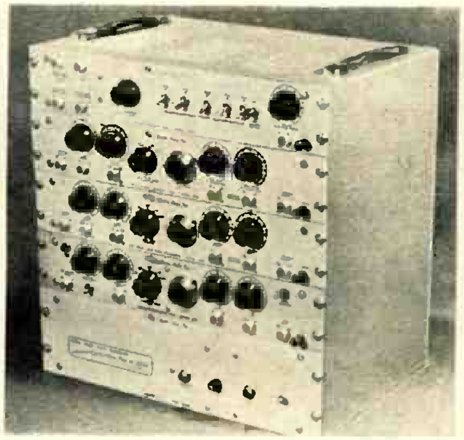
Type 1602-B admittance meter has been changed so that the effect of junction inductance has been eliminated. Therefore, corrections are no longer



necessary. Furthermore, accuracy has been improved by several additional calibrated points on the multiplying-factor scale. And, at low frequencies, a small, shielded, variable air capacitor replaces the adjustable stub previously used as a susceptance standard. The unit is direct reading from 41 to 1,500 MC. **General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES.

PULSE GENERATOR

Model 2120A pulse generator is constructed on the block-unitized principle and generates a positive or negative main pulse with width, amplitude, and delay from trigger are continuously



variable. Using no gas tube pulse-forming circuits, operation from either internal or external frequency are provided at repetition rates up to 100,000 cps with single pulse and gated operation. Main pulse amplitude is 80 v. maximum across an internal 93-ohm resistor. **Electro-Pulse, Inc., 11811 Major St., Culver City, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

FREQUENCY METERS

Three new precision meters, models LA-5, LA-6, and LA-61, enable frequency measurements at 10 to 100 MC, 100 to 500 MC, and 500 to 2,000 MC, and are accurate to 0.001%. The units are

two cu. ft. in volume and described as extremely rugged. **Lavoie Laboratories, Inc., Morganville, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

NEW TECHNICAL PRODUCTS
for the
Electronic Industries
on pages 130-131

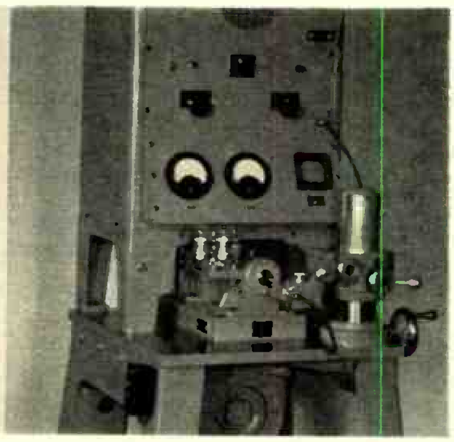
KLYSTRON TESTER

A klystron tube tester is available which tests the performance quality of commercially available klystron type tubes. The instrument provides complete metering facilities, control adjust-

ments, precautionary means for safely testing high voltages, and convenient tube data charts for the rapid determination of control settings. It also provides for external modulation so that the klystron tubes may be tested dynamically with external r-f measuring equipment. **Polarad Electronics Corp., 100 Metropolitan Ave., Brooklyn 11, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

WAVOMETER

Type WA wavometer enables measurement of waviness on surfaces of rotation, in contrast with surface roughness. Widely spaced deviations from a



true circular surface are measured in microinches. Basically, the Type WA consists of three units; a motor-driven spindle for rotating the work at constant speed, a converter which translates waviness into a small fluctuating voltage, and an amplimeter unit which shows the characteristics of the waviness of the rotating work. **Micrometrical Manufacturing Co., 345 S. Main St., Ann Arbor, Mich.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Measuring Equipment

NOISE GENERATOR

Model RUG-1-10 low frequency noise generator provides a random voltage source of controlled frequency spectrum and probability distribution for simulation studies and test purposes.

The basic noise source is a gas tube producing an approximate Gaussian output. This provides the signal source to the three controlled distribution channels generating the Gaussian, Rayleigh, and uniform distributions. The distributions are accurate to 2%. **Statistical Instrument Co., P.O. Box 552, Church St. Sta., New York 8, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

SCALING UNIT

The Model 2200 automatic scaling unit is a high-speed instrument for automatically counting electrical pulses obtained from nuclear particle detection equipment. It consists of an input pulse height discriminator, an electronic scaling channel with 1 μsec paired pulse resolution, mechanical register, time clock, and automatic control circuitry. High voltage is not supplied. The scaling channel consists of four plug-in decimal

counting units including one Model 706A and three Model 705A's. **Beckman Instruments, Inc., Berkeley Scientific Div., 2200 Wright Ave., Richmond, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

VOLTMETER

Covering a voltage range from 500 μv to 500 v. RMS, over a frequency range from 15 cps to 250 KC, the model 1520 vacuum tube voltage meter is calibrated both in ac voltage and deci-

bels. The scale range is from 0.5 to 5.0 v.; the db range from −5 to +17, based on zero db equaling 1 mw in 600 ohms. Power supply requirements are, 117 v. ±10% 50/400 cps. Power consumption, approx. 35 w. Usable band width, 15 cps to 250 KC. Accuracy, ±2%. Stability, ±1% with line voltage variation from 105 to 125 v. Input impedance, 2 megohms with 15 μμf shunt capacity. Amplifier is available for external use by rotation of ac output control. Voltage gain 1,600 (63 db). The unit is housed in a metal cabinet that is 5¾ x 11½ x 5⅞ in. in size. **Communication Measurements Laboratory, Inc., 350 Leland Ave., Plainfield, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

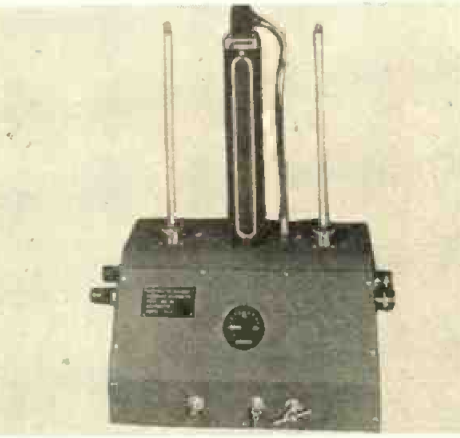
TEST EQUIPMENT

The "TWin-300" line of balanced 300 ohm components features, baluns, attenuators, detectors, and terminations suitable for use in the UHF-TV band. The line may be used with existing unbalanced 50 and 75 ohm equipment for complete measurements of balanced 300 ohm systems. Measurements such as gain, loss, impedance, VSWR, noise, etc., are facilitated on receivers, tuners, antennas, transmission lines, oscillators, amplifiers, and similar UHF-TV components. **Microlab, 301 South Ridgewood Road, South Orange, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

More Reviews of New Components
Appear on Pages 104, 105, 106, 132, 134, and 138

CALORIMETER

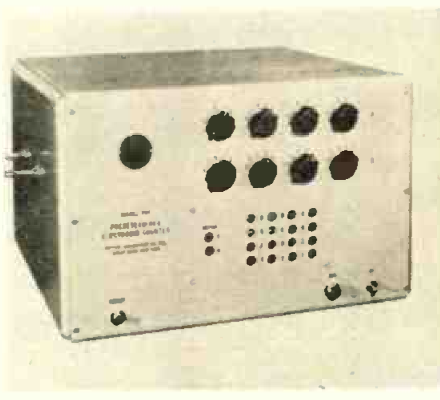
The Model SME microwave calorimeter and dummy load is designed for the measurement and absorption of microwave power of any magnitude between 500 and 90,000 MC. Responding



to energy levels from fractional watt to 50,000 watts, the unit is capable, it is said, of measuring or absorbing the power of any radar, UHF TV transmitter, microwave relay, microwave tube, communication equipment, or energy source. Further, with small modification, it is adaptable for detecting calormetric values and liquid or gas. The basic unit version utilizes tap water through combination pressure reducers and stabilizers. **Sightmaster of California Co., Gillespie Airport, Santee, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

COUNTER

The Model 244 shown is a dual-sequence counter that provides count ranges from 1 to 10,000 and counting rates to 60,000 per min. in each of two channels. Front panel rotary switches

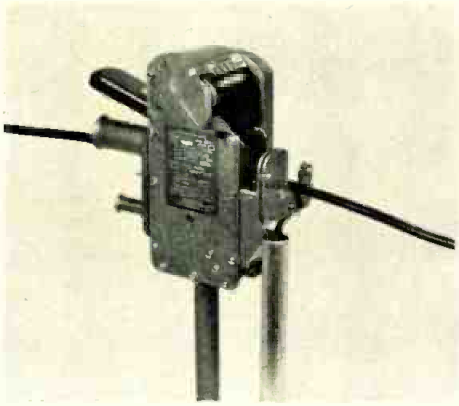


enable independent setting of each channel directly to the numbers to be predetermined. At the end of each predetermined channel count, a control output is provided in the form of a relay contact closure or a voltage pulse. **Potter Instrument Co., Inc., 115 Cutter Mill Road, Great Neck, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

New Lab and Plant Equipment

MEASURING DEVICE

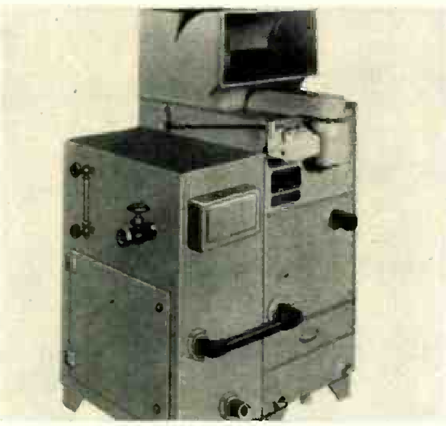
No. 600 lineal measuring device for wire cordage, TV ribbon, etc., has interchangeable guide tubes that enable capacity ranging from Nylon fishing leader to 1 in. diameter flexible electric



cable or cordage. "Feet" and "inches" are indicated on a Veeder-Root counter to 9,999 feet. An integral wax scraper cleans meter wheel to assure accuracy. The mechanism of the unit requires no lubrication. The cutter illustrated and a complete line of reeling equipment is also available. **The Olympic Instrument Laboratories, Cove, Washington.**—TELE-TECH & ELECTRONIC INDUSTRIES.

HEAT EXTRACTOR

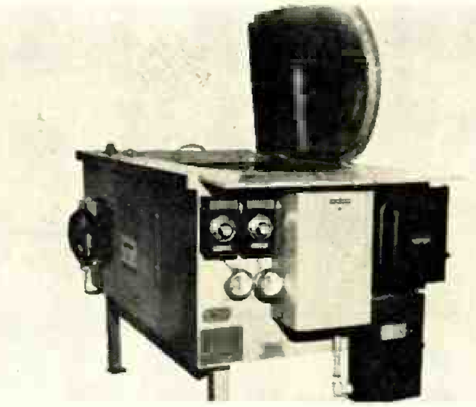
Model TX-50 heat extractor, designed to provide recirculated cooling water for transmitter tubes and applicable for supplying cooling water to machine jackets, oils, coolants, etc., employs the evaporative cooling principle and will



supply cooling water as low as 86° F with a 75° wet bulb condition. Capacity range is from 36,000 BTU/hr. to 465,000 BTU/hr. with entering water temperatures from 90° F to 160° F. Volume of cooling water from 20 G.P.M. to 150 G.P.M. **Mayer Refrigerating Engineers, Inc., Lincoln Park, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

COMPOUND HEATER

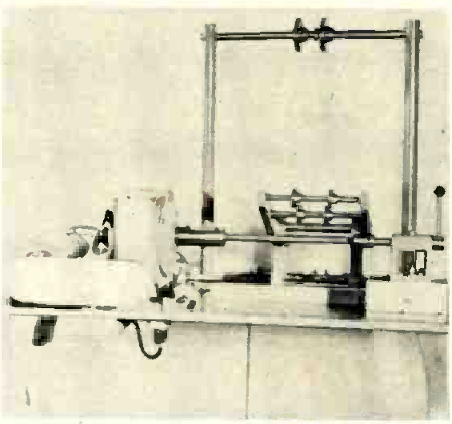
An insulating compound heater is designed for heating insulating waxes, varnishes, rosin, tar, pitch, plastic, and similar compounds requiring high temperatures, used in the production of



various electrical and electronic components. A jacket, or oil chamber, filled with non-carbonizing heat transfer oil, surrounds the compound chamber. The electric heating elements of the high temperature sheath are so placed as to distribute heat evenly and economically. **D. C. Cooper Co., 1467-71 So. Michigan Ave., Chicago 5, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

TRANSFORMER WINDER

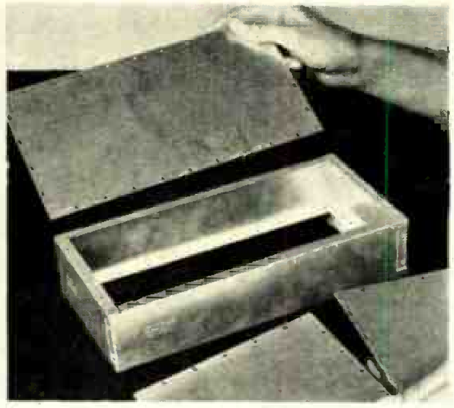
The heavy duty transformer winder, Model 147-AM, winds heavy wire in tight, uniform layers by using a variable transmission. It winds power, audio, and similar types of heavy duty transformer coils, and all types of heavy duty field coils and bobbins up



to 10 in. in length and 16 in. in diameter. Wire sizes are from 5 to 18 A.W.G. Winding speed is 50 to 85 rpm. A special ¾ h.p. variable speed motor operates on 115/230 v., 60 cps, single phase. **Geo. Stevens Mfg., Co., Inc., Pulaski Rd. at Peterson, Chicago 30, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

CHASSIS

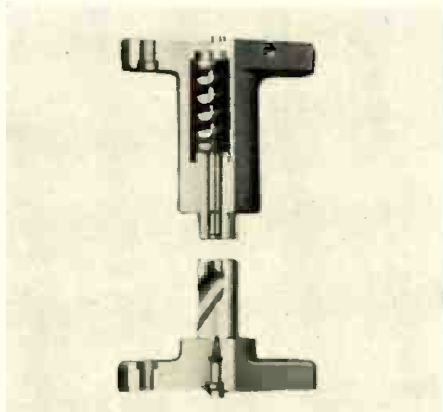
The "SeeZak" expandable chassis consists of rails and plates which form a finished chassis. One hundred and five sizes (4 in. x 4 in. to 17 in. x 17 in. in 1 in. increments) can be formed from 14



rail-lengths. Heights: 2 in. and 3 in. It is claimed that "L" and "U" shape chassis are easily made, and that plates and rails can be punched on a "Rotex" punch. Chassis can be expanded by means of longer rails and additional plates. **UM & F Mfg. Corp., 10929 Vanowen St., N. Hollywood, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

HOLE-PUNCHING UNITS

The Type "JD" hole-punching units are designed to punch mild steel up to ¼ in. thick and can be used and re-used in unlimited setups. Each punch assembly consists of holder, punch, stripping spring, punch guide, and pilot head. Each die assembly consists of holder, die, and pilot pin. Punch and

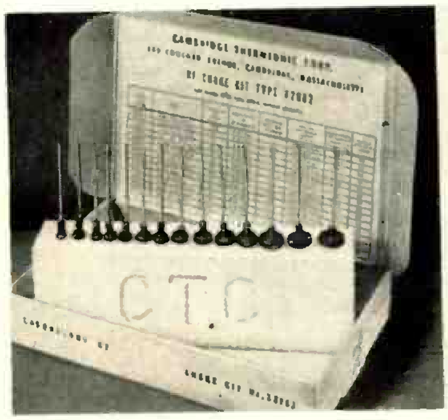


die assemblies are mounted in die sets and operate in a press in the same way as conventional dies, enabling unobstructed feeding. The units may be mounted directly to standard flat surface die sets, or on templates. **Wales-Strippit Corp., 345 Payne Ave., North Tonawanda, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

New Electronic Components

CHOKE KIT

Type X2082 RF choke kit contains 14 pie-wound chokes on LPB-3 forms with axial leads that are only 5/32 in. in diameter by ½ in. long. Windings are



⅛ in. wide and vary to approximately ½ in. in diameter. All units are varnish-impregnated for moisture and fungus-proofing. Inductances are RMA preferred values ranging from 6.8 µh to 1.0 mh. Color-coding is the RMA three-dot system. An inside cover chart gives all necessary electrical data. **Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES.

CONNECTOR KITS

Three r-f coaxial connector kits have been introduced in the industrial and laboratory markets. Each kit consists of a heavy plastic case with 18 compartments which contains the connectors and a functional wiring diagram. Kits Nos. 1, 2, and 3 contain Type "BNC"

connectors for small coaxial cables, Type "UHF" for non-constant impedance applications, and Type "N" for microwave applications. **Schweber Electronics, 122 Herricks Road, Mineola, Long Island, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

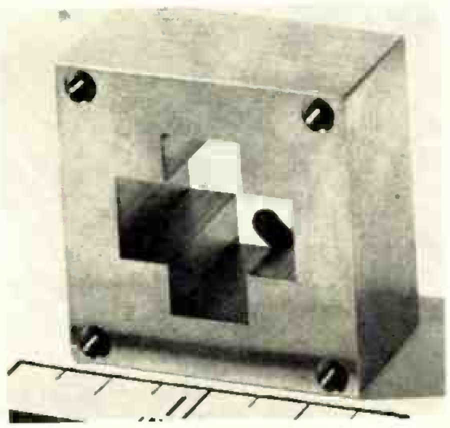
GERMANIUM DIODES

The IN67-IN67-P germanium diodes are now hermetically sealed. The soldering design is smaller in size and an entirely new plug-in construction is

available. It is said that these new units are more rugged and shock resistant. Quality is maintained by 12-hour high temperature test (105° C.) a 4-hour low-temperature (−25° C.) check, 32 hours temperature-humidity cycling, and complete electrical tests. Additionally, each production lot is put through the JAN-193 humidity tests. **Raytheon Manufacturing Co., Receiving Tube Div., 55 Chapel St., Newton 58, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES.

TWIST BLOCK

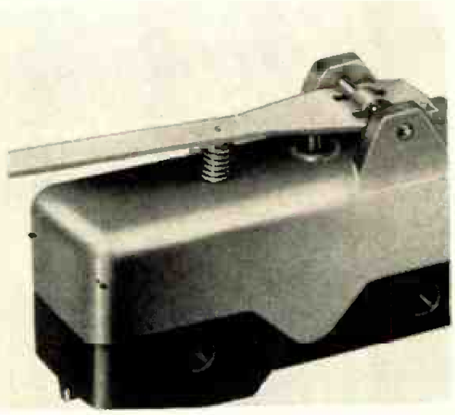
A broad band impedance matched 90° short twist for X band in RG-52/U waveguide size has been announced. Tapped holes in the twist block faces determine the angular orientation of the mating UG-40A/U choke flange terminated wave guides so that they will be



at 90° to each other. The units are impedance matched to afford a VSWR of less than 1.22 from 8,500 to 9,500 MC. **General Precision Laboratory, Inc., 63 Bedford Road, Pleasantville, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

SNAP ACTION SWITCH

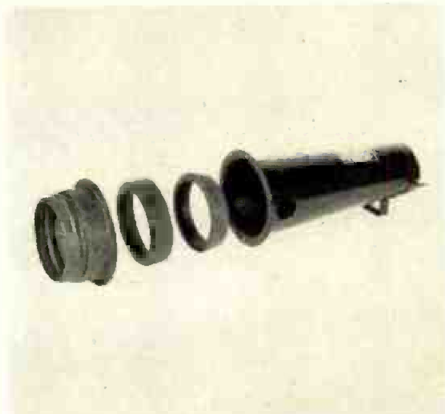
The "Unimax" Type MXT-1 snap action switch has a rigid lever arm pivoted on a bearing pin that is set in supports that are integral with the molded switch



cover. The actuating arm can be furnished in any length with special bends. By eliminating the coil spring, the actuator can be modified to enable operation by a 15-gram force. The long actuator over-travel makes the switch suitable for use in cam or slide-operated controls. The switch has a current rating of 15 amps. at 125 v. ac. A data sheet giving dimensions of the MXT-1, complete electrical ratings and operating characteristics is available. **The W. L. Maxson Corp., Unimax Switch Div., 460 West 34th St., New York 1, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

CRT SHIELDS

Standard magnetic cathode ray tube shields for popular, 2, 3, and 5 inch tubes are in production. Available for

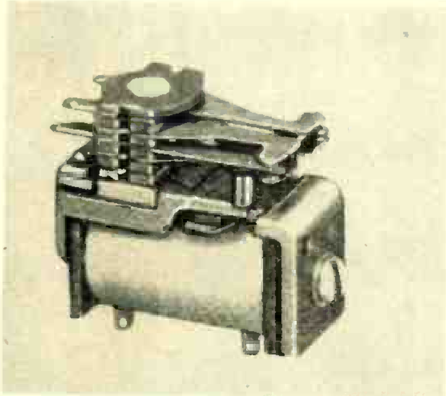


early delivery, the "MuMetal" and "Nicoloi" stock shields can be furnished with light hoods, retainers, and plexiglass windows. **Multi-Metal Wire Cloth Co., Inc., Electronics Div., Garrison Ave., New York 59, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

New Electronic Components

RELAY

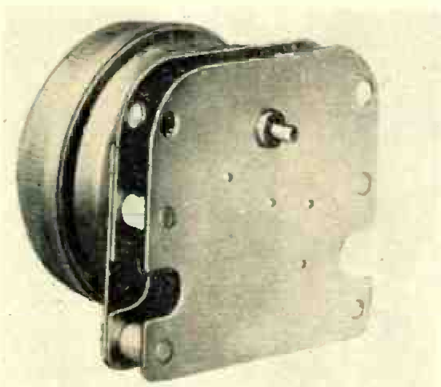
The Series 80 midget telephone type relay has vibration and shock-proof characteristics and is designed to meet



government specifications. Coil windings are rated for dc voltages up to 115 v. Contacts are palladium and rated non-inductive load at 3 amps. at 24 v. dc, or 115 v., 60 cps. Units can be supplied with silver contacts rated at 5 amps. on special order. Smallest of the series, in the hermetically sealed types, type 8614, measures $1\frac{5}{8}$ x $1\frac{1}{32}$ x $1\frac{21}{32}$ in. **Signal Engineering & Manufacturing Co., Long Branch, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

TIMING MOTORS

The new Sessions line of variable speed, high torque, permanent-lubrication motors provide time controls for



a wide variety of electrical appliances. The units are less than ½ in. in diameter and available in output speeds ranging from 450 rpm to 1 rev. in 31 days. Gear trains can be added to the basic unit to enable further speed variation. Gear pinion assemblies in reduction units are made of molded nylon which, in combination with "Lubricone", provides quieter operation and longer life. **Sessions Clock Co., Forestville, Conn.**—TELE-TECH & ELECTRONIC INDUSTRIES.

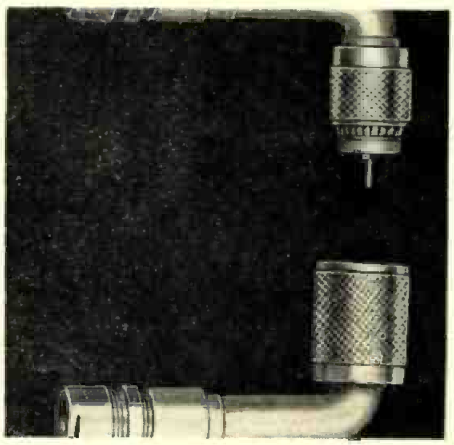
TRANSISTOR

The Type CK727 low noise PNP junction transistor has an average noise factor of 13 db, and average alpha of

0.97, and an average power amplification of 37 db. Details are available from the Technical Information Service, **Raytheon Manufacturing Co., 55 Chapel St., Newton, Mass.**—TELE-TECH & ELECTRONICS INDUSTRIES.

PULSE CONNECTORS

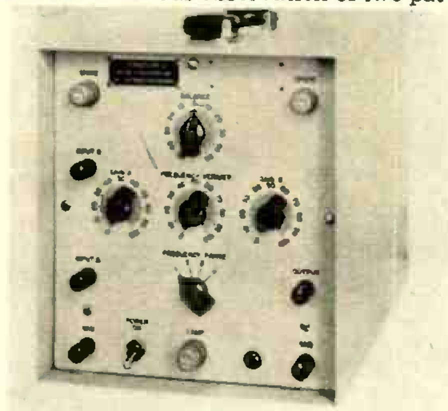
New angle pulse connectors for aircraft radar and microwave communications systems maintain a corona level



of 7,000 v. at an altitude of 55,000 ft. and at a temperature as low as —55° C. Dielectric strength is rated at 12,000 v. minimum. Spring contacts, with resistance not greater than 0.005 ohm, are used at the shells to maintain positive electrical contact at all times. The connectors will be employed principally with cable RG-88V because of their exceptionally high corona level. However, as standard field assembly types, the connectors may be used with other cables, as RG-64/A, RG-77/A, and RG-78/A, and they will mate with standard rubber insert type connectors. The product meets all applicable portions of MIL-C-3606 and has received first article approval for military service. It is now in production for general applications. **Airtron, Inc., Dept. H, Linden, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

SCOPE SWITCH

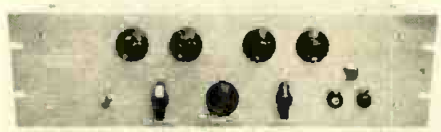
Built to JAN requirements, a portable electronic switch makes possible the simultaneous observation of two pat-



terns on the screen of a single cathode-ray oscilloscope. The positions of the patterns can be superimposed or separated which enables direct comparison of amplitudes, waveforms, frequencies, and phase relationships. A square-wave voltage of variable frequency and amplitude is available at the output terminals for testing vacuum tube amplifiers and other circuits. Direct-coupled amplifiers are alternately operative and inoperative at a rate determined by the selected switching frequency. Therefore, a direct current signal can be chopped suitably for transmission through oscilloscope amplifiers. Switching rate, continuously variable from 10 to 2,000 times/sec. **Chatham Electronics Corp. Livingston, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

PROGRAM EQUALIZER

Model EQP-1R is a low impedance passive equalizer followed by an amplifier to restore the equalizer inser-



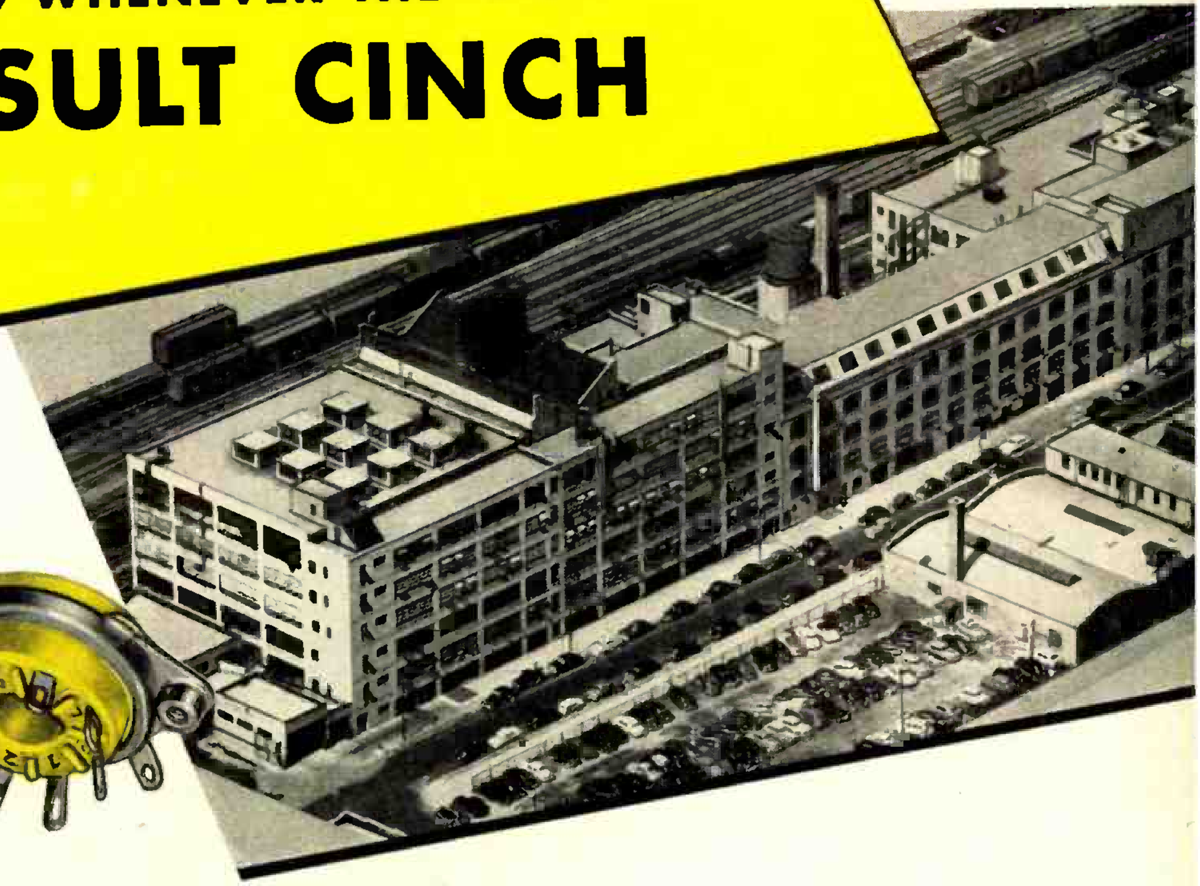
tion loss. The noise level is 92 db below 10±dbm; distortion 0.15%. Balanced input and output are rated 150, 250, or 600 ohms. Low frequency boost and attenuate curves at 30, 60, and 100 cps permit correction of bass deficiencies without disturbing the mid-low frequencies. Five high-frequency boost curves permit correction at 3, 5, 8, 10, and 12 KC and a bandwidth control varies these curves from sharp to broad. Separate boost and attenuate controls permit boosting any high frequency while attenuating on a 10 KC shelf curve. Continuously variable controls allow variation of the amount of equalization on sustained tones without steps in level, or noise. **Pulse Techniques, Inc., 1411 Palisade Ave., West Englewood, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

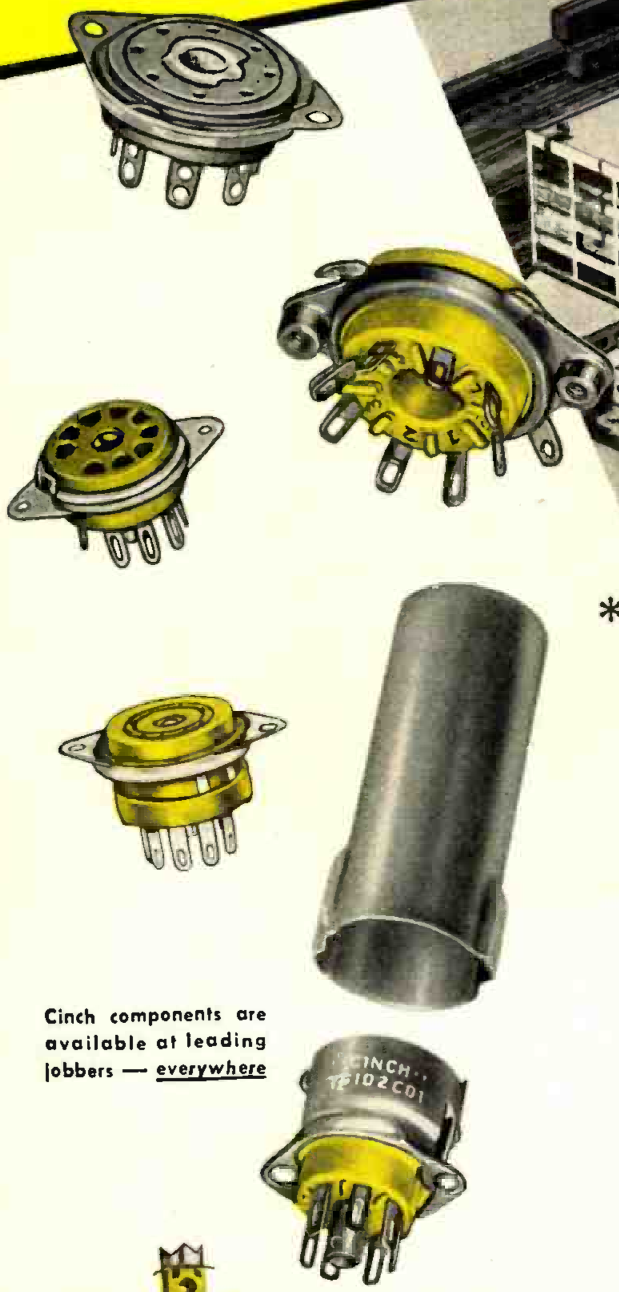
SOCKETS...

"QUALITY IN *QUANTITY"

WHATEVER, WHENEVER THE NEED

CONSULT CINCH





*QUANTITY PRODUCTION OF LOW LOSS MICA COMPONENTS...*QUICKLY*

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WASHINGTON
News Letter

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

UPCOMING FCC TASKS—Subscription television and TV "community antenna" systems are two of the most controversial subjects in video's progress to be considered by the FCC now that color television standards have been approved. Subscription television embraces both the basic policy whether this medium would serve the public interest and the substantial legal questions as to whether this service should be classified as broadcasting or common carrier (communications) or a special service. In addition, there is the engineering problem of where subscription TV could be squeezed into the crowded spectrum. Community antenna television also poses the problem of interference and the question whether such systems constitute common carrier or some other operation within the Commission's regulatory jurisdiction.

A.T. & T. READIES COLOR-TV ROUTES—The American Telephone and Telegraph Co. Long Lines Department moved rapidly during January to prepare its backbone routes for intercity color television transmission both by coaxial cable and microwave radio relay, according to its report to the Commission. The readying of the intercity facilities was launched on the basis of advance planning immediately after the FCC had approved the compatible all-electronic standards recommended by the National Television Systems Committee. In addition to equipping the routes with additional facilities to carry the color video picture signals, the A.T. & T. Long Lines Department had commenced a training program for the personnel to handle color television transmission months before the FCC sanction and this specially trained staff was ready for its assignments by the end of January.

NOTABLE ACHIEVEMENT—More television stations —130 in 79 cities—were connected for TV network service in 1953 than in the previous five years of commercial video network history, the A.T. & T. Long Lines Department reported to the FCC, and this year (1954) will be another record year for television network expansion. It is anticipated that approximately 100 more stations will be linked to the coaxial cable-microwave relay network and by the middle of 1954 the first round robin TV networks will be placed in operation with two television channels in each direction serving TV stations from New York to Chicago and back via St. Louis and Washington which will add considerably to the flexibility of routing network programs. Of course, it should be recognized the Bell System has the primary responsibility of providing telephone and communications services in its expansion of these facilities but at the same time is bending every effort to aid the broadcasting industry in the expansion of television.

DEFENSE CHIEFS LAUD INDUSTRY—The research and development achievements of the electronics industry in giving the United States superiority over the Soviet military might received full recognition from the Secretaries of the Army, Navy and Air Force in the semi-annual reports at the end of last year. Army Secretary Stevens cited "Nike" as a major weapon of defense against air atomic and H-bomb attacks and lauded the development of platoon and vehicular systems of walkie-talkies as well as the value of mobile television systems. Navy Secretary Anderson noted the importance of radar and sonar to the fleet and naval aviation. Air Force Secretary Talbott stressed how research has accomplished greater reliability and effectiveness of electronic equipment components with reduction in size and weight and how the electronic manufacturing industry has delivered more urgently-needed UHF equipment than anticipated. The satisfaction of the Defense Department's high command with the electronics industry augurs continued reliance on it for keeping the nation's defenses strong.

MICROWAVE COORDINATING COUNCIL—Establishment of a central microwave frequency coordinating council was considered at a meeting of six major groups of users of mobile radio services in Chicago Feb. 24. The group which launched the meeting included the public safety, forestry, industrial, land transportation, railroad, petroleum, public utilities, marine and aviation radio services. The objective is to establish a frequency plan for all the mobile services now using or planning to utilize microwave radio to aid the FCC in its assignments.

ELECTRONICS MODULAR DESIGN—The Navy has changed the name of Project Tinkertoy which its Bureau of Aeronautics and the National Bureau of Standards unveiled in September, 1953, to process certain electronic equipment through mechanized assembly of bulk or raw materials with minimum hand labor. The new designations are "modular design of electronics" (MDE) or "mechanized production of electronics" (MPE). More than 1,000 manufacturers had visited from September to the year-end the NBS pilot plant at Arlington, Va., and every large electronics manufacturer, according to the Navy, has expressed interest in the new process. Drawings for hand tools required to set up pilot plants or model shop production, together with an engineering handbook, were made available Jan. 1 to the industry by the Navy.

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ROLAND C. DAVIES
Washington Editor

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Color-TV Tubes Set Makers Problem!

Last month Arthur Loughren, Director of Research, Hazeltine Electronics Corp., Little Neck, L. I., announced that set makers have a difficult job ahead in selecting a color-TV tube for their receivers. There are two practical types available now. The one, a three-gun type, developed by RCA and the other the Lawrence tube, termed the "Chromatron", manufactured by Chromatic Television Labs. Inc. of New York City. RCA has already revealed circuit and application details of their tube. In recent months Hazeltine has been studying circuit and application details of the single-gun tube. As a result of this research Hazeltine now feels that the single-gun tube offers several advantages which receiver manufacturers might do well to take into consideration in their color set designs.

The principal advantage of the single-gun display lies in the elimination of the convergence and registry problems that occur in the three-gun tubes. A second advantage lies in the uniform tint for grays obtained during black and white transmissions. With the three-gun tube, differences in contact potential, drift, and power supply irregularities yield different tints for various values of gray. For this reason, also, the employment of regulated power supplies is practically a "must" in three-gun sets. With the single-gun type "Chromatron", regulation is not particularly critical and standard black-and-white power supply components (such as the flyback transformers) can be employed.

Undesirable Radiation

On the single-gun disadvantage side it was pointed out that about 20 watts of r-f power was required to operate the color-control grids at 3.5 MC. In the initial tubes received from Chromatic this high r-f power resulted in a high undesirable radiation (about 100 times too much on a frequency now employed by amateur communicators.) By the proper employment of shields within the tube, Hazeltine researchers have been able to reduce the radiation from 20 to 50 times, and they feel that this will place the unit within the 15 μv/meter degree of acceptability. Thus far no work has been done using the system Chromatic recently announced called "random switching", but further radiation reduction work is being directed at the color-control grid support structures which

COLOR-TV TUBES (Cont.)

apparently act as miniature antennas and use the tube envelope as a reflector.

Another disadvantage in the Chromatron is the relatively coarse line structure. In a 22-in. tube offering a diagonal of 17-in., 700 color strips, each appr. 15 mm. thick, are employed. Of this number 350 strips are green, 175 red and 175 blue. With close viewing on stills the line structure is quite apparent. However, with greater distance between viewer and screen and with program content this effect tends to disappear. Three fine equi-spaced vertical lines are especially noticeable when this tube is viewed on black and white transmissions. These are due to fibre-glass threads supporting the color control grids. Ultimately it is hoped that the size of these threads as well as the number may be reduced or eliminated.

Simple Circuit Techniques

With the three-gun tube the associated circuitry for color-TV is rather complex, and at present circuit complexity with the Chromatron is judged to be about equal. Hazeltine's recent research, however, has led to simple circuit techniques for directly processing the NTSC signal at the color receiver to form a signal which in turn is suitable for direct application to the tube. Information on these techniques is contained in their report 7148 entitled "Processing of NTSC Color Signal for One Gun Sequential Color Displays" and which has now been circulated to their licensees. Some set manufacturers, such as Crosley and Muntz, have already evidenced considerable interest in the use of the Chromatron, and Thomas Electronics Inc., N. J., has announced that they will manufacture this type color picture tube. One reason for this perhaps is that the tube also offers the possibility of larger future screen sizes with less difficulty and with less overall tube length.

RETMA Reliability Conference Planned

A Conference on Reliability of Electrical Connections, sponsored by the Radio-Electronics-Television Manufacturers Assoc. will be held April 15–16, 1954 at the Illinois Institute of Technology, Chicago, Ill. according to an announcement made by Ralph R. Batcher, chief engineer of RETMA a handful of components in one tiny package

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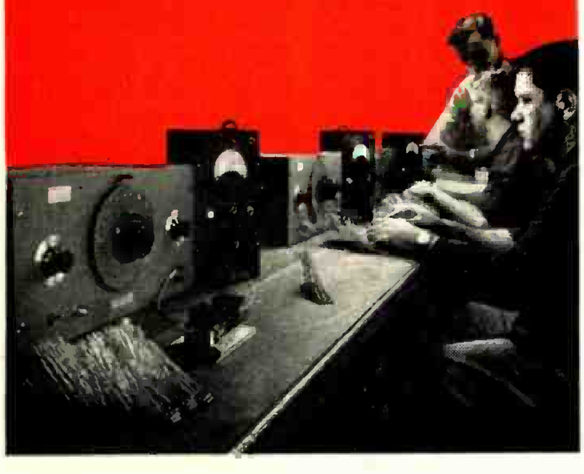


STUPAKOFF CERAMIC & MANUFACTURING COMPANY

LATROBE, PENNSYLVANIA

"Raydist" Applied to Off-Shore Exploration

Highly dependable navigation system aids search for oil in Gulf of Mexico. Narrowband requirements eliminate interference difficulties

By CHARLES E. HASTINGS, President, Hastings Instrument Co., Inc. Hampton, Va.

The application of Raydist to geophysical exploration in the Gulf of Mexico is very timely, since the Tidelands case was concluded by Congress. Although Raydist was not originally conceived as a geophysical surveying tool, its utility in that field was soon realized. Within less than a year this method of supplying radio location service to the oil industry has blossomed forth into the first large-scale commercial use of phase-comparison systems in this country.

Raydist is being used more and more extensively along the coast of Louisiana and Texas, playing a vital part in offshore oil exploration. In this particular application, Raydist is used in conjunction with gravity meters or seismic equipment, and enables the survey crews to know to within a few feet the exact location to which specific measurements were made, and leads them to that location at a later date.

The Raydist system most widely used in conjunction with this oil exploration work is called the Type N Raydist system. In this Type N method the transmitters associated with the system are all located on shore and only the receiving and phase-measuring equipment is required on the craft using the system. Fig. 1 shows the general arrangement of Type N apparatus on shore and in the vessel using the system.

In this particular system the phase of beat notes between fixed transmitters is compared as received directly in the craft and as relayed from a fixed relay station. Precise location can be determined by comparing the difference in phase between various pairs of transmitting locations. Each of the transmitters will differ in frequency from the others in the system by an audio note. R-F phase measurements are reduced to audio frequency phase measurements by the heterodyne signals between the transmitters, greatly simplifying the problem of comparing the phase of signals received. The transmittal of audio beats between the transmitters re-

(*Continued on page 116*)

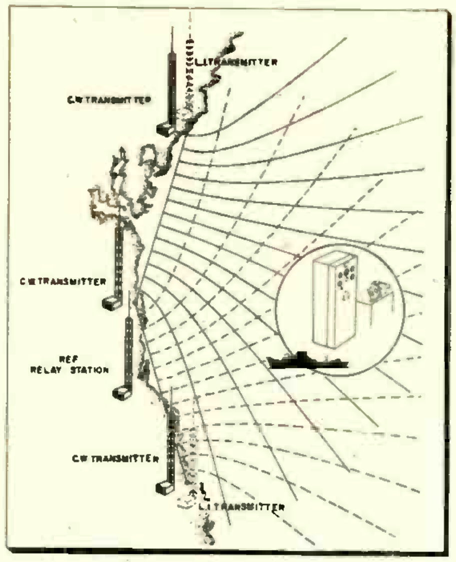
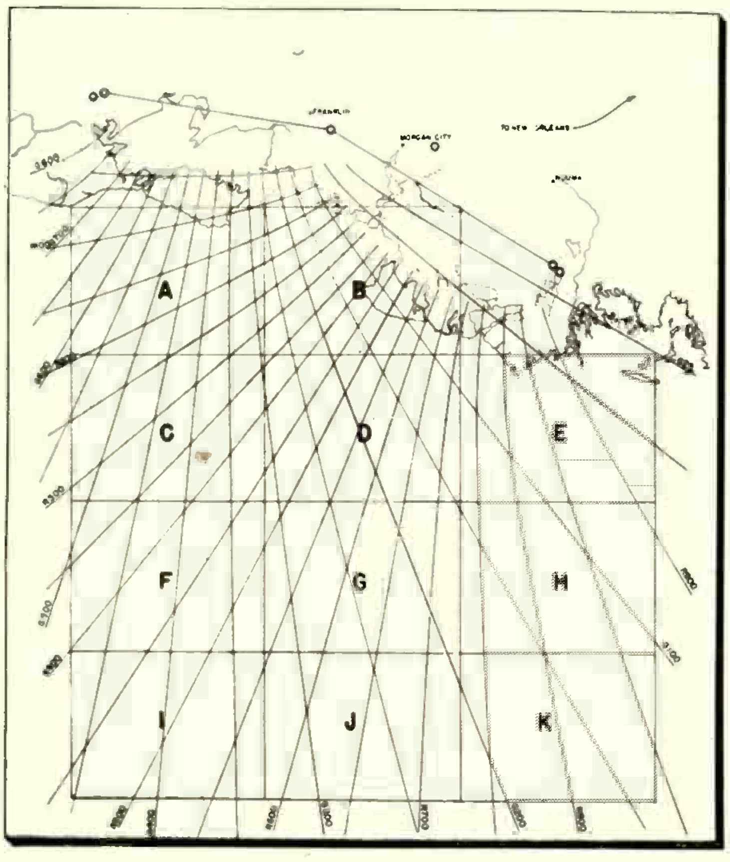
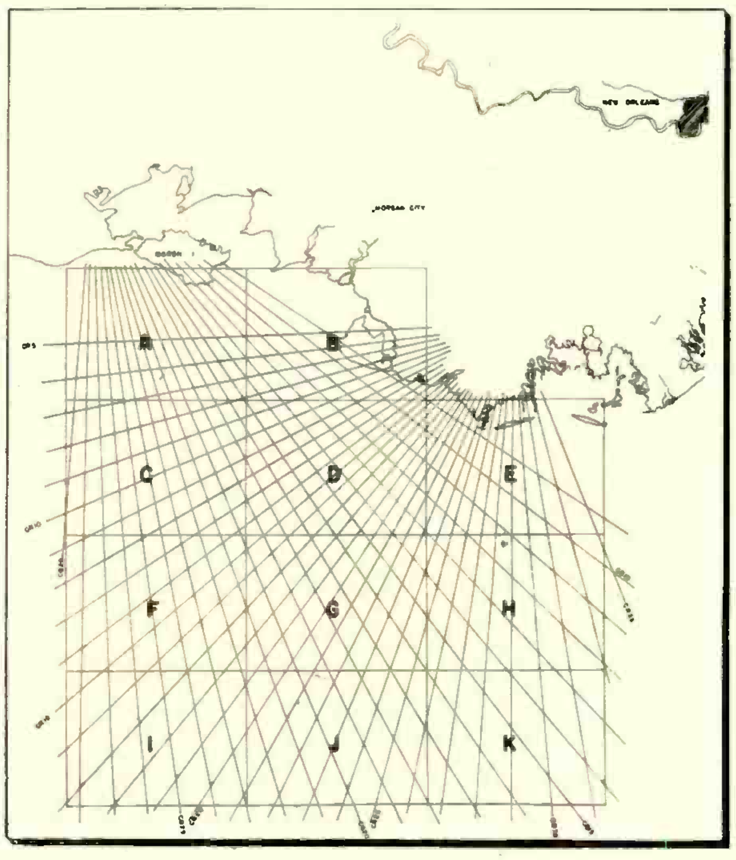


Fig. 1: Type N Raydist employs transmitters on shore, and receiving and phase-measuring equipment on craft exploring for oil in Gulf

Fig. 2: (l) Fine lanes with long baselines used in hyperbolic system in Gulf of Mexico network. Fig. 3: (r) Coarse lanes with short baselines





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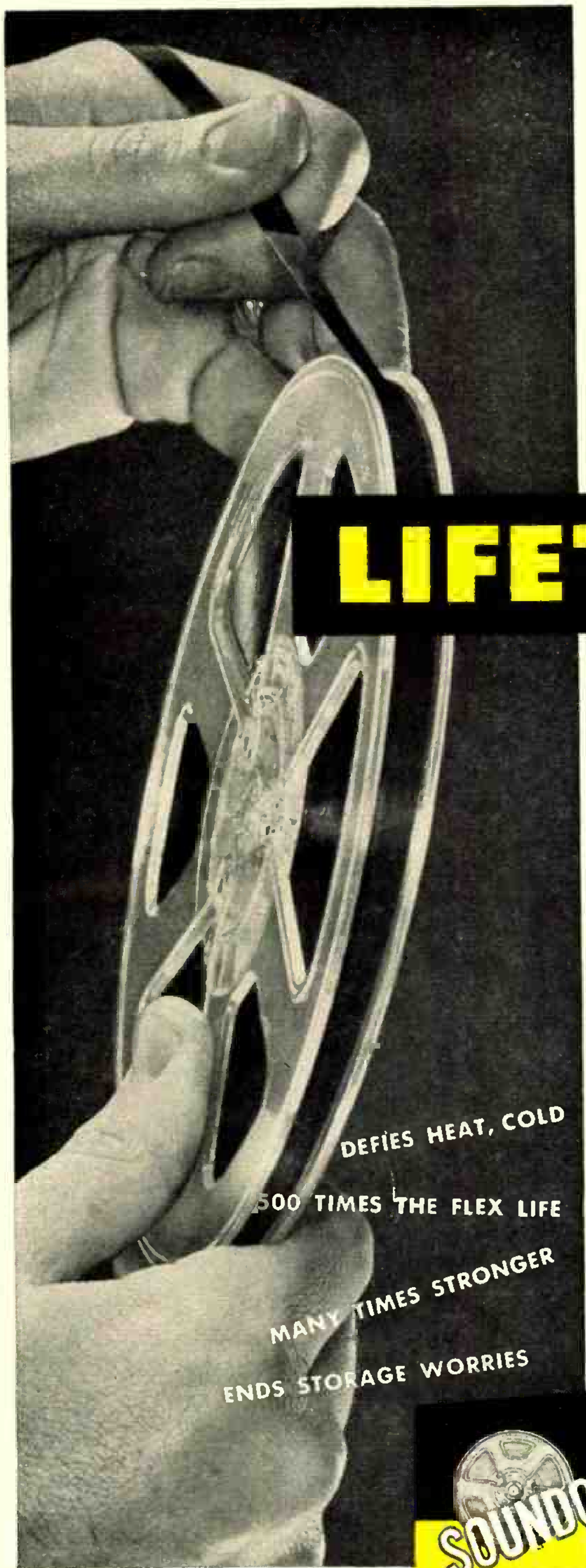

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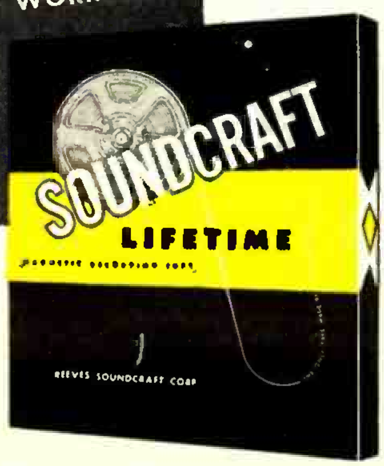

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RAYDIST

(*Continued from page* 114)

sults in audio signals being received at the fixed relay station and in the craft. The beat notes between these signals received at the relay station modulate the relay transmitter which in turn broadcasts to all craft being served by the system. After the audio notes are transmitted from the relay station to the craft, they are compared in phase with the audio beat notes received directly in the craft. Sufficient information is obtained from the phasemeter readings between pairs of these audio notes for an accurate determination of position.

The phase-measuring system is essentially a narrow bandpass filter. The signals are split in phase and supply torque to the synchro, or indicator, units. The synchro is driven first in one direction and then in the other direction by static or stray signals within this band. However, these effects are damped out by the inertia of the synchro. By using more transmitters than are required for a fix, it is possible to check the phasemeter readings and the accuracy of the measurements. At the present time nine Master Stations are being used on nine different boats in the Gulf of Mexico.

Lane Identification

The Type N System also includes a lane identification method. The phasemeter in the vessel denotes any fraction of a lane but is unable to determine which particular lane it is recording. A special means of identifying these lanes is also supplied. This may be done in two ways —either by the addition of transmitters to increase the number of lines of position with fewer ambiguities, or the operation of the system on different frequencies, thus enabling ambiguities to be resolved. Since frequency spectrum space is so scarce, the short baseline lane identification method has been used with the Type N System.

Referring to Fig. 1 once more, note that for this short baseline method an extra transmitter (marked L.I.) is added rather close to both of the end stations. The other transmitters are normally spaced about 50 miles apart whereas the distance between the end station transmitter and the lane identification transmitter would be about 2 to 3 miles apart. These extra transmitters result in two additional families of hyperbolas which overlay the original

(*Continued on page* 124)

A Statement on COLOR from Federal Telecommunication Laboratories

In view of the tremendous interest in equipment to meet the new FCC color specifications, we want the Television Broadcasting Industry to know exactly what Federal Telecommunication Laboratories has done and is doing with regard to color equipment.

Federal Telecommunication Laboratories produces a complete line of standard monochrome television equipment. Our VHF and UHF transmitters now incorporate many important basic concepts that meet the new color specifications.

Two outstanding examples of this are:

- The FCC Specifications require that the 4.5 Mc separation between picture and sound carriers shall be held to ±1000 cps in order to reduce mutual interference between sound and chrominance signals. Federal's transmitters use an exclusively designed circuit to electronically lock the aural transmitter frequency to the visual transmitter frequency with a precision such that the maximum deviation is ±100 cps.
- The FCC Specifications require a minimum phase shift of the chrominance sub-carrier signal with changes in video level to minimize color distortion. All Federal transmitters use mid-level modulation — a system that reduces the phase shift.

At present our engineering staff is completing the development of the remaining minor circuit modifications to enable all Federal transmitters now in the field, as well as those in current production, to transmit color.

Of particular importance is the fact that Federal transmitters have a built-in stabilizing amplifier that is being adapted to accept color inputs. This means that only the addition of a color monitor and a color distribution amplifier will be necessary to satisfy the minimum requirements for the transmission of network color signals.

The cost of these modifications will be nominal and will be published at an early date.

With the present outstanding performance characteristics of FTL's transmitters plus the minor modifications now being completed, you can be certain that Federal transmitting equipment will be fully compatible for the transmission of color as well as black and white.

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Duplexing System

(Continued from page 77)

ance. Therefore it was necessary to use two-gang capacitors. Because these were to be mounted with the plates vertical to avoid trapping of tiny air bubbles with resultant pin-point arcs, it became necessary to use right angle drives so that tuning could be done by means of knobs protruding through a top cover of the assembly. The desire to tune all circuits resulted in the use of eight dual capacitors instead of six. Doubtless, in a low-power application, a unit which could be mounted in air could be made with six fixed dual capacitor units, and minor changes made by adjusting inductors, with a resulting standing-wave ratio of acceptable value.

The inductors were made from standard, commercially available sections consisting of 8 turns/in. of No. 14 enameled copper wire, 2⅛ in. in diameter, air wound on polysty-

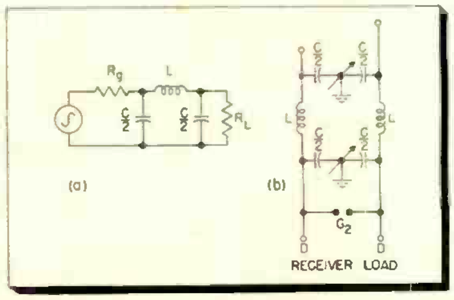


Fig. 3: A lumped constant section

rene ribs. The inductors L had 6⅓ turns and were reinforced with extra ribs because of the sudden large flux changes associated with pulsed transmission.

The test procedure was laid out so that it was necessary to raise and lower the heavy assembly into the oil a minimum number of times. The test equipment consisted of a signal generator and r-f amplifier, and a 600-ohm balanced match meter[5] although any good balanced impedance-matching meter could have been used.

Performance

Attenuation of a filter is usually calculated under the assumption that the load remains the same in the attenuation band as in the pass band where it has a value which matches the characteristic impedance for which the filter was computed. In practice, however, this is far from the case.[6] Almost any impedance combination may appear at the load terminals in the attenuation band and the most that can be said is that the calculated attenuation is a relative indication of attenuation if a sufficient number of filter sections are used.

In our case the calculated attenuation[4] was 40 db per section at 100 MC. In actual use the interference prevailing before the system was used could no longer be detected.

Although the equipment was designed to operate on a fixed frequency, it will function over a fairly wide band. The design frequency was 13.8 MC but a rough check with a signal generator indicated a reasonable standing-wave ratio on frequencies at least between 13 and 14 MC. Time did not permit a more exact check or a mathematical determination of useful frequency range.

Ed. Note: Material presented in this paper is also a part of NBS Report No. 2025 by the same title.

1. W. L. Hartsfield, S. M. Ostrow, and R. Silberstein, "Back-Scatter Observations by the Central Radio Propagation Laboratory—August 1947 to March 1948," *Jour. of Res. of the National Bureau of Standards*, Research Paper RP2071, 44, February 1950.
2. R. Silberstein, "Interpretation of High-Frequency C-W Field Intensity Records with the Aid of Simultaneous Pulse Data," *National Bureau of Standards Report* No. 1085, July 27, 1951; also *Proc. I.R.E.*, 40, 8, 974-976, August 1952.
3. W. L. Hartsfield and R. Silberstein, "A Comparison of C-W Field Intensity and Back Scatter Delay." *National Bureau of Standards Report* No. 1297, Nov. 16, 1951.
4. W. L. Everitt, *Communication Engineering*, McGraw-Hill, 1937.
5. P. G. Sulzer, "A VHF Match Meter," *Television Engineering*, July 1950.
6. George Grammer, "Eliminating TVI with Low-Pass Filters," Part I, *QST*, 34, 2, 14-25, Feb. 1950.

IRE Group on Component Parts Formed

A Component Parts Professional Group has been organized in the Institute of Radio Engineers for the purpose of promoting continued improvement of electronic components and providing channels for exchanging both functional and environmental test information on component parts among research, development and production organizations.

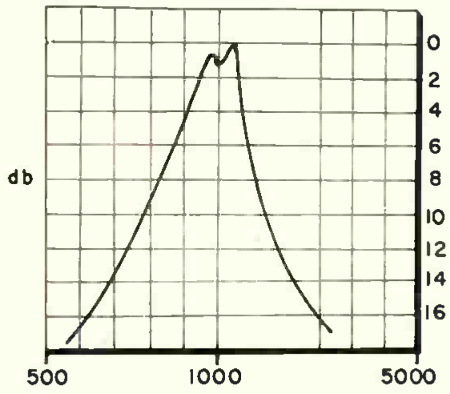
This group with the cooperation of the American Institute of Electrical Engineers, other professional groups of the IRE, the Radio-Electronics Television Manufacturers Association and the West Coast Electronics Manufacturers Association along with the active participation of the U.S. Department of Defense and the National Bureau of Standards will sponsor the Electronic Components Symposium scheduled to be held in the auditorium of the Department of Interior in Washington, D.C. on May 4, 5, 6, 1954.

Membership of the PGECP is open to all IRE members. Application forms may be obtained from Dr. Fred Haynes, Supervisor, Electronics Product Section, The Glenn L. Martin Co., Baltimore, Maryland or Miss Emily Sirjane, IRE, 1 East 79th St., New York 21, New York.

CUES for BROADCASTERS

(Continued from page 89)

desired effect. However the filter is too sharp and gives a ringing, typical of very sharply tuned audio circuits. A simple way to improve this



Response curve of telephone filter devised from FL 30 range filter and 1 meg. pot.

is to bridge the filter with a variable control. This can be removed after the desired effect is obtained, and replaced with a fixed resistor. The variable resistance we used was a one megohm volume control.

Remote Control for Pushbutton Transmitter

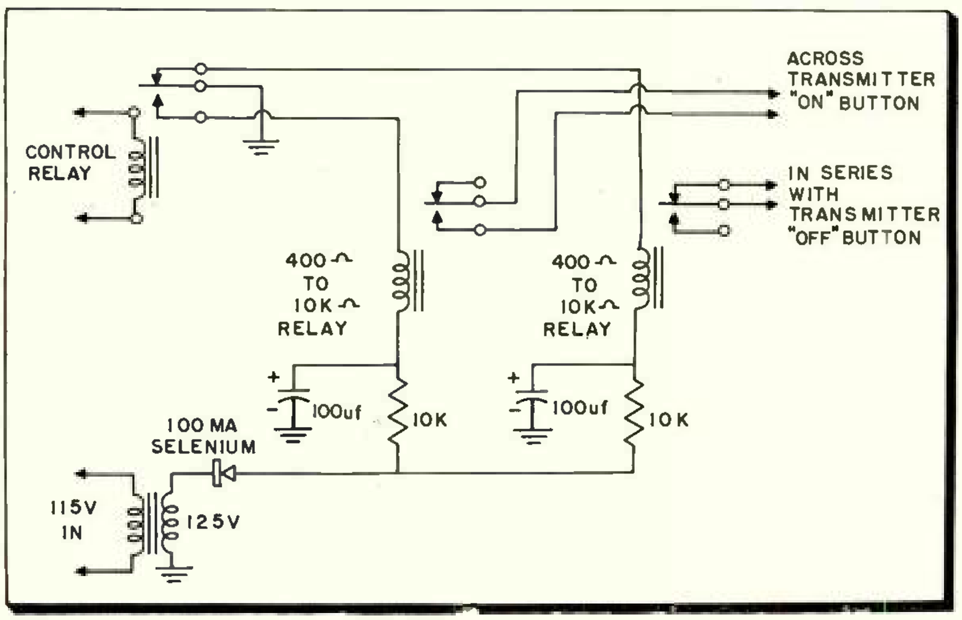
PHILIP WHITNEY, Chief Engineer WINC, WRFL, Waynesboro, Pa.

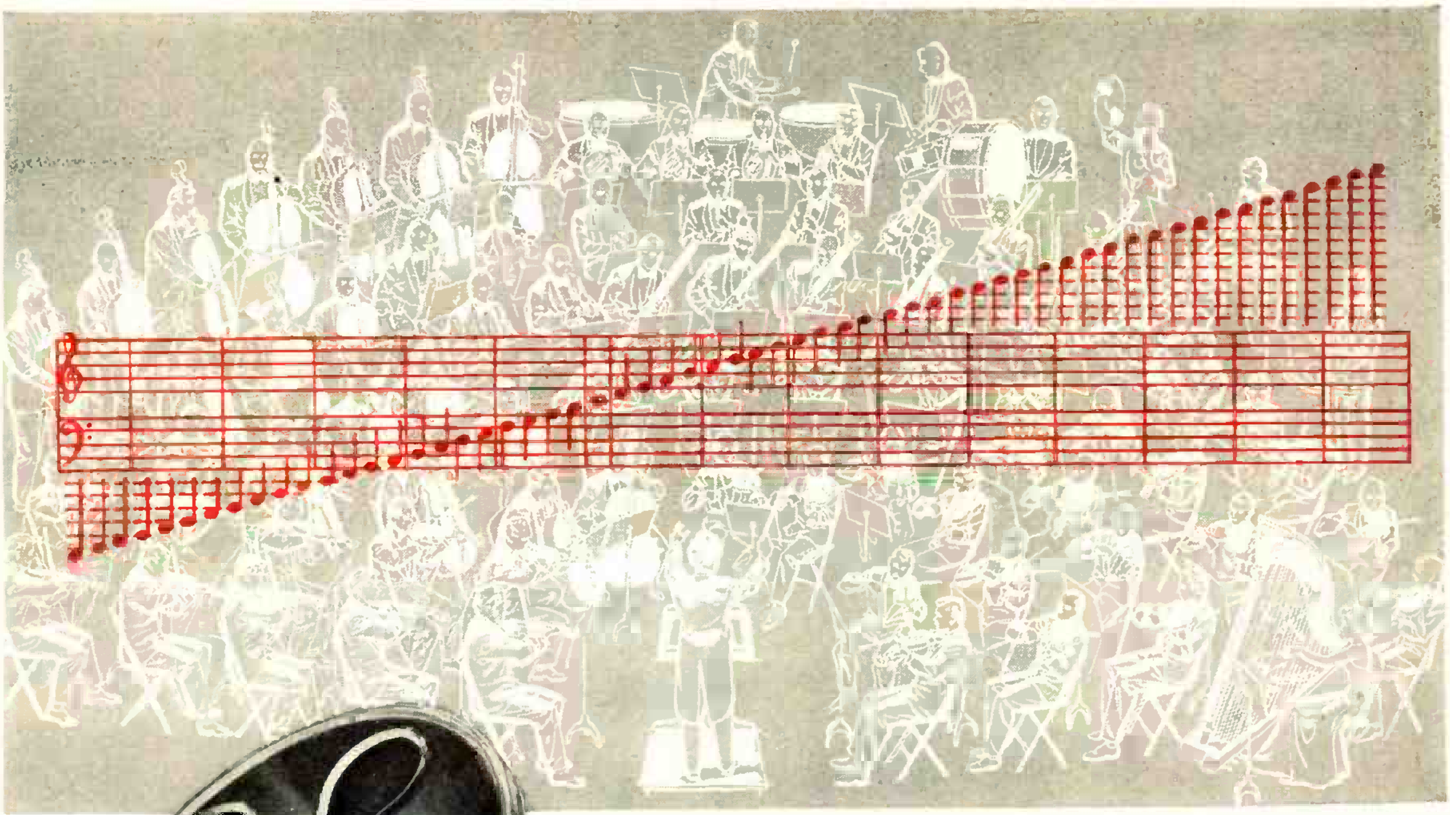
NOW that many stations are converting to remote control operation, a number of them have been confronted with "pushbutton" transmitter troubles. This type of transmitter is one which is started or stopped by depressing a button.

The filament and plate circuits are operated by a pushbutton which must be held down momentarily, and are shut off by the momentary depression of another pushbutton. The buttons lock in a relay having contacts which thereafter hold it in. If the button is shorted out for remote control purposes, the protective circuits in the transmitter power control relay arrangement are disabled. If the remote control relay is used only momentarily to put the transmitter on or off, the important "fail safe" feature of transmitter shutdown in case of line or equipment failure is not used. Therefore, a control relay with back contacts should be used to hold either the plate or filament controls on, or both. Then, a "momentary—on" relay arrangement as shown can be used to short the "on" button, or open the "off" button circuit, momentarily and return the circuit to normal after a second or two.

The circuit operates on a capacitor charge. The charging resistors between the power supply and capacitors are high enough in resistance to prevent the the relays being held in. Therefore, the relays operate only until the capacitor charge has been dissipated and cannot be reoperated until the controlling relay has been deactivated. As this relay returns to its back contacts, another set of relays is actuated by their capacitor charges, opening the "off" button circuit. Thus, should the remote control phone line become shorted, or opened, the transmitter would shut down. Relays with values between 400 ohms and 10,000 ohm plate relays have been used successfully. Capacitor size and resistance can be varied to match the particular relay and the time cycle.

Remote pushbutton transmitter control operated by capacitor charge provides safety





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ANALOG COMPUTING

(Continued from page 101)

not to produce so called self-heating) and in direct relation to ab cos ϕ. Assuming $\phi = 0$, one has:

$$d = C \times f(ab)$$

Experience also shows that if ab is within certain practical limits, said function f (x) is of the form

$$f(x) = (k^1 x) / (1 + p\tau)$$

where k^1 is an attenuation factor and τ a time constant. Both constants will be specified later. Suffice it to mention that the possibility of representing f(x) as above has been substantiated by recording the transient response of the transducer under the excitation of step function inputs.

Let us consider now a few applications of this transducer in circuits involving feedback amplifiers.

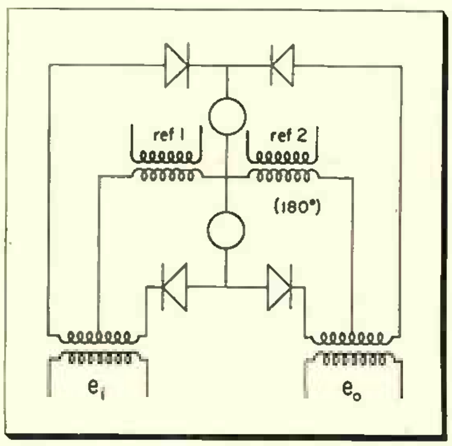
Multipliers and Dividers

The basic circuit is shown in Fig. 3. The transducer in this application has two pairs of sensing elements. Those of (1) are matched to each other, and so are the sensing elements, (2). As far as the heater is concerned, no matching is required with anything else. If G denotes the open loop gain of the amplifier, and b denotes one of the inputs, a simple analysis shows that:

$$x = \frac{b}{1 + \frac{1+p\tau}{k^1 G}\,\frac{1}{aR}} = \frac{ad}{c}$$

This multiplier and divider performs two functions: First, by the use of feedback amplification it matches x to b with an inherent accuracy and time delay depending on the feed back loop. Second, because of the matching of sensing elements (1) and (2), one has xc = ad or bc ad.

Fig. 5: Circuit of self heating transducers



For given value of a and R, good static accuracy requires high value of k^1G (consistent with stability and saturation). Similar requirement prevails for having short apparent time constant τ/k^1GaR. The limitation in high k^1G is imposed not only by considerations of stability, but also by dynamic requirements of the multiplier, viz., to avoid saturation of the amplifier in case of fast modulated input signals. The multiplier has, of course, basic limitations, due for instance, to the attenuation coefficient k^1. In the original unit constructed with a single pair of sensing elements as per Fig. 2, (and denoting by $T(p) = k/(1+p\tau)$ the transfer function d/a for the most appropriate values of reference signals b and c) k had a value of 1/300. This has been raised recently to 1/100. By a very latest redesign (to be described shortly) k could be raised to about ½. The open loop time constant (τ) has been reduced from about 10 seconds to 1 second in the original design. In an experimental model built lately, it barely amounted to a few milliseconds. As an indication to some design features, the multiplier weighs a few ounces, occupies a space of 5 to 6 cu. in., exclusive of the amplifier. The latter could be easily transistorized, although in all our tests VT amplifiers have been used. The overall accuracy achieved in this multiplier is of the order of ½% to 1%. It could possibly be improved.

AC Integrator and Differentiator

The technique employed for differentiation or integration of dc signals could not be used with ac for very obvious reasons; among others, because any direct integration or differentiation would be applied to the carrier, rather than the modulation of the carrier input. The use of a thermal transducer overcomes this difficulty with ease, since its transfer function $k/(1+p\tau)$ is applied to the RMS and not the instantaneous value of the incoming signal. If e_i and e_o denote the input and output signal respectively, the operation $e_o = -Ae_i/p\tau$. With A 1 can be instrumented by using the equation:

$$-ke_o + (e_o - Ae_i)\frac{k}{1+p\tau}G = e_o$$

$$\frac{e_o}{e_i} = \frac{-A}{p\tau}\,\frac{1}{1 + \frac{1+p\tau}{p\tau kG}}$$

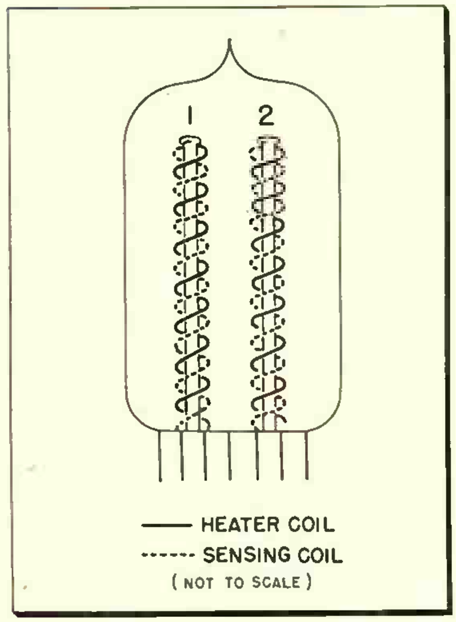


Fig. 6: Construction of thermal unit. Heating and sensing windings on rods are in thermal, but not electrical, contact with each other

Circuit shown in Fig. 4 is the physical embodiment of this instrumentation. It requires in addition to the thermal transducer one cathode follower, one high gain amplifier and sundry small parts.

A great variety of other applications has been worked out, not only in the computer field, but in the servo and instrument arts. Lack of adequate space prevents their full description here. Suffice it to mention among others, frequency changers, quadrature and harmonic rejectors, modulators and demodulators, lead networks, in phase and quadrature signal separators, precision phase shifters, etc.

Self Heating Transducers

These units are based on a design in which the heater elements and the sensing elements, (L_1) and (L_2), are identical. The circuit shown in Fig. 5 provides the basic feature of these units. Reference signals shown are 180° out of phase with respect to each other; thus, while L_1 is heated, L_2 is sampled and vice-versa. Physically, L_1 and L_2 are light bulbs with tungsten filaments. Because the filaments are maintained at very high average temperatures, the time constants involved appear to be just a few milliseconds, while the attenuation is barely of the order of 6 db. (k ½ or slightly less). The operation of this transducer is very similar though not identical with those previously mentioned. In particular, the average differential heat dissipation between L_1 and L_2 is proportional to $4R_1e_i \cos\phi$ where ϕ is the carrier phase differential between R_1 (reference signal No. 1) and the input e_i.

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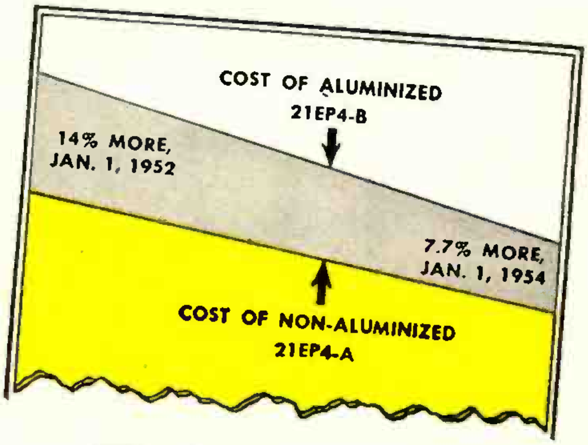

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16KP4-A	*21YP4-A	*24CP4-A
27EP4	*27RP4	

*Recommended types

GENERAL ELECTRIC

162-1A1

RAYDIST

(*Continued from page* 116)

hyperbolic families. These second families of hyperbolas are known as a coarse hyperbolic system (short baseline) since they have fewer hyperbolas than the original families which in turn are referred to as a fine hyperbolic system (long baseline). After the operator determines the coarse lane in which his vessel is located, he can refer to the phasemeter readings of the two coarse lanes, which in turn will enable him to determine the two fine lanes at which he is located at that time.

Fig. 2 shows the fine lanes (long baseline) of the hyperbolic Raydist system used in the Atchafalaya network on the Gulf. Note that the lanes are numbered at 50 lane intervals, illustrating the fineness of the system. The "G," standing for "Green," represents the lanes derived from one of the original hyperbolic families, and the "R," standing for "Red," represents the lanes emanating from the other original hyperbolic family. As each line of position represents 50 lanes, it is easily possible to read to 0.002 of a lane and considerable data are available where repeatability has been found to be better than 0.01 of a lane over long periods of time.

Coarse Lanes

Fig. 3 shows the coarse lanes (short baseline) of the hyperbolic Raydist system, covering the same area as in Fig. 2. In this photograph each lane is numbered consecutively, which illustrates how few hyperbolas make up this coarse hyperbolic system. The "CR" stands for "Coarse Red" which represents one additional hyperbolic family, and the "CG" represents the other additional hyperbolic family. It is true that there are still ambiguities which must be resolved in this coarse system. However, other general information as to the location of the ship is readily available through the use of regular navigational aids, such as radio bearings, radio direction finding devices, etc., which enable the operator to know his approximate position within the limits of the coarse system.

Some difficulties have been encountered with the short baseline lane identification system due to the small band of frequencies at our disposal and the urgent necessity of keeping the system operating at its highest peak of efficiency. In order to conserve frequencies we first proposed an automatic switching system

(*Continued on page* 132)

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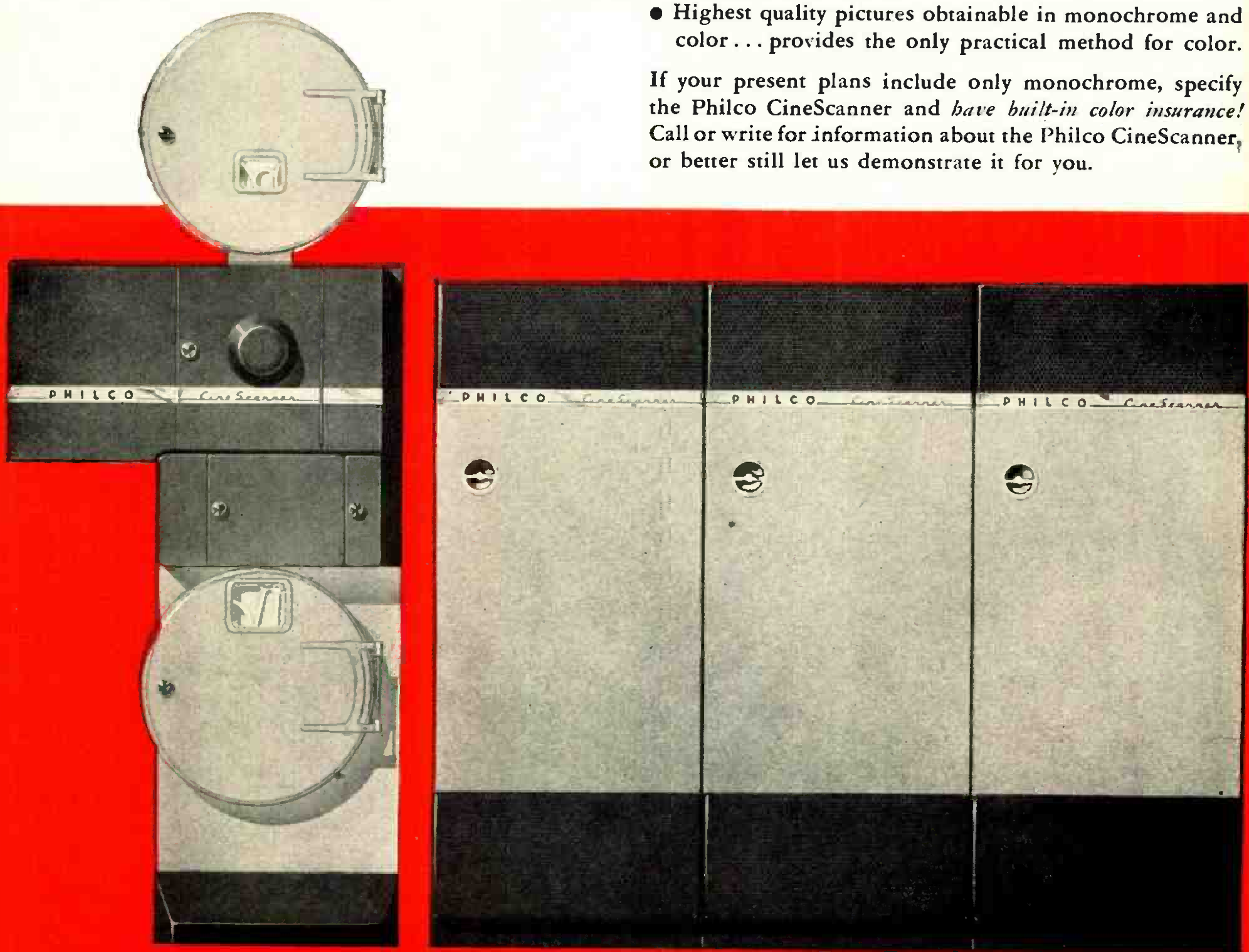

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Diode Noise Generator

(*Continued from page* 83)

equations of Eqs. (4) and (5).

From these two equations the values of R and X required for a specified R_0 can be calculated. In this derivation it has been assumed that R and X are in series. It is more practical to obtain the equivalent parallel combination of resistance and reactance which will present the same impedance as the series combination. From elementary circuit theory the parallel R′ and X′ are as in Eq. (6).

When the necessary network values are computed from the expressions derived above, it is found that the values are of the order that can be obtained from the associated reactances of the leads and capacitors employed for dc connections and bypassing, with the exception of R′. At 500 MC it was necessary to add a small "hairpin" inductance to obtain the exact X′ desired, while R′ was obtained from several resistors arranged to minimize reactance effects. As the value of R′ was not far from 300 ohms at 500 MC, a simple impedance matching network was made of the leads between the resistors and the output terminals so that the effective impedance of the generator as seen from the output terminals was 300 ohms resistive and balanced to ground.

After the proper diode network was designed, it was necessary to complete the generator design. Plate and filament voltages were supplied through quarter wave coaxial lines with the supply ends well bypassed. Not only do the lines present an extremely high impedance to the diode terminals but their outer conductors provide an excellent low inductance ground return for the diode load resistors.

Plate voltage was obtained from a conventional supply employing a glow discharge regulator tube. Filament voltage is adjusted by two series rheostats to provide both fine and coarse adjustment of plate current.

The generator was shielded and provided with a short, heavy ground strap to minimize regeneration problems. A complete circuit of the generator is shown in Fig. 2.

Several precautions in making noise factor measurements must be observed with any noise generator if reasonable accuracy is expected. The receiver must always be operated well below the overload point as any nonlinearity will produce serious errors. The output indicator must read relative *power* or be calibrated to do so between the points of interest. If the receiver has an AGC system, it must be disabled and the gain adjusted manually during the measurement. The noise generator should be grounded with a low inductance lead to the receiver chassis. Also, the generator should be connected to the receiver with UHF 300-ohm line which is preferably an integral number of half waves in electrical length (for example, 40 cm of polyethylene line at 500 MC). Unless the line voltage stability is unusually good, the use of a constant voltage transformer for *both* the receiver and the generator is advantageous. If these precautions are taken, the noise factor can be readily computed from the expression,

$$F = \frac{6I}{n-1} \text{ times,}$$

$$\text{or } F = 10 \log_{10} \frac{6I}{n-1} \text{ db}$$

where: I is diode current in milliamperes

n is change in receiver power output from diode off to diode on at I ma.

The major disadvantage inherent in the use of an essentially VHF diode at UHF is the necessarily narrow bandwidth which results if any reasonable output is desired. However, for a large amount of UHF investigation and production work this is not a serious limitation. The 5722 can be used at 500 MC to permit direct measurement of 24 db noise factor with n equal to two and with a balanced internal impedance of 300 ohms. Typical generators using this approach having a bandwidth of 40 MC at 500 MC produced noise factor measurements of the order of 20 db with less than one decibel of disagreement with other standard methods of noise factor measurement.

NEW ANTENNA PLANT

Harry, Joe and Lou Resnick prepare to throw the switch which put an extrusion press into operation at the opening of Channel Master's new TV antenna plant in Ellenville, N. Y. New facilities which are said to increase company's production potential more than four times provide 115,000 sq. ft. of floor space and six assembly lines

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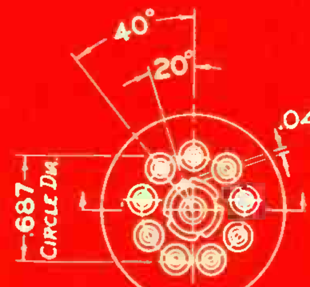
8 TERMINAL

FIG. 1	PART NO. FIG. 2	FIG. 3	FLANGE DIA.	SHOULDER DIA.	A	B	EXHAUST TUBULATION
A7079-1	A7042-1		1.250	1.175	1/8	040	As Shown
A7079-2	A7042-2		1.250	1.175	1/8	040	None
A7045-1	A7137-1		1.250	998	1/8	080	As Shown
A7045-2	A7137-2		1.250	998	1/8	080	None
A7138-1	A7139-1		1.235	1.062	1/8	045	As Shown
A7138-2	A7139-2		1.235	1.062	1/8	045	None
A7108-1	A7140-1		1.125	998	1/8	080	As Shown
A7108-2	A7140-2		1.125	998	1/8	080	None
A7141-1	A7142-1		1.062	998	1/8	080	As Shown
A7141-2	A7142-2		1.062	998	1/8	080	None
		A7041-1	—	1.062	1/8	—	As Shown
		A7041-2	—	1.062	1/8	—	None
		G7143-1	—	998	1/8	—	As Shown
		G7143-2	—	998	1/8	—	None

Bayonet Type

9 TERMINAL

FIG. 1	PART NO. FIG. 2	FIG. 3	FLANGE DIA.	SHOULDER DIA.	A	B	EXHAUST TUBULATION
A7144-1	A7058-1		1.250	1.175	1/8	040	As Shown
A7144-2	A7058-2		1.250	1.175	1/8	040	None
A7038-1	A7145-1		1.250	998	1/8	080	As Shown
A7038-2	A7145-2		1.250	998	1/8	080	None
A7146-1	A7147-1		1.235	1.062	1/8	080	As Shown
A7146-2	A7147-2		1.235	1.062	1/8	080	None
A7148-1	A7149-1		1.125	998	1/8	080	As Shown
A7148-2	A7149-2		1.125	998	1/8	080	None
A7150-1	A7151-1		1.062	998	1/8	080	As Shown
A7150-2	A7151-2		1.062	998	1/8	080	None
		A7047-1	—	1.062	1/8	—	As Shown
		A7047-2	—	1.062	1/8	—	None
		G7152-1	—	998	1/8	—	As Shown
		G7152-2	—	998	1/8	—	None

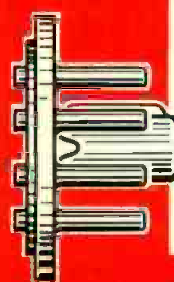


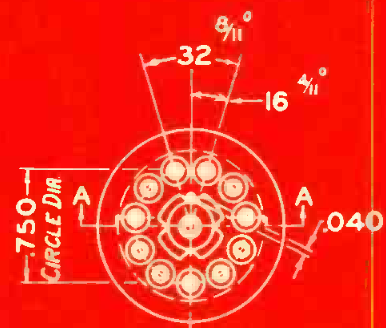
Polarizing Plugs

11 TERMINAL

FIG. 1	PART NO. FIG. 2	FIG. 3	FLANGE DIA.	SHOULDER DIA.	A	B	EXHAUST TUBULATION
A7085-1	A7059-1		1.250	1.175	1/8	040	As Shown
A7085-2	A7059-2		1.250	1.175	1/8	040	None
A7046-1	A7084-1		1.250	998	1/8	080	As Shown
A7046-2	A7084-2		1.250	998	1/8	080	None
A7153-1	A7154-1		1.235	1.062	1/8	045	As Shown
A7153-2	A7154-2		1.235	1.062	1/8	045	None
A7155-1	A7156-1		1.125	998	1/8	080	As Shown
A7155-2	A7156-2		1.125	998	1/8	080	None
A7157-1	A7158-1		1.062	998	1/8	080	As Shown
A7157-2	A7158-2		1.062	998	1/8	080	None
		A7048-1	—	1.062	1/8	—	As Shown
		A7048-2	—	1.062	1/8	—	None

Available also with solid pins





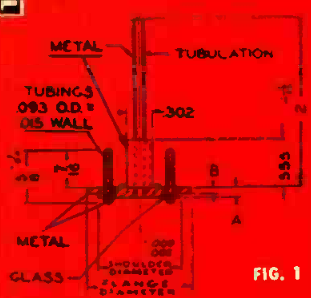


FIG. 1

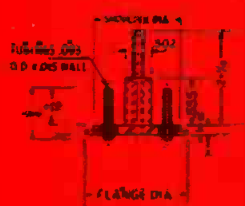


FIG. 2

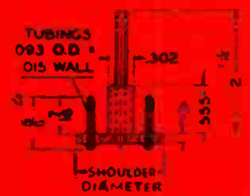


FIG. 3

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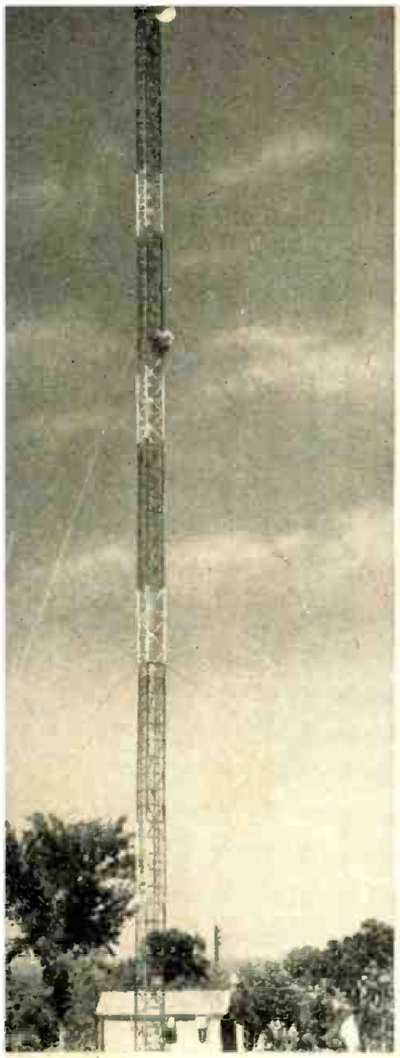
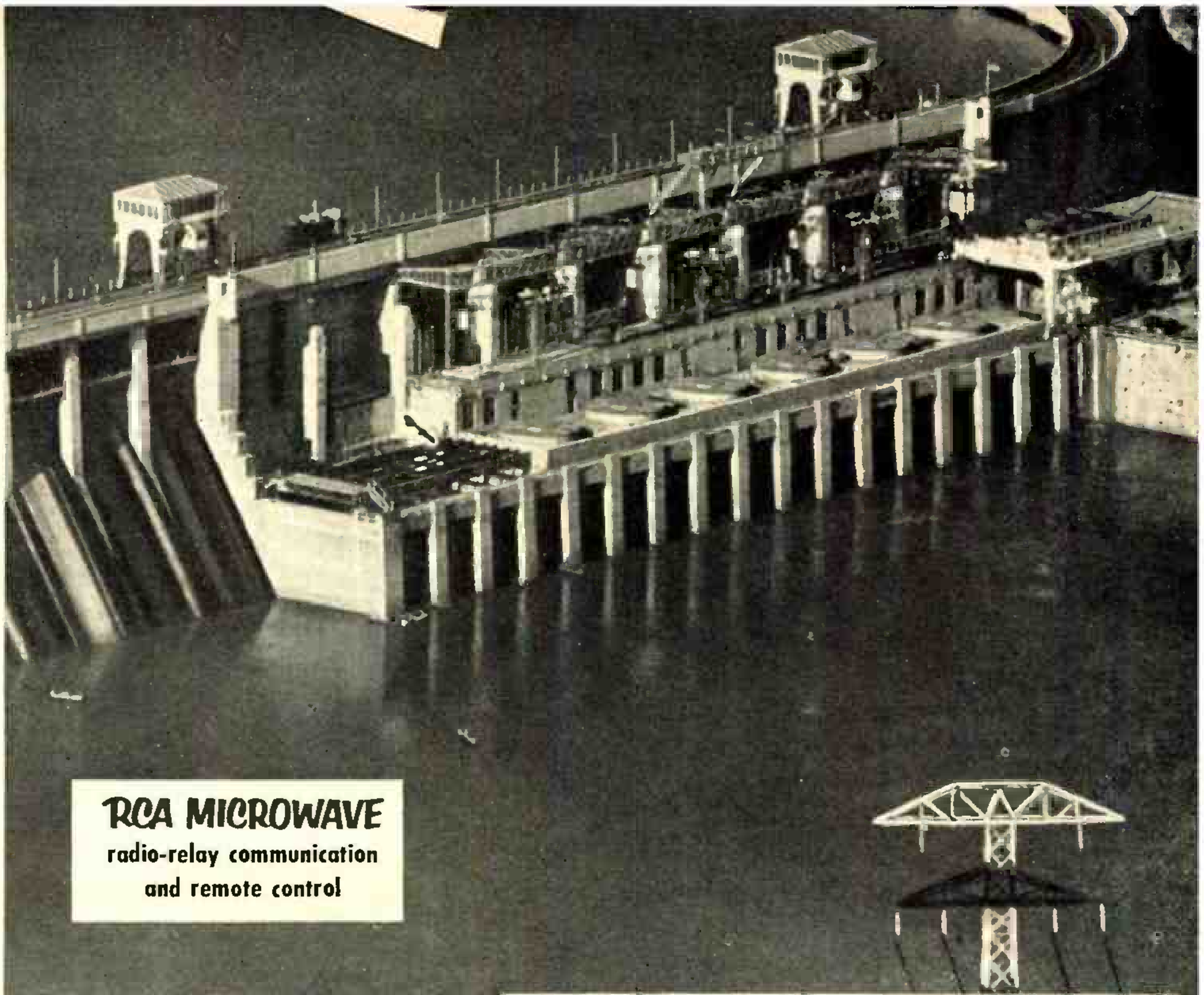
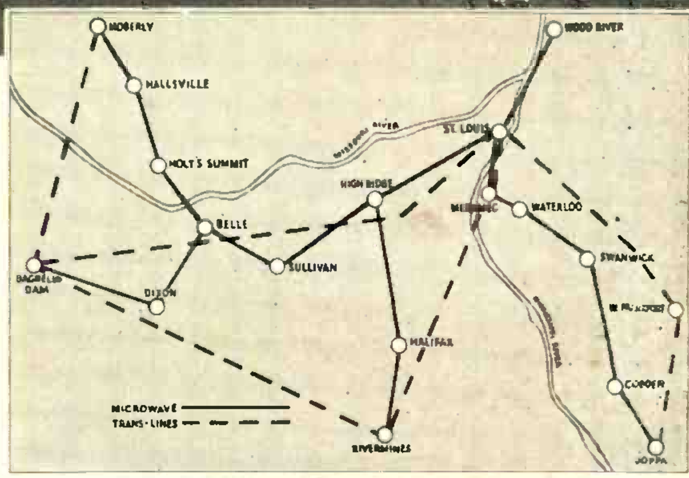


CA Microwave radio relay installation t High Ridge, Mo. Towers are rugged, esigned to withstand 100-mph winds nder severe icing conditions.



Osage Hydroelectric Power Plant installation of Union Electric Company of Missouri, at Bagnell Dam, Mo.—serviced by RCA Microwave.



Union Electric Co. Microwave system stretches out 425 miles in 3 directions from St. Louis.

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That prompted engineers to adopt Microwave, supplemented with mobile radio at major relay points. RCA Microwave provides channels for remote control of load dispatching, telemetering, teletype and voice communication. It results in close co-ordination of vehicles, field crews, executive and service personnel at outlying offices and stations. And, 70% of the RCA Microwave system is available for future expansion.

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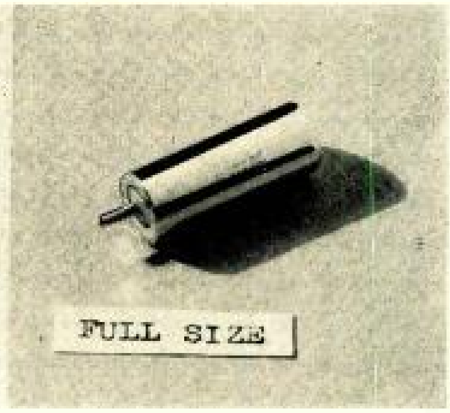
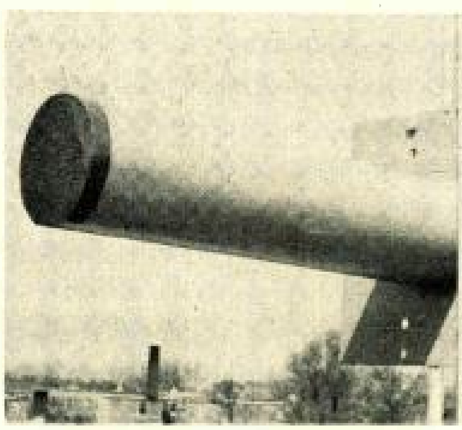
THERMOSTAT

The VAL 90 is a friction couple-type, snap-action, miniature thermostat that operates with less than half the former differential of 5F, i.e., 2F or better. The unit is designed to be laboratory-adjusted for differential and a setting tolerance of ±3F, or better. Standard settings to 300F, rating 30 v., 60 w., and 120 v., 100 w, ac-dc. Each thermostat is hermetically sealed, given a "life" run, and checked before release. **Valverde Laboratories, 252 Lafayette St., New York, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.


FULL SIZE

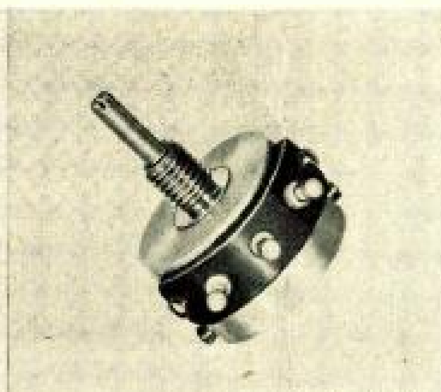
HELICAL ANTENNA

Comparable in performance to a 4 ft. parabola, the model H-960 helical beam antenna provides 15 db gain and is intended for point-to-point applications in the 890-960 MC region. So that advantage can be taken of their decoupling possibilities in adjacent circuits, the units are made available in either the righthand or lefthand sense. The antenna consists of a molded 30-in. fiberglas helix with a 4 in. diameter that is rigidly mounted to a 16 in. sq. ground plate. **Mark Products Co., 3547-49 Montrose Ave., Chicago 18, Ill.** —TELE-TECH & ELECTRONIC INDUSTRIES.



POTENTIOMETER

The D-100 precision potentiometer has an anodized aluminum case, ⅞ in. in diameter, that is equipped with a bronze bushing. Its centerless ground stainless-steel shaft is supported by sleeve bearings—ball bearings, if specified. Rotor and resistance element are separated by "Paliney" contact material. The take-off brushes are made of gold alloy and rotate on a coin-silver ring. The metals provide noise-free operation for a life of one million cps. The unit is available with up to 360° electrical and mechanical rotation in resistance ranges up to 50,000 ohms, ±1.0%. **Jet Electronics, Inc., 93 Massachusetts Ave., Boston, Mass.**—TELE-TECH & ELECTRONIC INDUSTRIES.


ACTUAL SIZE

Industries

MULTIPLIER PHOTOTUBE

RCA-6342 head-on type vacuum multiplier phototube is designed to be used in scintillation counters for the detection and measurement of nuclear radiation and other applications involving low-level, large-area light source measurements. Features of the tube include a semi-transparent cathode with a ½ in. diameter; a flat face to facilitate mounting flat phosphor crystals in direct contact with the surface; ten electrostatically focused dynode stages; and a focusing electrode with an external connection. In critical applications, the electrode permits optimizing the magnitude, uniformity, or the speed of response. **Radio Corporation of American, Tube Dept., Harrison, N.J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

INDUCTOR

Type 590-A inductor is designed for use in the Q circuits of the types 170-A and 190-A Q meters. It is useful for measuring the r-f characteristics of capacitors, resistors, and insulating materials over a frequency range of 20 to 230 MC. They are also useful as reference coils and to indicate any considerable change in the performance of Q motors. The unit consists of a high Q coil mounted in a shield with spade lugs for connection with coil terminals of Q motors. To minimize changes in characteristics caused by stray coupling to elements or to ground, the shield is connected with the lugs connecting with the low coil terminal. **Boonton Radio Corp., Intervale Rd., Boonton, N. J.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Raydist

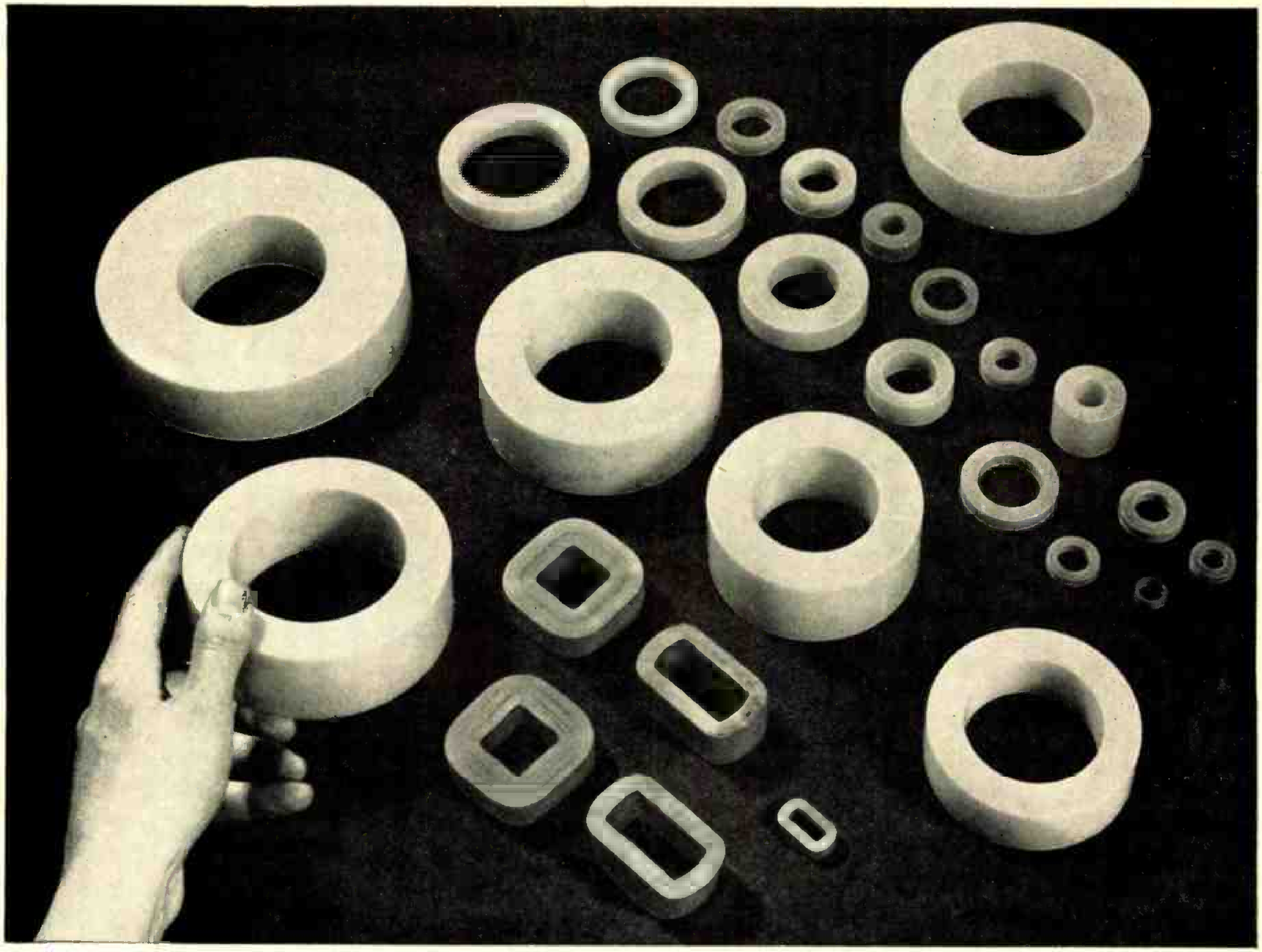
(*Continued from page* 124)

for the two components of a two-dimensional system. Due to the increased bandwidth requirements of a pulse system, we decided to use an audio frequency discrimination with filters between the two components, and by the use of matched filters, it has been possible to reduce the phase shift to a minute degree. This system has operated successfully even with lane identification superimposed on the same r-f frequencies, using the same type of audio frequency discrimination between components. Some difficulty has been encountered in filtering out the many unwanted harmonics and combination tones that occur between the fine lanes and the coarse lanes when both are transmitted simultaneously in the same narrow band. Also, considering the lack of real need for lane identification for this type of work in comparison with the desirability of having maximum stability of the system, continuous operation of the lane identification system has been temporarily suspended until certain improvements in the filters and detection of the many beats have been completed.

Type N Raydist is completely unsaturable and requires only two r-f assignments of narrow bandwidth. Therefore, being a multi-party system, it is ideal for setting up networks along the coast for this oil exploration work. For a navigation network any frequency assignment below 20 MC with a bandwidth of 0.1% of the frequency is satisfactory. Two such frequencies are required for operation of the system. The short baseline transmitters are operated on 450 and 850 cycle beat frequencies and the long baseline transmitters on 210 and 370 cycle beat frequencies.

It is interesting to note that there are only two narrow frequency bands assigned to Raydist in the radio spectrum on the Gulf. One is 10 kc wide and the other is 6 kc wide. With these two narrow bands of frequencies it has been possible to get three adjacent Raydist systems into operation. It has been necessary to have receivers with less than 3 kc bandwidth which are capable of discriminating between the systems.

The Raydist equipment on the Gulf has been used successfully 140 miles offshore during daylight hours, and the maximum range from the most distant transmitter was 155 miles. Satisfactory daytime operation may be realized in excess of 500 miles under excellent propagation conditions.



IN *TAPE-WOUND CORES*

JUST NAME YOUR REQUIREMENTS!

RANGE OF MATERIALS

Depending upon the specific properties required by the application, Arnold Tape-Wound Cores are available made of DELTAMAX . . . 4-79 MO-PERMALLOY . . . SUPERMALLOY . . . MUMETAL . . . 4750 ELECTRICAL METAL . . . or SILECTRON (grain-oriented silicon steel).

RANGE OF SIZES

Practically any size Tape-Wound Core can be supplied, from a fraction of a gram to several hundred pounds in weight. Toroidal cores are available in twenty-two standard sizes with protective nylon cases. Special sizes of toroidal cores—and all cut cores, square or rectangular cores—are manufactured to meet your individual requirements.

RANGE OF TYPES

In each of the magnetic materials named, Arnold Tape-Wound Cores are produced in the following standard tape thicknesses: .012″, .008″, .004″, .002″, .001″, .0005″, or .00025″, as required.

Applications

Let us help with your problems of cores for Magnetic Amplifiers, Pulse Transformers, Current Transformers, Wide-Band Transformers, Non-Linear Retard Coils, Peaking Strips, Reactors, etc.

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SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

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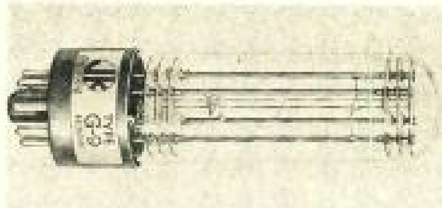
CRYSTAL

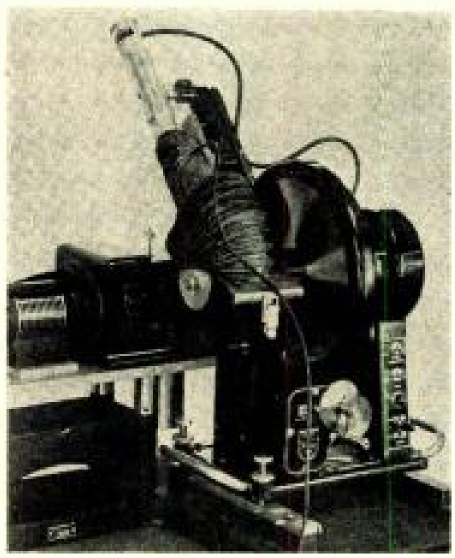
A new crystal has been added to the G-9 series which provides rugged, precise frequency control at temperatures



in the −40° to +70° C. range. Hermetically sealed in an evacuated glass holder, flexure mode crystals of the series are available from 4 to 80 KC. Their high ratio of capacities (C_0/C) provide a high degree of isolation from associated circuitry. **James Knights Co., Sandwich, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

X-RAY ATTACHMENT

A new attachment for Norelco X-ray spectrograph units uses helium instead of air in the path of the X-ray beam and extends the useful spectrum range of the analysis equipment. With an air path and a rock salt crystal good qualitative and quantitative results have



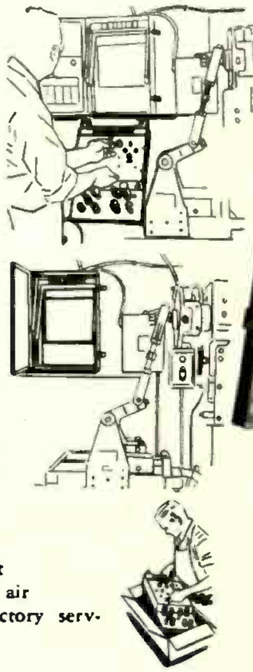
been possible from calcium (atomic #20) to uranium (atomic #92). With helium, the present work extends down to sulphur (atomic #16). A probable sensitivity limit of 0.02% for sulphur with comparable limits for other elements in the same atomic range is indicated. Accessory equipment includes a new X-ray tube and specimen-holder compartment housing, a new plate-type collimator and mounting, and an accordion-shaped rubber jacket that encloses the analyzing crystal and connects the specimen comparement to the Geiger-tube-collimator assembly. The jacket also has a helium supply tube attachment port. **North American Philips Co., Inc., Research & Control Instruments Div., 750 South Fulton Ave., Mount Vernon, N.Y.**—TELE-TECH & ELECTRONIC INDUSTRIES.

Are you designing any electronic equipment that should have —

❶ Easy installation and maintenance by non-technical personnel?

❷ Widest possible use by being instantly interchangeable between machines?

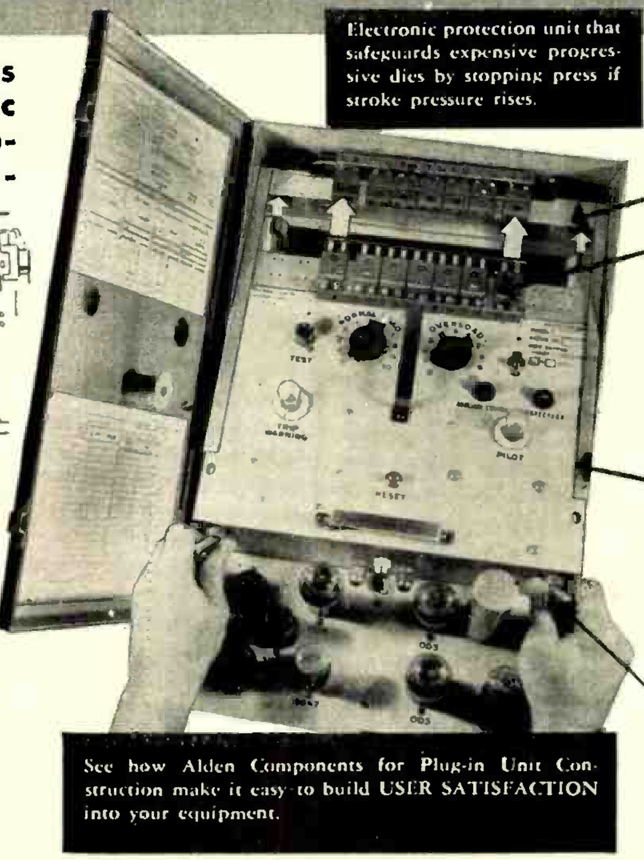
See how easily these features were built into this electronic punch press protection equipment with the Alden Serve-A-Unit Kit.



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

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

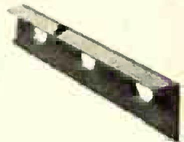
Inoperable unit easily shipable air express for factory servicing.



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

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

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



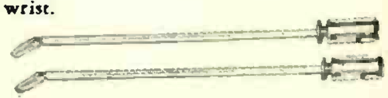
(B) ALDEN SLIDE-IN BACK CONNECTORS

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

(C) ALDEN SIDE RAILS

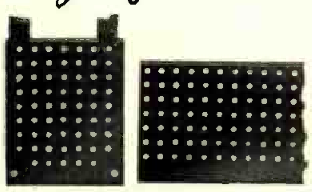
guide plug-in unit into position until pilot heads of Serve-A-Unit Locks take over.

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



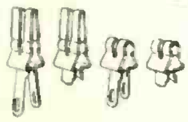
WITH ALDEN COMPONENTS, YOUR CIRCUITRY EASILY BECOMES PLUG-IN UNITS

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



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

+

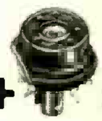


ALDEN MINIATURE STAKING TERMINALS Lay out in any pattern on Terminal Mounting Cards; ratchet slots hold elements for soldering without pliering or wrap-around.

+

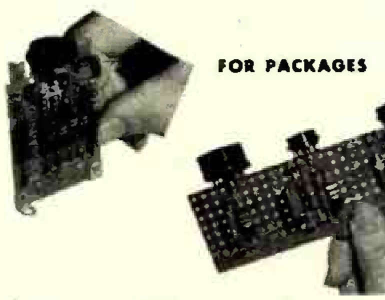
ALDEN JUMPER STRIP stakes right under Terminals providing common circuit without soldering.

+



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

=



FOR PACKAGES

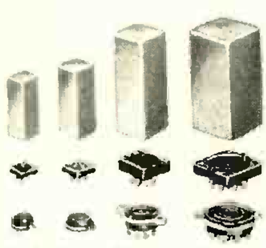
FOR CHASSIS

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

ALDEN PLUG-IN PACKAGE

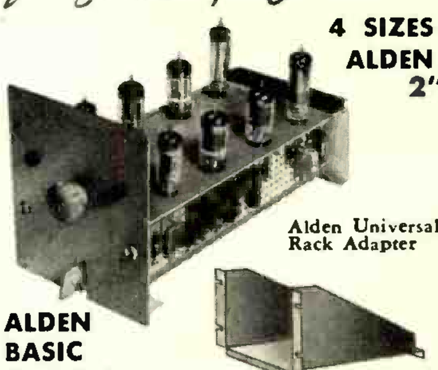
4 SIZES OF PLUG-IN PACKAGES

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



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

Package components and matching sockets.

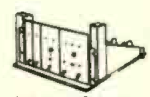


ALDEN BASIC CHASSIS

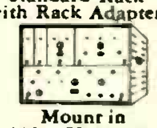
Alden Universal Rack Adapter

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

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



Plugged into Standard Rack with Rack Adapter



Mount in Alden Uni-Racks

Plugged into Portable Cases

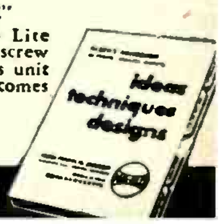
-and assign to each unit a tiny tell-tale to spot trouble instantly It's as simple as this —

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

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

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

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



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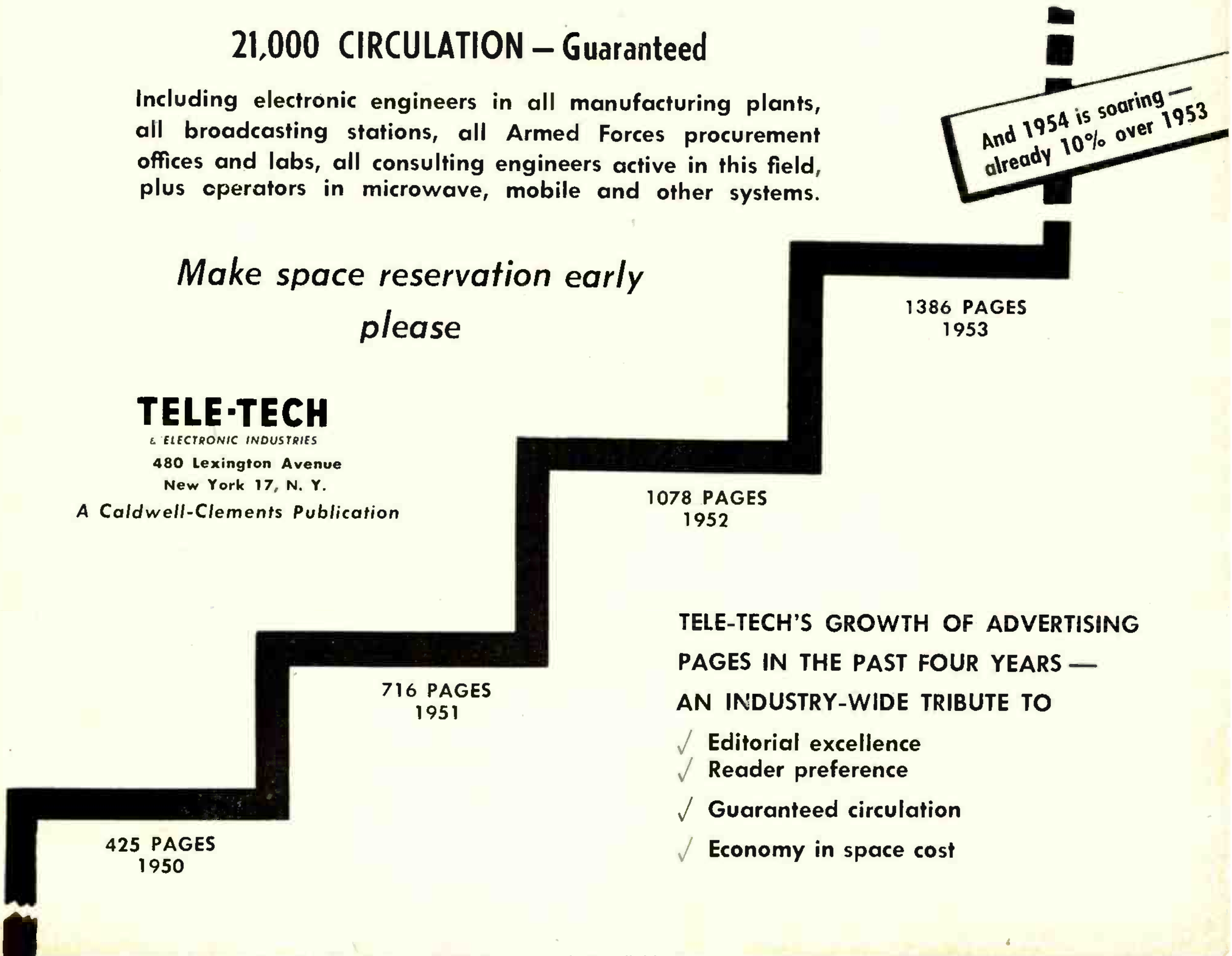
Including electronic engineers in all manufacturing plants, all broadcasting stations, all Armed Forces procurement offices and labs, all consulting engineers active in this field, plus operators in microwave, mobile and other systems.



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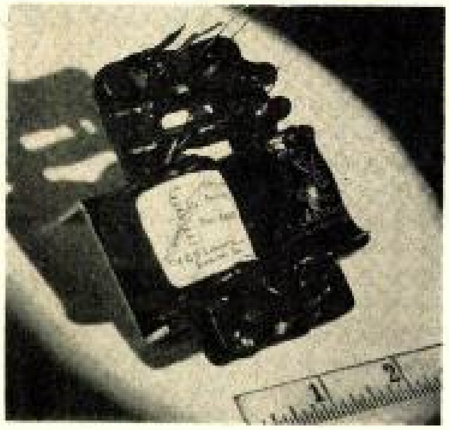
New Electronic Components

R-F INDUCTOR

Type 6XBK2 controllable inductor contains four current-controlled signal windings or bands, with a single con-



trol winding, and provides for an electronic sweep between 4 and 220 MC all on fundamental frequencies. The unit is adaptable in sweep oscillators. Specifications: bands 1, 2, 3, 4; respective frequency ratios, 2.5:1, 2.0:1, 1.5:1, 1.1:1; respective inductances, 25 µh, 2.5 µh, 0.5 µh, 0.07 µh. Overall dimensions: 3¼ x 2½ x 2¾ in. Weight 12 oz. **GGS Laboratories, Inc., 391 Ludlow St., Stamford, Conn.**—TELE-TECH & ELECTRONIC INDUSTRIES.

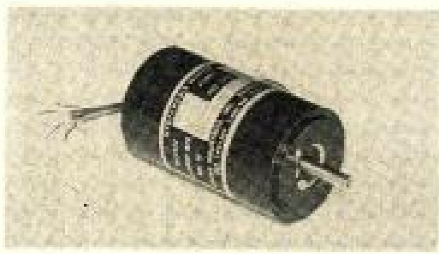
HYSTERESIS MOTOR

The "inside out" 5-in. diameter hysteresis motor, designed for magnetic tape recording equipment, in-

corporates a flywheel and a precision tape-drive capstan that is concentric within 0.0001 in. The capstan provides peripheral velocities of 7½ and 15 in./sec at synchronous speeds of 600 to 1,200 rpm, respectively. Full load torque is 12 in./oz. Flywheel action against abrupt load changes, provided by the flywheel-rotor, which has a distributed weight of 1 lb. 14 oz. The motor operates from 115 v. ac and requires approximately 40 va at 95% power factor and an external 3.75 µf capacitor. Direction of rotation is reversible by externally switching the field windings. **Technical Development Corp., 4060 Ince Blvd., Culver City, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

MINIATURE MOTORS

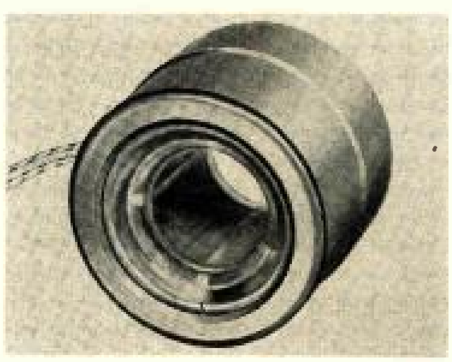
A new line of synchronous miniature hysteresis motors, adapted for 400 cps power, servo, and timing applications, is composed of units that are only 1¼ in. in diameter and 2¼ in. long. They are available for two pole or four pole winding and for 24,000 or 12,000 rpm. Furthermore, they can be wound for two-phase operation, for timing, and power application. Also, they are available as single-phase, capacitor-run motors. The rotor is mounted on greased-packed, double-shielded, ball bearings. The design incorporates similar mounting pole and holes to those found in Globe minature P.M. motors. Therefore, all Globe standard spur and



planetary gear reducers can be furnished with the motors as a package. **Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.**—TELE-TECH & ELECTRONIC INDUSTRIES.

DEFLECTION YOKE

Type Y16-6, a new magnetic deflection yoke is designed for high-speed data presentation and oscilloscope applications. Its low stray capacity results from a special series magnetic field design. Deflection angle is up to 60°. The unit is available over a wide range of impedances in push-pull combinations. The following electrical characteristics are for type Y16-AA6P which is the highest impedance available: inductance 75 mhy., resistance 230 ohms, sensitivity 115 ma. (52° at 12 kv), capacity per coil 80µµf, recovery time 24 µsec. I.D. is 1-33/64



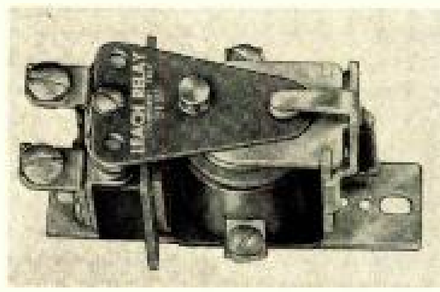
in., O.D. is 3⅜ in. max., overall length is 2¾ in. **Syntronic Instruments, Inc., 100 Industrial Rd., Addison, Ill.**—TELE-TECH & ELECTRONIC INDUSTRIES.

RELAY

The Series 6000 micro relay is a standard 7-pin miniature, hermetically-sealed ceramic unit with solid coined silver contacts. It has a temperature range of +85° C. to −55° C., a shock resistance of 50 G, and its insulation will withstand 500 v. at any terminal to ground. Its maximum coil resistance is 10,000 ohms. Operating power is 60 mw. Its normally-open SPDT switch is rated at 1.0 amp. and is capable of 1 million 24 v. non-inductive load operations. Dimensions: 0.750 in. diameter, +0.010 −0.000, length 1 45/64 in. ±1/64 in. **The Terado Co., 1068 Raymond Ave., St. Paul 14, Minn.**—TELE-TECH & ELECTRONIC INDUSTRIES.

HEAVY DUTY RELAY

Part No. 9191 is a heavy duty relay designed for electrical and electronic control applications. It is a compact, light-weight, rugged unit capable of handling heavy contact loads with low coil power requirements. Double break



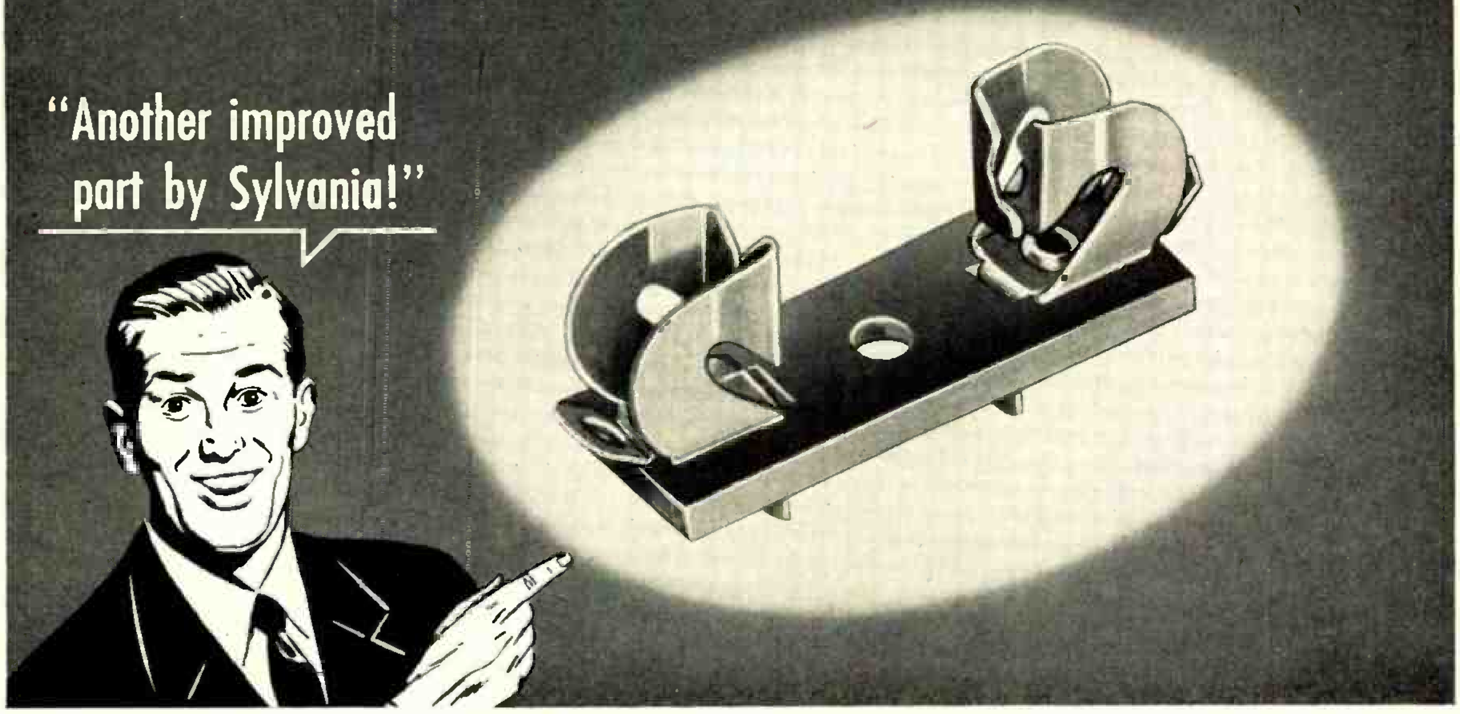
contacts provide a large gap to extinguish heavy load arcing. Insulation and spacing meets Underwriters' Laboratories requirements for industrial control equipment. **Leach Relay Co., 5915 Avalon Blvd., Los Angeles 3, Calif.**—TELE-TECH & ELECTRONIC INDUSTRIES.

TAPE RESISTORS

Stable tape resistors are being offered for a wide range of printed circuit applications. They are available either as cured, ready-to-use resistors, ½ in. long, ⅛ in. wide, and 1/100 in. thick, or as uncut, uncured tape in rolls. Both types have a resistance range of 100 ohms to 10 megohms, and conform to all JAN-R-11 specifications. It is said that these resistors are suitable for semi-automatic applications. A single operation fastens them permanently to the chassis and connects them into the circuit in less than one second. Power rating, ¼ w. at 150° C. Resistance tolerance, ±10%. Operating temperature range −55° C. to 200° C. Humidity, 95% at 40° C. for 250 hours. **Sanders Associates, Inc., 137 Canal St., Nashua, N.H.**—TELE-TECH & ELECTRONIC INDUSTRIES.

A new, efficient crystal diode holder

Sturdy Sylvania Holder Contacts Provide High Retention for Diodes



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

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

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

SYLVANIA

Sylvania Electric Products Inc., Dept. 4A-4402, 1740 Broadway, New York 19, N. Y.

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LIGHTING • RADIO • ELECTRONICS • TELEVISION

SENSING DEVICE FOR COMPUTERS

(*Continued from page 79*)

measured, (3) the scanning beam must be over the page, and (4) the apparent index mark must be genuine and not a thin vertical line crossed obliquely by the scanning beam. The reading program begins immediately after recognition of the index mark occurs.

All information is read out in serial order in blocks of 720 characters and occupies four of the eight channels on the magnetic tape. A character consists of four digits; thus each block can contain more than 2800 digits. Each document, either single or double sided, is included in one block and the remainder of the 720 characters is made up of dummy pulses. To assure that the order is not upset by the loss of a column somewhere on the page, FOSDIC makes a column count on each document. If a column is missed for any reason, such as a film defect, a characteristic record is made on the tape informing the computer that information in this block is not trustworthy. Information contained on such documents is then restored to the tape by a supplementary correction process.

Although a complete check is maintained on the information so that it cannot get out of order, this check is not as thorough nor as elaborate as a check on individual answers. Determination of overall system reliability was left to special evaluation tests in conjunction with the Univac computer. The instrument itself shows near-perfect response when operated under good marking and filming conditions. Tests with the Census computer indicate that film defects are the largest source of the few mistakes. For example, holes in the emulsion which happen to lie at an answer area leave FOSDIC with no choice but to declare an apparent mark. Although adequate statistics on the probability of these errors are not yet established, preliminary results for standard commercial processing appear to show less than one error in 100,000 ovals. If further tests indicate probable errors as infrequent as this, then it can be concluded that the transcription process through FOSDIC, including filming, does not appreciably add to other sources of error in the enumeration process.

Using electronic scanning, a high degree of flexibility can be incorporated into the instrument to meet or even ameliorate practical operating conditions. It offers advantages to almost all of the activities involved in the information collection process. Greater freedom in document layout and choice of size, lower cost of document paper stock, more tolerance to the weight and positioning of answer marks, and a large reduction in handling care are all obtained through the electronic scanning provided in FOSDIC. Among the more significant benefits are the use of multi-line documents several times the size of standard typewriter sheets but no thicker or stiffer, detection of rapidly made single-stroke marks of reasonable boldness, and tolerance to an appreciable amount of document mutilation and misalignment during handling and processing.

In many Census operations, microfilming has already been carried out as a routine procedure. The special problems thus introduced are the additional time for processing, the exposure control that is required, and errors due to the presence of dust and imperfections on the film. However, the use of the intermediate memory in the form of microfilm offers a number of advantages which well outweigh the problems it creates. For example, the massive paper-handling operation is separated from the scanning equipment, the mark strength is increased through the use of high-contrast films, and the electrical signal-to-noise ratio is enhanced.

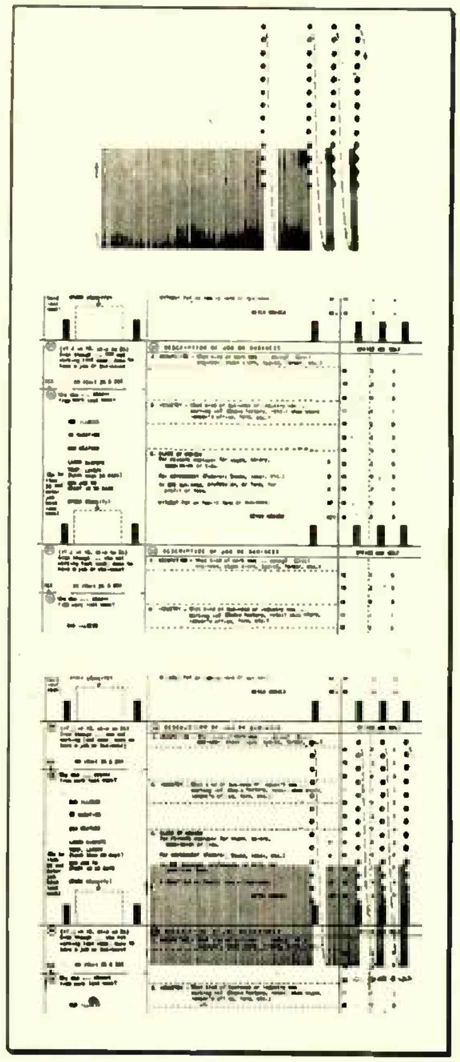


Fig. 3: FOSDIC scanning pattern (top) is superimposed on document (bottom) to locate large black index marks. Ovals in column are searched for answer marks. Beam stops at black dots to give reading circuitry time to recognize data. After column is read, beam picks up next index until entire frame is read

TRANSISTORIZED WRIST-RADIO

(*Continued from page 79*)

wire antenna, only one regenerative stage was needed to hear New York City from Evans Signal Laboratory at Belmar, N. J. With the addition of a single audio stage and an output transformer, a loudspeaker could be used. Two stages of audio were needed to compensate for the elimination of the antenna. In metropolitan areas the coils alone will pick up sufficient signal. In the wrist version, the antenna can be built into the strap.

Body Capacitance

When the receiver is held near the body both the tuning and regeneration are affected by body capacitance. The regeneration should be optimized for each tuning adjustment.

It was found that regeneration can be more easily controlled electronically than by moving a coil. One method is to insert a small 2000-ohm potentiometer in series with the collector coil. Another is to use a trimmer capacitor for feed back from collector to emitter. In this case, the collector coil can be replaced with a resistor.

The selection of a power source was primarily determined by the point contact transistor which operated best with 6 v. Junction transistors, however, can be satisfactorily operated from a 1-½ v. source. With minor modifications, the power requirements can be reduced by a factor of 2.5, and by replacing the point contact transistor in the regenerative stage with a junction type the requirements can be reduced considerably more.

For a photo of the unit, see Nov. 1953 *Tele-Tech & Electronic Industries,* page 63.

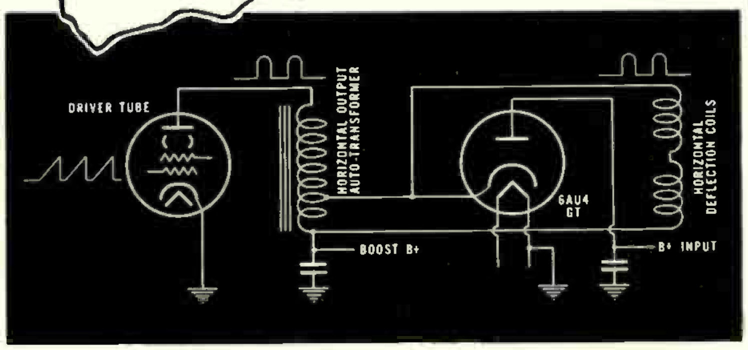
TUNG-SOL®

DAMPER DIODE

A Tung-Sol Designed and Developed Tube

6AU4 GT

for TV use with picture tubes having 90° deflection



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

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

DIRECT INTERELECTRODE CAPACITANCES

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

RATINGS [A]

Interpreted according to RTMA Standard M8-210

DAMPER DIODE [B]

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

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

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

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

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Coaxial Cables

(*Continued from page 73*)

two cables. The power rating of the cables for various ambient temperatures may also be obtained from the graph since the center conductor temperature equals the ambient temperature at zero power. Combining the equations of heat flow and r-f power attenuation, it can be shown that

$$P_{in} = B(t_{cc} - t_e) \quad \ldots\ldots\ldots\ldots (1)$$

Where

B = A constant, providing the attenuation and surface film coefficient of heat transfer remain constant over the temperature range for which the particular cable is being power rated.

t_{cc} = Temperature of center conductor.

t_e = Environment temperature.

P_{in} = Power input.

For a given environment temperature, the equation reduces to

$$P_{in} = B\,t_{cc} + C \quad \ldots\ldots\ldots\ldots (2)$$

Where

$C = Bt_e$ = Constant for a particular ambient temperature.

that is, Eq. (2) is that of a straight line.

Thus, a line parallel to the established line of Fig. 4 and intersecting the abscissa at the required ambient temperature would give the corresponding power handling capacity. These power rating values are shown in Table I and comparison is made with previously published data.

TABLE I

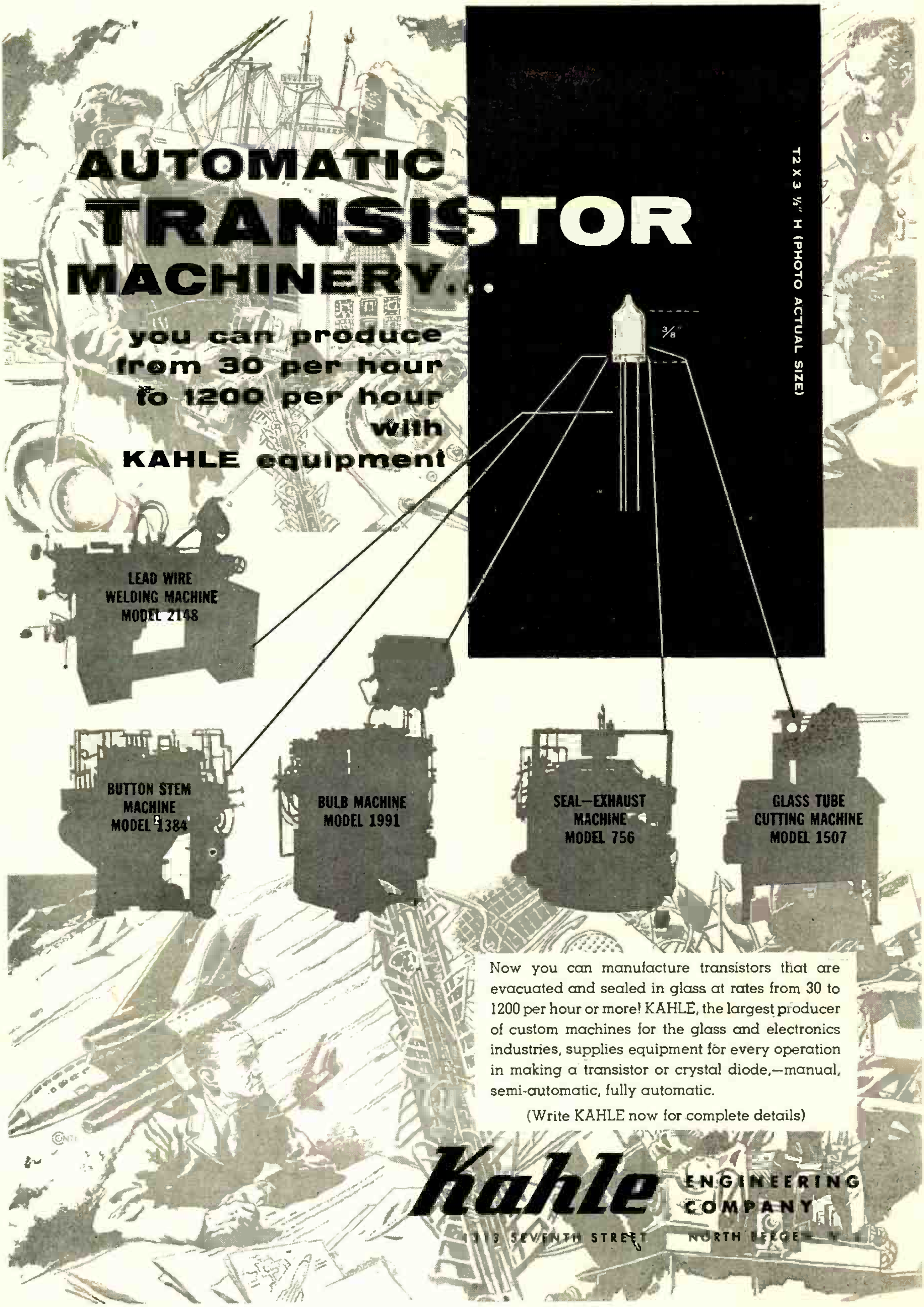
Power Rating Values of RG-8/U and RG-9/U Coaxial Cables at a Frequency of 915 MC

Ambient Temperature (°F)	Experimental Power Rating (Watts)	Calculated Power Rating (Watts)
72	368	340 calculated from Mildner's Analysis
74	361	—
104	255	208 Armed Services Index Based on Swicker's Data

Examination of Table I indicates that existing power ratings are conservative when compared to the experimental ratings of the present investigation. This may be further seen by comparison of Fig. 5 in which the experimental power ratings of this investigation and the power rating values calculated from Mildner's data and using the thermal constants of Swicker are plotted.

The experimental power rating values determined in this investiga-

(*Continued on page 146*)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News of MANUFACTURERS' REPS

Will Gold Electronic Sales Corp., 7806 Empire State Bldg., New York, N.Y., will represent the Atlantic Transformer Corp. of 30 Hynes Ave., Groton, Conn. in metropolitan New York and New Jersey. **Samuel C. Hooker, Inc.,** with offices at 397 Highland Ave., Winchester, Mass. and 135 Fountain St., New Haven, Conn., will represent the company in New England.

George Petitt, 549 West Washington St., Chicago, Ill., has been appointed to handle Illinois jobbers and small industrial accounts outside of Chicago and the **Samuel L. Stroum** Corp. 1612 Broadway, Seattle, Wash., will handle the jobbers and industrial accounts in Washington and Oregon, according to the Elco Corp., 2nd and Glenwood Ave., Philadelphia, Pa.

Al Engelman Co. has been appointed representative of the replacement tube department of the Raytheon Manufacturing Co., Receiving Tube Division, Newton, Mass. This newly-organized firm is located at 3205 Grump Ave., Memphis 12, Tenn. and will represent the Raytheon receiving, picture and industrial tube lines in Alabama, northwest Florida, Mississippi, and Tennessee.

Horace M. Whittlesey, Articulo 123, 127-5 Mexico, has been appointed to represent Brooks Electronics, Inc., 34 DeHart Place, Elizabeth, N.J. in the Mexico territory on the sale of audio amplifiers.

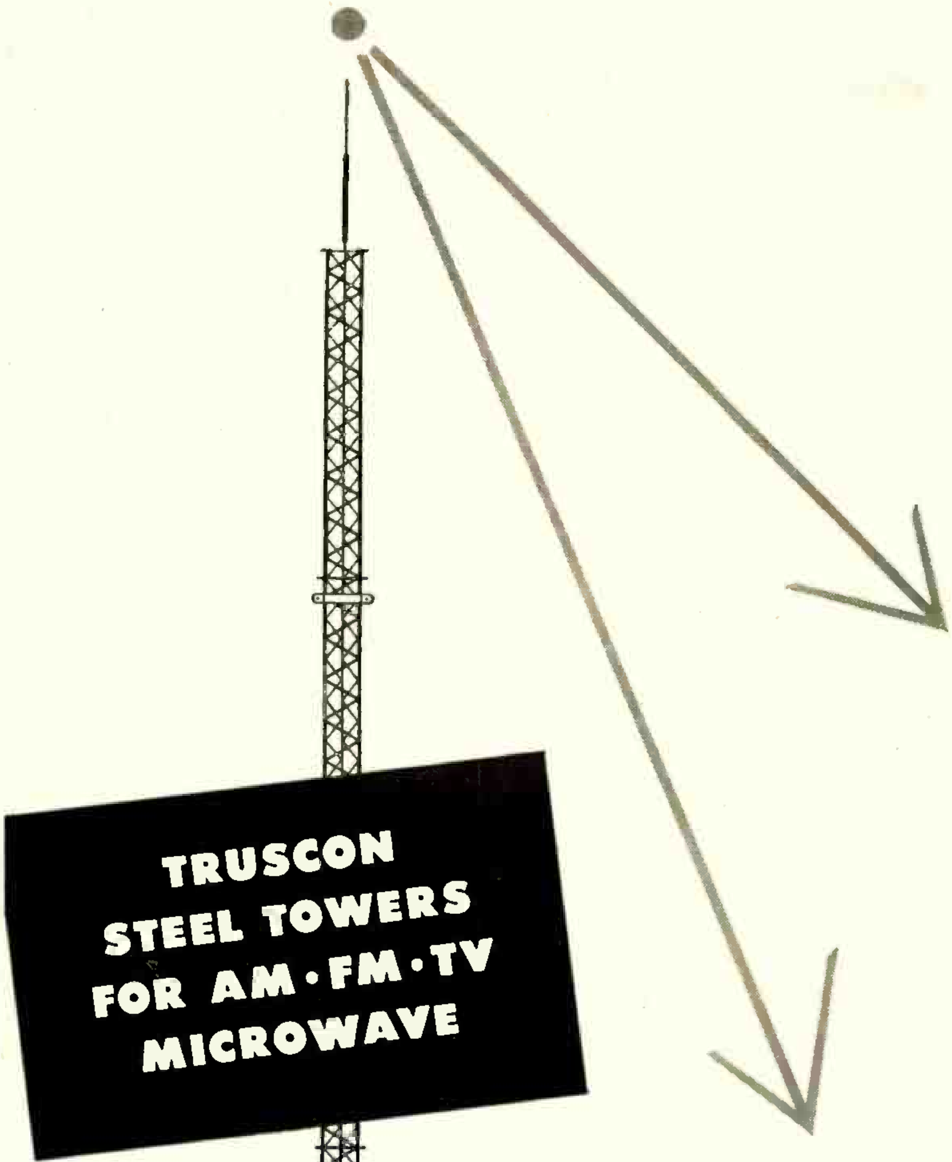
William G. Pliskin, Jr., has joined the industrial sales division of Gerber Sales Co., 739 Boylston St., Boston, Mass.

S. A. Shaw Co., 92 South Central Ave., Hartsdale, N.Y. has been appointed sales representative for the Radell Corp., Indianapolis, Ind. in the New York metropolitan area, Long Island, Weschester County, New York, and New Jersey north of the southern boundaries of Hunterdon, Somerset, Middlesex and Momouth counties.

N. E. Kern Assoc., 8350 Wilshire Blvd., Beverly Hills, Calif. have been appointed California representative for the welding equipment of the Federal Tool Engineering Co., 1386 Pompton Ave., Cedar Grove, N.J.

Frank A. Emmet Co., 2837 West Pico Blvd., Los Angeles, engineering and sales representatives, are adding mezzanine warehouse facilities and rear shipping-receiving docks to its two story building. The company engages exclusively in providing sales and engineering representation for electronic lines.

Bert Gilberg, former office manager of D. R. Bittan Co., manufacturers' representatives at 53 Park Place, New York 7, N.Y., has returned from military service in Germany and has been named sales engineer, serving the company's industrial accounts in Manhattan and Brooklyn.



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Coaxial Cables

(*Continued from page* 142)

tion at an ambient of 72°F were 7.6% greater than the calculated corresponding value using Mildner's analysis. At 104°F, the experimental values are 18.5% greater than those calculated from theoretical considerations and adopted as a standard.

In a manner similar to the testing of the RG-8/U and RG-9/U coaxial cables, a series of power rating measurements were made with an RG-14/U coaxial cable, and the results are plotted in Fig. 6 and tabulated in Table II.

TABLE II

Experimental Power Rating of RG-14/U Coaxial Cable at a Frequency of 915 MC

Ambient Temperature (°F)	Experimental Power Rating (Watts)	Present Rating (Watts)
72	650	—
77	612	—
104	436	275 Armed Services Index

It may be seen that the published ratings are conservative when compared with the experimental values.

The power rating of RG-87A/U and RG-116/U Teflon dielectric coaxial cables followed the procedure for the testing of RG-8/U coaxial cables. The quarter wave transformer was inserted at the point of maximum temperature as determined by surface temperature measurements. The power ratings for the RG-87A/U and RG-116/U coaxial cables are illustrated in Fig. 7 and summarized in Table III. Although the RG-116/U coaxial cable has an additional layer of braid, there was no measurable difference in the power rating of these two cables.

TABLE III

Experimental Power Rating of RG-87A/U and RG-116/U Coaxial Cables at a Frequency of 915 MC

Ambient Temperature (°F)	Power Rating Experimental (Watts)	Power Rating Present (Watts)
72.0	1,850	Have not been established
79.0	1,840	
104.0	1,770	

The power handling curve, as shown in Fig. 7, may be interpreted as were the curves for polyethylene cables. Values of the power rating, taken at the standard maximum inner conductor temperature of 482°F, were approximately seven times that of the equivalent RG-8/U cable with polyethylene dielectric. The power rating curves depart slightly from the straight line relationship of Equation (1) since both the film coefficient and attenuation vary slightly over the extended temperature range necessary for power rating Teflon dielectric coaxial cables.

Power Rating Increase

The curves of Fig. 4, 6, and 7 have been plotted in Fig. 8 to illustrate graphically the increase in the power rating by the use of high tempera-

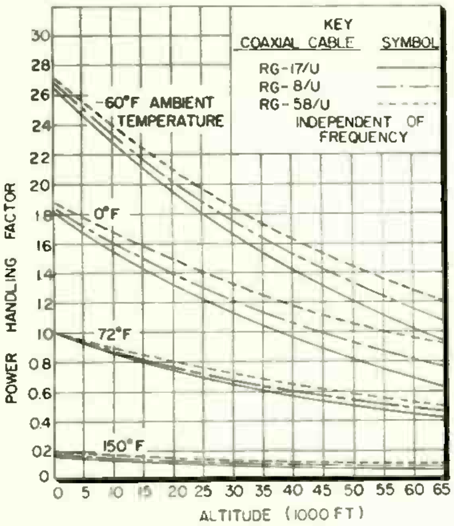

Fig. 9: Theoretical power rating factors for various coaxial cables at various altitudes with environment temperature as parameters

ture dielectrics. At 175°F center conductor temperature, the power handling capacity of RG-87A/U is slightly greater than that of the RG-8/U because of the slightly lower thermal resistance to the flow of heat from the cable to the surroundings. Therefore, Teflon dielectric coaxial cables will operate slightly cooler at low power input levels than equivalent size polyethylene dielectric coaxial cables.

Varying Atmospheric Conditions

In addition to the power rating at standard environmental conditions, it is necessary to determine the performance of coaxial cables under varying atmospheric conditions. A theoretical analysis was undertaken, using the dimensional correlations of heat transfer and the theory of similarity together with the thermal constants of the various cable materials, to determine and predict the performance of three coaxial cables, RG-58/U, RG-8/U, and RG-17/U (chosen to represent the extremes in physical dimensions) at altitudes from 0 to 70,000 feet and ambient temperatures from —60°F to 150°F. The performance of other cables may

COAXIAL CABLES (Cont.)

be interpolated as required. The center conductor temperature was maintained at a constant 175°F.

The correlation of Nusselt[1] was used for the calculation of the film coefficient of heat transfer for natural convection from a horizontal cylinder. In addition it was assumed, as a first approximation, that the total heat generated in the coaxial cable was generated in the center conductor, and thus the results will be conservative. However, since the relative performance of the cables at other than standard conditions is required, the results will enable the comparison of cable operations.

Set of Curves

As space precludes the presentation of the theoretical analysis and mathematical details, the results consisting of a working set of curves will be given. Fig. 9 presents the power handling factors of three coaxial cables at various altitudes with ambient air temperature as the parameter. These curves indicate the expected power input to polyethylene dielectric coaxial cables at any frequency and at various altitudes and environment temperatures when the standard power rating is multiplied by the power handling factor. It is seen that the power handling capacities of coaxial cables decrease as the environment air temperature increases at any constant altitude. The power rating will also decrease further as the altitude increases. These calculations compare favorably with published data at sea level, but further experimentation and analysis is necessary for verification of these data at other than standard ambient temperatures and altitudes. The same analysis may be extended to determine the performance of Teflon dielectric coaxial cables operating under extreme environmental conditions.

Scope of Investigation

The present investigation which is still in progress has illustrated that the semi-empirical power ratings for polyethylene dielectric coaxial cables in use at present are conservative when compared to the experimentally determined power ratings of this development. In addition, the results of this investigation have indicated the magnitude of increase in power handling capacities that are obtained with the utilization of Teflon dielectric coaxial cables. Caution, however, must be exercised in the application of coaxial cables at other than standard conditions since the power rating will decrease in most cases.

This investigation is being sponsored by the Wright Air Development Center, Dayton, Ohio.

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Western Computer Conference, Feb. 11-12

Trends in Computers with special emphasis on Automatic Control and Data Processing will be the theme of the Western Computer Conference and Exhibit to be held in the Ambassador Hotel, Los Angeles, Calif., Feb. 11-12. Papers to be presented include :

- An Experimental Digital Flight Control System, Maier Margolis, J. B. Rea Co., Inc.; Eric Weise, Dynalysis, Inc., Los Angeles, Calif.
- The DIGITAC Airborne Control System, E. E. Bolles, D. W. Burbeck, W. E. Frady, E. M. Grabbe, Hughes Research and Development Laboratories, Culver City, Calif.
- Use of Operational-Digital Techniques for a Simple Process Instrumentation, Bernard M. Gordon, Laboratory for Electronics, Boston, Mass.
- Machine Tool Control Operating Through a Digital Analog Computer, Harry Mergler, NACA, Cleveland, Ohio.
- Experiments with a Digital Computer in a Simple Control System, Thomas Burns, James D. Cloud, John M. Salzer, Hughes Research and Development Laboratories, Culver City, Calif.
- Survey Paper, (Data Processing-Design), Dr. Oliver Whitby, Stanford Research Institute, Palo Alto, California.
- Unit Control Ready-to-Wear Department, S. J. Shaffer, Controller, May Co., Los Angeles, Calif.
- Computer Characteristics, Dr. H. D. Huskey, Institute for Numerical Analysis, Los Angeles, Calif.
- System Engineering, Raymond Davis, Librascope, Inc., Glendale, Calif.
- Programming, M. J. Mendelson, Computer Research Corp., Hawthorne, Calif.
- Survey of Analog-Digital Conversion Techniques, A. Susskind, Massachusetts Institute of Technology.
- High Speed Multi-channel Analog-Digital Conversion, J. Mitchell, J. B. Rea Co., Inc., Los Angeles, Calif.
- Shaft to Digital Converter, B. Gordon, Laboratory for Electronics, Boston, Mass.
- High Speed Digital Computer for Control Applications, C. Eldert, Moore School of Engineering, University of Pennsylvania.
- Input Switching System, W. S. Shockency, Hughes Aircraft Co., Culver City, Calif.
- IBM Calculator 650: Engineering and Design Consideration, E. S. Hughes, Jr., International Business Machines, Inc.
- Design Features of Remington Rand Speed Tally, J. L. Hill, Engineering Research Associates, St. Paul, Minn.
- The ELECOM 125 Business System, Norman Grieser.
- A Centralized Data Processing System, Jerome J. Dover, Flight Research, Edwards Air Force Base, USAF.
- A Merchandising Control System, W. L. Martin, Telecomputing Corporation, Burbank, Calif.

PC Materials

(*Continued from page 70*)

In Fig. 4 are shown samples on which three peel tests, cold, hot, and recooled, have been made on adjoining strips. Separation of three characteristic types have been encircled:

A) Failure at the copper-adhesive interface

B) Failure below the main interface, and

C) Failure alternating between A and B

The last-mentioned type of separation was found in the strongest bonds.

The most severe test of the acceptability of materials and methods to be employed in the fabrication of printed circuits in radio and TV receivers is their ability to withstand the rigors of service shop procedures. The operating temperatures of the most frequently used implements are tabulated in the upper left of Fig. 5. Measurements were taken by imbedding a fine-wire thermocouple at the tip of the "iron" and recording the stabilized temperature free standing at 24°C ambient.

Duration of Soldering

The duration of soldering tip contact to a typical rigid-backed copper-foil conductor for several simple soldering operations was also determined, and the *minimum* range obtained for experienced service personnel is as follows:

TIME	OPERATION
(a) 1.5 to 4 sec.	Tinning a small cleaned area
(b) 2 to 4	Soldering a lead to tinned area
(c) 1.5 to 3	Unsoldering joint made in (b)
(d) 2 to 4	Soldering lead in punched hole
(e) 7 to 10	Unsoldering (d)
(f) 4 to 8	Resoldering (d)

The temperature level reached by etched conductors while being soldered may be judged by reference to the graph in the upper right of Fig. 5. The main curve in this figure depicts the impairment of bond under various typical hand soldering conditions, compiled from continuous recordings of samples peeled on a Tinnius-Olsen tensile machine. The plateaus of the curve reveal the normal resistance of the conductor to stripping and the valleys are the measured adhesion at spots along the conductors where typical soldering operations have been performed—the solder, of course, being removed before testing.

The second and third valleys are typical of carefully controlled assembly of phenolic based circuits with low wattage irons and indicate retention of a useful proportion of the original force retaining the conductor. The longer periods required for unsoldering in servicing, even though performed in minimum time with small irons is seen by the evidence of the first and fourth valleys to produce a severe deterioration. In most tests of the latter condition obvious blistering of the base or release of the conductor was observed.

The application of the stripping test to flexibly backed foil is illustrated in Fig. 6 with values from several specimens. The manner illustrated for holding the sample has

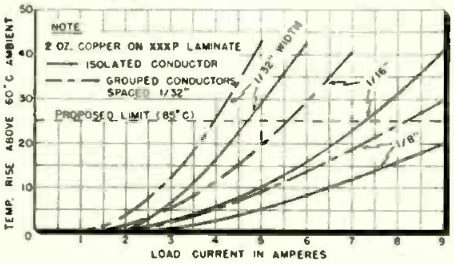

Fig. 9: Temperature rise of etched conductors

been chosen purely as a matter of convenience and no direct logical agreement with the test of rigidly based foils is expected. However, measurements of rigid and flexibly-backed samples fabricated with identical adhesive give values of the same order. The last two values in the table raise the question of the condition of samples prior to analysis. Investigation at Stanford for WADC[9] has yielded evidence that etching generally affects bond strength adversely; moisture conditioning before testing adhesive strength is also a general practice in the ASTM procedures cited.[4-8] Since peel tests may be performed on finished circuits as well as the raw material, these effects need to be taken into account.

Stripping Tests

In standardizing stripping tests, performance of the test on conductors of less than 1 in. width has been found to correlate within 1 or 2% except in the case of stamped circuits (see Fig. 7). In narrower widths stamped conductors give increasing values of peel resistance per unit width, because of the turned and mechanically clinched edges produced in this process.

Other tests of the strength of clad-laminates such as shear (per ASTM D-816-46) and straight tension or "pull" (per ASTM D-429-47T) have been found of limited use. Both present the difficult problem of attaching a test member to the cladding (by a cold setting adhesive or a low melting solder) in a manner not deleterious to the bond under test, yet superior in strength to it. With any but the poorest $1/16$-in. clad stocks, simultaneous delamination of an area by a test plug extends deeply into or through the base laminate. Such fractures often yield information as to the nature of the bond but the values resulting are widely dispersed and much dependent on the choice of plug diameter.

No completely satisfactory test for dielectric and loss factors has yet been proposed. The use of ASTM D150-47, wherein the average dielectric is measured between the two metal clad surfaces, is of limited control value because the adhesive layers, which are in closest proximity and have most influence upon fields generated by the conductor, are often a distinctly different dielectric from the main body of the non-conductor. Determining the "Q" of a specified coil etched on clad materials may be useful in control of a specific production situation but the standardizing of etching, washing and drying so as to make the test of wide general use, does not look promising.

Determination of surface resistance by ASTM D257-49 is as feasible on clad as on non-clad laminates because the simple pattern of conductors required for this may be scribed and stripped, thus avoiding the variable effects of etching.

Surface Resistance

Surface resistance between closely printed lines is markedly lowered by accumulation of dust which absorbs moisture. In Fig. 8, pairs of etched conductors exposed for only nine days in a dusty but dry location, show a ten-fold decrease of insulation resistance. The unprotected conductors show an appreciably greater sensitivity to dust plus humidity than do the pair protected by a single coat of a JAN approved fungus varnish, but both are seriously deteriorated. This is emphasized when the humidity is raised to a very common R.H. of 80, resulting in a drop of resistance of the unprotected lines from 2,500 to 25 megohms. This is illustrated at the right of Fig. 8. Adequate protection of printed circuits in radio design is strongly indicated.

Because of the lack of data concerning the useful life of etched foil circuits some hypothesis is warranted. One potential cause of failure is the deterioration of narrow conductors due to electrolytic corrosion effects. Such effects are apt to be noticeable when the piece is exposed to intermittent operation in moist environments, in which case electrolytic currents may be set up with the insulating material acting as an electrolyte. A semi-quantitative test to determine the extent of electrolytic

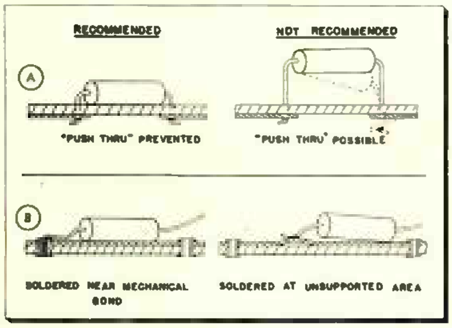

Fig. 10: Component placement should not be such as to stress the conductor bond.

corrosion caused by the combined effects of adhesive and backing material on fine wires has been reported by the Minnesota Mining and Mfg. Co.[11] and with slight modification may be applied to the determination of these effects in foil-clad laminates.

Insulation Deterioration

Deterioration of insulation and conductors are quite generally accelerated by heat, and circuits in the printed radios so far tested operate at surface temperatures of 75 to 102°C. Reference to existing standards[12, 13] concerned with the safe current capacities of conventional conductors reveals several possible ways of rating printed conductors. Generally, allowable current densities are derived from the permissible operating temperatures of the insulations in contact with the conductors. For rubber and thermoplastic hookup wire (Type R & T insulation) this limit is 60°C. Varnished cambric (Type V) is rated at 85°C and asbestos insulations start at 90°C. Common insulating bases for printed circuits are most similar to Type V insulation and, as such, *may* be classed by Underwriters for operation at 85°. Ratings for phenolic laminates range from 93° to 177°C and copper conductors are generally not recommended above 150°C. Associated components and wires of lower rating (55° and 65°C) may be the dominating factor. This consideration for associated components is highly pertinent for "printed circuits" assemblies because of the usual practice of placing RC components in intimate contact with the connective circuit.

The permissible operating temperature of printed circuit conductors which suggested itself, with consideration of all of the above, is 85°C (surface). The temperature rise of typical etched conductors in a 60° ambient are shown in Fig. 9. Limiting current densities derived from this data and an arbitrary 85° limit are quite ample, ranging from 85,000 amps/sq. in. for isolated $\frac{1}{32}$-in. conductors in 1 oz. copper, down to

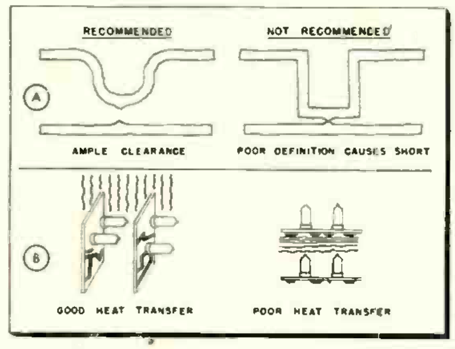

Fig. 11: (A) Adequate spacing of conductors avoids reduction of surface resistance (B) Properly orienting printed deck for heat transfer extends life and voltage characteristics

24,000 amps/sq. in. in groups of $\frac{1}{8}$-in. x 2 oz. conductors. The lowest is 10 to 20 times the density found in contemporary printed radio designs. The temperature in most printed decks, then, is the result of tube dissipation and the generally high ambient within cabinets, and better ventilation is indicated.

Minimal Recommendations

In addition to the suggestions made earlier in connection with the specific tests and procedures, the results of the measurements here reported may well be embodied in certain minimal recommendations of good practice in the design of printed circuit receivers. In deference to the low hot strength of conductor bonds, components should be placed so as not to stress the bond. In Fig. 10a is shown how the component may be properly locked by lead bending, and 10b suggests that no soldering be done along a printed conductor *except* at points mechanically anchored.

It is believed that dust and moisture reduction of surface resistance call for adequate spacing of printed conductors (Fig. 11a); probably a minimum of $\frac{1}{32}$-in. on rigid bases and $\frac{1}{16}$-in. on flexible. The life and voltage ratings of printed decks may both be extended by lowering operating temperatures; and a very simple method is illustrated in Fig. 11b.

Much remains to be done on the standardization of test procedures for clad-laminates and toward the establishment of performance minimums. The results of many aging tests will be needed to set accurately maximum continuous temperatures for printed decks, and to find better means of insulating and protecting them. It is hoped that by bringing some of these matters to attention that the development of an adequate body of information upon the application of printed circuits to receivers will be stimulated.

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Power and Channel Changes at WOOD-TV

WOOD-TV, Grand Rapids, Mich., has switched from channel 7 to 8 after an eight-day shakedown of simultaneous telecasting on both channels. Video power has been raised from 28.5 kw to 100 kw, and will go to 316 kw in Feb. 1954, when the final power amplifier is delivered. After paying $1,365,000 for WLAV-TV, WOOD-TV decided to replace technical facilities. Under the supervision of Chief Engineer Louis Bergenroth, the following was obtained: Transmitter building and site, $80,000; RCA transmitter, $300,000; tower and antenna, $157,000. Including other items, the total is about $600,000. A new $352,000 studio building will be added during 1954.

PM Focus Units

(Continued from page 95)

between the trajectory and the field is zero as the beam enters the yoke field and increases to a maximum of approximately 30° at point P. The angle then decreases to zero at a point approximately 4½ in. forward of the front face of the focus unit. Beyond this point it can be assumed that the field is very low in magnitude. For a rigorous solution to this problem the electron motion would have to be integrated over the 4½ in. of effective field. However, by estimating an average angle of 10° a good solution can be reached without attempting to describe the integral. The average field intensity in this area is estimated to be 25 gauss. Since the effective field is that perpendicular to the electron motion.

$$H = 25 \sin 10° = 4.3 \text{ gauss.} \quad (1)$$

An expression[1] for the radius of curvature of an electron beam in a uniform magnetic field is

$$r = 3.37 \sqrt{E}/H \quad (2)$$

Assuming an 18,000-volt beam

$$r = 3.37 \sqrt{18{,}000}/4.3 = 105 \text{ cm} \quad (3)$$

The angle of deviation from the plane of the paper in Figure 4 is

$$\Theta = \frac{4.5\ (2.54)}{105} \text{ radians} = 6° \text{-} 10' \quad (4)$$

In a 24-in., 90° tube, 24CP4, the length of the path of the deflected beam to the top center is 17 in. The displacement of the top center is then

$$17 \tan 6° \text{-} 10' = 1.85 \text{ in.} \quad (5)$$

The direction of this motion[2] in Fig. 6 is out of the paper or in viewing the picture tube from the rear the spot at the top center moves 1.85 in. to the right. If the focus unit were magnetized in the other polarity the movement would be in the other direction.

Using 17 in. as the picture height the angular raster rotation is

$$= \tan^{-1} (1.85/8.5) = 12°\text{–}20' \quad (6)$$

It is rather coincidental that this figure checks the measured angle of 13° so closely.

Since the stray field of the self-shielding or radial type focus unit is only 10% or 20% of that used above we may expect 1° or 2° rotation. In practice this measures 3/4 degree. Because of the fairly close agreement between the calculated results and the observed it is felt the assumptions made to simplify the problem are reasonable.

While this unit was initially developed because of the requirements of the 90° tubes, all of the advantages found for these tubes have been found in the 70° tubes. As for example, on the 21-in. tube, all data presented above applies. In using the curve to determine flux density for the 21-in. tube, it is found that if the unit is placed on the tube in the same relation to G_1 as was done on the 27-in. tube the 21-in. tube can be focused at about 1.5 kv higher voltage than shown on Fig. 3.

Conclusions

In summary, the authors believe that this new shielded PM unit represents a significant forward step in the development of PM focus units. Any tube utilizing magnetic focus performs better when the stray field from the focus unit has been eliminated.

The authors wish to acknowledge the assistance of Richard Wood and Nick Kafka, of Zenith Radio Corp., and D. P. Ingle, of All Star Products Inc., for their original thinking and helpful suggestions in the design of this unit.

1. Dow, William G., *Fundamentals of Engineering Electronics*, 1st ed., John Wiley & Sons, New York, p. 63.
2. Ibid, p. 62.

Nomographs

(*Continued from page* 87)

Another typical problem is to design a low-pass filter to cut off at 55 MC and match a 50-ohm input line. By employing the technique described above, the values C = 110 μμf and L = 0.3 μh are obtained from Nomograph 2.

Extending Frequency Range

Since the reactive values are inversely proportional to the critical frequency, it is a simple matter to extend the frequency range by multiplying or dividing by a proportionality factor. An example of an audio problem will illustrate this. Suppose, in the first problem above, a high-pass filter cutting off below 50 CPS (instead of 50 MC) were desired to match 300 ohms. The same lines would be drawn on Nomograph 1, but the capacitive and inductive values would be multiplied by the ratio of the frequencies $(50 \times 10^6)/50$, or 1 million. Thus, the elements would be C = 5.3 μf, and L = 0.48 h. The same rule applies to low-pass filters. Stated in other words, the reactive values increase in inverse proportion to the frequency. Conversely, as the frequency goes up in multiples of that shown on the nomographs, the L and C values are made smaller in the same ratio.

Integrator

(*Continued from page 100*)

frequency from the resultant wave form. The improvement in S/N ratio is limited only by the charge and discharge time of the capacitor-resistor network associated with the integrator. Fig. 6 is a photograph of an experimental model capacitor storage integrator.

The theoretical improvement in signal-to-noise ratio possible with the post detector type of signal integrator is shown to be equal to $So/No \times \sqrt{n}$ where (n) is equal to the number of cycles of information over which the integration takes place. Studies made at the Air Force Cambridge Research Center by Rogers and Harrington,[2] show that in the case of very weak signals, i.e., $S/N << 1$, this improvement gradually reduces to $So/No \sqrt[4]{n}$.

In considering the improvement possible with three types of units investigated at Rome Air Development Center, we will consider S/N ratios of 1 : 1.

Linear Additions

The magnesium delay line unit delivered to Rome Air Development Center permitted a total of seven linear additions giving us a S/N improvement of $20 \log \sqrt{7} = 8.44$ db when positive feed back is employed; the total improvement possible increases, and is limited by, the time one is willing to wait and the percentage of enhanced signal that can be fed back without oscillation.

The signal enhancer utilizing the magnetic storage drum permits a total of 16 linear additions, and the theoretical S/N improvement is increased to $20 \log \sqrt{16} = 12$ db. If we add positive feed back (or recirculation) the total improvement may be increased to over 20 db. However, with this much feed back, the information requires several seconds to register and the indications are very sluggish.

Self-Discharging Circuit

Since the capacitive storage drum must follow the variations in phase and respond to new signals in a relatively short time, the circuit must be self-discharging, and the number of effective additions will be less than the actual number.

In the work of Rogers and Harrington,[2] the signal-to-noise improvement is shown to be equal to

$$n^{1/2}\left[\frac{\tanh (n\gamma/2)}{n\gamma/2}\right]^{1/2},$$

where γ is the discharge factor. For 30 additions and assuming $\gamma = 0.1$, the improvement is 4.25 = 12.68 db. In the case of a 30 cps a 30 Direction Finding antenna rotational frequency, the delay time is equivalent to one second.

Figs. 7 and 8 are photographs showing the experimental results when the Radio Direction Finding Equipment was operated with and without the magnetic drum signal integrator. Fig. 7a is the bearing presentation on a good signal without the integrator in the circuit. Fig. 7d is a bearing presentation on a fair signal without the integrator. Fig. 7b shows the bearing on a poor

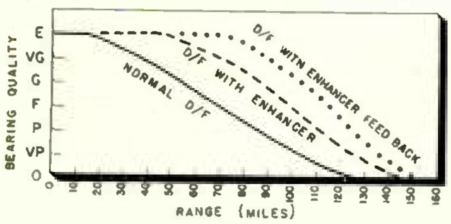

Fig. 9: Graph showing results of flight tests with and without the signal integrator

signal presented without the integrator, i.e. the transmitter is near scured by high noise level. Fig. 7e shows the same signal as Fig. 7b but with the integrator in the circuit between the receiver and the azimuth indicator. Fig. 7c is the bearing presentation on a very poor signal without the integrator in the circuit. Fig. 7f is the same as on Fig. 7c but with the integrator in use.

Fig. 8 shows the effect of employing positive recircuitation in the signal equipment. Fig. 8a shows a bearing on a poor signal. Fig. 8b shows this same bearing with the signal integrator operating normally. Fig. 8c shows the bearing when positive feedback has been used. In Fig. 8d we have a bearing presenation on a very poor signal. Fig. 8e is this same bearing with normal integration and Fig. 8f is this bearing with integration and positive feed back.

The results with the solid delay line were similar to those obtained with the magnetic drum. However, limitations in the length of the line did not permit the improvement obtainable with the magnetic drum.

Fig. 9 summarizes the results of flight tests made with and without the signal integrator. We see from this table that there is no improvement in bearing presentations on good signals. However, the integrator does improve the quality of the bearing presentations for the weak and very weak signals. The net results of these tests were to prove

INTEGRATOR (Cont.)

that bearings could be reliably presented on any signal received at the Direction Finding antenna, and by employing this technique, it was possible to make the Direction Finding range equal or exceed the communication range.

Another result of this post detector integration technique is to average the bearings received and to reduce the amount of flutter on the bearings caused by propagation difficulties. Azimuth accuracy is maintained only as long as the flutter of the bearings is symmetrical. Since signals which arrive at the Direction-Finding site via a direct path are usually much stronger than reflected signals, the proper signal will usually be favored.

Results of Study

The results of the study show that this technique of improving the Direction Finding quality and readability by signal integration is fully useable with field type radio direction finding station. It is practical to build a simple integrator type unit which may be inserted between the receiver and azimuth bearing indicator, for enhancing the bearing presented thereby increasing the readability and extending the range of the station. S/N improvements from 6 to 12db are easily obtainable at the present with the techniques we have described and greater improvements may be obtained at the expense of a longer integration time. If we arbitrarily accept a one second time limit as the practical limit of integration, this will restrict us to an improvement in the neighborhood of 12 to 16 db overall.

A credit is due to engineers of the Anderson Labs. and Crystal Research Labs., of Hartford, Conn. for their work on the magnesium delay line type of signal integrator, and suggestion for improving this technique, and to Mr. Anderson for application of positive feedback. Credit is also due to engineers of Engineering Research Associates at St. Paul, Minn. who fabricated the engineering model of the magnetic drum type of signal integrator, and to engineers of the Air Force Cambridge Research Center who worked with engineers of the Rome Air Development Center in developing the experimental units and applying these techniques to the Radio Direction Finding Station.

This paper was presented at the National Airborne Electronics Convention, Dayton, Ohio, May 11-13, 1953.

[1] H. Busignies and M. Dishal "Signal-to-Random-Noise Ratio in Radio Navigation and Direction Finding," *Proc. IRE*, May 1949.
[2] T. F. Rogers and J. V. Harrington, "Signal to Noise Improvement Through Integration in a Storage Tube," *Proc. IRE*, vol. 38, no. 10 Oct. 1950.

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PERSONAL

Richard D. Schotter has been appointed vice-president of Phen-O-Tron Inc., New Rochelle, N.Y. **Jack Bayha** has been made chief engineer of the company's new plant, said to be the first to be devoted exclusively to the production of printed circuits.

A. Melvin Skellett, head of the research division of National Union Radio Corp., Hatboro, Pa., was promoted to the new post of vice-president in charge of manufacturing and engineering. **Lawrence L. Hardin, Jr.**, was named director of the research division. Mr. Skellett was associated with Bell Telephone Laboratories, Inc. for fifteen years before he became head of National Union research in 1944. He will make his headquarters in Hatboro. Mr. Hardin will be in charge of the company's Orange, N.J. custom research work under Mr. Skellett's supervision.

A. Melvin Skellett

Charles F. Stromeyer has been promoted to the position of executive vice-president of CBS-Hytron. Mr. Stromeyer joined the company in 1942 as chief engineer and assistant to the president, and was later made vice-president in charge of manufacturing and engineering.

Dr. George E. Duvall and **Dr. Charlotte Zihlman LeMay** have joined the staff of Stanford Research Institute, Stanford, Calif. Dr. Duvall, formerly with the General Electric Co. at Richland, Wash., will work as a theoretical physicist in high explosives with SRI's department of physics. From 1946 to 1948 he was a research associate in the Research Laboratory of Electronics at M.I.T. Dr. LeMay, formerly in the transistor program of Texas Instruments Inc. Dallas, Texas, will undertake a research program of solid state physics for SRI's engineering division.

PERSONAL

(*Continued from preceding page*)

Sidney Gordon, formerly with Emerson Radio and Phonograph Corp. and **Serge Berstein**, formerly with Fada, have joined Tel Instrument Corp. of Carlstadt, N.J., manufacturers of color video test equipment. Both will serve as development engineers. **Lawrence Freeman**, formerly with Kay Electric Corp., has joined the company as a sales engineer.

Martial A. Honnell, professor of electrical engineering at the Georgia Institute of Technology from 1937 to 1953, was recently made a vice-president and chief engineer of Measurements Corporation of Boonton, N.J., wholly owned subsidiary of Thomas A. Edison, Inc., West Orange, N.J. Professor Honnell will be in charge of engineering design and development.

Martial A. Honnell

Henry Hulick, Jr., chief engineer for Station WPTF, 50,000 watt NBC affiliate in Raleigh, N.C., has been elected to the board of directors of the WPTF Radio Co. Mr. Hulick celebrated his twenty-fifth year with the station this year.

M. B. Sawyer, Jr., has been appointed factory manager of the electronic division plant of Thermador Electrical Manufacturing Co., Los Angeles, Calif. Mr. Sawyer was formerly vice president of Motor Mfg. Co. that was purchased by the A. O. Smith Corp. Following the purchase he became manager of the A. O. Smith Co. Pacific Coast Division.

Cyril N. Braum, former chief of the Television Facilities Division of the FCC has joined the consultant staff of the Joint Committee on Educational Television, 1785 Massachusetts Ave., N.W., Washington 6, D.C. where he will provide general engineering assistance to educational channel applicants. Further, he will keep educators informed on technical television developments. He also will serve as engineering consultant for the National Citizens Committee for Educational Television. The JCET works directly with educators; NCCET with the general public.

William R. Ludka has been appointed director of staff laboratories engineering for Minnesota Mining & Manufacturing Co. St. Paul, Minn. He will continue to head 3M's chemical engineering staff, but also will be responsible for all engineering connected with the firm's central research and products fabrication departments as well as its new products and defense products departments.

Walter E. Noller recently joined the engineering department of Lynch Carrier Systems, Inc. West Coast manufacturers of carrier telephone-telegraph and associated equipment. Mr. Noller formerly was engaged in the design and development of voice operated and fire control radar equipment with Bell Laboratories. Subsequently, he was a senior engineer with the Pacific Telephone and Telegraph Co.

W. E. Noller

Asru K. Das Gupta, who joined Solar Manufacturing Co., Los Angeles Calif. in 1950, has been promoted to director of engineering. Prior to his promotion he was director of ceramic operation of the company.

Ralph R. Stubbe has been made chief engineer of General Instrument Corp. and will make his headquarters at the company's home plant in Elizabeth, N.J.

Charles Fahrner has joined Electrical Windings, Inc., Chicago, Ill., where he will assume the duties of chief engineer. Mr. Fahrner was formerly associated with Standard Transformer Corp. (Stancor) and more recently with Chicago Standard Transformer Co.

NARTB Offers Tower Insurance Analysis

A confidential tower insurance analysis has been initiated by the NARTB as a free member service. The plan makes it possible to get a detailed comparison of risks covered and premiums payable under present policies as against the NARTB-endorsed plan. Service may be obtained by sending present policy to NARTB insurance consultants, Hufty, Eubank and Russel, 104 Marsh Bldg., Washington 6, D. C.

Shielded Enclosures

(*Continued from page 75*)

to use only the electric field intensities for "attenuation," although occasionally magnetic field intensities are used.

If measurement at point 2 or 3 is within the shielded enclosure, the presence of reflections causes the wave impedance (ratio of electric to magnetic field intensities) to differ considerably from that of free space and radically different results may be obtained for attenuation and insertion loss. On the other hand, if point 2 is outside the shielded enclosure it is practically impossible to obtain an incident wave which is plane and the results will again be widely different. Fig. 2 illustrates this difference for measurements made upon an experimental galvanized iron screened room of single-shield construction. Induction field effects are evident below 2.5 MC and leakage at joints is evident above 100 MC. Obviously the terms "attenuation" or "insertion loss" should not be used interchangeably.

Plane-Wave Attenuation

The measurement of plane-wave attenuation reveals much more clearly than insertion loss the quality or lack of quality of a shielded enclosure. This is also the characteristic which is of most value to a person conducting tests on sensitive equipment within the shielded enclosure. On the other hand, insertion loss gives a reasonable description of performance where the enclosure surrounds a generator of radio interference which must not escape from the room, provided the test incident wave is similar in nature to that of the r-f generator. Because of the less universal applicability of insertion loss and certain practical difficulties in measurements which are generally much greater than for attenuation, it is recommended that the engineering usage of "attenuation" be adopted as standard by the shielded room industry.

Methods of Measurement

Settling upon one of the quantities mentioned above is only the first, although major, step toward obtaining uniformity in the presentation of data. Within each method are many possible variations in procedure which will yield different results.

Among the most frequently used methods for the measurement of "attenuation" are the following:

(a) *Free-Field Method:* This

method requires a plane wave of sufficient intensity to permit the measurements indicated by Fig. 1. In practice it has been found expedient to use the radiation fields of powerful broadcasting stations (10 to 50 kw) for this purpose. The shielded enclosure is generally mounted upon a truck so that it may be placed in fields of adequate strength, but out of the induction field, at the various frequencies to be measured. This method most closely approaches ideal theoretical conditions but has many practical disadvantages. Among them, the enclosure must be small enough to be portable, and broadcasting stations must be available at the frequencies of interest. Stations are rarely available for very-high-frequency and extremely-low-frequency measurements. At low frequencies it is difficult to obtain the high field strengths required and still be outside the induction field of the transmitting antenna.

(b) *Military Method:* This method makes use of lower-power sources of signal, approximately 2 to 10 watts. All measurements below the fairly high frequencies are made in the induction field region. Measurements are of the rod-to-rod or dipole-to-dipole type in the induction field except for an additional loop-to-loop measurement at low frequency. This method was originally proposed as a production check on the performance of shielded enclosures for military use. Results obtained by this method are not directly comparable with those of the free-field method but are useful when compared with other results obtained by the military

TRANSISTOR TEST

Dr. C. W. Mueller, of the RCA research staff, checks an experimental type of high frequency transistor that amplifies signals at frequencies as high as ten MC. These high-frequency transistors have been field tested in experimental radio receivers under study at the David Sarnoff Research Center, Princeton, N. J.

SHIELDED ENCLOSURES (Cont.)

method. It is believed, wherever measurements are made in the induction field region, attenuation to both the electric field and the magnetic field components should be separately stated. While this method produces results difficult to support by mathematical theory, which is also complicated, it lends itself fairly well to practical use in the field.

Insertion Loss

"Insertion loss" measurements are frequently attempted by one of the following methods:

(a) *Uniform-Field Method:* This method requires a plane wave of sufficient intensity to permit the measurement indicated by Fig. 2. The practical execution of this method and its advantages and disadvantages are similar to those for the measurement of free-field "attenuation."

b) *Induction-Field Method:* This method is similar to the Military Method for measurement of attenuation except that ideally the shielded enclosure must be removable from between the fixed source and receiver of energy. In practice, the room is left in place but both source and receiver are moved to a new location where the distance between the two is kept the same as with the presence of the shielded enclosure. It is important that measurement 4 of Fig. 1b be performed in a region free from reflection of r-f energy. Generally, adequate care is not given to see that this is true and the measurement suffers in accuracy accordingly.

(c) *Open/Closed Door Method:* In this method, removal of the shielded enclosure from between source and receiver is supposedly accomplished by opening the access (door) to the enclosure. Since a significant amount of loss may be sustained even with an open door, results are quite misleading and almost always pessimistic. Fortunately, this method is vanishing from current usage.

Need for Standard

Each method of measuring insertion loss has some inherent disadvantages sufficiently serious to keep any of them from being recommended as a standard method. Considerable work has yet to be accomplished before a standard method can be universally accepted but choice of an interim standard would certainly be helpful to industry.

Curve Tracer

(*Continued from page* 92)

The Curve Tracer Test Set was built in the console form, as shown in Fig. 1, to facilitate ease and speed in operation. All power supplies and circuits are contained in the cabinet. The ac line voltage, 117 v., is the only external connection necessary.

The front panel contains, essentially, the controls for the tube under test and the recorder. A row of switches on the panel connects various supplies to the tube under test which is plugged in an adaptor. Other switches select the desired voltage and current range and the electrode voltage or current to be plotted. There are X and Y axis select switches which have three positions: voltage, current, and plate resistance or transconductance. It is possible to locate the zero any place on the chart with the biasing circuits which are also located on the front panel.

The right-hand panel contains three regulated B supply controls, and plug-in meters to monitor their voltages and currents. The select switch for the voltage divider circuit is located on this panel as well as the sweep select switch and the sweep controls. A microswitch to lift the recorder pen is located near the sweep start and return switch so both can be operated with one hand.

The left-hand panel contains the controls for the heater supply, two C supplies, the chopper circuit, the plate resistance circuit, and the transconductance circuit. The C^1 supply is stabilized by a VR-Tube and equipped with a ten-position divider. The divider is located near the C_1 controls and is also used with the regulated power supply divider circuit. The C_2 supply is regulated and used with the sweep circuit and the chopper circuit. A control on the cutoff voltage used in the chopper circuit is also located on the panel. Plug-in type meters are used on the panel to monitor the heater and two C supply voltages, and the current from the C_2 supply. The current meter is also used to check the ratio of the chopper circuit.

The author wishes to acknowledge the work of Wray U. Shipley who did much of the preliminary development on the Curve-Tracer Test Set.

Miniature Tube Aid

Frank D. Mirabella, President, and Nicholas Zanzano, Sales Manager of S/C Labs., Inc., 37 George St., Newark, N. J., report that patent 2659061 has been issued for the S/C Guide-A-Tube. The device is a low loss plastic wafer used for insertion of miniature tubes into their respective sockets.

Cylindrical Iron Cores

(*Continued fom page 86*)

may be easily calculated once the low frequency inductance and high frequency permeability is known.

Although the measurement of distributed capacitance will not be treated here,[8] attention is called to a special phase of this subject unique with cylindrical iron cores, namely, the relationship between distributed capacitance and grounded vs. floating cores.

When iron cores with diameters 0.8 times the mean diameter of the coil, or greater, are introduced into the coil, the presence of the core produces an additional capacitance between the coil and the core which increases the self-capacitance of the coil. This added capacitance results in an increase in the apparent inductance of the coil. This capacitance was investigated by Foster and Newlon[3] and is a function of wall thickness of the coil form and the length of the coil and core. The effect is especially pronounced with long coils wound on thin wall forms such as are used for permeability tuning in the standard broadcast band. Grounding the core further increases the distributed capacitance.

Grounded Core

Along with increasing the capacitance of the coil, other factors such as coil losses and electrostatic coupling to adjacent circuits change when the core is grounded. If a grounded core is not required, the deleterious effects may be reduced by employing special cores with the tuning screw mounted in an insulated end section. This insulated section also helps keep the tuning screw out of the magnetic field of the coil. The presence of the screw might otherwise lower the inductance and Q of the coil.

The effect on the coil of grounding the core may easily be measured on the Q-Meter by alternately measuring the properties of the coil with and without a grounding strap connected to the tuning screw. The grounding strap should be connected, not to the Q-Meter ground, but to the LO inductor post. The cores should be similarly grounded when measuring the distributed capacitance of coils with powdered iron cores unless the circuit design specifically calls for ungrounded cores.

The curves of Figs. 7 and 8 are taken from Foster and Newlon's paper and show how the apparent inductance of a coil is increased when its core is grounded. The increase of apparent inductance is plotted as a function of core-diameter to mean-coil-diameter and coil-length to coil-diameter, respectively.

Another correction, peculiar to iron core measurements, is sometimes required when small inductors are measured at high frequencies. Under these conditions the internal inductance of the Q-Meter often forms an appreciable part of the total inductance, but when the core is inserted in the test coil only that part of the total inductance increases. Thus, the ratio of inductance

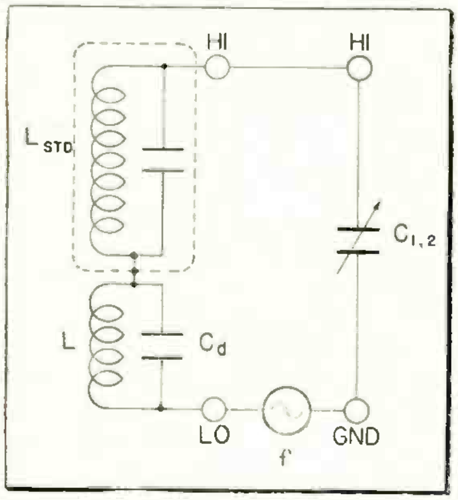


Fig. 10: Circuit for measuring coil inductance accounts for distributed capacitance

with and without the core is measured as something less than the true value. Let

L_o = true inductance of coil in air
L_i = true inductance of coil with iron core
L_m = internal inductance of Q-Meter
$L_o' = L_o + L_m$ = apparent inductance of coil in air
$L_i' = L_i + L_m$ = apparent inductance of coil with iron core

The true ratio of L_i/L_o is then

$$L_i/L_o = (L_i' - L_m)/(L_o' - L_m) \quad (6)$$

The true ratio of L_i/L_o is then
Dividing the numerator and denominator by L_o',

$$L_i/L_o = \frac{\frac{L_i'}{L_o'} - \frac{L_m}{L_o'}}{1 - \frac{L_m}{L_o'}} = \frac{\eta - \tau}{1 - \tau} \quad (7)$$

where η = the apparent change of inductance

$\eta = L_i'/L_o'$

and τ = the ratio of internal inductance to the apparent inductance of the coil in air

$\tau = L_m/L_o'$

The expression apparent inductance" used in this instance does not account for the effect of distributed capacitance or other outside influence on the inductance of the coil. As applied here, the term refers only

CYLINDRICAL IRON CORES (Cont.)

to the inductance of the coil as affected by internal Q-Meter inductance.

When using laboratory Q-Meters of recent design[9] this correction is needed only if the apparent inductance measured without its core is less than about 1.0 μh. For values of inductance greater than 1.0 μh the internal inductance may be neglected.

Occasionally small iron core inductors are used for low frequency applications. When investigating such a coil, the properties of both the coil and core should be measured at the design frequency. This may be accomplished with a series measurement wherein an auxiliary, or standard, coil is used in conjunction with the test coil. This method is suitable for the measurement of coils as low as 0.01 microhenries and requires two separate measurements, each with a different connection to the Q-Meter.

Tuning Q Circuit

The Q circuit is first tuned to resonance with an auxiliary coil (hereafter called a standard coil) connected to the inductor terminals. Then the unknown coil is placed in series with the standard inductor and the Q circuit is restored to resonance by changing the Q capacitance from C_1 to C_2. During the measurement the frequency, f, and the values of C_1 and C_2 must be noted. Both connections for this measurement are shown in Fig. 9.

An equation for the unknown inductance, L, can be derived in terms of f, C_1, and C_2. With the standard coil alone in the circuit, we may write

$$\omega L_{std} = 1/\omega C_1 \qquad (8)$$

whereas

$$\omega L_{std} + \omega L = 1/C_2 \qquad (9)$$

with both the standard coil and unknown inductor in series in the circuit. It is assumed that coupling between the coils is negligible. It is good practice to enclose the standard coil in an aluminum or copper shield to negate any inductive or capacitive coupling that might otherwise exist. The shield may be returned to ground thru the LO inductor post of the standard coil. See Fig. 9.

Substituting Eq. (8) in Eq. (9) yields

$$\omega L = (1/\omega C_2) - (1/\omega C_1)$$

or,

$$L = (C_1 - C_2)/\omega^2 C_1 C_2 \qquad (10)$$

The accuracy of this measurement is maximum when the inductance of the standard coil equals that of the unknown. Fortunately, this ratio is not critical and since we do not always have an optimum value of standard inductor on hand, measurements may be made with slightly reduced accuracy using standard values other than optimum; a ratio of two to one is not excessive.

A further requisite for standard coils is a high Q. Q's in the order of 200 to 250 are desirable but lower values will permit satisfactory measurements of many coils. However, if the Q of an unknown coil is especially low, it may be necessary to use standard coils with Q's of 300 or more.

Distributed Capacitance

The distributed capacitance of coils accounts for an increase in the apparent inductance above the true inductance whether they are measured directly or by the series method. Because the usual coil that requires a series measurement has so little inductance and distributed capacitance, its self-resonant frequency, f_o, is generally considerably greater than the measuring frequency, f. When this is true the apparent rise of inductance over its true value is negligible.

However, larger coils which are sometimes measured by the series method do not enjoy the same immunity from the effects of distributed capacitance. It is necessary, therefore, to examine the ratio of frequencies, f, and f_o, as it relates to true and apparent inductance.

Consider the circuit of Fig. 10 where L, the inductor to be measured, is shown with its distributed capacitance, C_d. Incidentally, the standard coil is also shown with the distributed capacitance. It is important to note that if the frequency of the Q-Meter is not changed during the measurement, the self-capacitance of the standard coil has

PLANT RADIO

Two-way radio helps maintain smooth flow of material and sub-assemblies along the mile-long B-36 production line at Consolidated Vultee's Fort Worth, Texas plant. Fifteen materials handling vehicles are equipped with General Electric units. Security and fire departments operate a separate two-way radio system of 12 vehicles, and the plant maintenance department has eight trucks with radios on a third frequency

CYLINDRICAL IRON CORES (Cont.)

no effect on the measurement of the unknown inductor, L. The apparent reactance of L_{std} will be greater, of course, than the true reactance, but since its value varies only with frequency it will remain constant thruout the measurement and not appear in the final expression for L.

The apparent reactance of coil, L, with distributed capacitance, C_d, is

$$\omega L_a = \omega L/(1 - \omega^2 LC_d)$$

or,

$$L = L_a (1 - \omega^2 LC_d) \qquad (11)$$

By definition, the self-resonant frequency, f_o, is a function of L and C_d, as follows,

$$LC_d = 1/\omega^2_o$$

Substituting this expression in Eq. (11),

$$L = L_a (1 - m^2) \qquad (12)$$

where L = the true inductance
L_a = the apparent (measured) inductance
and $m = f/f_o$

Series measurements are greatly facilitated with a test jig. This jig provides terminals for both the unknown and standard coils.

Series Measurement

Considering a series measurement for a test coil in which the permeability of an iron core is to be determined, an equation can be derived that expresses the true change of inductance produced by the core in terms of measured parameters. Knowing L_1/L_o, we can calculate the effective permeability of the core.

Referring to Fig. 11, let

L_{std} = inductance of the standard coil
L_o = inductance of the test coil in air
L_1 = inductance of the test coil with iron core
$\Delta L = L_1 - L_o$ = inductance added to the test coil by the iron core
θ = measured increase of inductance with a standard coil in series with the test coil

Then

$$\theta = (L_o + \Delta L + L_{std})/(L_o + L_{std})$$

Dividing numerator and denominator by L_o,

$$\theta = \frac{1 + \frac{\Delta L}{L_o} + \frac{L_{std}}{L_o}}{1 + \frac{L_{std}}{L_o}} \qquad (13)$$

The first two terms in the numerator of this expression may be rewritten as follows,

$$1 + (\Delta L/L_o) = (L_o + \Delta L)/L_o = L_1/L_o$$

If we let

$$\gamma = L_{std}/L_o,$$

then rearranging Eq. (13) we have for the true ratio of L_i/L_o

$$L_i/L_o = \theta(1+\gamma) - \gamma \qquad (14)$$

Example 1:

Coil Data

Number of turns	35
Wire size	28 PE
Mean diameter	0.511 in.
Length	0.492 in.

Core Data

Material Pyroferric	PY-14A
Diameter	0.368 in.
Length	0.492 in.

The coil alone resonates at 2.75 MC with 305 μμf of capacitance. With the

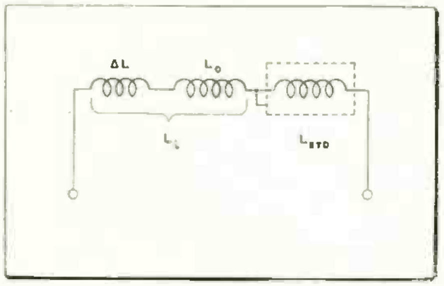


Fig. 11: Arrangement for determining iron core permeability in series measurement of a coil

core inserted in the coil, the capacitance must be reduced to 150 μμf to restore resonance to the Q circuit. What will the L_i/L_o ratio equal when a core of the same material and diameter, but 0.984 inches long, is inserted in this coil?

With the coil and core lengths equal, the L_i/L_o ratio measures

$$L_i/L_o = 305/150 = 2.035$$

Using this value in Eq. (2a), we can find the effective permeability, μ_e.

$$\mu_e = \frac{(L_i/L_o) - 1}{(d_i/d_o)^2} + 1$$

Substituting,

$$\mu_e = \frac{1.035}{0.518} + 1 = 3.0$$

If a core of greater length is now inserted within the coil, the effective permeability, μ_e', of the longer core may be found with Eq. (3).

$$\mu_e' = 3.0 \sqrt[1.8]{\frac{0.984}{0.492}} = 4.41$$

Using this value in Eq. (2) to find L_i/L_o for the longer core,

$$L_i/L_o = 1 + 0.518\,(4.41 - 1) = 2.76$$

This was checked on a Q-Meter with a PY-14A core 0.984 in. long. The measured value equalled 2.70; an error of only 2.2% for the calculated value.

Example 2:

Coil Data

Number of turns	35
Wire size	26 PE
Mean diameter	0.517 in.
Length	0.625 in.

(*Continued on page 176*)

CYLINDRICAL IRON CORES (Cont.)

Core Data
Material Stackpole G-2
Diameter 0.368 in.
Length 0.625 in.

This coil in air resonates with 347 μμf of capacitance at 2.75 MC. When the core is introduced in the coil, the Q capacitance must be decreased to 161 μμf to restore resonance. What length core is required for an L_i/L_o ratio of 2.5?

The L_i/L_o ratio of the given core and coil is

$$L_i/L_o = 347/161 = 2.16$$

and the effective permeability equals

$$\mu_e = \frac{1.16}{0.507} + 1 = 3.29$$

whereas the effective permeability required for an L_i/L_o ratio of 2.5 is

$$\mu_e' = \frac{1.5}{0.507} + 1 = 3.96$$

With this value of μ_e' in Eq. (3), the core length is found to equal

$$\text{core length} = 0.625 \left(\frac{3.95}{3.28}\right)^2 = 0.873 \text{ in.}$$

As a check, a G-2 core 0.873 in. long was inserted in the coil and the measured ratio of L_i/L_o equalled 2.56; an error of 2.4%.

Example 3:

Using the same coil of Example 2, what will be the value of L_i/L_o if the G-2 Stackpole core is decreased in length to 0.375 in.?

The effective permeability, μ_e', for a shorter core can be calculated from Eq. (4).

$$\mu_e' = 3.29 \sqrt[1.14]{\frac{0.375}{0.625}} = 2.1$$

Substituting this in Eq. (2), we find the L_i/L_o ratio should equal,

$$L_i/L_o = 1 + 0.507\,(2.1 - 1) = 1.56$$

The measured value was 1.59; a 1.9% error.

Example 4:

Coil Data	*Coil "A"*	*Coil "B"*
Number of turns	19	16
Wire size	26 PE	26 PE
Mean diameter	0.643 in.	0.643 in.
Length	1.187 in.	0.75 in.

Core Data
Material Unknown
Diameter 0.367 in.
Length 0.75 in.

Coil "A" (with a spaced winding) tunes without a core to 8.0 MC with 140 μμf of capacitance. When the core is placed in the center of the coil the capacitance must be reduced to 70.4 μμf to restore resonance. Calculate the effective permeability, μ_e', and predict the L_i/L_o ratio if this core is used with coil "B".

The L_i/L_o ratio for coil "A" measures

$$L_i/L_o = 140/70.4 = 1.99$$

and from Eq. (2) the effective permeability is

$$\mu_e' = \frac{1.99 - 1}{0.326} + 1 = 4.04$$

If we assume for the moment that the coil was increased to 1.187 in. from an original length equal to that of the core, viz., 0.75 in., we can say the effective permeability, μ_e, was reduced to a value of μ_e' of 4.04. Such a reduction is related directly to Eq. (5) and we can rearrange the expression and solve for μ_e.

$$\mu_e = \frac{\mu_e'}{\sqrt[4]{\frac{\text{core length}}{\text{coil length}}}} \qquad (5a)$$

Substituting,

$$\mu_e = \frac{4.04}{\sqrt[4]{\frac{0.75}{1.187}}} = 4.04/0.891 = 4.53$$

Using this value of μ_e, we can predict L_i/L_o for a coil length of 0.75 in. with Eq. (2).

$$L_i/L_o = 1 + 0.326\,(4.53 - 1) = 2.15$$

The measured value of L_i/L_o for coil "B" was 2.19.

Example 5:

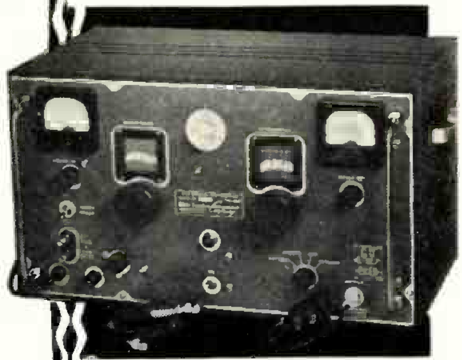
At 30 MC the measured values of L_i' and L_o' for a certain coil equal 0.27 µh and 0.114 µh, respectively. The internal inductance, L_m, of the 160A Q-meter used for this measurement measures 0.012 µh. What is the true ratio of L_i/L_o.

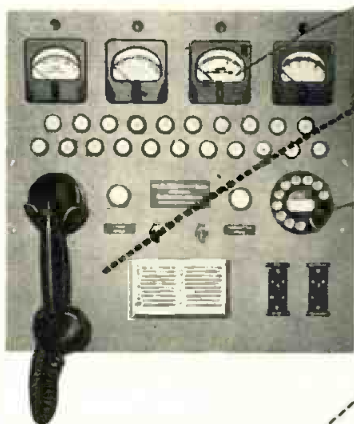
From the above information, L_i'/L_o' equals

(*Continued on page 178*)

AWARDED ARMSTRONG MEDAL

Dr. Raymond A. Heising has been presented with one of radio's prized honors, the Armstrong Medal. The award was made by The Radio Club of America. He invented the system of modulation which bears his name and was responsible for the design and construction of the first transmitter used in overseas telephone service. Other activities of Dr. Heising include carrier currents, piezo-electrics, and fundamental research. He retired recently from the Bell Telephone Labs.





CYLINDRICAL IRON CORES (Cont.)

$$\eta = \frac{0.27}{0.114} = 2.37$$

$$\text{and } \tau = \frac{0.012}{0.114} = 0.1052$$

Using Eq. (7),

$$L_i/L_o = (2.37 - 0.1052)/(1.0 - 0.1052) = 2.265/0.895 = 2.53$$

In this particular case, neglecting the internal inductance would have resulted in an error of over 6%.

Example 6:

An auxiliary coil (of about 85 μh) is connected in series with a test coil and the combination tunes to a frequency of 1.0 MC with 233 μμf of capacitance. The auxiliary coil tunes to this frequency without the test coil with 298 μμf.

The inductance of the test coil is given by

$$L_o = \frac{C_1 - C_2}{\omega^2 C_1 C_2}$$

Substituting,

$$L_o = \frac{(298 - 233) \times 10^6}{(6.28 \times 10^6)^2 \times 233 \times 298} = 65/2.745$$

$$L_o = 23.6\ \mu h$$

When the core is introduced into the test coil the tuning capacitor must be decreased from 233 μμf to 175.5 μμf in order to maintain resonance in the Q circuit. Thus, the apparent ratio of increased inductance is 233/175.5, or 1.33. Calculating γ

$$\gamma = L_{std}/L_o = 84.9/23.6 = 3.6$$

From Eq. (14), the true ratio of inductance equals

$$L_i/L_o = 1.33\ (1 + 3.6) - 3.6 = 2.52$$

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6—Lafferty, R. E., "Q Voltmeter Correction Chart," *TELE-TECH & ELECTRONIC INDUSTRIES*, Oct. 1952.
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LA Council Selects WCEMA Officers for '54

The West Coast Electronic Manufacturers' Assoc., Los Angeles Council, has selected E. P. Gertsch as chairman for 1954. He is head of Gertsch Products Inc., Los Angeles, manufacturer of electronic test equipment and instruments, and a Senior Member of the IRE.

Transistor Test

(*Continued from page 75*)

For typical transistors biased in the normal operating range only the intermediate sensitivity (M=1.0) is necessary. However, if it is desired to make measurements at very small input signal levels, the 0.1 position provides additional sensitivity. Conversely, if transistor noise causes excessive fluctuations, readings may be taken at higher signal levels by using the meter in its least sensitive position (M=10). The factor of 100 in the r_{21} and r_{22} positions (last two columns of Table I) was chosen to insure that typical values of these parameters for grounded base point contact transistors would fall near the center of the available range. Similarly, the factor of 1000 in the last two positions was chosen with typical grounded base junction parameters in mind. The Transtester is calibrated against internal networks of precision resistors which simulate the various parameters of transistors.

Phase Sensitive Detector

One of the most important features of the equipment is the phase sensitive (coherent) detector used in the ac voltmeter. Since the equipment is designed to measure only resistive parameters, it is necessary to insure that only those components of the measured voltage or current which are in phase (or 180° out of phase) with the ac signal input give rise to an indication on the meter. The method by which this is accomplished is indicated in the following section; here we are concerned only with the advantages of such an arrangement. A detailed analysis of the ac measuring circuits shows that inaccuracies present due to inevitable stray wiring capacities are considerably reduced by using a phase detector. For point-contact transistors, these inaccuracies are very small and the phase detector makes them quite negligible. In measuring junction transistors, however, normal wiring capacity can cause considerable inaccuracies when the collector resistance is very high. For example, if r_c is 50 megohms and the stray capacity (including that of the transistor itself) is 12μμf, a 30% inaccuracy will result if a conventional ac meter is used. Proper adjustment of the phase detector entirely corrects this source of error. The particular circuit used has an additional advantage in that various types of noise and 60 CPS pickup do not produce a mean displacement of the meter, but merely cause the meter

TRANSISTOR TEST (Cont.)

to fluctuate about the correct reading. Such disturbances cause both fluctuations and incorrect mean readings when conventional detectors are used.

The phase sensitive meter employed also permits one to distinguish between negative and positive small-signal parameters. This feature is particularly useful when investigating peculiar units having small-signal parameters of the "wrong" sign which are sometimes encountered in the present state of the transistor art. Negative values of h_{12} (indicating negative equivalent base resistance) and $1 - \alpha$ have been observed for junction transistors, and negative values of r_{22} for point contact types. Note that a conventional meter would not indicate the typical behavior of these transistors. The ability to distinguish and measure negative parameters is also useful in investigating the negative resistance characteristics of germanium diodes, point contact transistors and input or output impedances of switching circuits as a whole.

Stability Considerations

To obtain meaningful results from any of the measurements discussed above it is necessary to insure that the circuit as a whole including the two or four terminal device under test is stable, not only in the frequency range at which the measurements are being made, but throughout the entire frequency spectrum. Oscillations which invalidate results are most often encountered in point contact units because of their inherent short circuit instability. For circuit stability the determinant of the equations describing the ac behavior must be greater than zero. At low frequencies this condition may be written

$$(r_{11} + R_G)\,(1 + R_L/r_{22}) - \alpha r_{12} > 0$$

where r_{11}, r_{12}, α and r_{22} are properties of the unit under test, R_G is the dynamic resistance in series with the input terminal, and R_L is the dynamic resistance in series with the output terminal. Low frequency stability is easily achieved since either R_G, R_L or both may easily be made as large as necessary. In the equipment described the minimum value of R_G is 100K. In order to insure stability at high frequencies, the various reactive elements present in the circuit must be included in the analysis. The high frequency characteristics of a point contact transistor may be represented by writing

r_{21} $(1+\omega/\omega_\alpha)$ for r_{21} in the ac equivalent circuit where ω_α is 2π times the α cutoff frequency, f_α. Although this is certainly not an exact representation, it is sufficiently accurate to obtain realistic results. A second important circuit parameter influencing high frequency stability is the total capacity between emitter and base, C_{eb}. Imposing either the Nyquist or Routh stability criterion to this equivalent circuit we find that instability results if $1/f_\alpha$ is less than $2\pi C_{eb}(\alpha r_{12} - r_{11})$, where α is the low frequency short-circuit current

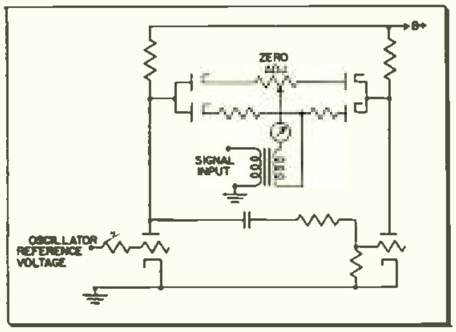


Fig. 3: Schematic of phase sensitive detector

gain. Accordingly, care should be exercised in keeping the stray wiring capacity at the emitter terminal low. For typical values of r_{11}, r_{12} and α, oscillations may be expected if the α cutoff frequency is greater than 40 MC. However, the critical cutoff frequency may vary by an order of magnitude depending on the exact values of r_{11}, r_{12}, and α. The insertion of a series resistor of several hundred ohms right at the emitter terminal will aid in maintaining circuit stability (by increasing r_{11}): the value of this resistance must then be subtracted from the measured r_{11} to determine the equivalent f_{11} of the transistor.

Instrumentation

The primary source of signal current and voltage is a conventional Wien bridge oscillator, the frequency of which may be varied by 5% from the nominal value of 270 CPS by a front panel control. In normal use, the output amplitude is adjusted for approximately 20 volts at an impedance level of 40 ohms.

Three separate cascaded amplifiers and a phase sensitive detector are included in the ac metering circuit. The first amplifier has a nominal stabilized gain of 100 with a relatively broad pass band centered at the design frequency. A three position decade switch for changing the meter sensitivity is included at the output of the second amplifier which also has a nominal stabilized gain of

100. Two feedback paths are incorporated in the third amplifier. The first is resistive and stabilizes the maximum gain at 100. A second feedback through a twin-T coupling network is degenerative at frequencies remote from the null of the twin-T resulting in an amplifier with a maximum gain of 100 at 270 CPS and selectivity equivalent to that obtained from a single tuned circuit with a Q of 12. Minor phase shifts in the preceding amplifiers can be compensated by adjusting the oscillator frequency slightly since the phase changes quite rapidly with frequency in the selective amplifier.

The phase detector itself consists of an over-driven amplifier and two dual diodes as shown in Fig. 3. During one half of the reference cycle the diodes are biased off by 100 volts and no current can flow through the meter. On the other half cycle the diodes conduct heavily. When no signal is present, the bridge circuit consisting of the four diodes and their associated series resistors may be balanced by the zero adjustment. Signals in phase with the oscillator reference voltage unbalance this bridge and cause a deflection on the meter. Signals 90° out of phase with the oscillator give rise to equal positive and negative currents during the "on" half cycle and consequently no net deflection. Similarly, random noise and stray 60 CPS pickup yield no average deflection although excessive spurious voltages will cause the meter to fluctuate about the true reading. It can be shown that the effective bandwidth of a phase detector is essentially the bandwidth of the meter movement itself considered as a low pass filter.

The dc current supplies employ pentodes with negative current feedback obtained from large series cathode resistors. Analysis of this circuit yields a value of approximately 10 megohms for the internal dynamic resistance with the particular choice of tubes and circuit parameters. The output current of the supply may be adjusted between 0 to 15 ma of either polarity subject to a maximum load voltage of approximately 200 volts.

Measurements of the "h" parameters of transistors requires that the output terminal be returned to either an ac ground or an ac generator through a low impedance. Several modifications of a conventional voltage stabilizer circuit yield a design with the following features:

a) voltage adjustable from 0 to 100 volts of either polarity (to a maximum current of 35 ma)

b) internal impedance of less than 5 ohms (plus a 10 ohm resistor used for measuring a-c current)

c) injection of oscillator voltage into the feedback loop which essentially adds an ideal ac generator to the supply without increasing the impedance.

The dc operating point of the transistor under test is continuously monitored by meters indicating the input and output current and voltage. Seven current ranges (50 μa to 25 ma full scale) are provided for both input and output current, while the corresponding vacuum tube voltmeters have five ranges (100 mv to 25 v for input voltage and 1 v to 100 v for output voltage).

Although the equipment described here was specifically designed for measuring the small signal behavior of point contact and junction transistors in the grounded base connection, it has proven sufficiently versatile to permit a number of other types of measurements with relatively minor modification or recalibration. Specifically, the equipment has been used to measure grounded emitter and grounded collector dynamic characteristics of junction transistors, dc and dynamic characteristics of point contact and junction diodes, h parameters of point contact transistors, and input and ouput impedances of complete amplifiers and switching circuits. The addition of a precision resistor to change the input ac and dc current source to a voltage source permits the accurate measurement of vacuum tube dynamic characteristics over a very wide range of values. Likewise, additional dc supplies permit the measurement of all of the small signal parameters of transistors with four or more terminals.

TV CAMERA TEST

An inspector in Camden, N. J., plant of RCA Victor Div., Radio Corporation of America, checks circuits of the company's new "TV Eye" closed-circuit television camera as initial models come off assembly lines. Midget 4-lb. camera, with housing removed from chassis, is focused on test pattern at left. Signal, channeled through control unit seen between camera and receiver, reproduces pattern on receiver screen.

TELE-TECH

CLOSING DATES

25th of second month preceding date of issue, for all ads requiring proofs, composition, foundry work, key changes, etc.

1st of preceding month for complete plates only—no setting.

20th of preceding month—Publication Date.

Cancellations not accepted after 1st of preceding month.

Caldwell-Clements, Inc., 480 LEXINGTON AVENUE, NEW YORK 17

TV Towers

(*Continued from page 97*)

are planned for erection adjacent to the site of the AM station with which the TV station is associated. Most of the associated AM stations have directive antennas, and it is usually more expensive and more difficult to isolate a separate TV tower of this height so that it will not adversely affect the operation of the directive antenna system, than it is to incorporate the high element as the main radiator of the directive antenna system. Such use of the high TV tower as a radiating element of the AM antenna system will

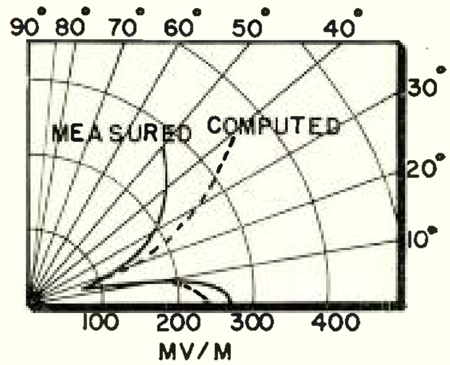


Fig. 4: WKY vertical radiation toward WTAD

ordinarily not only permit a very much improved coverage for the station involved but may also permit it to reduce, rather than increase, the interference caused to the other stations operating on the same frequency.

The cost of the additional isolating insulators and the insulation of the concentric line feeding the TV antenna represents but a very small increase in cost for the TV antenna and imposes no handicaps whatsoever on the operation of the tower as a support for the TV antenna system.

Spacings Not Critical

The spacings of the individual elements of such a radiator are not critical, and it is not difficult to arrange the spacings so that they will fit into any antenna height contemplated for a TV antenna. For instance, we computed for a 1000 ft. TV tower, which was to be used by one of the 50 kw stations at the upper end of the AM band, that by the use of this proposed TV tower as the main element of its AM directive antenna system, the radiation could be increased to the equivalent of nearly 125 kw. Certainly, the gain in coverage and service, which such a station could render with such an increase in effective radi-

TV TOWERS (Cont.)

ated power, would be worth many times the few thousand dollars that it would have required to obtain it. It should also be emphasized that this small cost is a capital expenditure, and that hence the first cost is the last cost and not a continuing and recurring operating cost. On the other hand, any increase in coverage obtained through increased transmitter power, even where it is feasible, entails very substantial increases in operating costs for power, tubes, etc., in addition to the capital expenditure required. Also, due to the limitations imposed by the FCC's Rules and Regulations, the high towers offer for most stations the only possible means of increasing coverage, regardless of cost.

Actually, these antennas are, on their own merits alone, often not only economically feasible but also offer substantial economies. Before the war we made a study of the economics of antenna efficiency versus transmitter power. We found that it could be shown that if you consider merely the problem of laying down a given signal at any given point for the least money, even on the basis of a five-year write off, you can save money in the overall cost by spending between once and twice as much for your antenna system as you do for your transmitter. While this ratio of costs is, in the case of directive antennas, frequently reached for regional stations limited to a maximum of 5 kw, there are very few Class I or II stations which have even approached a proper economic balance between the cost of their antenna systems and their transmitter plants.

The author wishes to express his appreciation to E. K. Gaylord, Edgar T. Bell and Jack Lovell of WKY for their vision and cooperation in bringing the designs into being.

1. R. Harmon, "Some Comments on Broadcast Antennas," *Proc. IRE*, vol. 24, pp. 36-47, Jan. 1936.
2. Brown, "A Critical Study of the Characteristics of Broadcast Antennas as Affected by Antenna Current Distribution," *Proc. IRE*, vol. 24, pp. 46-81, Jan. 1936.

Atlantic Transformer to New London Instrument Co.

Atlantic Transformer Corp. (formerly AJF Industries, Brooklyn, N. Y.) has been acquired by the New London Instrument Co., New London, Conn. Expanded facilities for the manufacture of audio, pulse power and magnetic amplifier transformers are provided at the company's new location at 3 Hynes Ave., Groton, Conn. Key engineering and production personnel have moved to Groton with the company.

BULLETINS

Engineering Data

A 20-page booklet for design and methods engineers has been prepared by the Special Products Div. I-T-E Circuit Breaker Co., 19th and Hamilton Strs., Philadelphia 30, Pa. Designated Publication No. SP-100, the literature discusses radar antenna systems, major components of jet engines, advanced theories on thermodynamics, guided missiles, titanium welding, etc.

Power Resistors

Bulletin P-2 recently released by International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa., presents comprehensive data covering the characteristics, applications, construction, ranges, ratings, tolerance charts, and graphs of the Types PW-7 and PW-10 power resistors.

Resistors

Arnhold Ceramics, Inc., 1 East 57th St., New York 22, N.Y., have released Bulletin 1A which presents style specifications, dimensions, and ratings covering Stemag "Chemo-Carbon" resistors.

Panel Meters

A new data sheet gives complete performance information on the miniature side indicating panel meters recently announced by International Instruments Inc., P.O. Box 2954, New Haven 15, Conn.

Selenium Rectifiers

Sarkes Tarzian Inc., Rectifier Div., 415 N. College Ave., Bloomington, Ind., have published a four-page brochure entitled "Selenium Rectifiers for Color Television" which is offered as a guide on B+ power supply designs.

Recorder Problems

"Sound Talk" Bulletin No. 27 is a three-page discussion of azimuth alignment and tape skewing, importance of head contact, and the effects of head wear on magnetic tape recording released by Minnesota Mining and Manufacturing Co., 900 Fauquire Street, St. Paul 6, Minn.

Instruments

El-Tronics Inc., Fifth and Noble Sts., Philadelphia 23, Pa., have published a new catalog which describes the company's instruments and accessories used in the detection and measurement of radioactivity. It is available without cost.

Conversion Chart

Cinema Engineering Co., Division of Aerovox Corp., 1100 Chestnut St., Burbank, Calif., have issued a wall or desk top audio power conversion chart that is available without charge. The chart shows power level in watts, decibels, and voltage across a 600 ohm line.

Bobbins

A four-page brochure on dielectric coil bobbins manufactured by Precision Paper Tube Co., 2033 West Charleston St., Chicago 47, Ill., is available to those who write to Dept. T-5.

Calculator

A new 3 x 6 in. slide chart calculator which enables engineers and sales people to compute quickly the efficiency and regulation of dynamotor power supplies is available at 25c each at the Carter Motor Co., 2654 N. Maplewood Ave., Chicago 47, Ill., Dept. 11.

Labels

"A Revolution in Metal Nameplates"—a color brochure released by North Shore Nameplate Co., Bank of Manhattan Bldg., Bayside, L.I., N.Y.—describes "Speedy-Cals," nameplates made from .003 foil laminated with a fine bonding material.

Instruction Sheets

Berkshire Laboratories, 518 Beaver Pond Road, Lincoln, Mass., have released new publication sheets, I-1 and I-18 covering the company's "Labmarkers" and "Labstrobe," Model 18.

Turn to pages 136-137 for full information about the **IRE SHOW ISSUES** of

BULLETINS

Instruments and Controls

General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass., has released its January 1, 1954, 275-page profusely illustrated Catalog N. covering the company's industrial instruments, controls, parts, and accessories. The book also contains valuable engineering data, charts, and tables.

Color Equipment

"TV Studio Equipment Bulletin No. 181," issued by Tel-Instrument Co., Inc., 728 Garden St., Carlstadt, N. J., describes and discusses a complete NTSC color equipment package consisting of color sync and wave form generator, matrixer and encoder, color monoscope, color transmitter, equalizing filter, and color picture monitor.

Application Guide

Yarney Electric Corp., 105 Chambers St., New York 7, N. Y., offers, free of charge, a new pocket-size application guide to facilitate model selection and provide technical data covering "Silvercel" models. A rotating selector-disc indicates the most suitable model for a particular application in terms of cell size, weight, recommend charging rate, representative discharge voltage and w/hr. value. Charging methods and characteristic curves are on the reverse side.

Triode

A new data sheet has been prepared by Lewis and Kaufman, Ltd., 52 El Rancho Ave., Los Gatos, California, which illustrates and presents outline dimensions, general characteristics, and average static performance curves covering the "Los Gatos" brand medium-mu triode—maximum plate dissipation 25 w., maximum ratings 60 MC.

Check Sheets

Two new connector check sheets for color TV prepared by Alden Products Co., 117 North Main St., Brockton 64, Mass., present two new connectors. The new sheets also incorporate corrected errors, revisions and design changes related to other company products.

Nine Catalogs

To simplify planning hydraulic circuits and component ordering, the Hydraulic Press Mfg. Co., Mount Gilead, Ohio, has produced a set of nine individually-bound catalogs. Each catalog has a visual index which shows a product photo and specifications location, and classifies line-type, style, product, and pressure range.

Electric Plant

A new 16-page, two-color, pocket-size issue of "Power Points Digest," company publication of D. W. Onan & Sons Inc., Minneapolis 14, Minn., describes various standby and mobile applications of the new Model "CW" electric generating plant.

Twin Tetrode

A 26-page data and application booklet prepared by Amperex Electronic Corp., 230 Duffy Ave., Hicksville, N. Y., includes detailed data, application notes, performance curves, special features, and construction descriptions covering the Type 5894/AX-9903 "Amperex" twin tetrode tube.

Time and Motion Study Proceedings

The Proceedings of the 17th Annual Time and Motion Study and Management Clinic sponsored by the Industrial Management Society, November 4-5-6, 1953 at the Sheraton Hotel, Chicago, including charts, forms, illustrations and complete transcripts of talks are now available from the Industrial Management Society, 35 East Wacker Drive, Chicago 1, Ill. Price is $4.00.

INDUSTRY NEWS

Dick O. Klein, vice-president and general manager of Raytheon Distributors, Inc., recently was appointed director of marketing for the Television and Radio Division of the Raytheon Manufacturing Co., Chicago., Ill. Concurrently, Mr. Klein was appointed assistant vice-president of the parent Raytheon Manufacturing Co. In his new post, he will supervise all Raytheon national sales, advertising, and service activities.

J. Kneeland Nunan recently succeeded Philip S. Fogg as president of Consolidated Vacuum Corp. of Rochester, N.Y., subsidiary of Consolidated Engineering Corp. of Pasadena, Calif. Mr. Fogg continues as chairman of the board of Consolidated Vacuum Corp. Mr. Kneeland has been executive vice-president of the high-vacuum equipment concern since early in 1953.

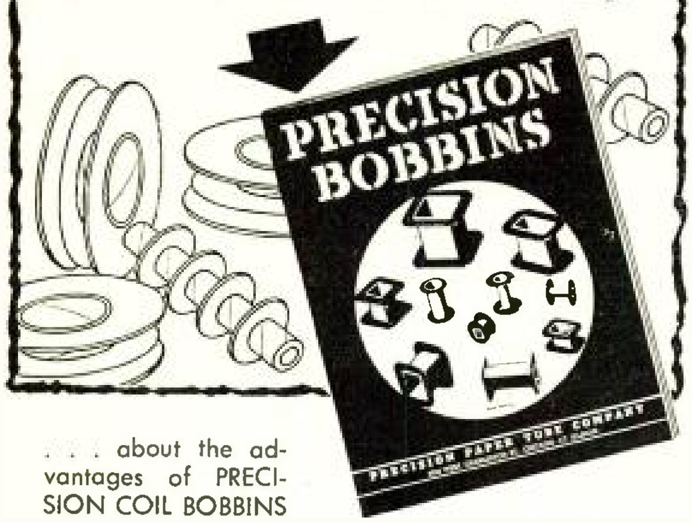
J. K. Nunan

Robert A. Van Valkenburgh, newly appointed government contract manager for the National Co., Inc., Malden and Melrose Mass., will head the new company sales office in Washington, D.C.

Bob Kuhl, former West Coast sales engineer for the Gates Radio Co., Quincy, Ill., was recently made manager of the new Gates Factory Branch Store, 7501 Sunset Boulevard, Los Angeles, Calif. **Howard Decker** was made manager of the new Gates Factory Branch Store at 1133 Spring St., N.W., Atlanta, Ga. He was formerly the head of the customer order service department in the home office. A short time ago, **Harold Arment** rejoined the Gates sales organization to cover the Los Angeles and Southern California territory. His headquarters will be at the Los Angeles store.

Four RCA vice-presidents have been elevated to the position of executive vice-president. They are: **Joseph B. Elliot**, new Consumer Products Div.; **W. Walter Watts**, new Electronic Products Div.; **Dr. Elmer W. Engstrom**, RCA Labs Div.; and **Charles M. Odorizzi**, consolidated corporate staff.

Get the facts...



. . . about the advantages of PRECISION COIL BOBBINS

. . . about what goes into them to make them better — the research, the materials, the precision workmanship. *Learn these facts to improve your coils.*

Send for your copy of this informative PRECISION BOBBIN bulletin . . . *write today!*

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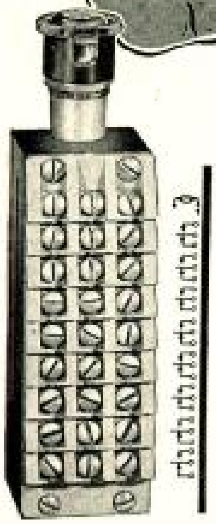
Also Mfrs. of Precision Paper Tubes

LET SAFEGUARDS GO ON WITH THIS LONG LIFE

GUARDIAN 8 P.D.T. *Switch*



Hit the button or throw a lever on the Guardian 8 P. D. T. Switch and this overriding master unit instantly switches or disconnects 8 primary circuits. Constant contact pressure (4 ounces per point) is maintained throughout the stroke until positive *snap-action* occurs in either direction. No dead center. Contacts handle 5 amps, 28 V. D.C. inductive—10 Amps, 115 V. A.C. non-inductive—60 to 400 cycles. Unit mounts on 1½" x 1½" panel area to conserve space and decrease overall costs. Sand and dust type enclosure easily removed for inspection. Built to exceed military specification ANS-63 applicable to this type switch to resist shock and vibration and to operate at −65° F. to +160° F. Easy to wire—easy to mount—compact—low cost. Available with auxiliary "push-to-test" S.P.D.T. circuit and dial light. Weighs approximately 8 oz.

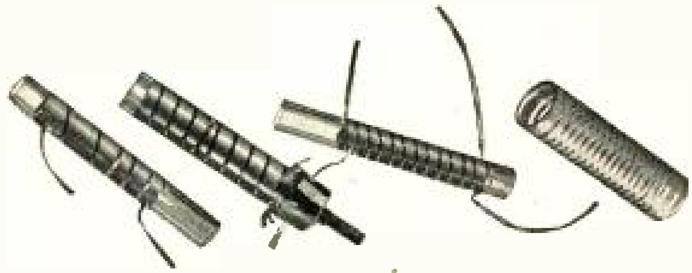
GUARDIAN ELECTRIC

1607-B W. WALNUT STREET CHICAGO 12, ILLINOIS
A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

Why you get greater stability with Corning metallized glass inductances and capacitors

To begin with, specially selected glass is used that has excellent temperature and electrical characteristics. Then we fire in metal to make an integral contact with the glass forms. The result is a rugged unit with unusually high electrical and thermal stability.

Corning Midget Trimmer Capacitors—have practically zero temperature coefficients in the VHF range. Capacity shift is negligible even with widely variable ambient temperatures. They're available in standard types covering the ranges of .3 to 3, 1 to 8, and 1 to 12 u.u.f., or we'll design them to your special requirements. With direct traverse trimming, there is negligible capacity shift under vibrations and an absolutely smooth capacity curve.



Corning Metallized Glass Inductances—are noted for their exceptionally high electrical stability and negligible drift characteristics, even under widely variable ambient temperatures. High Q is inherent. They can be furnished with uniform, variable or double-pitch windings and for fixed tuned, permeability tuned inductance trimmer combinations.

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Name.................................... Title....................
Company..
City.................................... Zone......... State..........

INDUSTRY NEWS

(Continued from page 190)

Charles H. Fritz has been made assistant sales manager of Shallcross Manufacturing Co., Collingdale, Pa. For the past seven years, Mr. Fritz has had charge of the design and development of the company's line of precision rotary switches and audio attenuators.

G. W. DeSousa, formerly manager of the General Electric Company Tube Department marketing administration, Schenectady, N.Y., has been named to succeed **Grady L. Roark** as manager of equipment tube sales. Mr. Roark is department marketing manager. Mr. DeSousa will direct the sales of G-E receiving, cathode ray, industrial, and transmitting tubes. Milton J. Strehle, previously manager of Tube Department intra-company sales, will succed Mr. DeSousa as manager of marketing administration.

G. W. DeSousa

John A. Curtis was recently made general sales manager of the Westinghouse Electronic Tube Division, Elmira, N.Y. Formerly with the Pullman-Standard Car Manufacturing Co., Mr. Curtis replaced Harold G. Cheney, now assistant to the vice-president of the division.

Edward L. Saxe was recently appointed vice-president and assistant to J. L. Van Volkenburg, president of CBS Television. He was formerly comptroller of CBS, Inc. David J. Hopkins has become director of sales for CBS-Columbia, TV and radio manufacturing division of the Columbia Broadcasting System. He was formerly director of sales and advertising for Emerson Radio and Phonograph Corp. with whom he was associated for nine years.

Charles B. Sweatt, younger brother of Harold W. Sweat, board chairman of Minneapolis-Honeywell Regulator Company, was recently elected to the newly-created post of board vice-president. **Tom McDonald and A. M. Wilson,** former company vice-presidents, were elected executive vice-presidents and will assist Paul B. Wishart, president, in carrying out managerial duties at the policy-making level.

TELE-TECH ADVERTISERS — FEBRUARY, 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.

INDUSTRY NEWS

(Continued from page 192)

Vic Lees, formerly production manager of Cole Instrument Co., Los Angeles, recently joined Cinema Engineering Co., Division of Aerovox Corp., Burbank, Calif. in a similar capacity. **Gordon Edwards** became a sales engineer for Aerovox Corp. He had been chief engineer of Cole Instrument Co.

Herbert M. Cole, formerly area chief for the New York and New England Area of the Signal Corps Supply Agency (New York Regional Office), has been named manager, of the Government Sales Div., New London Instrument Co., New London, Conn.

Herbert M. Cole

Arnold Kalland was recently appointed assistant general manager of James B. Lansing Sound, Inc., Los Angeles, Calif. Priorily, he had been purchasing agent and assistant office manager of Wells All-Steel Products Co., North Hollywood, California.

C. W. Powell, manager of the Pittsburgh branch sales office of the Carboloy Department of the General Electric Co., has been named manager of the newly-created Allegheny district, the office of which is located at 704 Second Ave., Pittsburgh, Pa. **Harry H. Jason,** manager of tool sales, Detroit, Mich., has been named manager of the Department's newly-created New England sales district, and J. D. Kennedy, manager of product projects has been named manager of the South Central sales district with headquarters in St. Louis, Mo. **Alfred M. Thomson, Jr.** with headquarters in Cleveland, O., is now manager of East Central District Sales.

Edward Edison has become broadcast field sales representative in RCA Victor's Western Region, with headquarters in Los Angeles, Calif. He joined RCA Service Co., Inc., in 1942. Mr. Edison became assistant chief engineer at Station KLAC-TV in Hollywood in 1951, then transferred to NBC as TV engineer in 1952.

RCA *Receiving Tubes*

For Peak Performance

in your TV circuits . . .

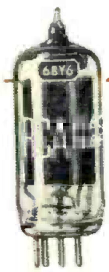
New RCA Tubes for Economical TV Receiver Designs

RCA-6AN8
General-Purpose Triode-Pentode

RCA-6AN8 is a general-purpose multi-unit tube combining a medium-mu triode and a sharp-cutoff pentode in one envelope. It is designed for versatility in many TV receiver applications. A special basing arrangement, together with internal shielding, virtually eliminates coupling between units of the tube. All of these features contribute to economical design of TV receivers.

RCA-6AS8
Video IF Amplifier and Detector

RCA-6AS8 features two units—a high-perveance diode and a sharp-cutoff pentode—in a single envelope. Designed for use in the last picture if amplifier stage and video detector stage, the 6AS8 offers a pentode transconductance of 6200 μmhos and a basing arrangement which provide effective isolation of the diode and pentode units. These features facilitate economy in TV receiver design.



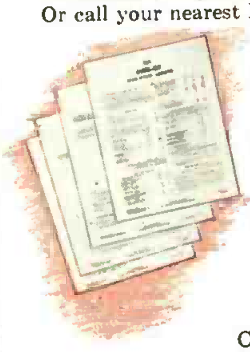
RCA-6BY6
Pentagrid Amplifier

RCA-6BY6 is a pentagrid amplifier designed for gated amplifier service in TV sync-separator circuits. An important operating feature of 6BY6 design is its favorable ratio of plate current to grids No. 2 and No. 4 current—which permits achieving the desired output signal with relatively low power input to grids No. 2 and No. 4.

RCA-6AU4-GT
Damper Diode

RCA-6AU4-GT is half-wave rectifier of the glass-octal type. It is especially useful as a damper diode in TV receiver circuits. This tube can withstand a maximum peak inverse plate voltage of 4500 volts (absolute), and can supply a maximum peak plate current of 175 ma. The RCA-6AU4-GT can handle negative peak pulses up to 4500 volts between heater and cathode (with a dc component as high as 900 volts).

For technical data on these important TV tubes—or for help on specific design problems—write RCA, Commercial Engineering, Section B50Q, Harrison, N. J. Or call your nearest RCA Field Office:



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744 Broad St.,
Newark 1, N. J.

(CENTRAL) Whitehall 4-2900
589 E. Illinois St.,
Chicago, Ill.

(WEST) Madison 9-3671
420 S. San Pedro St.,
Los Angeles, Cal.

Complete technical bulletins on RCA-6AN8, 6AS8, 6BY6, and 6AU4-GT are yours for the asking—from RCA, Commercial Engineering, Section B50Q, Harrison, N. J.

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ELECTRON TUBES — **HARRISON, N. J.**