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TELE-TECH

RADIO-TELEVISION-ELECTRONIC INDUSTRIES

INSTITUTE of RADIO ENGINEERS

FOUNDED 1912

AUDIO GROUP 1948	BC & TV RECEIVERS 1949
BROADCAST TRANSMISSION 1948	RADIO TELEMETRY 1950
ANTENNAS & PROPAGATION 1949	INSTRUMENTATION 1950
CIRCUIT THEORY 1949	AIRBORNE RADIO 1951
VEHICULAR COMMUNICATIONS 1949	INFORMATION THEORY 1951
QUALITY CONTROL 1949	ENGINEERING MANAGEMENT 1951
NUCLEAR SCIENCE 1949	INDUSTRIAL ELECTRONICS 1951

IRE'S RECENT TREND TO SPECIALIZED GROUPS

March • 1952

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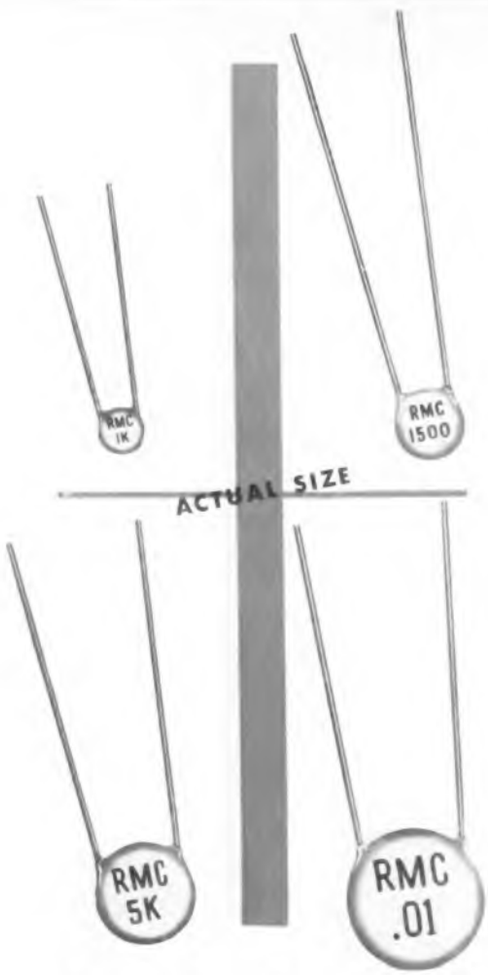
RMC "HEAVY DUTY" By-Pass DISCAPS



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"HEAVY DUTY" CERAMIC CAPACITOR

The heavier ceramic dielectric element made by an *entirely new process* provides the necessary safety factor required for line to ground applications or any application where a steady high voltage condition may occur. Designed to withstand constant 1000 V.A.C. service.

It is wise to specify RMC "HEAVY DUTY" by-pass DISCAPS throughout the entire chassis because they *cost no more* than ordinary lighter constructed units.

Specify them too, for your own peace of mind, with the knowledge that they can "take it." And if you want proof — request samples.

"RMC DISCAPS" *The Right Way to Say Ceramic Condensers*

A New Development from the RMC Technical Ceramic Laboratories

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MARCH, 1952

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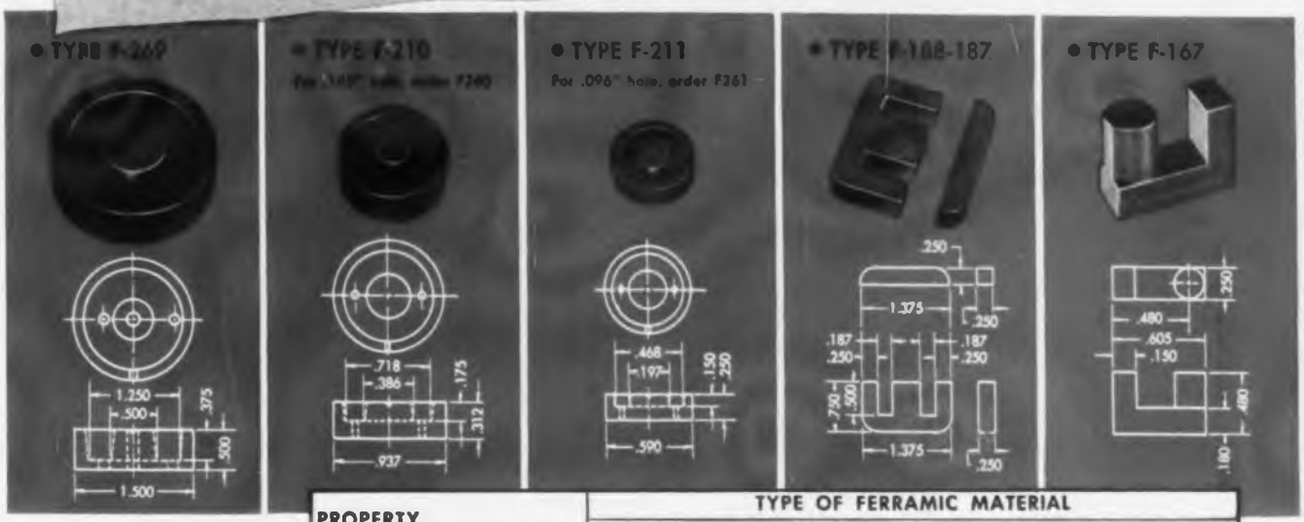
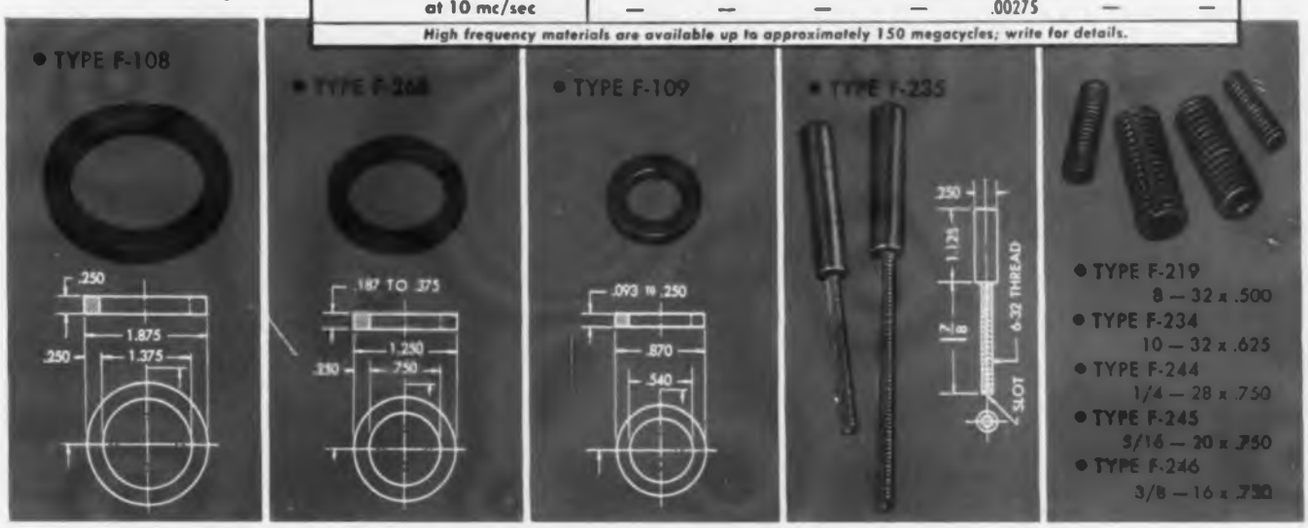


Ferramics offer many important advantages as an electro-magnetic core material. The result has been wide adoption of this material in commercial and military electronic applications. We would welcome an opportunity to tell you how Ferramics can improve your components. For complete information call or write today.

PROPERTY	UNIT	TYPE OF FERRAMIC MATERIAL B-90	C-159	E-212	H-419	I-141	J-472
Initial permeability at 1 mc/sec	—	95	220	750	850	600	330
Maximum permeability	—	183	710	1710	4300	1010	750
Saturation flux density	Gauss	1900	3800	3800	3400	1540	2900
Residual magnetism	Gauss	830	2700	1950	1470	660	1600
Coercive force	Oersted	3.0	2.1	0.65	0.18	0.40	.80
Temperature coefficient of initial permeability	%/°C.	0.04	0.4	0.25	0.66	0.3	0.22
Curie point	°C.+	260	330	160	150	70	180
Volume resistivity	Ohm-cm	$2x10^5$	$2x10^3$	$4x10^5$	$1x10^4$	$2x10^5$	—
Loss Factor: at 1 mc/sec	—	.00016	.00007	.00008	.00030	.0003	.000055
at 5 mc/sec	—	.0011	.0008	.002	.00155	.005	—
at 10 mc/sec	—	—	—	—	.00275	—	—

High frequency materials are available up to approximately 150 megacycles; write for details.



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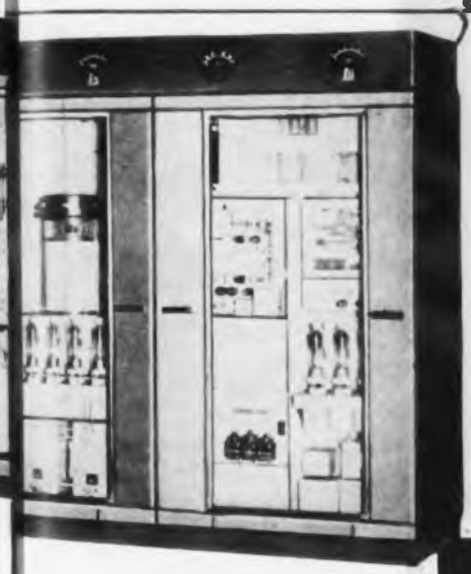
waiting for!

SAVINGS ARE TREMENDOUS WITH THESE NEW STANDARD ELECTRONICS TV TRANSMITTERS

because **extreme flexibility is achieved by adding amplification to the basic 500 watt transmitter for power outputs to 20 KW**

because **a complete station package can be supplied to put you on the air quickly**



● Greater Flexibility

ADD-A-UNIT design offers additional advantage in adapting the transmitter, which is completely self-contained, to any station layout whether in a straight line "L" or "U" arrangement.

● Lower Tube Costs

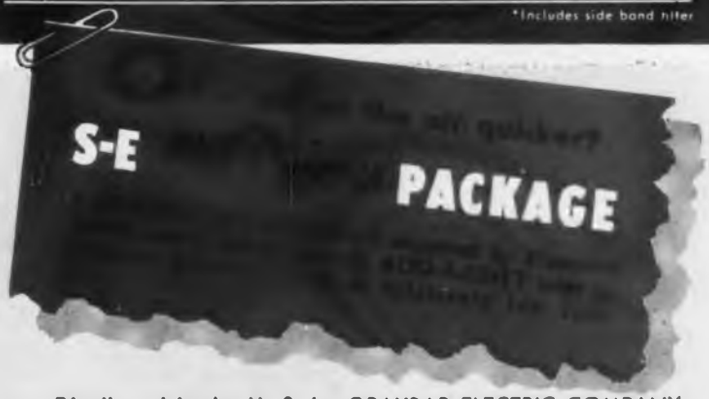
In addition to lower installation, operating and maintenance costs, additional savings are realized in tube replacement. Aging tubes, incapable of supplying adequate power in the visual section are interchangeable to the aural section where power requirements are considerably less. This similarity in the tube line-up also reduces your investment in spares to meet FCC requirements.

COMPARATIVE ADVANTAGES OF THE NEW STANDARD TV TRANSMITTER BASED ON 5 KW OUTPUT

SPECIFICATIONS	Standard Electronics	Competitive Transmitters A	B	C	D
Approx. cost – 1 Set of tubes	$1400	$1500	$1600	$1700	$3000
Approx. power consump. (aver. per.)	15KW	18KW	25KW	23KW	25KW
Similarity of tube line up, aural and visual	YES	NO	NO	YES	NO
Physical length	178 in.*	180 in.	199 in.	215 in.	208 in.
Self-contained, both bands	YES	NO	NO	NO	NO
Air cooled, both bands	YES	YES	YES	YES	NO
Factory adjusted side band filter	YES	NO	YES	NO	YES
Ability to use driver as stand by transmitter	YES	NO	NO	NO	NO

*Includes side band filter

- Completely air-cooled
- Entirely self-contained
- Full length tempered—glass front doors
- All vacuum tubes visible during operation
- Covering the entire VHF-TV band



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TIS-61
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RPORATION

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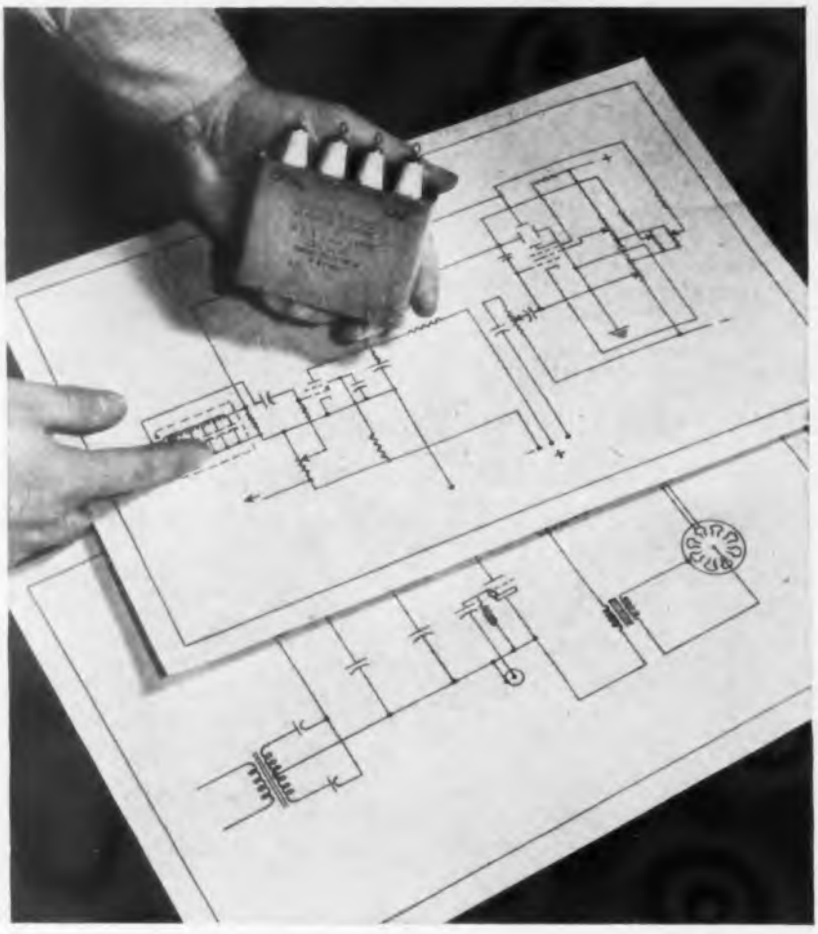
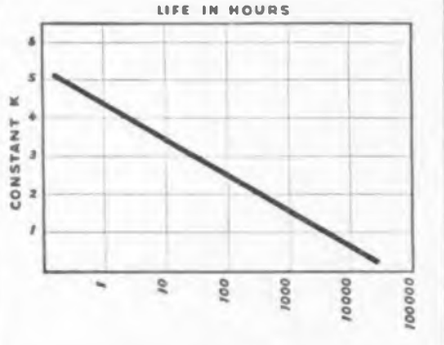
Got a really tough capacitor network problem for us?



...let our network designers help you solve it!



This curve results from actual life tests of capacitor networks under pulsing conditions in a radar modulator. Service life, for varying values of "K", starts at 2 tenths of one hour and stretches out to something over 40,000 hours (more than 4½ years of continuous operation at full-rated voltages.)

It's just one example of actual performance data G-E engineers use in designing capacitor networks for the job they must do.

Whether your problem deals with guided missiles—aircraft—land or sea radar equipments, General Electric application and design engineers can help you solve it. We've designed and built capacitor networks for every type of pulse radar equipment since the inception of radar.

Take service life for example. You can specify a service life of 10,000 hours—or just 60 seconds. And we'll deliver pulse networks to match your requirements. Here's why:

> Since 1944 General Electric has been running continuous life tests on many types of networks. We've established life limitations, under varying conditions of temperature and voltage, for all types of dielectrics, bushings, materials for coil forms and treating processes.

Let us use this store of information and experience to solve your capacitor network problems. Your inquiry addressed to your nearest Apparatus Sales Office, or to Capacitor Sales Division, General Electric Company, Hudson Falls, N. Y. will receive prompt attention.

General Electric Company, Schenectady 5, New York.

GENERAL ELECTRIC

407-308

SAVE making all these expensive soldered connections

by using Centralab Printed Circuits instead!

for more information . . . see the next two pages ▶▶▶

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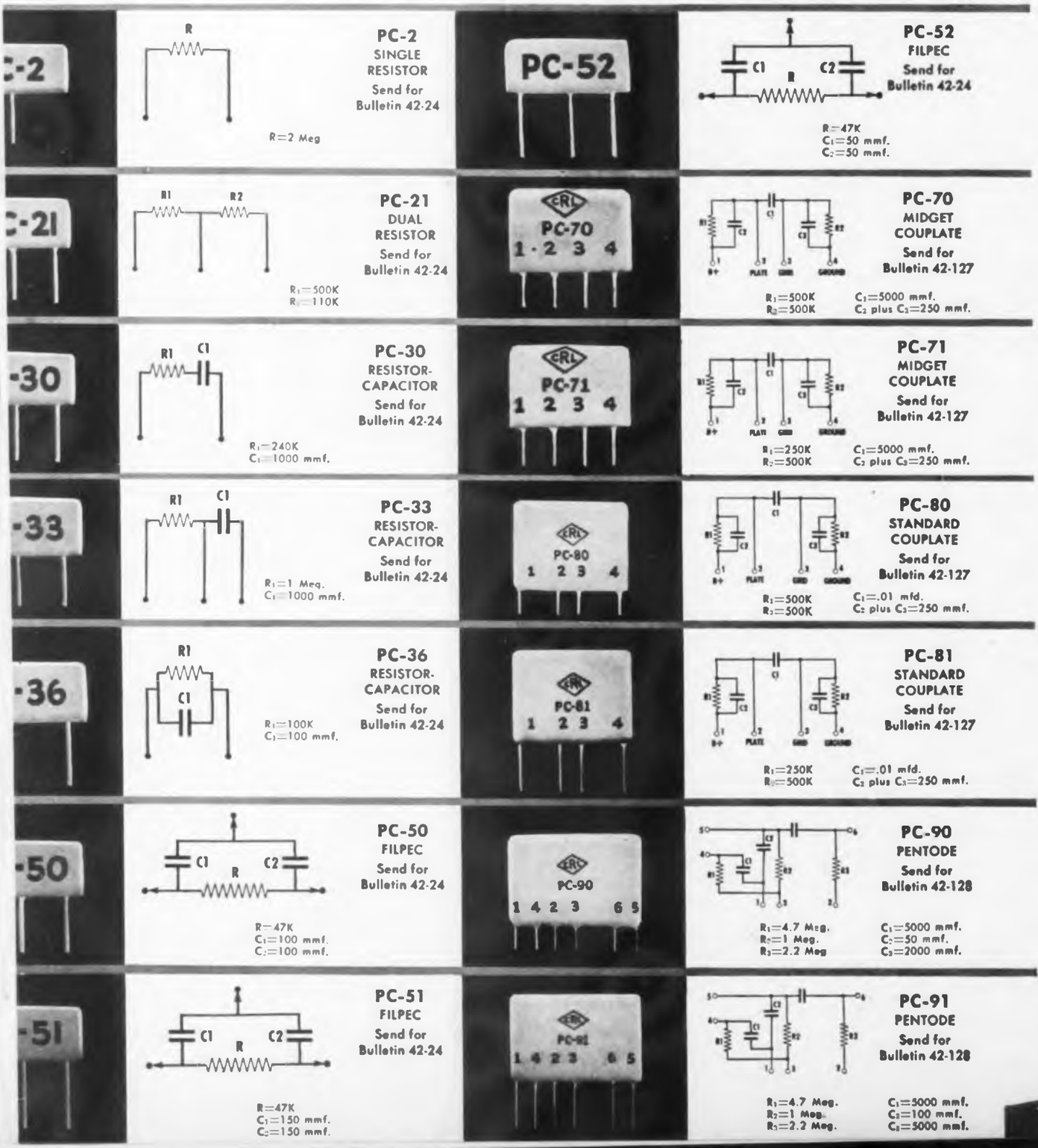
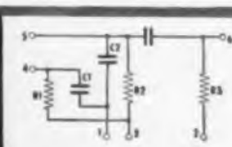
. are complete or partial circuits (including all integral : connections), consisting of pure metallic silver and ance materials fired to Centralab's famous Steatite or ic X and brought out to convenient, permanently an- d leads.

They provide miniature units of widely diversified circuits — from single resistor plates to complete speech amplifiers.

All those illustrated here are available for standard applications. Save these pages for reference. Numerous other circuit complements can be furnished for volume requirements.

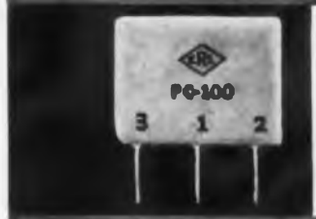


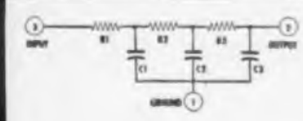
CIRCUIT PLATES ALREADY TOOLED FOR Y



PC-92
PENTODE
Send for Bulletin 42-128

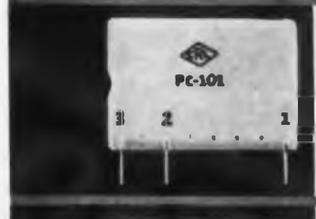
R_1=4.7 Meg. C_1=5000 mmf.
R_2=1 Meg. C_2=100 mmf
R_3=2.2 Meg. C_3=2000 mmf.

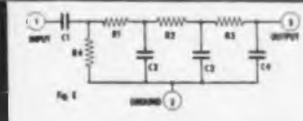




PC-100
VERTICAL INTEGRATOR
Send for Bulletin 42-126

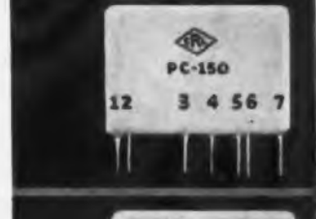
R_1=22K C_1=2000 mmf.
R_2=8.2K C_2=5000 mmf.
R_3=8.2K C_3=5000 mmf.

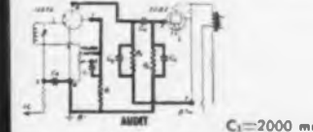




PC-101
VERTICAL INTEGRATOR
Send for Bulletin 42-126

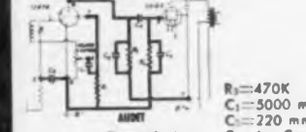
R_1=22K C_1=.01 mfd.
R_2=8.2K C_2=2000 mmf.
R_3=8.2K C_3=5000 mmf.
R_4=22K C_4=5000 mmf.





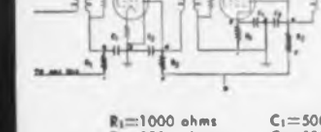
PC-150
AUDET OUTPUT STAGE
Send for Bulletin 42-129

R_1=6.8 Meg. C_1=2000 mmf.
R_2=470K C_2=220 mmf.
R_3=470K C_3 plus C_5=250 mmf.
C_4=5000 mmf.



PC-151
AUDET OUTPUT STAGE
Send for Bulletin 42-129

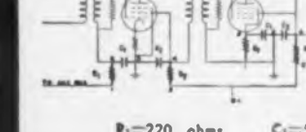
R_3=470K C_1=5000 mmf.
C_2=220 mmf.
R_1=6.8 Meg. C_3 plus C_5=250 mmf.
R_2=470K C_4=5000 mmf.



PC-110
FILPLATE FILTER PLATE
Send for Bulletin 42-131

R_1=1000 ohms C_1=5000 mmf.
R_2=820 ohms C_2=5000 mmf.

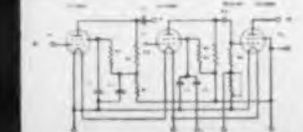
Filplates as connected in TV I.F. circuits



PC-111
FILPLATE FILTER PLATE
Send for Bulletin 42-131

R_1=220 ohms C_1=5000 mmf.
R_2=1000 ohms C_2=5000 mmf.

Filplates as connected in TV I.F. circuits



Model 3
AMPEC
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R_1=3000 ohms
C_1=.02 mf.
C_2=.005 mf.
C_3=.001 mf.

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☐ 42-24 ☐ 42-117 ☐ 42-126 ☐ 42-127
☐ 42-129 ☐ 42-130 ☐ 42-131 ☐ 42-149

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SPEEDS UP INSPECTION. Resistors, capacitors and inductors are rapidly and accurately inspected by this Brush Deviation Test Bridge. Indicates percentage of deviation of a test component from the standard. Has large, easy-reading dial. Very high indicating speed permits testing at rates as high as 4,000 elements per hour. Free bulletin on request.

RECORDS TWO PHENOMENA SIMULTANEOUSLY. This team of Brush Dual Channel Amplifier and Magnetic Oscillograph are here being used to record generator voltage and field current time-curves. This simplifies plotting of saturation curve to study build-up of voltage. Requires only a few minutes . . . compared to hours for conventional plotting methods. Investigate these Brush instruments for the study of many other electrical variables. Write for bulletin.

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Brush Model BL-809
Regulated Frequency Power Supply

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Write Dept. FF-19 for free copy of Bulletin 618 giving details on these Brush instruments.

Brush "Universal" Strain Analyzer

PUT IT IN WRITING WITH A BRUSH RECORDING ANALYZER

THE Brush DEVELOPMENT CO.

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ELECTROACOUSTICS • ULTRASONICS • INDUSTRIAL & RESEARCH INSTRUMENTS

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"At National, engineering research is of prime importance. We believe only through it and by large investment in it are we able to: *first*, provide industry with dependable laminated plastics for the efficient production of today's products which were developed yesterday; *second*, give practical assistance to the design engineer who is creating today, new, better products for tomorrow."

J. Warren Marshall, **President**
National Vulcanized Fibre Co.

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Here is the Phenolite Pilot Plant—coating machine and press in miniature—where under exact commercial production conditions, testing and experimental work are conducted on thermo-setting products requiring special resins or base materials. This is representative of the research engineering facilities National provides in which over a million dollars are invested.

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

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TELE-TIPS

CITIZENS' RADIO—After a long wait to utilize this service, allocated by the FCC several years ago, equipment is to be made available for general use during 195_. Stewart-Warner engineers are now designing the new transceivers for the Citizens Radio channels, and expect to have finished apparatus on the market by Fall.

TV INTERFERENCE ELIMINATION, long under study, is now the subject of a new FCC two-pronged plan. This plan to eliminate interference caused by neighborhood electrical devices and amateur radio stations calls for the establishment of community inspection committees and agreements by manufacturers to make certain receiver modifications. When an interference complaint is made by a set owner, the local committee acts to determine the source of interference and to eliminate it whenever possible. Should the committee find that the trouble is due to inadequate rejection of undesired electrical impulses at the TV receiver, the manufacturer would install the required filters or shielding free of charge. To date, several manufacturers have agreed to cooperate with this plan.

MICROWAVE-MULTIPLEX Training School for supervisory and maintenance men is being conducted at Philadelphia by Philco's Government and Industrial and TechRep Divisions. This 240 hour course, now in its fifth semester, is designed to give technically qualified operating men from industry and government a rapid up-to-date briefing in microwave and multiplex fundamentals and preventative maintenance procedures.

"NO-SKINNING" WIRE is one of newest developments in military-production race. This new wire can be soldered without stripping off the insulation. Just put insulated conductor in position, apply hot iron, and—pf-f-f—a sound joint is made!

R-F INDUCTION HEATING—R-F heating in American factories now has a total rating of over 500,000 kw and represents an investment of more than 75 million dollars.

(*Continued on page* 28)

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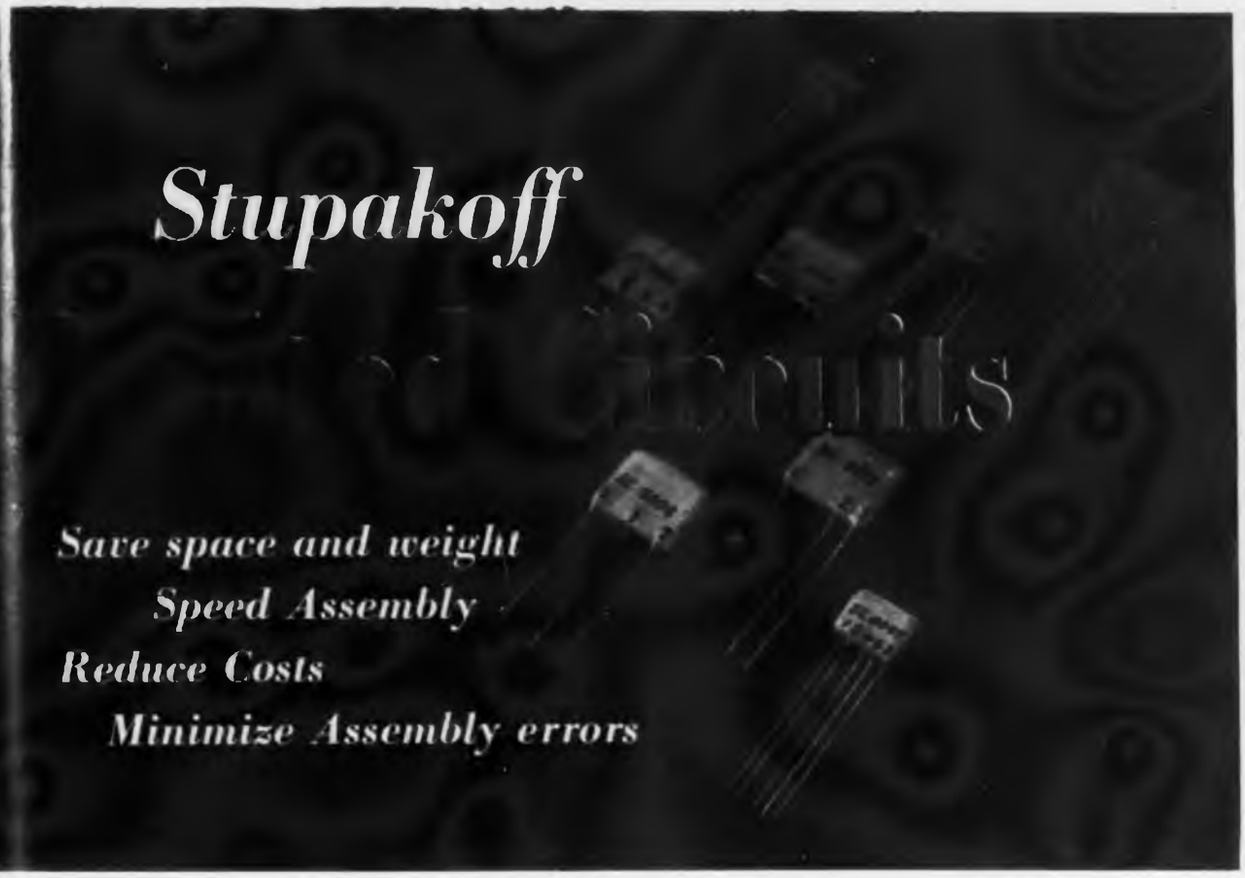

Soldered connections are reduced by 25% to 80%, assemblies are lighter and more compact, your production time is reduced and better products are made when Stupakoff Printed Circuits are used. These sturdy, compact, accurately produced units combine resistors and capacitors of precision values, in circuits designed in accordance with the requirements of individual applications. One Stupakoff Printed Circuit will replace many individual components, with consequent simplification of the assembly and reduced costs.

Visit us at Booth 376, Radio Engineering Show

Send for Bulletin

Contains complete specifications of a number of typical standard circuits and detailed information on the design and construction of Stupakoff Printed Circuits. *Ask for Bulletin 1151.*

STUPAKOFF *Products for Electrical and Electronic Applications*

ASSEMBLIES—Metallized ceramic induction coils and shafts; metallized plates for fixed rigid assemblies; ceramic trimmer condensers.

CERAMICS—Precision-made ceramic products for electrical and electronic applications, all voltages, frequencies and temperatures.

RESISTOR CERAMICS—Used for temperature indicating or measuring equipment, for infrared light source and for heating elements. Complete with terminals, in the form of rods, tubes, discs, bars, rings, etc.

CERAMIC DIELECTRICS—For by-pass, lead-through, blocking, stand-off and trimmer applications. Temperature compensating Ceramic Dielectrics and high K materials. Tubes, discs and special shapes, plain or silvered.

STUPALITH—Will withstand extreme thermal shock. May be made to have zero, low-positive or negative expansivities. Safely used at temperatures up to 2400° F.

SEALS, KOVAR-GLASS—Terminals, Lead-ins; Stand-offs—for hermetically sealing and mechanical construction in radio, television, electronic and electrical apparatus. Single or multiple terminal units, in a wide variety of sizes and ratings.

KOVAR METAL—The ideal alloy for sealing to hard glass. Used for making hermetic attachments. Available as rod, wire, sheet, foil—or as cups, eyelets and other shapes.

STUPAKOFF CERAMIC & MFG. CO., Latrobe, Pennsylvania

For ripple currents in amps or milliamps . . .

SPECIFY MALLORY FP CAPACITORS

When you specify Mallory Capacitors for television receivers or other equipment where heat is a problem, you can be sure they will stand the test. Mallory FP Capacitors are designed to give long, trouble-free performance at 85° C.—naturally they give even longer service at normal temperatures. In addition, Mallory FP Capacitors are famous for their long shelf life. Write for your copy of the FP Capacitor Engineering Data Folder.

Even in ambient temperatures approaching the boiling point of water, Mallory FP capacitors give long, trouble-free service in TV circuits where ripple currents reach up to a full ampere or more.

Mallory capacitors are able to withstand the burden of high ripple currents in the voltage doubling rectifier circuit because of their superior heat dissipation characteristics which result from Mallory's exclusive production methods.

They give the same outstanding performance that radio and TV manufacturers have learned to count on.

Mallory's unexcelled experience in the development and improvement of a wide range of capacitors is ready to work for you whenever you have a problem involving capacitors or related circuit arrangements.

FP is the type designation of the Mallory developed electrolytic capacitor having the characteristic design pictured and famous throughout the industry for dependable performance.

P. R. MALLORY & CO. Inc.
MALLORY

SERVING INDUSTRY WITH
Electromechanical Products—Resistors • Switches • TV Tuners • Vibrators
Electrochemical Products—Capacitors • Rectifiers • Mercury Dry Batteries
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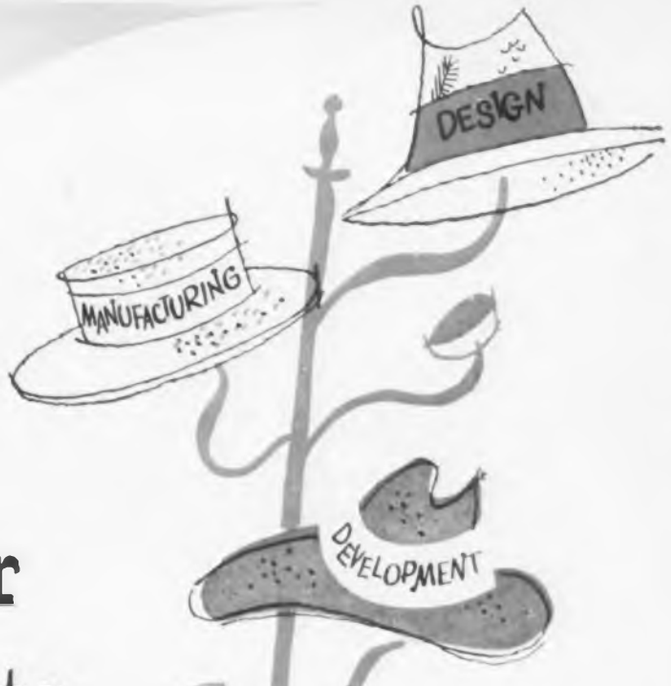

We wear 3 hats...

DESIGN · DEVELOPMENT · MANUFACTURING

Standard Coil's experience-proved design, development and manufacturing facilities are at your command. In addition, coast-to-coast manufacturing locations assure you of diversified, prompt, efficient, economical production for any civilian or military electronic work. Give us a call . . . write or wire!

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Picture I. F. Transformers
Cathode Trap Coils
Video Peaking Coils
Heater Choke Coils
Sound I. F. Transformers
Sound Discriminator Transformers
Horizontal Oscillator Coils
Horizontal Linearity Control Coils
Width Control Coils
I. F. Strips Flyback Coils

Radio and Miscellaneous Components

I. F. Transformers
R. F., Oscillator & Solenoid Coils
Antenna Loops
Ferrite Core Antennas
Permeability Tuning Pre-selector Assemblies
Miscellaneous Electro-Mechanical Assemblies

In TV It's Standard

"The Standard Tuner" designed and developed by Standard Coil and now used as original equipment in more than 5 million television sets.

Standard COIL PRODUCTS CO. INC.

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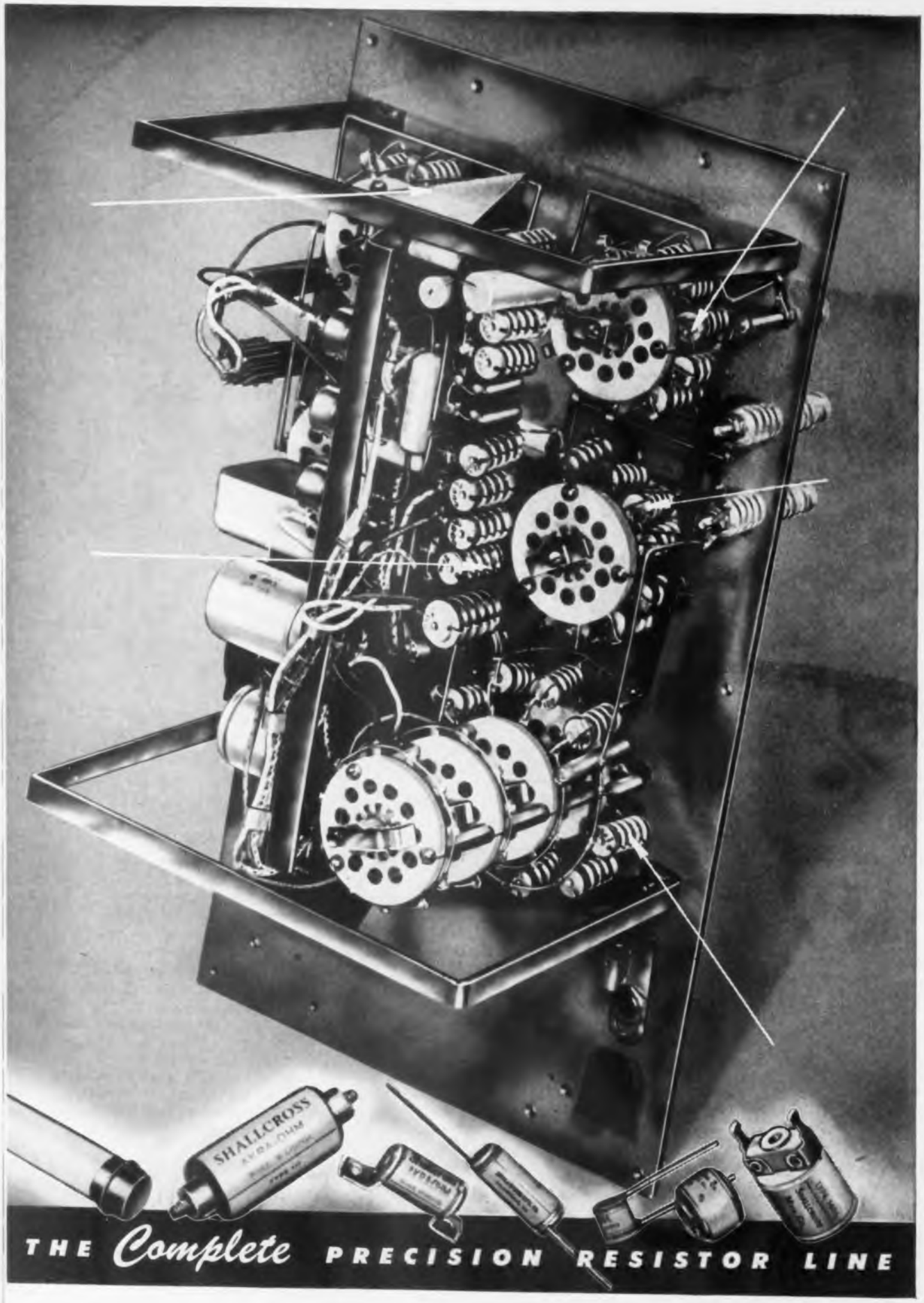

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THE GATES DYNAMOTE
Here is the latest model GATES DYNAMOTE — as new as next fall's election!

YOU'RE THERE WITH THE Gates "Dynamote"

Some Outstanding DYNAMOTE Features

- Three microphone channels
- Public address take-off with level control
- Cue circuit to studios
- A.C. or battery powered
- Instant — automatic — changeover to batteries if line fails
- High gain — low noise
- Four inch V.U. meter with dimmer control
- Completely self-contained
- Weighs just 31 pounds with batteries installed
- One-piece construction

Whether baseball or politics, symphony or jazz — you can be sure of clean, crisp quality when Dynamoting your "out of studio" shows.

The GATES DYNAMOTE, originated about two decades ago at the advent of the Dynamic microphone, is each year brought up to date as the latest major league standings. — Your 1952 Dynamote is the engineers' choice, the producers' choice and the people's choice — compulsory, of course, because GATES DYNAMOTES are used wherever there is broadcasting.

Heavy political and sports coverage will create unusual demands on remote facilities. Recognizing this, production on the GATES DYNAMOTE has been increased. Orders are being handled same day as received in most cases.

GATES

GATES RADIO COMPANY, QUINCY, ILLINOIS, U.S.A.
MANUFACTURING ENGINEERS SINCE 1922
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Canadian Marconi Company, Montreal, Quebec

Kenyon TRANSFORMERS

FOR STANDARD AND SPECIAL APPLICATIONS

KENYON TRANSFORMERS FOR

J A N Applications

Radar

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For more than 25 years, Kenyon has led the field in producing premium quality transformers. These rugged units are (1) engineered to specific requirements (2) manufactured for long, trouble-free operation (3) meet all Army-Navy specifications.

Write for details

KENYON TRANSFORMER CO., Inc.

840 Barry Street, New York 59, N. Y.

NEW! FOR VHF-UHF...

PRD TYPE 907 sweep frequency generator

FREQUENCY RANGE:
35 TO 900 MEGACYCLES

•

MINIMUM OUTPUT VOLTAGE:
1 VOLT

•

DIRECT READING FREQUENCY DIAL:
CONTINUOUSLY VARIABLE

•

OUTPUT IMPEDANCE:
75 OHMS-BNC CONNECTOR

•

MINIMUM SWEEP WIDTH ABOVE 60 MC/S:
20 MC/S

The Type 907 is a fundamental oscillator which can be swept in frequency over a band of not less than 10 mc/s for a center frequency of 35 mc/s. The sweep width is greater than 20 mc. for carrier frequencies above 60 mc/s. Output is continuously variable over a voltage range of 10 microvolts to 1 volt. Internal blanking circuits provide a "true zero" base line for an oscilloscope display.

For further information concerning this instrument and additional UHF-VHF equipment, address inquiries to Dept. T-1, or visit us at the IRE Show, Booths 268-269.

Polytechnic RESEARCH & DEVELOPMENT COMPANY · Inc
55 JOHNSON ST., BROOKLYN 1, N. Y.

Type 396-A Balun
Balance-Unbalance Transition
provides a low VSWR transition between 50 ohm unbalanced to 300 balance transmission line over a frequency range of 470 to 890 mc/s.

Type 904 VHF-UHF Noise Generator
permits direct measurements of noise factors as high as 20 db for r-f amplifiers and receivers operating from 10 to 1000 mc/s.

Type 584 UHF Frequency Meter
is a high Q Frequency Meter covering the band of 470 to 890 mc/s.

WESTERN SALES OFFICE: 737 NO. SEWARD STREET, HOLLYWOOD 38, CALIFORNIA

New developments are essential in resistors, too!

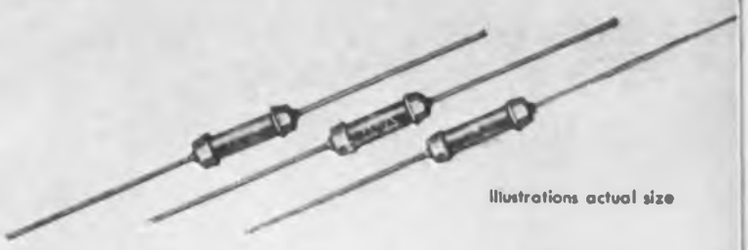
IRC LAUNCHES NEW BORON-CARBON RESISTOR (Type BOC)
LATEST DEVELOPMENT IN STABLE FILM-TYPE RESISTORS

- Reduces temperature-coefficient of conventional deposited carbon resistors . . .
- Provides high accuracy *and* long-time stability...
- Replaces high value wire wound precisions at savings in space and cost!

NO LONGER A LABORATORY ITEM. NOW FULLY AVAILABLE THROUGH IRC'S MASS PRODUCTION TECHNIQUES AND QUALITY CONTROL.

Here's a completely new tool for electronic and avionic engineers — one that's going to make possible higher stability circuits with smaller components. IRC's new Type BOC Boron-Carbon Resistor promises tremendous advantages in military electronic equipment such as gunfire control, radar, communications, telemetering, computing and service instruments. Heretofore strictly a laboratory item, Type BOC is now available to equipment manufacturers. Be sure **you** get full details.

TYPE BOC BORON-CARBON ½-WATT RESISTOR



Illustrations actual size

Stability and high accuracy under widely varying temperatures make Type BOC Boron-Carbon Resistors ideal for a host of critical circuitry needs. Greatly improved temperature coefficients of resistance permit its use in place of costlier wire wound precisions in many applications. Small size makes it invaluable where limited space is a problem. And lower capacitive and inductive reactance allows it to be used in many circuits where the characteristic of wire wounds cannot be tolerated.

The characteristics of Type BOC have been designed to meet Signal Corps Specification MIL-R-10509.

IRC Boron-Carbon Resistors are particularly recommended for:—Amplifiers and computer circuits requiring better resistance-temperature characteristic and stability than those of carbon compositions or deposited carbons . . . Voltmeter multipliers, divider circuits, bridge circuits, decade boxes, requiring unusual accuracy and stability **with** economy . . . High frequency tuned circuit loading resistors, terminating resistors, etc., requiring wire wound resistor stability **without** undesirable high inductive and capacitive reactance.

Tolerance—1%, 2% and 5%. Resistance values— 10 ohms to ½ megohm. Full technical data contained in Catalog Data Bulletin B-6. Mail coupon for your copy.

Parts per Million Change in Resistance per °C temperature				
Resistance Value	Type BOC	Type DCC	Nichrome	Advance Karma Evenohm
10 ohms	50	—	170	20
100 ohms	80	280	170	20
1000 ohms	100	310	170	20
10,000 ohms	100	330	170	20
.1 megohm	150	350	170	20
1.0 megohm	200	400	170	20

Latest small size addition to IRC's famous Deposited Carbon PRECISTOR line

Illustrations actual size

IRC TYPE DCC (DEPOSITED CARBON) HIGH-STABILITY RESISTORS

The ultimate in non-wire-wound accurate resistors, Type DCC has been developed to meet the latest needs of modern electrical and electronic circuits. Conservatively rated at ½-watt, it combines accuracy and economy with high stability, low voltage coefficient, and low capacitive and inductive reactance in high frequency applications.

Especially recommended for: — Circuits in which characteristics of carbon compositions are unsuitable and wire wound precisions are too large or too expensive . . . Metering and voltage divider circuits requiring high stability and close tolerance . . . High frequency circuits demanding accuracy and stability, but where wire wound resistors are unacceptable. **Tolerance**—1%, 2%, 5%. **Resistance values**—100 ohms to 2 megohms. Designed to meet Signal Corps Specification MIL-R-10509. Send coupon for complete technical information in Catalog Bulletin B-7.

Type DCC ½ Watt • Type DCF 1 Watt • Type DCH 2 Watts • Power Resistors • Voltmeter Multipliers • Insulated Composition Resistors • Low Wattage Wire Wounds • Volume Controls • Voltage Dividers • Precision Wire Wounds • Deposited Carbon Precistors • Ultra-HF and High Voltage Resistors • Insulated Chokes

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INTERNATIONAL RESISTANCE COMPANY

401 N. Broad Street, Philadelphia 8, Pa.

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Please send me complete information on items checked below:—

☐ Type BOC Boron-Carbon Resistors ☐ Type DCC Deposited Carbon Resistors

☐ Name and Address of nearest IRC Distributor

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TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

WATERMAN PIONEERING

PULSESCOPE®

Model S-4-A

PULSESCOPES are Oscilloscopes to portray the attributes of the pulse: such as amplitude, duration and time displacement. Both of the PULSESCOPES have Video fiers with frequency response up to 11 megacycles with Video delay of 0.55 micros and pulse rise and fall time better than 0.07 microseconds.

S-4-A SAR PULSESCOPE—Video Sensitivity 0.5vp to p/in. S Sweep 80 cycles to 800KC, either trigger or repetitive. A Sweep 1.2 microseconds to 12,000 microseconds. R Delay 3 microseconds to 10,000 microseconds directly calibrated on precision dial. R Pedestal (or Sweep) 2.4 microseconds to 24 microseconds. Internal Crystal Markers 10 microseconds and 50 microseconds. Size 9⅛ x 11¼ x 17¼". Weight: Less than 32 pounds.

S-5-A LAB PULSESCOPE—Video Sensitivit to p/in. Sweep 1.2 microseconds to 120,00 seconds with 10 to 1 expansion. Sweep either or repetitive. Internal Markers synchroniz Sweep from 0.2 microseconds to 500 micro Trigger Generator and built-in precision a calibrator. Completely cased. Size: 16½ x 14⅛ Weight: Less than 60 pounds.

3 SP

WATERMAN RAYONIC TUBE DEVELOPMENTS

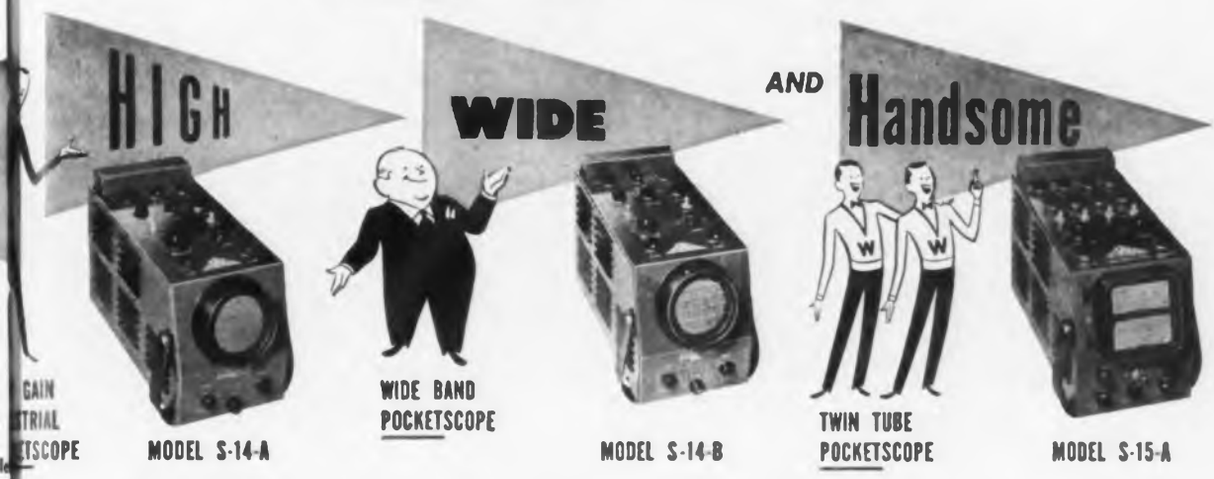
Since the introduction of Waterman RAYONIC 3MP1 tube for miniaturized oscilloscopes, Waterman has developed a rectangular tube for multi-trace oscilloscopy. Identified as the Waterman RAYONIC 3SP, it is available in P1, P2, P7 and P11 screen phosphors. The face of the tube is 1½" x 3" and the over-all length is 9¼". Its unique design permits two 3SP tubes to occupy the same space as a single 3" round tube, a feature which is utilized in the S-15-A TWIN-TUBE POCKETSCOPE. On a standard 19" relay rack, it is possible to mount up to ten 3SP tubes with sufficient clearances for rack requirements. All RAYONIC cathode ray tubes are available in P1, P2, P7 and P11 phosphors. We are authorized to supply 3SP1, 3JP1 and 3JP7 with JAN stamp. All RAYONIC tubes listed below operate on 6.3 volts heater with .6 amp. current.

TUBE	PHYSICAL DATA			TYPICAL VOLTAGES				DEFLECTION FACTOR V/IN.		MA
	Face	Length	Base	Anode # 3	Anode # 2	Anode # 1	Grid # 1	D1 to D2	D3 to D4	Anode #
3JP	3 inch Round	10 inches	Medium Diheptal 12 Pin	3000	1500	300 to 515	−22.5 to −67.5	127 to 173	94 to 128	4000
				4000	2000	400 to 690	−30 to −90	170 to 230	125 to 170	
3MP	3 inch Round	8 inches	Small Duodecal 12 Pin		1000	200 to 350	0 to −68	140 to 190	130 to 180	
					2000	400 to 700	0 to −126	280 to 380	260 to 360	
3SP	1½ x 3 inches	9.12 inches	Small Duodecal 12 Pin		1000	165 to 310	−28.5 to −67.5	73 to 99	52 to 70	
					2000	330 to 620	−58 to −135	146 to 198	104 to 140	

IRE SHOW, MARCH 3rd THRU 6th AT BOOTH 29

THE WATERMAN LINE-UP

POCKETSCOPE®



GAIN
TRIAL
TSCOPE

MODEL S-14-A

WIDE BAND
POCKETSCOPE

MODEL S-14-B

TWIN TUBE
POCKETSCOPE

MODEL S-15-A

DE and HANDSOME POCKETSCOPES are ized by small size, light weight, and out- electrical performance. All units have fre- ompensated attenuators as well as non-fre- discriminating gain controls. All units have odic and trigger sweeps from ½ cycle to The amplifiers are direct coupled thus fre- sponse starts from 0 cycles. No peaking coils thus, the transient response is good. Full n of trace, both vertical and horizontal, is Means for amplitude calibration are pro- C coupling in POCKETSCOPES provides stability of the trace, regardless of the line hanges or variations of impedances in the input circuit. The HI, WIDE and HANDSOME POCKETSCOPES are the outgrowth of Waterman pioneering of the first commercial miniature oscilloscope, which has proved to be useful and reliable over a period of years. Combination filter and graph screens are used for better visibility, thus traces can be observed even under high ambient light conditions. Binding posts for convenience of connections, with an effective shield, are used. S-14-A has sensitivity of 10 mv/inch with pass band above 200KC. S-14-B has sensitivity of 50 mv/inch with pass band above 1 megacycle. S-15-A is similar to S-14-A except that it has two independent CR Tubes for multi-trace oscilloscope work. Accessories such as carrying cases and probes are available.

-A

The Model S-11-A Industrial & Television POCKETSCOPE is a small, compact, lightweight instrument for observation of repetitive electrical circuit phenomena. The Industrial & Television POCKETSCOPE is a complete cathode ray oscilloscope incor- th cathode ray tube, vertical, horizontal, nsi y amplifiers, linear time base oscillator, synchronization means and self-contained pp y. The Industrial & Television POCKET- ca be used, not only for AC measurements, DC as well, inasmuch as it has vertical and al mplifiers which are capable of reproducing y w thin —2 db, from 0 to 200KC. The sen- of t e vertical and horizontal amplifiers is high th order of 100 mv rms/in.

S-12-B

Model S-12-B RAKSCOPE has the features of S-11-A POCKETSCOPE, plus. The RAKSCOPE is JANized and the government model number is OS-11. The Sweep, from 5 cycles to 50KC is either repetitive or triggered. Vertical and horizontal amplifiers are 50 millivolts rms per inch with band pass from 0 to 200KC. Special calibrating circuitry is provided for frequency comparison. Both the vertical and horizontal amplifiers are identical and use no peaking. The panel is only 7" high and the scope fits standard rack. The functional layout of the control permits ease of operation.

WATERMAN PRODUCTS CO., INC.

WATERMAN PRODUCTS

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

CABLE ADDRESS, POKETSCOPE, PHILA.

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Note how varied are their properties . . . how endless in variety are the diameters, lengths, and wall thicknesses in which this tubing is produced by us.

A grade for every need!

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Grade EEE ...	Critical electrical and high voltage applications.		
Grade XAX ...	Special grade for government phenolic specifications.		

Tell us your needs. We are known for our dependable service and prompt deliveries.

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The Brochure You've Been Waiting For Is

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Are you one of the thousands of electronic engineers who has already requested a copy of this important, new, 32 page brochure on hermetic sealing? If not, send your name in today for your FREE copy.

Nothing before has ever been done in this highly specialized field that can compare with this new presentation on glass-metal headers.

Beautifully printed in 3-colors, this brochure will bring you up to date on hermetic sealing, because it shows a remarkable exposition of what HERMETIC SEAL PRODUCTS CO. has achieved in miniature and sub-miniature plugs and seals, as well as in standard-size headers.

Years of creative, fruitful effort by HERMETIC have made it the largest exclusive manufacturer of hermetic seals in the world. This company has pioneered and introduced almost every important innovation in this most exacting field.

HERMETIC's specialist-engineers, with such a background, are eager to help you with your problems in the ever-expanding usage of hermetic sealing.

VISIT HERMETIC'S BOOTH NUMBER 129 AT THE 1952 I. R. E. SHOW.

SEALED IN by HERMETIC HEADERS

HERMETIC SEAL PRODUCTS CO.

33-35 SOUTH SIXTH STREET • NEWARK 7, NEW JERSEY

TELE-TIPS

(*Continued from page 12*)

FATIGUE AND STRAINED LISTENING can prevent the ear from hearing short duration sounds. This observation was expressed by Joel Tall, veteran tape editor of CBS Radio Technical Operations Dept., at a recent talk presented to the Audio Engineering Society. Tall told of the time he was required to remove a brief duration cough from the magnetic tape recording of a radio show. The cough was present on the tape, but even after several playbacks, fatigue prevented him from hearing it. To reduce fatigue, it is suggested that loudness throughout the frequency range be at normal room volume, good quality audio equipment be used, and the room be acoustically quiet.

DEAD-BEATS, BEWARE! We hear that Kellogg Switchboard has a device which can be attached to telephone line, or radio link, and which will enable suburban, branch department stores to quickly find out credit standing of customer from the main, downtown department store. To do this a punched, credit card is inserted in an electronic sender. At the receiver a credit form is automatically punched to agree with the master card.

BOMBAY EXHIBIT—The Radio & Electronic Society of India announces that the International Radio and Electronic Exhibition scheduled to take place in Bombay, India, February 9 to 29, has been postponed to November 10 to 30, 1952. Further details about the exhibition can be obtained from: The Secretary, International Radio & Electronics Exhibition of India, Fateh Manzil, Opera House, Bombay, India.

US-CANADA TV NETWORKING—The forging of this international television link by the Am. Tel. & Tel. Co. has been authorized by the FCC. Antennas will be added to the Bell System's microwave station at Buffalo to beam U.S. network programs across the border to Toronto and later, by relay, to Montreal.

TV FOR MOVIES!—It is interesting to note that one of the new South American television stations has made arrangements to sell the motion-picture films made of its top TV shows. Exhibitors located in areas without TV facilities will show the films. American telecasters might do well to copy.

MAGNETIC AMPLIFIERS can now be made to operate in frequency ranges from below commercial power frequencies to ultra high radio frequencies. Because of its ruggedness and reliability, the magnetic amplifier is fast becoming a very popular substitute for the vacuum tube in new equipment designs since, even in the most complex magnetic amplifier, there are no fragile or moving parts to be damaged by shock or vibration.

WHOOPS, WAILS, GRUNTS, and snores have been heard each spring at the U.S. Navy SOFAR Station in Hawaii, which listens to underwater sounds at an ocean depth of 2,100 ft. The period during which the sounds are heard most often coincides with the time of year when hump back whales are present in the area in large numbers, and it seems possible that these sounds are made by the whales. At times the sounds are as loud as the noise made by small fishing boats in the area. Echoes from the sea floor and water surface have been heard following some of the sounds, but whether or not the marine life which make these sounds use the echoes for navigation or depth-finding is unknown.

SMALLER AND SMALLER— Progress has been made with miniaturization of components but it is realized that apparatus size is often dictated by the amount of *power* that must be handled. All such limitations have been reduced by the advent of the Transistor. This device (called by the British "crystal triode") operates at reduced power levels and thus permits the development of new materials and methods, smaller terminals, coils, resistors, capacitors, and transformers.

GOOD HUMOR is one of the best articles of dress one can wear in company (says Salesman Sam), and you grow up the day you have your first real laugh—at yourself. A good laugh is sunshine in the house, and a sense-of-humor is the oil of life's engine. Courtesy enables us to get along with others and to live with ourselves; it is the honey that blunts the sting of unkindness in another. The art of living rightly is like all arts, it must be learned and practiced with incessant care; the first recipe for happiness being: "Avoid too lengthy meditations on the past." Don't worry too much about what lies ahead; go as far as you can see, and when you get there, you can see farther on.


TELEVISION'S ONLY
2 KW VHF
TRANSMITTER
IT'S ALL
AIR COOLED

for 2 to 20 kilowatts ERP*

IF you plan to start TV station operations with a modest equipment investment . . . and still be sure you get adequate signal coverage . . . this new "2 kw" is a logical, economical solution to your problem. Initial equipment expense is lower than that of most TV stations on the air today. And tube costs are low—*because all the tubes are standard types.*

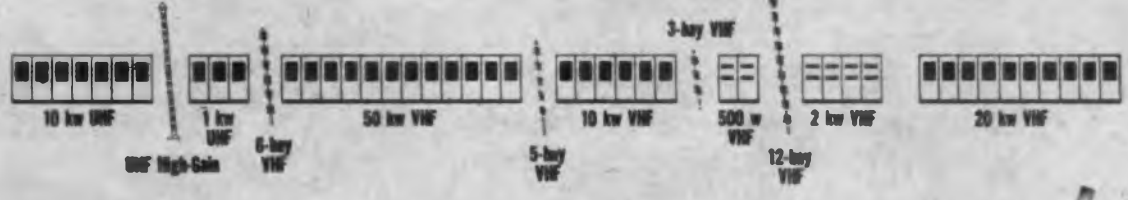
Used with RCA's popular and inexpensive high-gain 3-section Super Turnstile Antenna, this transmitter produces 5 kilowatts ERP—at the lowest cost per radiated kilowatt in TV history. Used with RCA TV antennas of higher gain, this transmitter provides up to 20 kw ERP!

Why not ask your RCA Broadcast Sales Specialist to help you with your planning. He can tell you precisely what you'll need to go on the air—and how to do it at lowest cost. Make use of his "know-how." Call him today.

ANNOUNCING—a 64-page book on RCA's new line of TV broadcast equipment for all channels, 2 to 83! An indispensable reference for station planning. *Available only from your RCA Broadcast Sales Specialist.*

*Effective radiated power

For any TV power to 200 KW—go RCA!



The heart of the "2 kw"—
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MEET JAN-R-26A!

WITHSTAND SEVERE HUMIDITY!

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RADIO-TELEVISION-ELECTRONIC INDUSTRIES

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

Greater Membership Value Through IRE's Plan of

Specialized Groups

Additional usefulness for the Institute of Radio Engineers is promised by the recent trend to special Professional Groups, which already include more than a third of the IRE membership.

Complex as the radio-electronic-TV art has grown—bringing correspondingly complex responsibilities to the Institute—a way is now found by which specialists and those interested in particular fields, can follow out their specialties fully, while still operating under the broad IRE charter.

A number of professional groups are already in operation, as shown by the chart on the front cover of this issue. In addition, there are new groups on Electron Devices and Electronic Computers just launched, and half a dozen others in planning and organization stages.

Group Meetings—Chicago Plan

Creation of the Professional Group Plan will mean that no longer need specialized outside associations be formed to care for the interests of technical specialists in our broadening field. These requirements can now be fully taken care of by the intramural group organizations, while members still enjoy the wide benefits of the parent body, today grown to 23,000 members and 8,000 students.

Of particular usefulness is the so-called Chicago Meetings Plan, which indicates how local IRE sections can promote Professional Groups while still retaining the cohesion of full local membership. In Chicago the practice has been to hold first a general-membership dinner session, followed by a speech on a broad engineering topic. Then the general membership meeting breaks up and the various local professional adherents reassemble in groups to hear papers and discussions on their own specialties. Here is a formula which should have wide adoption by other local IRE sections, since the plan can be made as flexible and responsive as local membership interests may dictate.

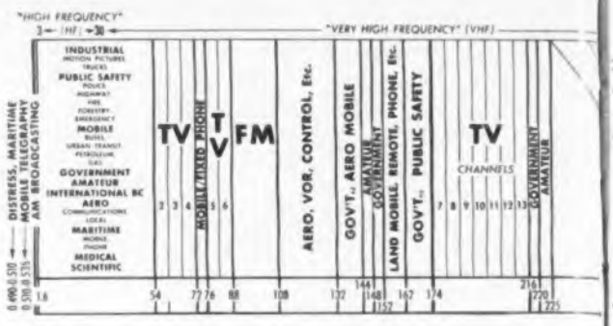
Group Symposiums at N. Y. Convention

Indeed a similar philosophy underlies the programming of the national IRE convention at New York City, March 3-6. By organizing symposiums of special group interests and topics, this 1952 convention plan secures for the attending engineer all the advantages of the big convention sessions, plus special-interest coverage at his own professional level. And to further social contacts among engineers with common interests, arrangements have also been made for Group tables at the President's Luncheon of Tuesday, March 14.

The radio-electronic-TV industry has grown so huge and so diversified that the new trend in IRE to specialized groups can accomplish great things. It will intensify membership interest and usefulness, while cementing our diversified specialists into a united radio-engineering front.

RADARSCOPE

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



REARMAMENT

$3 BILLIONS may be nearer the actual production of radio-electronic equipment during 1952, if we are to credit the statement by Captain W. I. Bull of the Office of Naval Materiel, made before the Radio-Radar Industries of Chicago. Captain Bull estimates the radio-electronic program to be presently 27% behind schedule. Applying this deficiency factor to the $4 billions schedule figure approved by Munitions Board and NPA officials, and presented in our January issue, brings the total down to a practical $3 billion level, which is also in accord with conservative informed outside authorities. Several other Pentagon programs have been "re-phased" (in Potomac jargon), and similar reshaping of electronic rearmament may revise electronics' present "dubious distinction as the bottleneck of defense," to quote Captain Bull further. At any rate, says he, electronic production is now showing a definite upward slope.

PRODUCTION

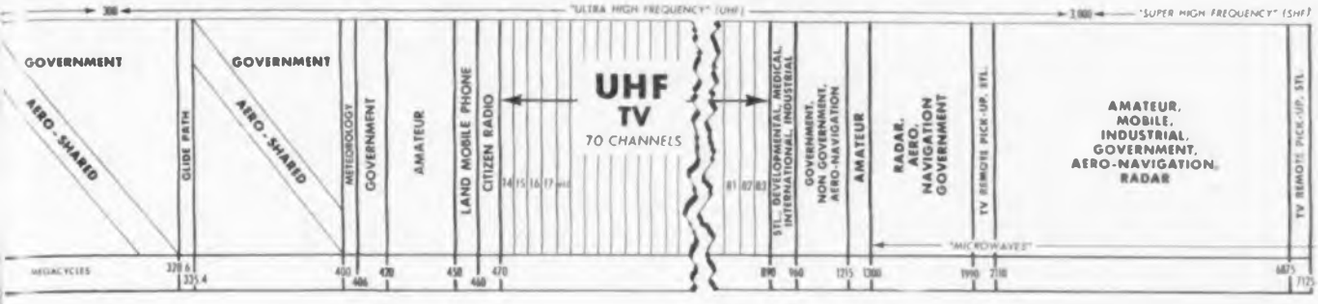
LAST YEAR, our production lines, says Captain Bull, "were turning out military electronic equipment at an annual rate over $1.5 billions. Projecting all of the intangibles ahead, and taking a good look into the crystal ball, we find our annual production rate as of July 1, 1952, will be about twice the present rate, with the curve continuing to rise, although having a tendency to level off to a predicted peak level for the third and fourth quarters of calendar 1952. A recent Defense Production Administration release has stated that electronics manufacture is due to rise approximately 268% in calendar 1952, as compared to production in 1951." This reference is to the production upsurge as the contracts now on the books get into full production and, while stated differently, is in close agreement with the $3 billions figure.

CONSTRUCTION

$700 MILLIONS—New television construction, after the freeze is lifted, will exceed $700 million, predicts President Harold E. Fellows of the NARTB. Basing his estimate on a survey conducted by Neil McNaughten, NARTB engineering director, Fellows explains that this figure does not include professional fees such as lawyers', engineers' and consultants' charges. Construction costs of TV were estimated in the VHF: $219,000 in cities under 50,000; $274,000 in cities of 50,000 to 250,000; $332,250 in cities 250,000 to one million and $433,250 over a million. Complete station costs with a maximum ERP of 100 to 200 kw range from $587,500 to $593,500, according to channel. In the UHF, construction costs will be: $235,500 in cities less than 50,000, to which $27,500 should be added if the tower is self-supported; $281,250, to which $70,000 should be added for self-supported towers, in cities 50,000 to 250,000; $339,750 in cities 250,000 to one million (add $70,000 for self-supported tower); $471,250 in cities over one million (add $70,000 for self-supported tower).

IRE FOUNDERS, WITH OTHER OLD-TIMERS, IN 500-YEAR GROUP

This collection of radio old-timers, aggregating 500 years of radio experience, includes the only two living founders of the Institute of Radio Engineers, John V. L. Hogan, consulting engineer, and Dr. Alfred N. Goldsmith, consulting engineer and long-time editor of the IRE Proceedings. In the group, standing left to right, are Paul Godley, short-wave pioneer and consulting engineer; O. B. Hansen, engineering vice-president NBC; Walter Lemmon, owner WRUL and WCCH; Founder Hogan; Louis Pacent, consulting engineer; Elmo Pickerill, pioneer telegrapher; William Dubilier, inventor; and Founder Goldsmith. Seated: left to right, O. H. Caldwell, editorial director TELE-TECH; I. E. Showerman, president Radio Executives Club; Brig. Gen'l David Sarnoff, Chairman RCA; Gen'l Harry C. Ingles, former Chief Signal Officer U. S. Army; and Elmer E. Bucher, radio author and consultant.



SPECTRUM ANALYSIS

TELE-TECH'S CAMPAIGNS for a continuous TV spectrum and for higher broadcast powers, receive emphatic confirmation in the new JTAC 200-page analysis of Spectrum Conservation, being made ready by the joint IRE-RTMA committee, as reported in more detail on a following page. Ideal TV layout would be 100 TV channels from 100 to 700 MC, says JTAC—with AM radio stretching from 180 to 1200 KC, and emphasis being laid on our British friends' 200-KC band as of especial AM merit. TV powers of 500 KW are urged, a step adopted long ago by even the Russians. Frank criticism of international short-wave broadcasting is courageously offered; obvious engineering preference is for relays and recordings feeding into local BC bands. Beyond 30,000 MC some new physiological effects are looked for; approaching 300,000 MC, power concentrations in radio beams may even drill holes!

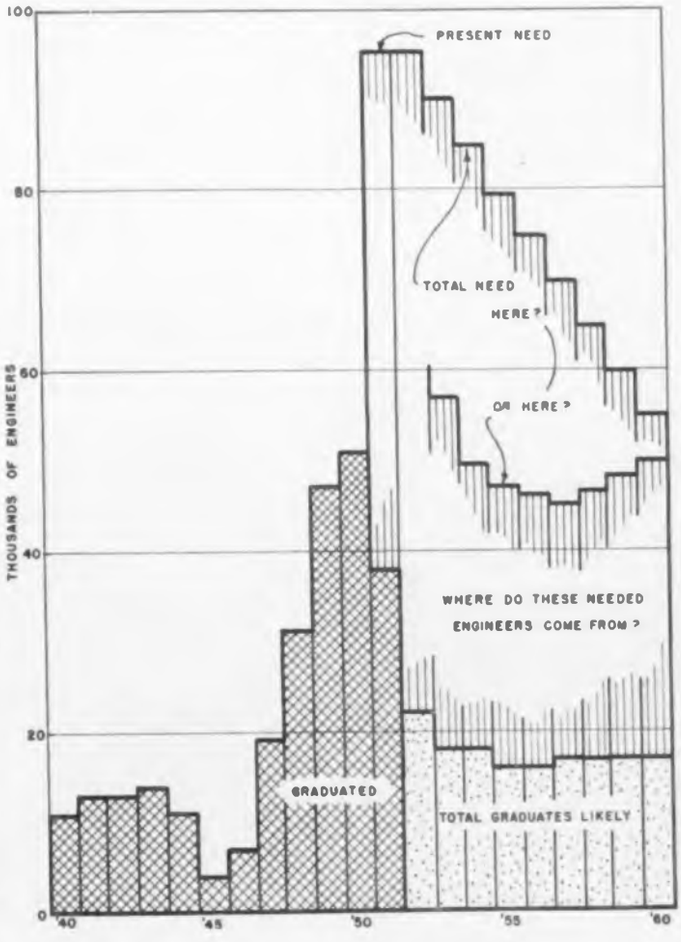
TELE-COMMUNICATIONS

LONGEST-DISTANCE radio message ever transmitted, by all odds, was that sent a short time ago over a 480,000-mile path from Cedar Rapids, Iowa, to Washington, D. C. via the moon as a reflector. During half-hour tests slow hand-keyed messages were transmitted and recorded. The transmission-delay period of 2½ seconds corresponded with the moon's distance of 240,000 miles, and the received message in azimuth and elevation coincided with the moon's position. The Collins Radio transmitter laboratory employed a crystal-controlled transmitter with a resnatron amplifier in the final stage. Frequency used was 418 MC, and power output to antenna was 20 kw. A tapered-wave-guide horn antenna was connected to the transmitter through several feet of waveguide. This antenna was 75 ft. long with an aperture of 24 by 20 ft. Receiving antenna used by National Bureau of Standards was a 30-ft. parabolic reflector.

COLOR-TV

INTERIM IMPROVEMENT is now going on in the color field behind closed doors. But when the united-industry system eventually comes up for public presentation, it should be interpreted not merely as a new color-TV system but as a "better black-white system, plus." For under the new standards most of the limited channel space is devoted to producing a good "brightness" or black-white signal. Meanwhile, all the needed information about color—hue and saturation—can be conveyed on a small invisible sub-carrier tucked in at the upper end of the video channel. Thus the new system can be thought of as delivering, first, a standard black-white signal, exactly like the one now broadcast. This provides the basic picture. To this is added a small sub-carrier which colors the resulting picture to its final color form. In this way the present 16,000,000 receivers will get good black-white from the basic signal,—while future color sets will use the additional sub-carrier information to get a full-color picture.

ENGINEER PERSONNEL



The critical shortage of engineers in the days ahead is indicated by the above chart of all U. S. engineering graduates, compiled by the Engineers Joint Council, New York. By years, the numbers of engineers graduated are contrasted with two sets of estimates of the number of engineers likely needed by civilian and Defense activities. Figures are based on data from Amer. Society for Engineering Education and Engineering Manpower Commission.

A New UHF

Continuously tunable over the 470-890

over 60 db i-f rejection, and low rad-

Fig. 1: UHF converter in cabinet has lighted dial marked in channel numbers that range from 14 to 83

By HENRY HESSE,

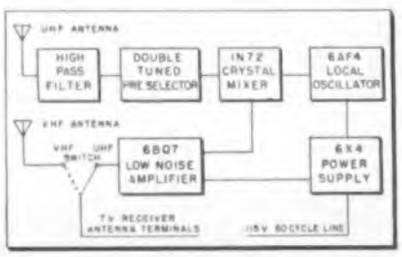
Senior Engineer, Television Receiver Div. Allen B. Du Mont Laboratories, Inc., East Paterson, N. J.

THIS paper will first outline briefly the design requirements of a UHF television converter, and will continue with a detailed description of a practical converter together with its performance characteristics.

The fundamental design requirement of a UHF TV converter is that it shall be universally adaptable to any TV receiver. This design requirement implies the following specific requirements:

1. The converter output frequency must be on one of the 12 regular TV channels.
2. The output impedance of the converter must be 75 ohm coaxial as well as 300 ohm balanced to match all TV receiver antenna impedances.
3. The converter must be self-powered.
4. The converter must be operatable on both intercarrier and separate sound type TV receivers. This is a very severe requirement for a converter used with a separate sound receiver with regard to microphonic howl and local oscillator frequency drift. This requirement is important since many receivers use a separate sound i-f channel.
5. Tuning of the converter should be as easy as tuning a TV receiver even though the precision of tuning is increased four times.

Fig. 2: Block diagram of converter which changes UHF input frequency to an i-f of 76 to 88 MC



This converter is designed to cover the complete UHF TV band of 470 to 890 MC in a single continuous tuning operation. The UHF signal is converted to an i-f between 76 and 88 MC. The converter is connected to the antenna terminals of any standard VHF receiver tuned to either channel 5 or 6. The UHF input is designed for 75 ohm coaxial line RG-59/U or equivalent. The VHF output will match either 75 or 300 ohm VHF TV receiver antenna connections.

The converter in its cabinet presents a small unobtrusive view, as shown in Fig. 1. The edge lighted tuning dial is marked in channel numbers from 14 to 83. The knob on the left is the combination off-on and VHF-UHF switch. The concentric knobs on the right are for coarse and fine tuning. The tuner drive reduction ratio is 6.6:1 on coarse tuning, and 20:1 on fine tuning. This tuner drive and fine tuning knob was used to tune in an 880 MC CW carrier to zero beat on a communications receiver without difficulty.

A block diagram of the converter is shown in Fig. 2. The UHF antenna is connected to a high pass input filter, which serves to attenuate VHF signals from the converter. Following the high pass filter is a double tuned preselector circuit to provide maximum UHF selectivity. The preselector feeds a 1N72 crystal mixer, which, together with a 6AF4 local oscillator, converts the signal to i-f between 76 and 88 MC. The output of the mixer is amplified by a 6BQ7 cascode low noise amplifier. The signal then goes to the VHF receiver tuned to channel 5 or 6. A power supply provides heater and plate voltage to the low noise amplifier and the local oscillator.

The optional use of channel 5 or 6 on the TV receiver is to minimize interference from a local VHF TV station that may be operating on one of these channels. The user is instructed to select the channel not occupied by a local TV station.

The converter chassis, as removed from the cabinet, is shown in Fig. 3. The r-f preselector and oscillator are in the well shielded box located just behind the dial. Attached to the rear of the shielded box is the input high pass filter. The low noise amplifier tube and output transformer are located on the left front corner of the chassis. The power transformer, rectifier, electrolytic capacitor and the terminal board for UHF antenna and receiver connections are all located at the rear of the chassis.

Each section of the converter will now be described in detail.

High Pass Filter

As shown in Fig 4, the UHF signal picked up on the antenna, is conveyed to the converter via a 72 ohm coaxial cable, type RG-59/U. The coaxial cable is connected to the high pass input filter. The filter consists of a half-section M derived, 2 constant K, T sections followed by a terminating M derived half-section. The M derived half-sections have an M of 0.6. The cutoff frequency is 400 MC, while the infinite attenuation of the M derived sections is 320 MC. The high pass filter assembled and disassembled is shown in Fig. 5. Note the conventional capacitors and coils used in the filter and the small size of the filter. The high pass filter attenuation curve is shown in Fig. 6.

Three ganged tuning elements shown in Fig. 7 are used to tune the double tuned preselector and oscillator. These tuning elements consist of two concentric flat strips with a movable shorting contact between the strips. The shorting contacts of each tuning element are coupled together on a common bakelite shaft to rotate in unison. A metal disc is

Television Converter

MC band, design with 21 db noise figure, iation, is adaptable to any TV receiver

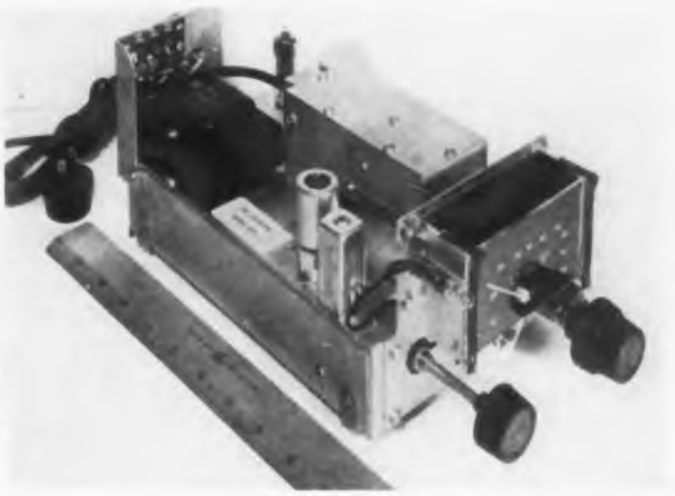


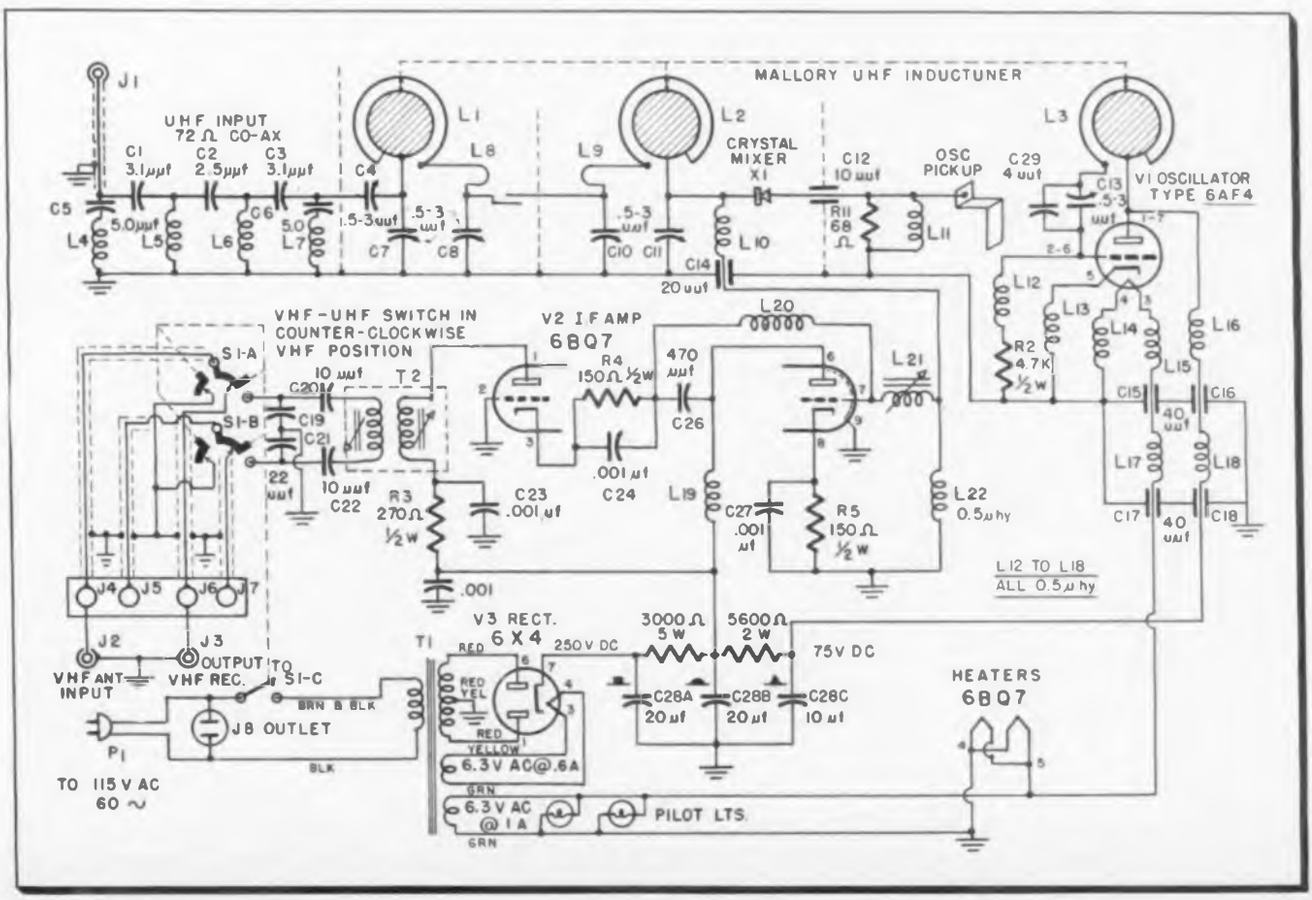
Fig. 3: Converter chassis layout shows r-f preselector and oscillator in shielded box behind dial, input filter attached to rear of box, amplifier tube and output transformer in left front corner, and power supply in rear

inserted within and contacting the inner concentric strip at many points. This disc was found necessary to eliminate a parasitic resonance and to reduce the inductance of the tuning elements. Fig. 7 also shows two separate tuner elements and a bakelite rotor carrying the shorting contact used in the preselector.

The tuning elements are shown as L1 and L2 on the schematic diagram, Fig. 4. The preselector consists of two tuned circuits coupled together through a small adjustable coupling capacitor about 0.3 μμf, C9 in Fig. 4. The high pass input filter is matched to the first preselector circuit by means of capacitors C4, C7, while C8 is used for tuning this preselector to resonance. The second preselector is matched to the crystal mixer by means of C11, while C10 is used to tune this preselector to resonance. All capacitors are 0.5-3 μμf ceramic trimmers. The physical layout of the preselector and oscillator components may be seen in Fig. 8 showing the tuner box with its shield cover removed. The oscillator tube and the four preselector trimmer screws are obvious.

The crystal mixer is a 1N72 germanium diode shown as X1 in Fig. 4. The UHF input signal appearing across C11 is applied to one side of the crystal mixer. The r-f

Fig. 4: Converter schematic indicates 72 ohm input to high pass filter, feeding i-f amplifier through tuned circuits and crystal mixer



UHF CONVERTER (Continued)

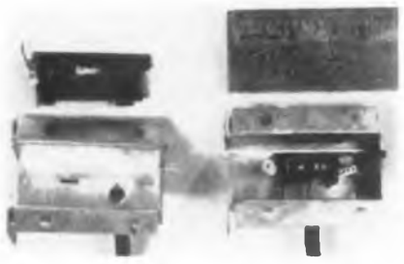


Fig. 5: Construction of high pass filter

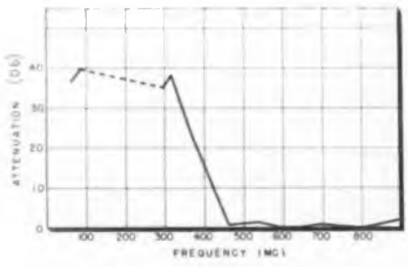


Fig. 6: Filter attenuation characteristics

choke L10 is part of a low pass filter to pass the i-f output of the mixer, to prevent loss of r-f signal, and to reduce oscillator radiation. The other side of the crystal is connected to the oscillator injection network consisting of R1, C12, L11, and a pick-up tab. The injection network is inside the oscillator compartment to reduce radiation.

Uniform Crystal Current

A uniform crystal current is important to maintain a constant crystal impedance at r-f and i-f and also to obtain a low noise figure. The injection network was designed to obtain a relatively uniform crystal current characteristic over the band as shown in Fig. 9. Because the pick-up is capacitive, the injection will increase with frequency. Capacitor C12 and L11 are resonant near the minimum oscillator frequency and help to increase the injection at the low frequencies. Resistor R1 limits the maximum impedance to 68 ohms at 400 MC. The impedance of the injection network is only 20 ohms at 800 MC due to C12, and 8 ohms at i-f due to L11. The injection circuit losses must be kept low since the network is in both the r-f and i-f circuits.

The oscillator circuit shown in Fig. 4 is a Colpitts oscillator using a 6AF4 tube and is tuned by tuner section L3. The grid capacitor C13 is used for the high frequency oscillator tracking adjustment, while fixed grid capacitor C29 (4 μμf N 750) is used for temperature compensation. A special oscillator tube socket had to be designed because excessive capacitance and inductance, encountered in conventional tube sockets, prevented the oscillator from reaching the maximum frequency required. The special oscillator socket is shown in Fig. 10. The socket contacts the tube pins very close to the glass, reducing inductance to a minimum. Air dielectric between the grid and plate contacts reduces socket capacitance to a minimum. A tube may be changed in this special socket as easily as in a conventional socket.

R-F chokes have a bad reputation for developing parasitic resonances at UHF. We have been very fortunate in picking a 0.5μh choke from stock that has caused very little trouble. Eight of these chokes are used in the oscillator and preselector circuits.

The oscillator performance, as measured by its developed grid bias, is relatively uniform as shown by Fig. 12. This variation of oscillator bias accounts for variation of mixer crystal current shown in Fig. 9.

Radiation is an important consideration in the design of a tuner or converter. We have endeavored to reduce the radiation by thorough shielding of the tuner and additional shielding of the oscillator. The oscillator supply leads (heater and B+) pass through a two-section filter. The mixer output is also filtered. By these means we have been able to reduce oscillator radiation from the chassis to a very low level.

For example, a converter receiving a 140μv signal was connected to a receiver in the normal manner. A converter without antenna connections was placed adjacent to the first converter. The second converter, when tuned so its oscillator was on the frequency of the received signal, only produced sound bar interference but did not black out the picture, indicating that the chassis radiation was about 140 μv. The oscillator voltage measured at the UHF antenna was 10 mv maximum.

Tracking and Alignment

Tracking the r-f preselector circuits was not difficult, but tracking the r-f circuits with the oscillator was quite difficult. Conventional methods cannot be used at UHF because of residual inductance and capacitance effects within the oscillator tube envelope. This makes the shape of the oscillator tuning curve different than the r-f tuning curve which cannot be even approximately

Fig. 7: (L) Three ganged tuning elements consist of concentric strips and shorting contacts. Fig. 8: (R) Physical layout inside tuner box

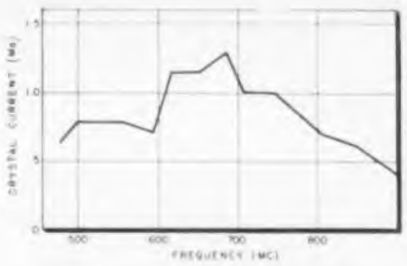


Fig. 9: Crystal current characteristics

Fig. 10: Oscillator with special tube socket has minimum inductance and capacitance

correlated at two or three points as conventional low frequency circuits are tracked. The method finally adopted was to alter the characteristic impedance of the tuner elements (see Fig. 7) by tapering the width of the outer strip to obtain the correct frequency difference between the oscillator and r-f preselector circuits at all frequencies. In order to align the double tuned preselector circuit properly, it is necessary to have a high output UHF sweep generator and an oscilloscope. No suitable UHF sweep generator was available so this had to be designed and built before a preselector could be designed. But this development is another story.

The alignment procedure uses the mixer crystal as a rectifier. The rectified output of the crystal shows the response curve on an oscilloscope. (See appendix.)

Low Noise Amplifier

The i-f output of the crystal mixer may, with proper impedance transformation, be connected directly to the TV receiver antenna terminals. This is not advisable since most TV receivers in use do not have low noise cascode tuners. While the low noise amplifier principle has been known a long time, TV tuners have only recently adopted this idea. It was deemed advisable to include a low noise amplifier as part of the converter since a large proportion of UHF reception will be in fringe areas.

The low noise amplifier employs a 6BQ7 dual triode in a neutralized cascode circuit (grounded cathode triode feeding a grounded grid triode) as shown in Fig 4. The first stage is neutralized by L20. The double tuned output transformer (T2) secondary circuit has provision for 72 ohm unbalanced or 300 ohm balanced output functions:

The VHF-UHF switch performs balanced output impedances:

(1) In VHF position the converter is turned off and the VHF antenna connects to the VHF receiver antenna terminals.

(2) In the UHF position the converter is turned on, the UHF converter output is connected to the TV receiver antenna terminals and the VHF antenna is shorted to ground.

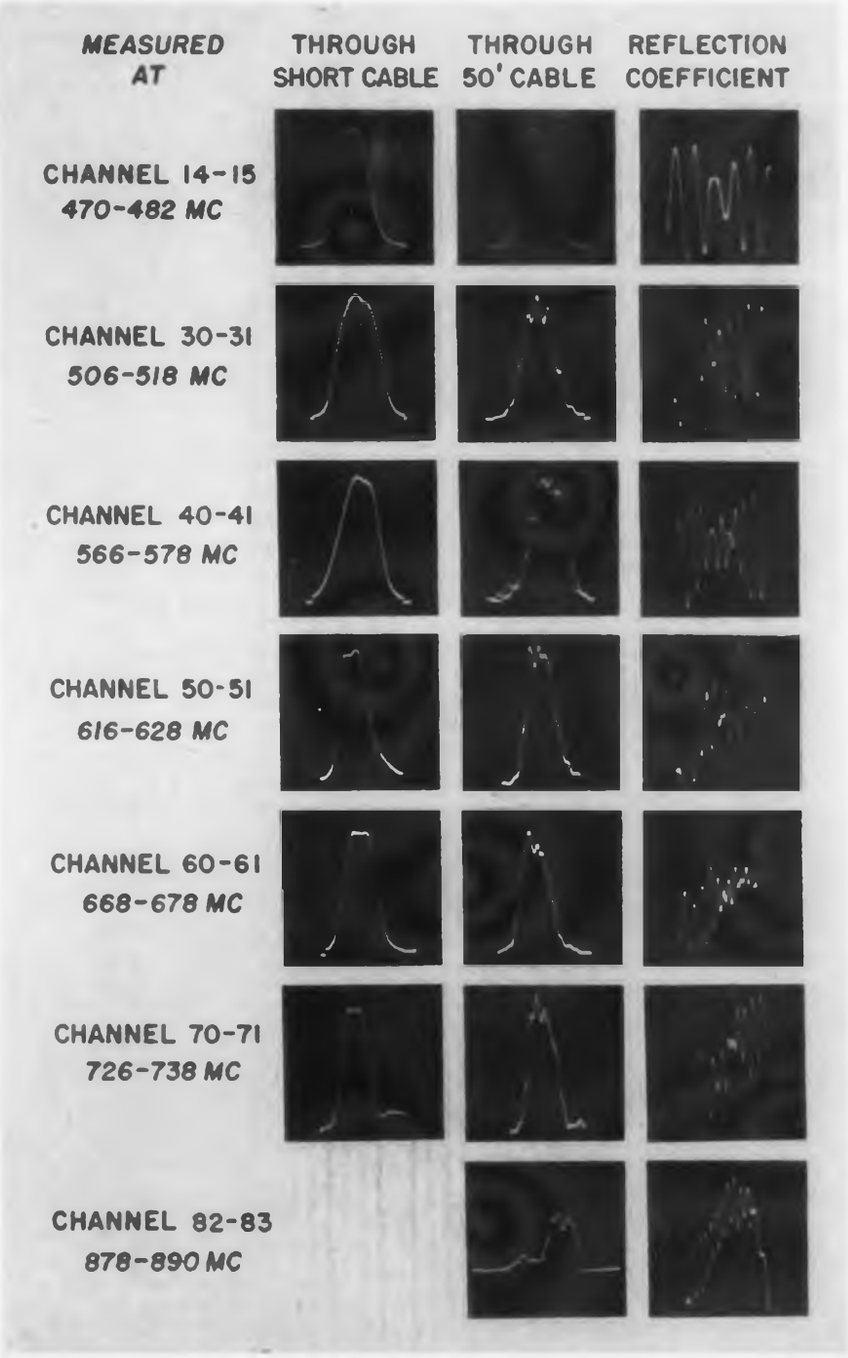
The power supply is a conventional transformer type using a 6x4 rectifier and a two-section RC filter. The low noise amplifier is operated at 150 v and the UHF oscillator is operated at 75 v.

Overall Performance

The most important criterion of any input circuit is its noise figure. The maximum and minimum noise figure obtained on three converters

(*Continued on page* 114)

Fig. 11: Oscillograph photos of preselector and crystal mixer response and reflection coefficients



Subminiature Tubes

New tubes designed for 26.5-volt battery cations. Long life, excellent high frequency

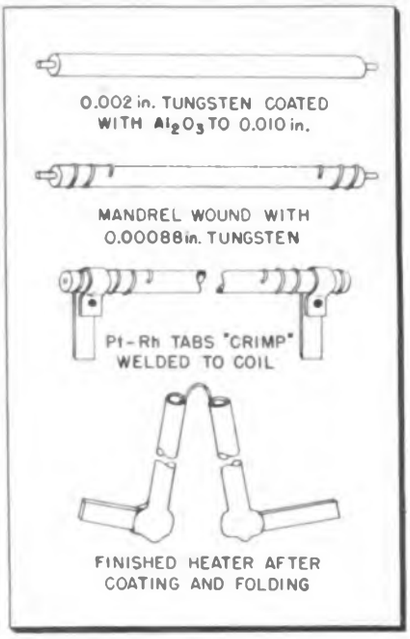


Fig. 1: 26.5 volt heater made by crimp welding to reduce heat transfer to coil wire

By ***WILLIAM R. WHEELER,***
Sylvania Electric Products, Inc.
83-30 Kew Gardens Road
Kew Gardens 15, N. Y.

THE operation of electron tubes from 26.5 v. battery supplies is particularly desirable in such applications as airborne and vehicular communications equipment, where units must continue to perform during "standby" or "ground" time of the carrier. Until recently, there were available only a few types of tubes which could be operated with 26.5 v. electrode potentials, and all were miniatures or larger. In line with current trends to miniaturize all electronic components, the Services have sponsored the development of several 26.5. v. subminiature types. UHF types developed by Sylvania for military use with 26.5 v. on all elements include the 5904 medium-mu triode, 5905 sharp cutoff r-f pentode, 5907 remote cutoff r-f pentode, and 5908 pentode mixer. UHF tubes utilizing 26.5 v. heaters with conventional B+ voltages are the 5903 double diode. 5906 sharp cutoff r-f pentode, and 5916 pentode mixer.

In addition to the special operating conditions specified for these tubes, the development contracts called for other high quality features, including long life, high ambient temperature operation, high frequency performance, low vibration noise output, and resistance to high levels of impact shock and sustained mechanical vibration.

26.5 Volt Heater

The development of a heater to operate at a center rating 26.5 v. was complicated by the limited size within a subminiature cathode, and by the high resistance required to limit heater dissipation to one watt. In the early stages of the program, some investigation was made of the possibility of using solid body heaters which were to be refractory semiconductors coated or infused with conducting material. Since it was believed necessary to maintain a positive temperature coefficient of resistivity to prevent "run away" of heater current, efforts were concentrated on ceramic-metal powder mixtures and metal films on ceramic bodies. In general, the method was to mix a refractory oxide with a metal powder and a binder, extrude the mixture through a steel die in a hydraulic press, fire the rods in a controlled atmosphere, and attach connectors. Although satisfactory methods were developed for preparing and testing the samples, it was not possible to develop a heater composition possessing the required resistivity of 0.895 ohm/cm by these means. Consequently, all further work on the program was concentrated on wire heaters.

A typical one-watt 6.3 v. heater in use at the inception of this program consisted of six folds of 0.0013 in. tungsten wire. A 26.5 v. one-watt

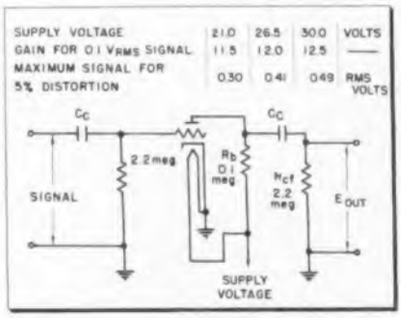


Fig. 2: R-C amplifier using 5904 tube shows stable gain over wide range of voltages

Fig. 3: Life test effect on g_m with 26.5 volts on all tube elements.

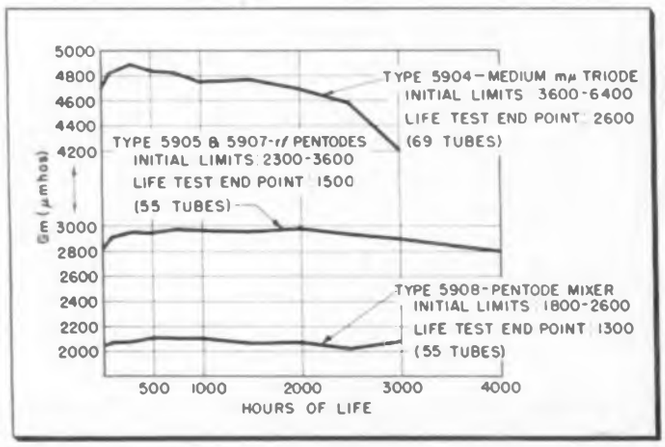
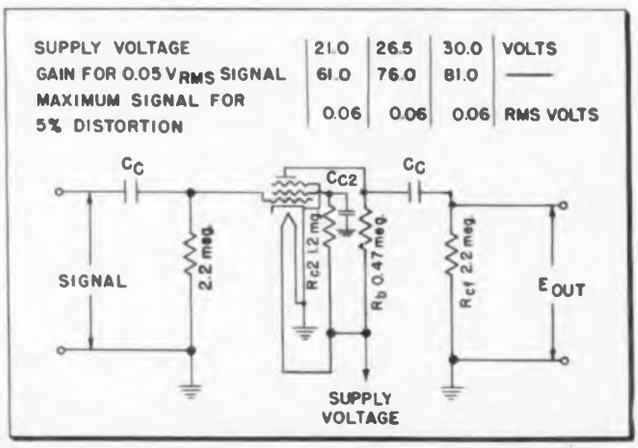


Fig. 4: (R) R-C amplifier and voltage change data, 5905 tube



for Mobile Communications

operation are ideally suited for aircraft and vehicular equipment appli-

response, resistance to shock and vibration are outstanding features

heater of similar design would require 42 folds of 0.00094 in. wire, which obviously could not be inserted into a round cathode of 0.025 in. ID. As a result, attention was directed to designs using coiled wire. Several types of coils were tried and found to be unsatisfactory, including a straight coil with a heater return connection through the tube mount, a straight coil containing an insulated return connection, a small insulated coil within a larger coil, etc.

The use of a simple folded coil was made possible by a change in cathode sleeve to an oval 0.025 in. x 0.048 in. x 12 mm. The folded coil utilized a total coal length of 28 mm, as opposed to 18 mm in former designs, and entailed no heater return problems. Early models of this heater were made of 0.00088 in. tungsten wire wound at 700 TPI on a 0.010 in. molybdenum mandrel. The coils were tacked welded to the mandrel, cut to length, dip coated cataphoretically with aluminum oxide, and fired one minute in wet hydrogen, at 1600°C. The mandrels were then dissolved out of the heaters in a solution of sulphuric and nitric acids. These heaters proved reasonably satisfactory for all objective requirements, but posed a difficult handling problem in manufacturing because of their fragile nature.

Insulated Mandrel

This problem was solved by winding the coil directly on an insulated mandrel which remains within the heater to make it stronger. The mandrel was prepared by a continuous process of cataphoretically coating 0.002 in. tungsten wire with aluminum oxide to a diameter of 0.010 in., and firing in hydrogen. This cataphoresis process is similar in principal to wire plating. The coated mandrel was then fed into a standard automatic coil winding machine of the type used in the lamp industry, and the heater coil was wound continuously on the insulated mandrel. The coil was then tabbed, cut into heater lengths, dip coated cataphoretically, and again fired. After final coating, the heaters were nicked in the center and folded. This procedure produced a heater of solid but flexible mass which could be handled without danger of breakage.

The heater connection used in early designs consisted of a refractory metal tab which was formed around the heater and welded directly to the coil wire. This "sandwich" type weld often resulted in damage to the coil due to the heat involved and to the possible mechanical stress on the fine coil. A subsequent method consisted of forming the platinum-rhodium tab around the heater, and making the weld next to, rather than through, the coil. This "crimp" welding procedure reduced the heat transferred to the coil wire and prevented the coil from being smashed by the welder, at the same time providing a good mechanical and electrical connection. The heater design is illustrated in Fig. 1. A modified version of this heater

Fig. 5: Circuit of 400 MC single-stage amplifier using 5905 or 5907 tube with 26.5 volt supply

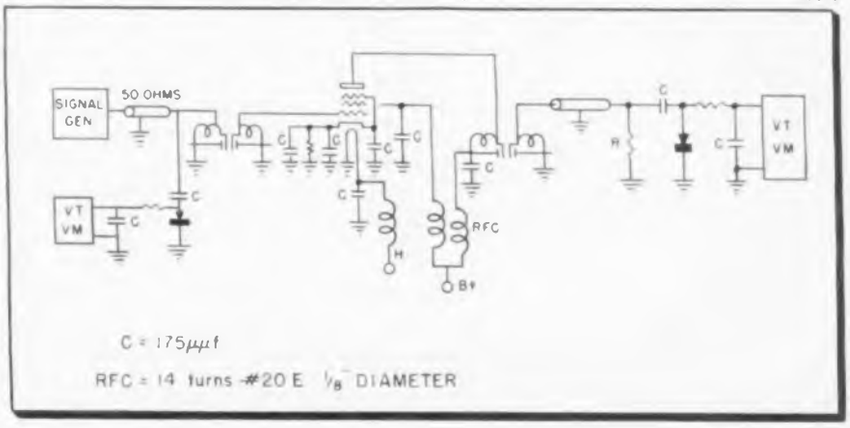
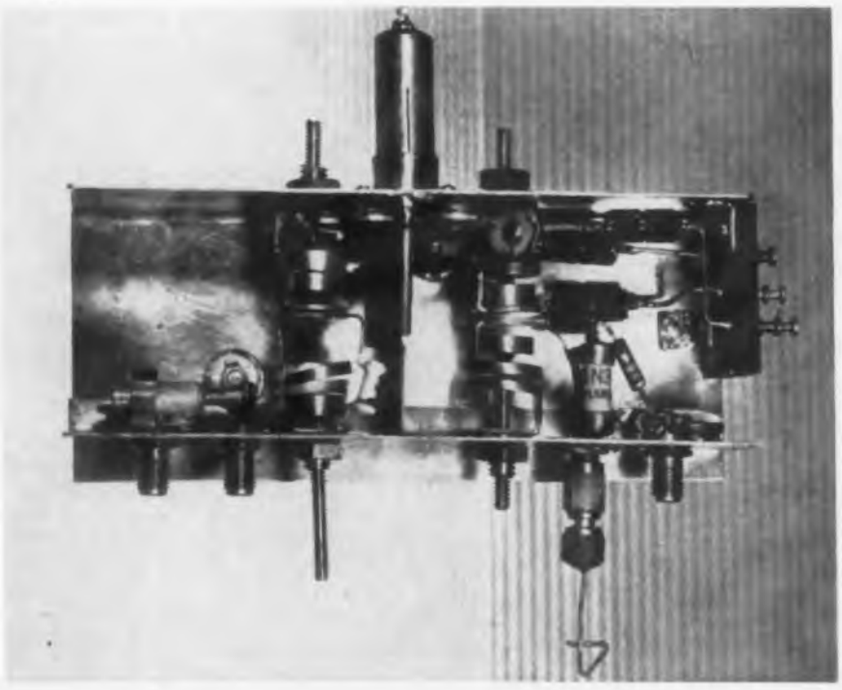


Fig. 6: Photograph of 400 MC single-stage amplifier showing under-chassis constructional features



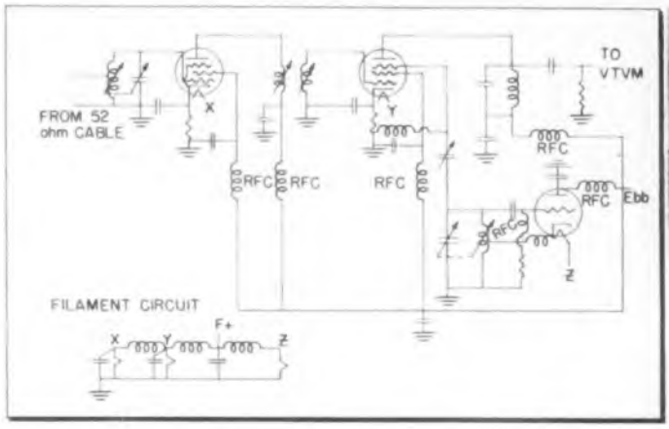


Fig. 7: (L) Circuit diagram of typical receiver front end. Using 26.5 volt tubes such as type 5908, it produces gains as high as 28 with bandwidth of 0.5 MC. Fig. 8: (R) Photograph of receiver front end showing size

shows promise of being quite suitable to high speed production.

These 26.5 v. coiled wire heaters are mechanically very strong, and are easy to handle. They are not critical to exhaust and can withstand voltages as high as 85 v. without burnout. Pilot line production of these heaters at Kew Gardens resulted in processing failure of 2.5%. The quality of heaters of tubes released for shipment is assured by running a sample from each manufacturing lot on heater-cycling test, at maximum heater voltage and with 140 v. RMS applied between heater and cathode, with all other elements grounded.

The cycle time is one minute on and four minutes off, and each sample must complete 2500 cycles with less than 5% of the total possible tube cycles being lost due to heater failure. Tube failures within 2500 cycles have been reduced from 14.5% on early tube lots to approximately 1.5% on current production. This compares with about 0.5% on 6.3 v. coiled heater types of the premium subminiature line.

The 5904 triode, the 5905 sharp cutoff pentode, the 5907 remote cutoff pentode and the 5908 pentode mixer were required to operate directly from aircraft battery supplies at a design center voltage of 26.5 v., and to provide useful performance at frequencies as high as 400 MC. These types are revisions of their 100 v. predecessors. In order to provide adequate performance at 26.5 v., it was necessary to increase the field potential in the control grid region, to maintain maximum plate resistance of pentodes, and to operate the tubes at the lowest possible control grid bias. It was decided that the tubes should not be rated at zero bias, since the grid current at this condition would be intolerable in many circuits. A rating with fixed or cathode resistor bias was undesirable as it would reduce the transconductance rating if sufficient safety factor were allowed in the matter of grid current.

Contact Potential Variations

Instead, the tubes were rated with 2.2 megohm grid resistors and zero applied bias, the bias being developed by 0.2-0.4 μa of positive grid current. This system has the advantage of operating each tube at its lowest possible grid bias, and hence its greatest transconductance. The disadvantage lies in the dependence of the bias value on the total contact potential between the cathode and the grid, a potential which is generally regarded as rather difficult to control. This situation has been relieved through the selection of proper grid materials and processing schedules. Recent pilot plant production indicated that considerable progress has been made toward controlling contact potential variations from lot to lot, and that shift of contact potential during tube life is not a problem.

The redesign of 100 v. tube types for efficient operation at 26.5 v. involved reduction of grid-to-anode spacing, and in some cases reduction of the projected area of the control grid, to increase plate current and transconductance. However, these spacings cannot be decreased to the point where larger interelectrode capacitances would interfere with high frequency operation. Desirable properties for UHF performance, such as small interelectrode capacitances, short transit time paths and low inductance leads, were already present in subminiature designs. In the case of the triode (type 5904), it was necessary to develop large plate currents to produce any usable power

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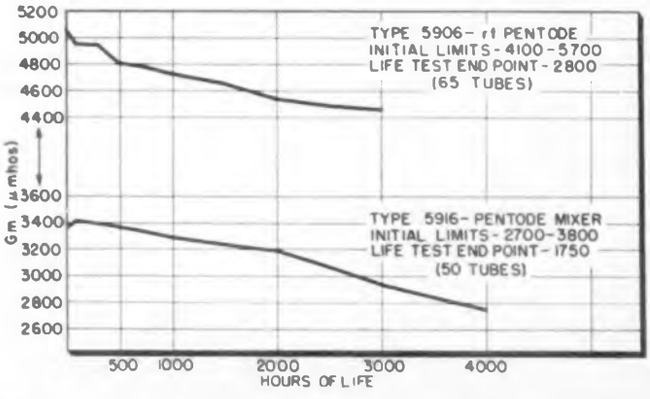
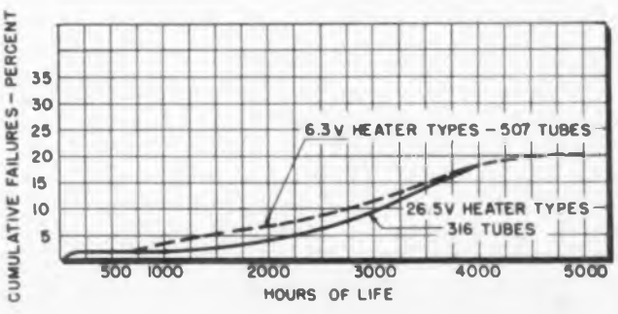


Fig. 9: (L) Effect of life test on g_m of two tubes with 26.5 volt heaters and 100 volts on plate and screen. Fig. 10: (R) Cumulative life failures of subminiature tubes. Measurements taken at 30° C ambient temperature



Performance of Ultrasonic Vitreous Silica Delay Lines

Results of tests at 10 and 60 MC with resistive terminations of 75 to 1000 ohms. Low terminating impedance values yield wide bands but involve higher insertion losses

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Murray Hill, N. J.

THE object of this paper is to analyze the electrical performance of an ultrasonic delay line in terms of its equivalent circuit, and to show the relation of insertion loss and bandwidth to the parameters of the piezoelectric transducer, the acoustic medium, and the electrical termination. To assist in the understanding of this treatment, some fundamental considerations of solid delay line transmission will be reviewed.[1,2,3,4]

Basic Delay Line

The elements of an acoustic delay line are shown in Fig. 1a. The transmitting crystal is generally driven with pulse-modulated high-frequency voltage, the carrier frequency being the same as the fundamental resonant frequency of the crystal or an odd overtone. For most efficient conversion of energy, the pulse duration should be sufficient to establish steady-state conditions in the transducers. The electrical energy is converted to high-frequency acoustic waves which are transmitted through the medium and reconverted at the receiving end by a second transducer or, after reflection from the end of the line, by the transmitting element itself. The delay time is equal to l/v, where v is the velocity of the acoustic wave in the medium of length l.

Velocity of Waves

Because of the rigidity of solids it is possible to transmit plane shear waves and torsional waves through them as well as the compressional type normally associated with liquids. For plane shear waves in an infinite medium the velocity is given by the relation

$$V_s = \sqrt{\frac{\mu}{\rho}} = 3.76 \times 10^5 \text{ cm/sec} \quad \text{(vitreous silica)} \qquad (1)$$

in which the shear elastic modulus $\mu = 3.12 \times 10^{11}$, and the density, $\rho = 2.2$. The delay is $(1/v_s)$ or 2.66 μsec/cm.

Such waves are characterized by particle motion which is at right angles to the direction of propagation and are generated by Y-cut or the rotated AT and AC piezoelectric quartz crystals one half-wavelength in thickness. These crystals, vibrate in a thickness-shear mode when a field is applied in the thickness, or Y direction. The relation of thickness to frequency for the Y-cut crystal is given by:

$$t = \frac{1.97}{f} \text{ mm (Y cut)}$$

$$t = \frac{1.66}{f} \text{ mm (AT and AC cut)} \qquad (2)$$

where f is in megacycles.

The acoustic velocity for compressional waves in vitreous silica is given by

$$V_c = \sqrt{\frac{\lambda + 2\mu}{\rho}} = 5.96 \times 10^5 \text{ cm/sec} \qquad (3)$$

where the compressional stiffness modulus, $\lambda = 15.9 \times 10^{11}$, and μ and ρ are as given in (1). The delay is $(1/v_c)$ or 1.68 μsec/cm. Such waves are characterized by motion in which the wave front is a plane perpendicular to the direction of propagation, and are generated by X-cut quartz crystals These crystals vibrate in a thickness longitudinal mode when a field is applied in the X-direction. Thickness is related to frequency by $t = (2.86/f)$ mm; where f is in megacycles.

Reflection of Waves

Because of the widely different acoustic impedances of fused silica and air, almost complete reflection generally takes place at the air boundary. Except for special cases, the reflection results in partial conversion of acoustic energy to other modes of vibration with consequent pulse distortion and the generation

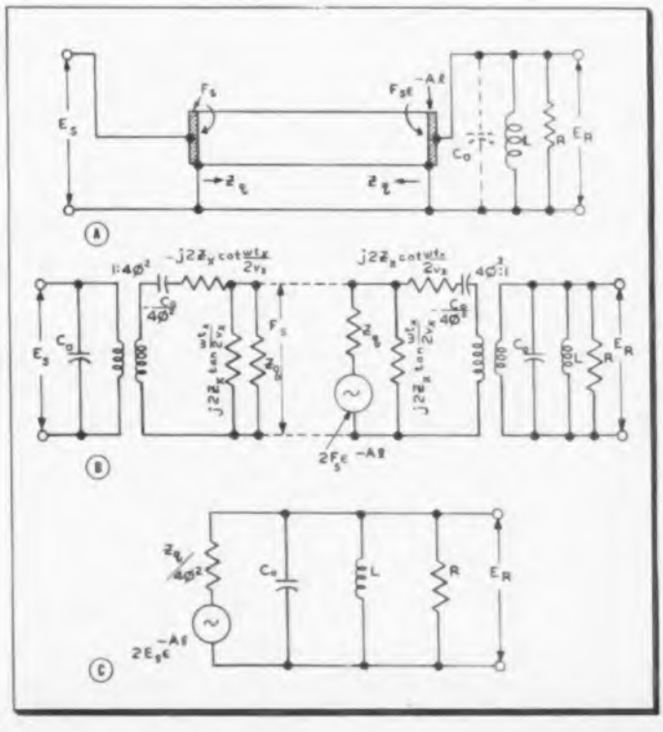


Fig. 1: Diagram of basic delay line (A), equivalent circuit (B), and simplified circuit (C) for mid-band loss calculation

of spurious pulses. In the case of transmission through a rod, compressional waves at the lower frequencies in the megacycle range, i.e. below 20MC, reflect at the air boundary in such a way that they break up into a reflected compressional wave and a generated shear wave at a large angle with the surface. This shear wave, on the next internal reflection, is partially converted back into a compressional wave which trails the original pulse. There may be a number of such trailing pulses, closely spaced, arriving at the receiving transducer. At the higher frequencies the trailing pulses are not significant.

Shear waves, even at lower frequencies, are free from trailing pulses and, with proper orientation, can be totally reflected.

Attenuation

Of the solid materials suitable for delay line use, vitreous silica of high purity has the lowest loss for high frequency ultrasonic waves. The loss can be expressed as a linear function of frequency, as $A=Bf$; where, for shear waves, B=0.08 db/ft/megacycle and for compressional waves B=0.05 db/ft/megacycle.

The directivity pattern of the ultrasonic beam within the medium can be approximately calculated using the classical laws which apply to diffraction and interference phenomena in light and sound. These apply to compressional or shear waves in solids and compressional waves in liquids. Fig. 2 is a beam pattern which was calculated for 10MC ultrasonic shear waves in vitreous silica, assuming a source 1cm square. It shows, to scale, relative intensity of the side lobes and the central beam for increasing distances from the source. The first lobe pattern is shown at the point where the directivity pattern begins to form its separated lobes. This distance, which represents the limit of the Fresnel zone, is given by

$$X_m = (a^2/\lambda) \Big/ (m - 1/4) \qquad (4)$$

in which m=1, a=half-length of radiator=0.5 cm, λ=wavelength in medium=.0376 cm, x_1=distance=8.9 cm (m=1)

The distances off the axis for the maxima and minima of the lobes are given by

$$h_q = \frac{q}{(a/\lambda)} X \qquad (5)$$

in which q is a parameter equal to

Fig. 2: Calculated spreading pattern of 10 MC ultrasonic waves in vitreous silica, from 1 cm source

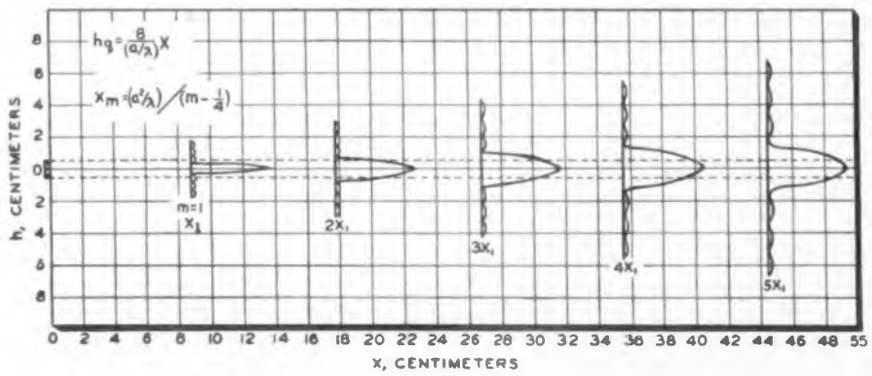
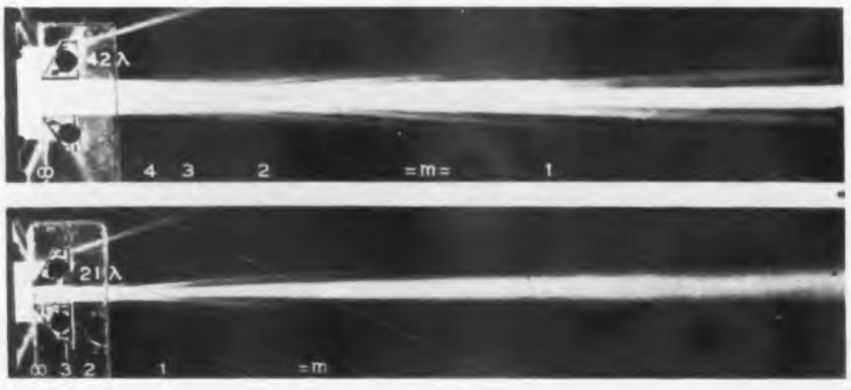


Fig. 3: Photo of diffraction pattern of 10 MC waves in water showing effect of source length



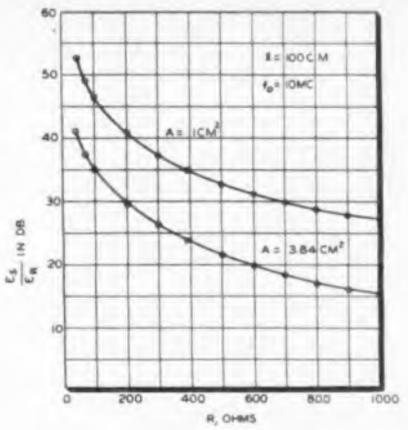


Fig. 4: Calculated midband loss as function of R for 10 MC shear wave delay line 100 cm long

0.5, 1, 1.5, 2 for successive zeros of intensity and is equal to 0.715, 1.230, 1.736 for the successive maxima and h is the distance off the axis for particular values of q.

The directivity pattern is plotted at distances along x corresponding to x_1, $2x_1$, $3x_1$ . . . on to $5x_1$. It is seen that at $5x_1$, or a distance of 44.5 cm, the main lobe has spread to a width of 3 cm. The amplitude of the side lobes relative to the main beam is 4.8%, 1.6%, and 0.8%. From equation (5) it is seen that the directivity is proportional to a/λ, a factor which is important in delay line design.

The acoustic energy represented in the spreading main lobe and in the secondary lobes, as shown in Fig. 2, may be reflected from boundaries of the medium and so reach the receiving transducer as unwanted responses at times different from the main pulse. Many delay line applications impose severe requirements on the amplitude of these unwanted responses. In such cases special techniques must be employed to limit, insofar as possible, the energy within the area of the receiving transducer and to prevent any energy which has spread outside this area from reaching the receiving transducer.

Fig. 3 is a photograph obtained by an optical method in which compressional ultrasonic waves in water were used to diffract a light beam.[5] The two patterns for apertures of 42λ and 21λ clearly indicate the relative distances at which beam formation and spreading begin, and show that from this distance outward, the lobes spread as though they originated from a point at the center of the radiator.

The equivalent circuit of a delay line shown in Fig. 1b is based on earlier work done by H. J. McSkimin and R. A. Sykes and is derived from the general equivalent circuit given

by W. P. Mason[6] for a vibrating crystal transducer. The following conditions are assumed in the analysis:

1. The shunt capacitance of the crystal at the output circuit is anti-resonated at the resonant frequency of the crystal by means of an inductance.
2. The terminations to be considered will be of relatively low values compared to the effective impedance, exclusive of C_o presented by the delay line at the transducer terminals.
3. The crystals are mechanically loaded on one face only and the effect of the bonding material between the crystal and the medium is neglected.
4. The input voltage is assumed independent of frequency, i.e. the driving circuit is not considered in this analysis.
5. The reactance of the series capacitance in the equivalent circuit is small enough to be neglected.

The applied voltage E_s is transformed into a mechanical force F_s by means of the electromechanical transducer whose equivalence is an ideal transformer of impedance ratio $1 : 4\phi^2$, a series impedance $-j2Z_x \cot \omega t_x/2V_x$ and a shunt element $+ j2Z_x \tan \omega t_x/2V_x$. This force is impressed on the mechanical impedance Z_q presented by the transmitting medium and appears at the far end of the line attenuated by the factor ε^{-Al}. The equivalence of the receiving end is obtained by the application of Thevenin's theorem in which the open circuit force is that which would be exerted on a clamped line. In this case, no energy is lost, the reflection is complete and the force is $2F_s\ \varepsilon^{-Al}$. The source impedance seen by the receiving crystal is Z_q, as shown. The circuit is completed by the receiving crystal and its termination.

The symbols used in the preceding paragraph have the following meanings: $\phi = (e/t_x)$ (for 1 cm² area), where e is the piezoelectric constant of the crystal which relates stress to e.m.f. for the particular mode of motion being considered and t_x is the thickness of the crystal. Z_x and Z_q are the characteristic mechanical impedances of the crystal and the transmitting medium, respectively. Numerically, the impedance in mechanical ohms for 1 cm² area is equal to ρv. This can be converted to e.s.u. of resistance by the ratio $1/4\phi^2$ and from e.s.u. to practical ohms by 0.9×10^{12}.

Midband Loss

At the resonant frequency, f_o, the equivalent circuit reduces to Fig. 1c. The loss of the delay line is given by:

$$\frac{E_s}{E_g} = \frac{1}{2\varepsilon^{-Al}} \left[\frac{Z_q / 4\phi^2}{R} + 1 \right] \qquad (6)$$

In this formula $Z_q/4\phi^2$ and R must be in the same units and it is to be noted that $Z_q/4\phi^2$ varies inversely with the cross-sectional area. Fig. 4 shows the calculated midband loss for delay lines 1 cm² and 3.84 cm² in cross-section and 100 cm long, using 10 MC Y-cut quartz crystals with terminations varying from 75 to 1000 ohms.

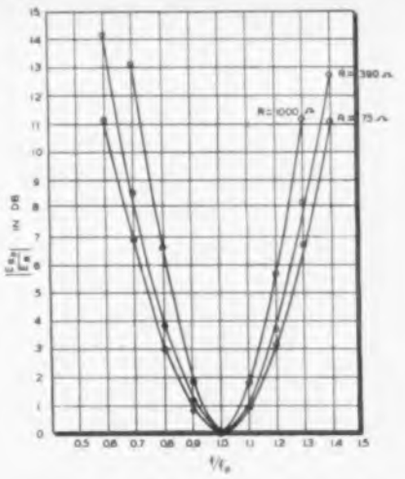


Fig. 6: Overall bandwidth characteristics

Bandwidth

From consideration of the equivalent circuit of Fig. 1b it appears that the approach which would show most clearly the contribution of the basic elements, i.e. the input transducer, the delay line medium, the output transducer, and the termination, would be to separate the network into three relatively simple sections. These are shown in Fig. 5. For the first section, representing the sending end,

$$F_s = I_q Z_q = \frac{Z_q E_g 2\phi}{Z_q (1 - \cot^2 a) - 2j Z_x \cot a} \qquad (7)$$

(E_g constant)

$$\left| \frac{F_{so}}{F_s} \right| = \sqrt{(1 - \cot^2 a)^2 + 4 \left(\frac{Z_x}{Z_q} \right)^2 \cot^2 a} \qquad (8)$$

where $a = \frac{\omega t_x}{2v_x} = \frac{\pi}{2} \cdot \frac{f}{f_o}$

and F_{so} is the value of F_s at the resonant frequency. This ratio is plotted for the vitreous silica line.

The second section, representing the receiving crystal, is solved for the velocity ratio, assuming an elec-

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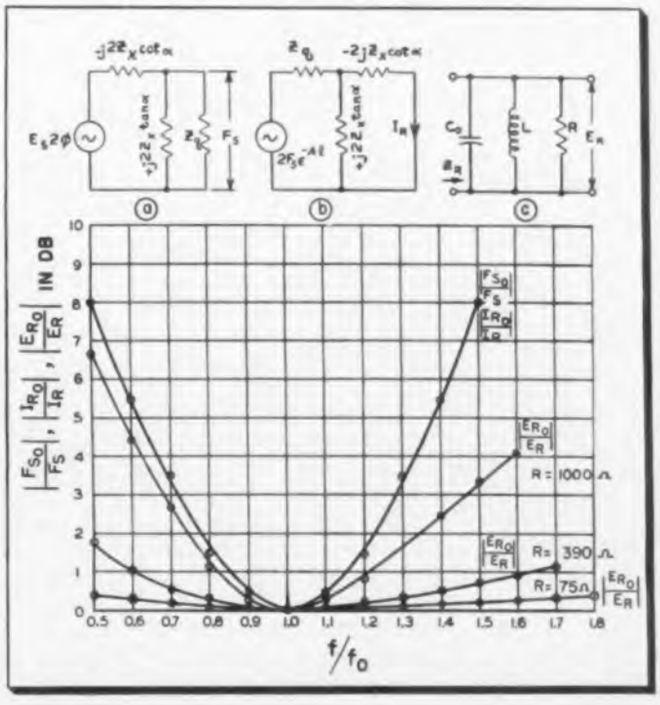

Fig. 5: (Left) Bandpass characteristics for delay line sections

Fig. 7: Block diagram of measuring circuit

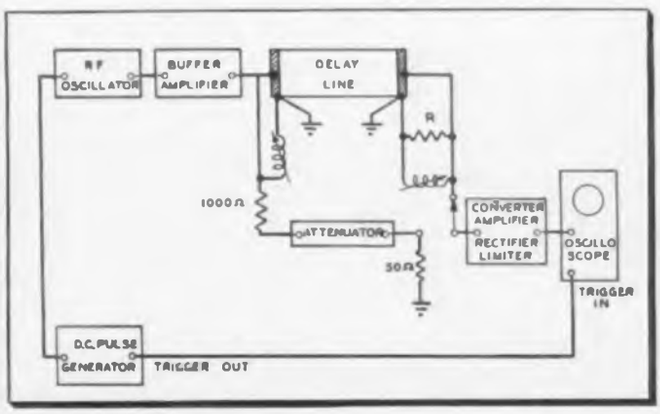

Fig. 1: Photograph of equipment employed to measure characteristics of iron-core transformers

High

Spurious resonances, affect feedback cir-

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Georgia Institute of Technology
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THE wideband iron-core transformer was for many years the most common type of interstage coupling device used in audio frequency amplifiers. Following the development of the pentode resistance-coupled amplifier, the transformer lost its dominant position as an interstage coupling device except in the field of push-pull driven applications. Nevertheless, the transformer is still employed universally as an input and output coupling and isolation device in amplifiers. In recent years, many new applications have been created for high frequency iron-core transformers in airborne and other electronic equipment of which the servomechanism and the computer are important examples.

It is the purpose of this article to show that the generally-accepted simplified high frequency equivalent circuit of an audio frequency transformer is not of sufficient accuracy for the prediction of the true frequency response of many iron-core transformers above the upper cut-off frequency. Many transformers tested by the authors with the equipment in Fig. 1 exhibited high frequency resonances not accounted for by this equivalent circuit.

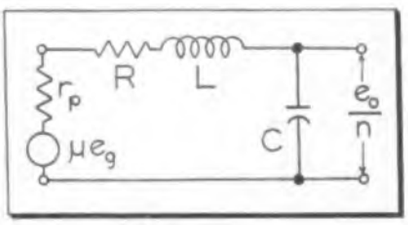


Fig. 2: Simplified high frequency equivalent circuit of transformer-coupled amplifier showing winding resistances R and leakage inductances L of primary and secondary referred to primary, and total capacitance C referred to primary.

If either the transient response or the intermodulation characteristic of an amplifier is of importance, it is desirable to investigate the gain and phase response of the amplifier over a wide band of frequencies. Furthermore, in amplifiers, servomechanisms, or computers which include a transformer in a feedback loop, the high frequency response of the transformer is of prime importance at frequencies extending several octaves beyond the upper half-power, or cut-off, frequency.[1]

Transformers are a potential source of instability in amplifiers having a feedback loop, because the relative phase shift of a transformer will cover a range extending asymptotically from 90° lead at low frequencies to 180° lag at high frequencies.[2] The gain and phase excursions may be reduced somewhat by loading the secondary of the offending transformer with a resistor, provided that the accompanying gain reduction can be tolerated. Alternatively, equalizers may be employed to stabilize feedback amplifiers.[3]

The simplified high frequency equivalent circuit of an input, or interstage, audio frequency transformer is shown in Fig. 2. The computed relative gain based on this circuit yields results which agree closely with experimental data up to the upper cut-off frequency. If the plate resistance of the driving tube (or the generator impedance) is of such a magnitude as to make the Q_{eq} of the equivalent circuit exceed 0.707, the relative gain will exceed unity. This resonant rise in the relative gain occurs near the frequency at which the leakage inductance of the transformer referred to the primary is in series resonance with the equivalent shunt capacitance.[4]

The magnitude of the resonant peak may be reduced to an optimum value through a reduction in the equivalent circuit Q_{eq} by increasing the resistance of the driving source, or by shunting a resistor across the secondary of the transformer. An output transformer does not in general exhibit this high frequency resonance if it is terminated in a resistor equal to its rated load value.

Additional Resonances

Numerous audio and high frequency iron-core transformers which were tested exhibited pronounced resonances at frequencies above the generally recognized high frequency resonance. Unfortunately, these additional resonances may exist even though the associated amplifier is operating under conditions yielding the most uniform gain characteristic over the desired pass band.

The curves in Fig. 3 show the relative gain and phase responses of a high-quality input transformer. The data for these curves were obtained by use of the basic circuit arrangement of Fig. 4. The magnitudes of the generator and load impedances are indicated on the curves. The zero impedance generator was simulated by measuring the ratio E_2/E_1 and the phase shift between E_2 and E_1 for the data plotted in Fig. 3 a, 3 b and 3 c. Furthermore, E_1 was maintained at a constant low magnitude in order

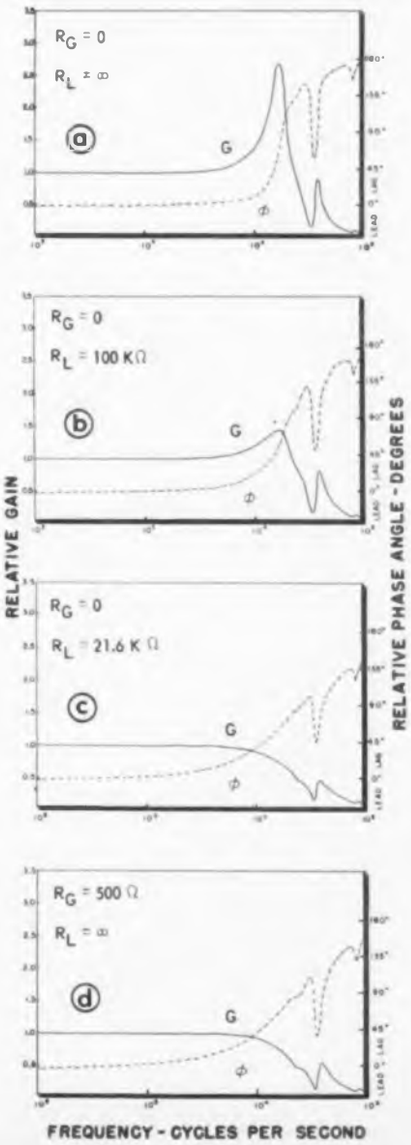
Frequency Response of Transformers

not taken into account in conventional design, can seriously cuits in audio amplifiers, servomechanisms, and computers

to reduce core saturation effects.

Referring to Fig. 3 a, the customary resonant peak due to resonance between the leakage inductance and the equivalent shunt capacitance occurs at a frequency of 17 KC. However, the relative gain curve does not decrease sharply to a low rapidly-diminishing value as is stated in the classical descriptions of the high frequency response of audio frequency transformers. Instead, the gain goes through a minimum at 33 KC, followed by a second maximum at 38 KC, a second minimum at 76 KC and a third maximum at 82 KC. The figures show that near these frequencies, the phase shift goes through large excursions. If a polar diagram of the vector gain of the transformer is plotted, the resultant curve will describe a complete loop for each of the gain-phase resonant excursions.

Fig. 3: Relative gain and phase vs frequency response for different values of R_L and R_G employed by an input transformer having spurious high frequency resonances 100-10,000 cps



The effect of secondary loading is shown clearly in Fig. 3 b and 3 c. The data for Fig. 3 c were obtained by initially reducing R_L until the relative gain at the first resonant peak was reduced to 0.707. In spite of this comparatively heavy secondary loading, the additional resonances are still quite pronounced.

Fig. 3 d shows the relative gain (E_2/E_G) and the relative phase characteristics of the transformer operating from its rated source impedance of 500 ohms. It is to be noted that the relative gain at the resonant peak of 38 KC has the comparatively high value of 0.55, and that the phase changes very rapidly in the vicinity of this resonant frequency. The simplified high frequency equivalent circuit would lead one to conclude that the gain decreases smoothly to a low value at frequencies above the pass band. A comparison of the four sets of curves reveals the fact that neither the magnitudes nor the frequencies of the additional resonances are greatly affected by a reduction in the Q_0 of the transformer by connecting resistors in series with the primary or across the secondary.

Conclusions

Although the simplified high frequency equivalent circuit of a transformer accounts for the first resonant peak in the frequency response characteristic, it should be recognized that additional resonances may exist at high frequencies. An equivalent circuit which accounts for the additional resonances may be synthesized by making open-circuit and short-circuit impedance measurements on the primary and the secondary of a transformer over the significant frequency range.[5]

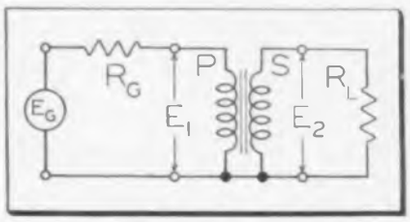


Fig. 4: Basic circuit for obtaining data

It is true that a mathematical analysis of the complete equivalent circuit of a transformer involves an unwarranted amount of labor. The authors suggest, however, that it is a simple matter to measure the gain-frequency characteristics of a particular transformer in order to determine the magnitudes and the locations in the frequency domain of the additional resonances. These resonances are most readily detected if the secondary voltage E_2 is measured while the primary voltage E_1 is maintained constant, or if the transformer is driven from a generator whose impedance is much lower than the normal input impedance of the transformer.

In view of the fact that resonant peaks in the gain characteristic of a transformer-coupled amplifier are accompanied by large excursions in the phase characteristic, it is apparent that these resonances can produce undesirable instabilities if a negative feedback loop includes a transformer exhibiting resonances similar to those described in this paper. For example, oscillation difficulties are likely to be encountered when negative feedback is employed over several audio frequency stages in a radio-telephone transmitter if the feedback loop includes a transformer. It is clear that this problem may also arise in connection with servomechanisms and computers in which transformers are included in feedback loops. Furthermore, it is important to note that these additional resonances affect the intermodulation and transient characteristics of a transformer-coupled amplifier.

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[1] **F. E. Terman, Radio Engineering**, 3rd ed., pp. 322-323.
[2] **F. E. Terman, "Feedback Circuits", Proc. IRE**, vol. 32, p. 403, July 1944.
[4] **F. E. Terman, Radio Engineers' Handbook**, pp. 366-373, 1943.
[5] Von H. Knapp, "The Influence of Capacitances between the Windings of a Transformer on its Characteristics", **Elektrische Nachrichten Technik**, vol. 20, no. 8, p. 192, Aug. 1943.

1952 Convention Hails

Expanded exhibits, technical papers and able social meetings to make this Na-

Dr. I. S. Coggeshall
President of the IRE during 1951

GROWTH and congeniality will mark the 1952 National Convention of the Institute of Radio Engineers at New York City's Waldorf-Astoria Hotel and Grand Central Palace on the 40th anniversary of the Institute. From March 3 through March 6, about 25,000 visitors are expected to roam the 53,000 sq. ft. of exhibit space at the Palace, examining and wrinkling brows at the 356 exhibits of the latest in the radio field. Approximately 215 technical papers, including several Group symposia, will highlight the rapidly increasing scope and complexity of today's engineering knowledge.

Touchstone of IRE's expansion, today's 29,682 members, 1,975 more than 1951 and double the number enrolled by 1945, are a far cry from the 33 members of two radio clubs that joined hands in 1912 to form the Institute.

Reflecting the organization's development, the Radio Engineering Show at Grand Central Palace boasts an increase of 79 exhibitors and 10,000 sq. ft. of floor space over 1951, as well as an anticipated audience increase of 2,000 above last year's 22,919.

The major address, that by Charles E. Wilson, Director of Defense Mobilization, at the banquet to be held on March 5 in the Grand Ballroom of the Waldorf, is expected to be an important policy speech of prime significance to the nation. Other highlights in the four day program include the President's Luncheon in the Starlight Roof on March 4, and the let-your-hair-down get-together cocktail party on March 3 in the Grand Ballroom. A four day social program for the ladies includes a series of tours, shows and luncheons.

Dr. Donald B. Sinclair, chief engineer of the General Radio Co., has been elected president of the IRE for 1952, succeeding Dr. I. S. Coggeshall, general manager of Western Union's overseas communications. Recognizing the international character of the Institute's membership and activities, Harold L. Kirke, assistant chief engineer of the British Broadcasting System, succeeds Jorgen Rybner of the Royal Technical University of Denmark as vice-president. Elected as directors for the 1952-1954 term are John D. Ryder, chairman of the electrical engineering department of the University of Illinois, and Ernst Weber, head of Brooklyn Polytechnic's electrical engineering department.

The Military Radio Exhibit this year will permit approximately 24 companies to display the equipment produced for government use in the field of communications, radar, guided missiles, nucleonics and instrumentation. The Institute is making 2,500 sq. ft. of space on the fourth floor of the Palace available to these firms free of charge. This move has been made possible by an $8 million cut in Department of Defense public information appropriations which caused the withdrawal of government-sponsored exhibits, for which space had always been provided cost-free.

Another Convention feature is the symposium presented on Tuesday evening, March 4, discussing the present status of NTSC color TV standards. A panel of leading engineers will exchange information on the progress of preparing and field testing NTSC standards.

Listed below are some of the technical papers to be presented which should prove notably interesting:

Scene of 1951's Radio Engineering Show, Grand Central Palace again plays host to the IRE in 1952

Monday, March 3

Symposium: TRANSISTOR CIRCUITS

Transistor Operation: Elements
(a) "Equivalent Circuits"–**J. A. Morton**
(b) "Parameter Measurement"–**V. P. Mathis**
(c) "Stabilization of Operating Points"–**R. F. Shea**
"Transistor Band-Pass Amplifiers"–**R. P. Moore**
"Transistor Oscillators"–**J. S. Schaffner**
"Transistor Pulse Circuits"–**J. H. Felker**

INFORMATION THEORY 1—CODING PROCEDURES

"Efficient Coding"–**B. M. Oliver**
"Television-Signal Statistics"–**E. R. Kretzmer**

IRE's 40 Anniversary

symposia coupled with professional group and memorial Convention a milestone in IRE's steady growth

"Coding with Linear Systems"-**J. P. Costas**
"Predictive Coding"-**P. Elias**
"Experiments with Linear Prediction in Television"-**C. W. Harrison**

AUDIO

"Microphones for the Measurement of Sound-Pressure Levels of High Intensity over Wide-Frequency Ranges"-**J. K. Hilliard**
"An Insturment for Measuring the Time-Displacement Error of Recorders"-**E. N. Dingley, Jr.**
"A Method for Measuring the Changes Introduced in Recorded Time Intervals by a Recorder/Reproducer"-**J. F. Sweeney**
"Application of Electric-Circuit Analogies to Loud-Speaker Design Problems"-**B. N. Locanthi**
"A Sound-Survey Meter"-**A. Peterson**

Tuesday, March 4

INSTRUMENTATION 1—HIGH-FREQUENCY INSTRUMENTATION

"VHF Q-Measurement Techniques"—**D. M. Hill**
"A High-Sensitivity Method for Measuring Conductance and Capacitance at Radio Frequencies"—**W. C. Freeman, Jr.**
"A Mean-Square Vacuum-Tube Voltmeter"—**L. A. Rosenthal and G. M. Badoyannis**
"A New Technique for the Evaluation of Leakage and Radiation from Signal Generators"—**W. A. Stirrat**
"A Wide-Band Sweep Generator"—**F. P. Blecher**

TELEVISION 1—GENERAL A

"Gamma Correction in Constant-Luminance Color-Television Systems"—**S. Applebaum**
"The Specification and Correction for Nonlinearity of Cathode-Ray Tubes"—**R. C. Moore**
"Colorimetric Measurements in Color TV"—**S. W. Moulton**
"Frame Synchronization for Color Television"—**D. Richman**

CIRCUITS 1

"Network Alignment Technique"—**J. G. Linvill**
"Network Analysis by a New Semi-Automatic Computer"—**R. L. Bright and G. H. Royer**
"Network Analysis by Two New Computers"—**D. Herr**
"Network Response Characteristics Using the

(*Continued on page* 124)

Dr. D. B. Sinclair
President of the IRE for 1952

TO meet the needs arising from the trend toward scientific specialization, the Institute of Radio Engineers has fostered the establishment of Professional Groups within the framework of the parent organization. These Groups (see cover and contents page) will enable investigators engaged in the same branches of radio-electronic study to focus their activities within a narrower scope than previously, and to probe more deeply. While the 16 groups presently established encompass the primary phases of radio-electronic interest, it is expected that several new groups will be formed in the near future. The formation of these professional groups, which has gained momentum since its inception in 1948, sets the pace for more concentrated activity through specialized association within the IRE.

TECHNICAL PAPER TOPICS, SYMPOSIA, AND THEIR LOCATIONS FOR 1952 IRE CONVENTION

	BELMONT-PLAZA		WALDORF-ASTORIA		GRAND CENTRAL PALACE	
Time	Moderne Room	Ball Room	Astor Gallery	Jade Room	Maroon Room	Blue Room
Mon. P.M.	Sub-Audio Instrumentation*	Management of Research*	Transistor Circuits*	Information Theory I—Coding Procedures	Audio	Telemetering*
Tues. A.M.	Instrumentation I—High Frequency Instrumentation	Television I—General A	Circuits I	Information Theory II-Noise statistics and Signal Detection	Microwaves I—Waveguides A	TV Broadcasting*
Tues. P.M.†	Instrumentation II—Electronic Measurements A	Television II—Color	Circuits II and Information Theory III	Medical Electronics	Microwaves II—Waveguides B	Television Station Construction*
Wed. A.M.	Instrumentation III—Electronic Measurements B	Television III—General B	Circuits III	Propagation	Microwaves III—Filters and Circuits	Digital Computers*
Wed. P.M.	Antennas I—General	UHF Receivers Session I*	Circuits IV	Electron Tubes I—Power Output and Gas Tubes	Radar and Radio Navigation	Magnetic Memory Devices*
Thurs. A.M.	Antennas II—Microwave A	UHF Receivers Session II*	Feedback Control	Electron Tubes II—Small High-Frequency Tubes	Equipment and Airframe Integration	Digital Computers
Thurs. P.M.	Antennas III—Microwave B	Radio Communication Systems	Circuits V	Electron Tubes III—Cathode Ray Tubes	Mobile Radio*	Reliability of Military Equipment*

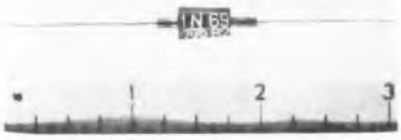
*Symposium. †Special Symposium: Present Status of NTSC Color TV Standards, Grand Ballroom, Waldorf-Astoria.

Previews of New Equipment

Booth numbers and survey of latest developments featured in exhibits

Germanium Diodes (N-16)

Diode construction consists of germanium wafer, contact whisker, supporting and insulating structure, and contact leads enclosed in a hexagonal form to prevent rolling when mounted in clip. Shape of glass-filled phen-



olic cartridge body indicates at a glance, by means of its taper, the direction of current flow. Nine different units, all vacuum filled with flexible wax, are available in following types: 1N48, 1N51, 1N52, 1N63, 1N65, 1N69,, 1N70, 1N75, and 1N81. Range of characteristics for group is 2-5 ma at 1v. forward, 50-1667 microamps at 50 v. reverse, 25-50 ma average, and 50-125 v. inverse peak.—**Radio Receptor Co., 251 W. 19 St., New York 11, N. Y.**—TELE-TECH.

Output Power Meter (948-95)

The 50-watt, type OP-961, output power meter is designed to read power or impedance at all impedances over the audio

frequency range. With an impedance adjustable over a range of 40 steps from 2.5 ohms to 20,000 ohms, the instrument will measure 50 watts in steps of 0.1 mw., and db from -10 to plus 47 db. Over a range of 20 to 15,000 cps, the readings are accurate within 2%. The impedance changing network remains essentially resistive at audio frequencies, and the meter multiplier network has a constant impedance at all frequencies. — **Daven Co., 191 Central Ave., Newark, N. J.** —TELE-TECH.

Oscillosynchroscope (512-13)

A sweep system which may be operated in either triggered or recurrent fashion with direct reading panel calibrations of sweep speed is featured in the models ON-5A and

ON-5X oscillosynchroscopes. Sweep writing rates are continuously variable from 1.0 microsec. sec. per in. to 25,000 microsec. sec. per in. Vertical amplifiers are flat within ±3 db from 5 cps to 5 MC with a maximum sensitivity of 0.15 p. to p. volts per in. Horizontal bandwidth is from dc to 500 KC. A vertical deflection calibration source of 0-2, 0-20 and 0-200 v. provides a convenient means for determining amplitude of vertical input voltages. Model ON-5X is identical to Model ON-5A except for a 0.45 microsec. sec. signal delay line which permits the display of the leading edge of a pulse which is used to trigger the sweep.—**Browning Laboratories, Inc., Winchester, Mass.**,— TELE-TECH.

Sweep and Marker Generator (113-119)

Model ST-11A combination sweep and marker generator for r-f alignment of TV head-ends and over-all systems features single knob selection of sweep and from one

to five marker frequencies, simultaneously. Continuously variable capacitor type attenuator has a range in excess of 100 db. Output is 0.25 v. at 300 ohms balanced or 72 ohms unbalanced. Two other instruments shown are Model ST-2B five-inch oscilloscope and Model ST-9A dual regulated power supply. Oscilloscope features identical high-gain direct-coupled vertical and horizontal amplifiers essentially flat to 500 KC, uses a driven sweep and high accelerating voltage to permit use of tubes having long persistance phosphors, and has 10 mmf input probe and internal voltage calibrator covering range 0.1 to 300 v. peak to peak in eight steps. Each supply in ST-9A is independently regulated from 0 to 500 v. up to 100 ma., and hum and noise is below 3 mv. Two uhf tubes being presented are forced-air cooled GL-6019 transmitting tube for one kw at 900 MC. and r-f amplifier for use in tuners covering entire TV range.—**General Electric Co., Electronics Park, Syracuse, N. Y.**— TELE-TECH.

Miniature Concentric Switch (232-233)

Series 30-C dual concentric miniature switch shown in the photograph is also available in switch-control concentric. Ad-

ditional new presentations at the IRE exhibit include the miniature eyelet feed-through capacitors, miniature trimmer capacitors, two printed circuit plates, flat-shaft radiohm, high torque miniature Model 1 controls and metalized ceramic parts. — **Centralab, 900 E. Keefe Ave., Milwaukee 1, Wis.** — TELE-TECH.

X-Band Klystrons (55)

V-50 X-Band klystron, developed from the Varian X-13 general purpose signal source

is designed as a local oscillator for rugged service. It is tuned by a screwdriver from 8.5 to 10.0 KMC. Substitution of this tuning mechanism for the micrometer tuner of the X-13 allows the V-50 to perform smoothly under severe vibration and shock conditions. The more rugged V-51 is tuned by a lock-nut device manipulated with a standard open end wrench, and is suitable for radar local oscillator or low-power transmitter use. X-13 delivers over 100 mw with 500 v. on the resonator while V-50 delivers 25 mw with 300 v. V-51 delivers 75 mw with 350 v. on the resonator. All three tubes have waveguide output mating with the UG39/U flange.— **Varian Associates, 990 Varian St., San Carlos, Cal.**—TELE-TECH.

Plug and Receptacle (249-250)

Type AN2551 battery plug (Navy BuAer No. 49A1A8) for external power connection has split rubber shell held together with strap clamps. With two 7/16 in. and one 5/16 in. socket contacts, plug is rated at 400 amps and 28 v. dc. Mating receptacle is Type AN2552 (Navy BuAer No. 49A1A7-1) available with and without shield, having linen bakelite or melamine bonded glass mat-laminated insulation.—**Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Cal.** —TELE-TECH.

Vibration Control Mountings (N-5)

Designed to meet the requirements of base-mounted airborne electronic equipment. Temproof mountings for standard and mini-

ature equipment function efficiently from −80°F. to +250°F. and can withstand a 30G drop test. Friction dampers prevent excessive equipment motion at resonant frequencies, and mounting drift is negligible even after long service. — **Lord Manufacturing Co., Erie, Pa.** — TELE-TECH.

Aircraft Approach Simulator (75-80)

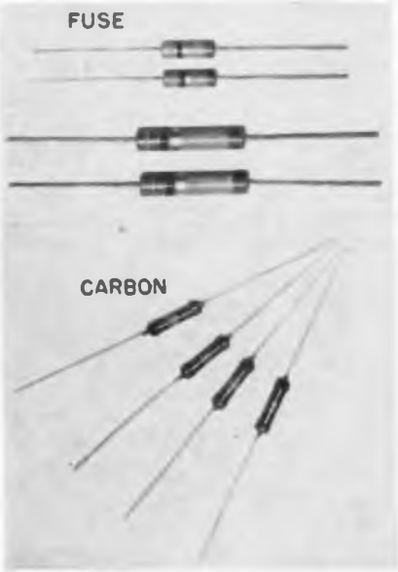
Aircraft instrument landing and approach simulator, integrated with flight instrumentation system, demonstrates flight path of airplane in landing and en route navigation. In addition, exhibit includes equipment for aircraft communication, AM and FM broadcasting, and amateur radio.—**COLLINS RADIO CO., Cedar Rapids, Iowa.**—TELE-TECH.

at the IRE Show, March 3-6

presented by 356 companies at Grand Central Palace

Fuse & Carbon Resistors (102)

Compact and insulated type FS unit functions as a resistor under normal conditions, and as a fuse under abnormal conditions is especially useful as surge limiting resistor in rectifier circuits for ac series filament re-



ceivers. Unit acts as fuse if rectifier develops short. Type DCC deposited carbon and Type BOC boron carbon resistors provide higher resistance values in small space and at low cost. Boron carbon component provides high degree of temperature stability. Radar, gun directors, instruments, and meter multipliers are typical applications. Also shown are line of wire wound precision resistors with high stability and dependability, and low noise level.—**International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.**—TELE-TECH

TV Camera (102-128)

Improved circuitry is featured in the Model TA-124-E TV studio camera with Type 5284-A mobile-mount dolly, features extended frequency response, increased gain

and improved shading control of image orthican camera chain. Other TV transmitter equipment to be shown include a sync generator, monochrome scanner, universal color scanner, model studio control room, and video switching and mixing equipment. **Allen B. Dumont Labs., Inc., 1000 Main Ave., Clifton, N. J.**—TELE-TECH

Nickel-Saving Alloys (35)

Nickel-clad steel strip requires about 80% less nickel than pure strip. It has been adopted for vacuum tube plates but is not a replacement for nickel in construction. Particular application of the bimetal alloy to radio-electronic equipment in jet planes is indicated. Another nickel alloy application is in jet engine turbine blades and "afterburners" where 0.5 in. pad of metal foil and silica glass batting keep tailpipes at 1450 F from overheating nearby parts. Using reflective, 77% nickel - 15% chromium alloy foils of Inconel, thinner than human hair, the pad reduces heat to below 212 F. As a substitute for this same nickel alloy in some uses, a 34% nickel - 21% chromium alloy called Incoloy is used for the outer sheathing of electric heating elements. — **The International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.**—TELE-TECH.

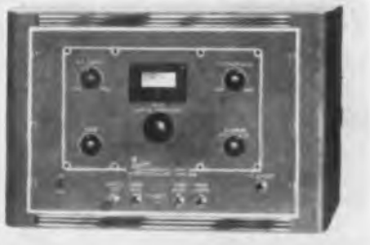
Metal Picture Tube (344)

Type 27QP4, 27 in. rectangular electrostatic-focus, magnetic-deflection, direct view tube is shorter from face to back than standard 20 in. tube by reason of using 90

deflection. Screen provides picture area of approximately 390 sq. in. Face plate of tube is absorbent gray filter glass and is treated so that reflections from inner and outer surfaces are 97.5% eliminated. The 27QP4 can be used as a zero-voltage focus or can be focused to maximum sharpness with low-voltage supply. A single external magnetic field must be used in conjunction with the indicator ion trap to prevent ion spot blemish.—**Rauland Corp., 4245 N. Knox Ave., Chicago 41, Ill.**—TELE-TECH

Wideband Sweep Generator (268-269)

Covering 35 to 300 MC range, Type 907 wideband sweep generator for VHF-UHF



TV has resonant vibrating reed to provide FM. Instrument is basically a grounded-grid Colpitts oscillator with 6F4 acorn triode. Tuning is accomplished by sliding contact which shorts oscillator transmission line. Resistive pickup loop and r-f attenuator insures 1 v. output into 75 ohms over entire frequency range. Other features include video type blanking circuit for providing true horizontal zero base line, and provision for external frequency marker.—**Polytechnic Research and Development Co., 55 Johnson St., Brooklyn, N. Y.**—TELE-TECH.

BOOTH NUMBERS at which the equipment described will be on display in Grand Central Palace are indicated by the numbers in parentheses

Radio Towers (230)

Type G-W guyed radio towers are of uniform triangular cross-section, and are able to withstand wind loads of 30 lbs./sq. ft. They are manufactured in heights up to 528 ft. Several other types of self-supporting and guyed towers are also available. A photographic reproduction of a 1212 ft. tower will be shown.—**Truscon Steel Co., Youngstown 1, Ohio.**—TELE-TECH

Spectrum Analyzer (5-7)

Model LSA direct reading spectrum analyzer covers the frequency range 10 to 22 MC, employing four r-f tuning units, Models

LTU-1 to 4. Frequency distribution of energy is displayed on a 5 in. CRT in the Model LDU-1 Spectrum Display Unit. Frequency accuracy is 1%, spectrum resolution is 5 KC, and continuously adjustable frequency dispersion is from 50 KC/in. to 7 MC/in. Unit has 120 db overall gain, 600 watts power input, 50 ohm coaxial input, 110 db r-f attenuation and 60 db i-f attenuation.—**Polarad Electronics Corp., 110 Metropolitan Ave., Brooklyn 11, N. Y.**—TELE-TECH.

Coil Winding Machine (306)

Continuous assembly permitting segmental or 360° continuous coil winding is one of five developments in toroidal coil winding machines. The 3sm shuttle for miniature type cores permits winding of small coils to a wound hole size of approximately 0.140 in., while the 6s3 shuttle permits winding smaller stacked typed coils. A toroidal winding machine for large size cores and heavier wire sizes uses a 12 in. shuttle assembly. A window winding attachment allows straight winding on side legs of a rectangular window shape core form. — **Boesch Manufacturing Co., Inc., Danbury, Conn.** — TELE-TECH

Remote Positioning Device (490)

Electrowriter, one application of a precision remote positioning device, is used for the transmission of graphic intelligence, such as handwriting, sketches, and diagrams, over telephone or radio telephone facilities with-

(Continued on page 68)

CUES for BROADCASTERS

Practical ways of improving station operation and efficiency

Reverberation Generator

EDWARD B. BENCH, Jr., Chief Engineer, KSTL, St. Louis 1, Mo.

ANY standard three-head tape recorder with separate recording and playback channels can be used as an excellent reverberation generator. The method is very simple requiring only patching of units existing in every broadcast studio.

To set up the tape recorder as a reverberation generator the program is patched out of the monitor channel of the console as shown in the diagram into the high level input of the tape recorder. As the machine records, the tape is played back a moment later through the reproducing head and amplifier. The output from the reproducing amplifier is then patched back into one of the high level inputs to the console such as a remote input. The remote potentiometer then becomes the reverberation control.

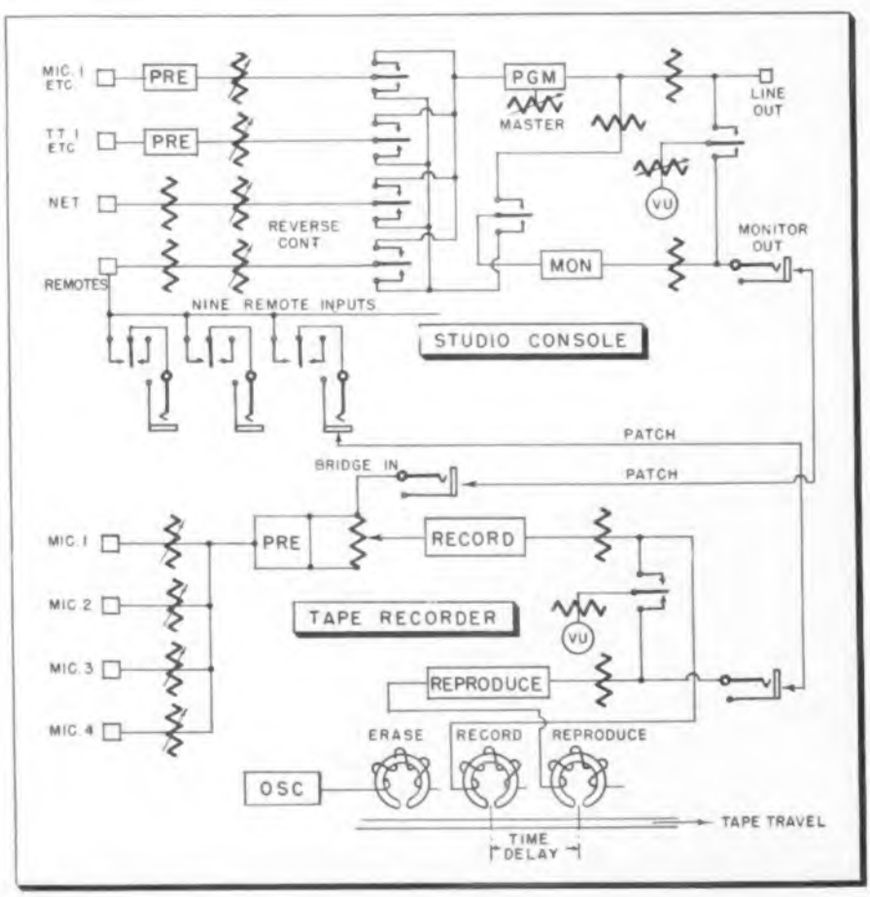
$$$ FOR YOUR IDEAS

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

Reverberation control is obtained by two methods. The first is the utilization of the 7.5 in/sec and 15 in/sec switch on the tape puller. This gives two reverberation times as it changes the time delay between the recording and reproducing head. The second is the remote potentiometer which controls the amount of echo signal fed back and mixed with the outgoing program. The amount of control possible by this simple method is amazing, varying all the way from "liveness" to a complete echo.

One advantage of this reverberation generator is the fact that one has an exact copy of the whole process from microphone or turntable to line output for audition or re-use. One disadvantage of the system is the limit of running time. For example, if 7.5 in. reels are used the tape will run for 30 minutes at 7.5 in/sec and 15 minutes at 15 in/sec. At KSTL we have a Raytheon studio console and a Presto PT-900 tape recorder.

Using standard three head tape rceorder as reverberation generator with variable echo



Camera Solves TV Prop Storage Problem

THE problem of devising a convenient storage system for television props has been solved with the aid of a miniature camera at WLW-T, Cincinnati, Ohio.

Over 1600 television props were photographed on 35mm film and each picture was pasted on a filing card. The cards were classified according to the character of the prop. Thus, a producer in need of a chair is able to flip through the card file, see a picture of the chair, a description of its fabric, color and size. In addition, its location in the storage warehouse is given.

The system has enabled WLW-T to eliminate considerable handling and man-hours of work by storing props according to the frequency of use. Moreover, the filing system has lead to other improvements. Producers are now able to hand to the set-up department, rough scale drawings of all settings and order all props into place by the time rehearsals begin.

Transcribing Without Spare Turntables

KENNETH J. DOLAN, Chief Engineer, WARA, Attleboro, Mass.

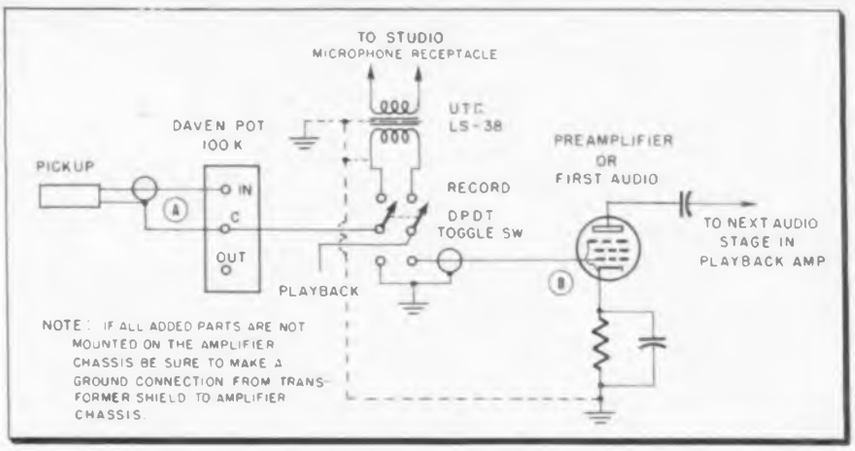
DURING the regular broadcast day it is almost impossible for an independent radio station to make any recordings consisting of records, transcriptions and voice, unless it has spare turntables and amplifiers, because the regular turntables are usually in constant use.

At WARA we have two studios. One is large, used primarily for originating programs consisting of 2 or more people; the other is a combination studio-control room, announcer-operated. We have an RCA

Transcription player model 6S7 ED which is used in the record library for auditioning new records, transcriptions, sound effects, etc. Ninety percent of all programming is done from the studio-control room, thus leaving the large studio with two microphone inputs not being used.

By adding a volume control, switch and matching transformer to the existing transcription player it is possible, whenever needed, to make recordings with music on tape or discs. Previous to this setup when any recordings were made they would have to be done during any program which could be done without turntables i.e., programs originating from the large studio. The only alternative was to come in after sign off hours (11:00 P.M.) As can be expected, the programs that were recorded under these conditions were usually rushed and as a result, quality was poor. We can now make recordings consisting of music and voice at almost any time. When the DPDT switch is thrown to "record," the playback arm is disconnected from the grid circuit of the self contained amplifier in the transcription player and is connected to the matching transformer hi impedance primary. The secondary matches 250 ohms. A regular mike plug and cable are connected to the secondary to plug into the large studio mike input. The Daven potentiometer is to control the input to the mic preamp in the console. When the DPDT switch is thrown to the "playback" position the transcription player functions as a normal record player.

When a recording is to be made from the large studio the switch on the player is thrown to "record." The output cable is plugged into the studio mike input receptacle and a regular mike is plugged into another studio mike input. The console monitor and the corresponding large studio mike switches are placed on "audition." The output from the monitor amplifier is now fed into either a tape recorder or disc recorder.



Points "A" and "B" indicate new circuit elements added to RCA transcription player

Audio Failure Alarm Circuit

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

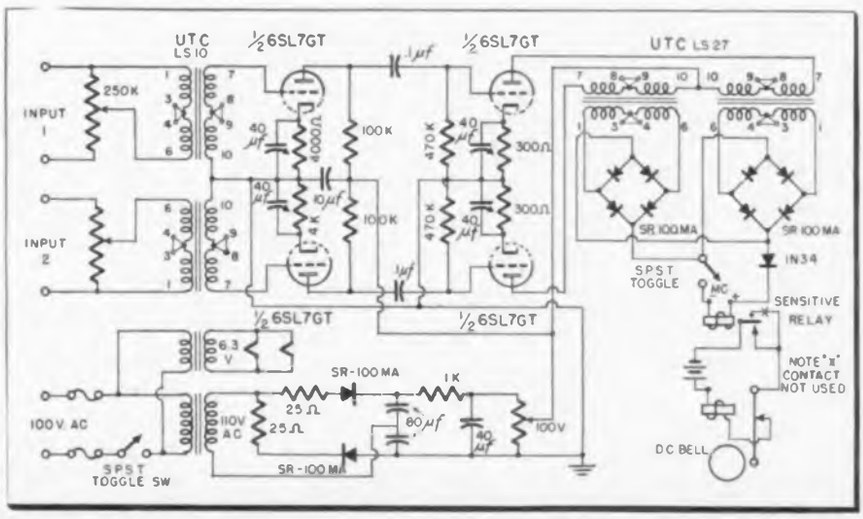
AUDIO failure alarms are especially needed where more than one transmitter carrying the same program must be monitored in the same room. There are three major requirements: (1) an alarm must be given when either the r-f, or audio section of the transmitter fails; (2) it must give a practically instantaneous alarm; (3) it must not give a false alarm. The circuit shown is one designed for guarding one transmitter only.

The dual audio amplifier shown was necessary only because the audio levels encountered were too low for relay operation. The device may be located at the transmitter site, in which case one channel input is bridged across the audio line from the studio and the other channel is supplied from the percentage meter output. When used at the studio, the output channel is fed from a receiver lock tuned to the transmitter being guarded.

In operation, the voltage from the input channel is adjusted to a value sufficient to close the contacts of the sensitive relay at an audio input level which will produce 30% modulation of the transmitter. The voltage from the output channel is then applied, in the opposite polarity and is increased until it not only balances out, but is approximately double the voltage obtained from the input channel. This overbalancing prevents transient tinkles in the alarm due to phase shift in the transmitter audio circuits with varying audio frequencies. If the output voltage fails, the voltage from the input channel is again present in the relay circuit at 30% modulation or more, thus setting off the alarm.

Selinium rectifiers are used in the balance circuit to decrease the effect of phase shift, since these rectifiers discriminate against the higher audio frequencies. The 1N34 rectifier in the relay coil circuit is to prevent high currents in the reverse direction due to the doubled overbalancing voltages.

Dual level audio failure alarm guards against transmitter and audio input failure



Remote Recorder Starting

ROBERT D. HOUGH, Chief Engineer, WPDX, Clarksburg, W. Va.

STARTING two rack-mounted PT6JA Magnecorder tape recorders from two other console locations, remote from the master control room, was a problem that faced us recently. We solved it by the use of a four-gang, three-

(*Continued on page* 100)

Mechanical Considerations Affecting

Tubes manufactured mechanical fatigue,

Fig. 5: Photo of machine used in conducting sampling tests for mechanical fatigue

By R. J. E. WHITTIER
Commercial Engineering Dept., Raytheon Manufacturing Co., 55 Chapel St., Newton 58, Mass.

THE problem of mounting conditions to avoid trouble from high level mechanical shock requires an evaluation of the equipment usage. Uncrated equipment will be subjected to shocks of hundreds of G during transportation, but a servo amplifier mounted in a commercial airliner doesn't receive a shock of hundreds of G until the aircraft has no further use for an amplifier. Since the best shock mountings are often incompatible with mountings which eliminate vibration in low signal level applications, the objective design of a particular equipment must be reviewed with respect to its intended mechanical environment.

The preferred type of tube mountings in electronic equipment, from the point of view of high level shock conditions, rigidly attach the tube to the equipment base. For the GT tube types which have a metal sleeve on the GT base, a tight fitting clamp around the base is quite satisfactory and is commonly used in many equipments. For miniature tubes, the JAN standardized shield which includes a hold-down spring in the top section of the shield, providing the spring does not have a sharp edge to scratch the shoulder of the bulb, has yielded very satisfactory results. The use of the shield contradicts some of the precepts indicated for heat transfer problems, and this shield has been eliminated in certain equipments by providing a rigid bracket to hold the spring. Theoretically, the resilience provided by the spring is undesirable because of the possibility of extra vibrations being shock excited but shock tests on hundreds of miniature tubes with the spring shield mounting yielded results comparable to other more rigid mountings.

For subminiature tubes, the equipments which coat the tubes with synthetic rubber, and then imbed the tubes in a plastic compound, provide an ideal shock mounting, but this mounting is not ideal for heat transfer. A shield clamp which is solidly attached to the chassis to provide maximum mechanical rigidity and thermal conductivity is preferable. On this type of mounting, the bulb is held rigidly and the leads are attached with enough slack to provide some flexibility. The use of phenolic or linen bakelite V-block mountings are also suitable for rigidly mounting both miniature and subminiature tubes, providing the blocks are machined with sufficient accuracy to distribute the forces evenly, and providing controlled pressures are used so that some tubes will not be broken during insulation or subsequent heat expansion periods. With a rigid envelope mounting on miniature tubes, some form of non-rigid socket terminal device must be used.

Vibration

The tube manufacturers are aware that serious vibration problems exist in certain military equipments but they are poorly informed as to types and intensity of the vibration. The problem of standardized testing and evaluation of vibration has been very formidable. For the 2.5 G testing requirements, the procedures are now well standardized and the uniformity of results for certain types of tube vibration effects is quite satisfactory. The basic secret of the standardization of 2.5 G vibration tests is very simple—"Do not use any type of vibration equipment which does not consistently have a good sinusoidal wave shape." Much of the confusion which has existed between equipment manufacturers and tube manufacturers on vibration characteristics has originated from the use of poor wave form vibration equipment. Fig. 4 shows a vibration machine which produces a fixed 25 cycle, 2.5 G vibration. This machine has been custom built for most of the tube manufacturers and is known as the BTL Leaf Spring Vibrator.

The three basic types of vibration output from tubes are, mechanical resonance of parts, the sinusodial movement of certain parts below their normal resonant frequency, and intermittent slapping of parts in loose fitting assemblies. In addition, the vibration equipment shows up defective tubes such as intermittent open welds. On the standardized test, the vibration output is evaluated with an audio frequency amplifier and meter indicator. Actually, most of the troublesome vibration output arises from movement of the cathode and grid #1 parts, slapping back and forth in the mica holes, and the out-

Vacuum Tube Reliability

PART TWO OF TWO PARTS

for guided missile equipment require special attention to heat dissipation, vibration, microphonism and noise factors. Designers should avoid "tube-critical" circuits

put wave form is extremely irregular and non-sinusoidal. A microscopic examination of typical small dimension mica holes shows many ragged edges as a result of mica punching, rather than the smooth contours that draftsmen put on the enlarged mica drawings. The ragged edges on the mica are a function of the mica characteristics and the wear of the mica die, and these items represent constant quality control problems.

The obvious idea of forcing grid leads and cathodes into tight mica holes, to make an extra good bond against the ragged edges, has several design and manufacturing complications. The extra tight mica holes require extra force to insert the cathode and grids, and this frequently yields bowed cathodes and grids which in turn produce shorts, low transconductance, and poor cutoff characteristics. Since mica has surprisingly high heat conductivity, the cathode temperature is lowered by tight fitting micas and a temperature difference between the center of the cathode and the ends where the mica is in good thermal contact may approach 40°C. The 40°C temperature differential is enough to seriously affect long life performance and low filament voltage transconductance. The above comments are intended to indicate that the vibration characteristics of most tube types are not necessarily a result of faulty design and assembly practices which were adopted with careless abandon. Special tube types can be designed and have been made available to meet particular vibration requirements, usually for the price of modified characteristics.

One way in which equipment design engineers can help themselves on vibration problems is by selecting tube types which have reasonable cathode to grid #1 spacing. The internal tube dimensions are not published on data sheets, but high transconductance per unit of heater power is a fair indication of close spaced types. On such a rule, the type 6AK5 would not be selected for the most critical microphonic applications. This is another situation where frequent consultations with the commercial engineers of the tube manufacturers can be profitable.

A sampling test for mechanical fatigue is now common for many JAN tube types. The fatigue test is essentially a vibration life test. The tubes are rigidly mounted on a table vibrating with simple harmonic motion at a frequency of 25 cps with an amplitude of 0.040 in. (approximately 2.5 G) for 96 hours. The tubes are mounted in a different orientation for each 32-hour period. Rated heater voltage is applied during test. After the 96-hour vibration, the tubes must be free of shorts and open circuits and must lie within prescribed limits for transconductance, vibration output and heater-cathode leakage. This test is conducted on a sampling basis as it is considered a destructive test. Fig. 5 shows a photograph of the machine.

Rejects Uncommon

Rejects are not common on this test and these results are borne out by the experience of commercial airlines with reliable tubes in that difficulties which might be attributed to many hours of service under vibration are not occurring after 1,000 hours of airline service. There are, however, many pieces of military electronic equipment more unkind to the tubes in subjecting them to vibration, and for this reason there are now several programs within the industry to explore higher frequency and higher acceleration life test factors.

Naturally, this lack of rejects on the presently standardized fatigue test has been criticized by several equipment designers. As a result, a special type vibration machine has been used experimentally by several organizations. This machine subjects the tubes to non-sinusoidal vibration and has produced some very violent changes in tube characteristics—sometimes in 15 minutes and sometimes in a few hours. So far the efforts to describe the vibration wave form and acceleration of this machine and to duplicate wave forms, have been very unsuccessful and the condition of tubes returned to various tube manufacturers has produced more confusion than useful design information.

Consistent improvement in tube design can only come from consistent and reproducible performance

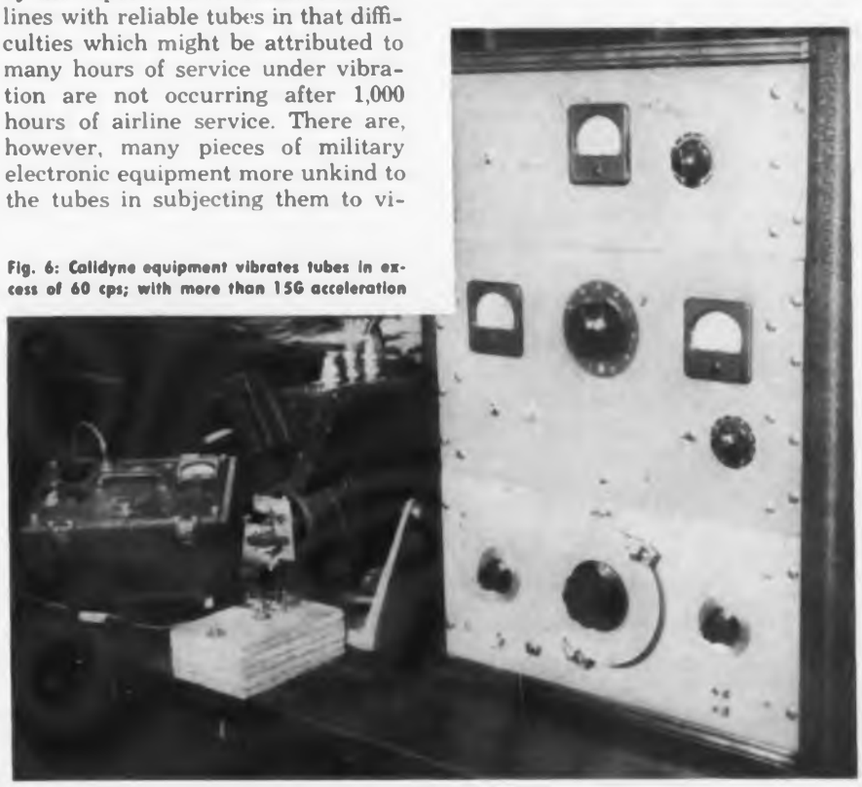


Fig. 6: Calidyne equipment vibrates tubes in excess of 60 cps; with more than 15G acceleration

data. For that reason it is felt that higher frequency and higher acceleration vibration equipment which supplies extremely good sinusoidal wave form is necessary. There are at least two equipments which are known to have good wave form and which will vibrate tubes at frequencies in excess of 60 cycles and at accelerations of more than 15 G. One of these equipments is made by the M-B Company and the other is made by the Calidyne Company. Fig. 6 shows a photograph of the Calidyne equipment. A few of the JAN specifications now have a 40 cycle or 60 cycle vibration test requirement and this testing will become more common in the near future.

Microphonism and Noise

Microphonic and noise effects, both from the point of view of tube design and equipment application, can not be divorced from vibration. As a matter of fact, vibration is a special case of microphonism and noise in which the mechanical forces applied to the tube are of a particular simple harmonic wave form and acceleration. The standardized tube testing procedures from microphonism and noise have been, and continue to be, an assembly of the most difficult phenomena to duplicate. During the past year or two, there has been further progress in standardized test methods which has been recognized in the form of revised JAN specifications. The JAN Audio Frequency Noise and Microphonic Test which is paragraph F-6e (3) of the JAN basic section is usually used as a test procedure applied to 100% of the production. This test is convenient, particularly because it can be effected at a high production rate, and it serves the purpose of rejecting tubes which have faulty mechanical structure, acoustic feedback, and intermittent high resistance leakage or lint between elements. Actually these effects can usually be identified by a sinusoidal vibration test with the application of sufficiently tight voltage output limits, but the vibration test is seldom a 100% test.

A second form of the Microphonics and Noise Test is used in other recent JAN types such as the type 5654. On this JAN Specification a complete set of constructional drawings and test procedures are given and the distinguishing feature of this test is the use of an automatic mechanical tapper. Coincident with the application of these new tests, the electrical conditions have been revised for several tube types so that the JAN Specifications on such types are now much better indicators of the relative microphonic qualities of the various tube types. Both of these tests have specified audio frequency pass-bands and both have the obvious deficiency that the relative response data can't possibly be correlated against all possible equipment applications. This is particularly true of amplifiers which extend above audio frequencies into the low video frequency range. However, test results can be duplicated on tube lots which are free of intermittent noise defects such as certain types of leakage and lint shorts.

Because microphonic output varies over such a wide range in a given tube type, or even tube lot, there is a great danger that equipment engineers may unconsciously use a selected good tube for early model work, only to discover a serious microphonic problem late in the equipment development. For this reason, in addition to large sample testing of several makes, it is suggested that the JAN noise, vibration and microphonic circuit conditions, and maximum output noise signal levels be compared with the signal levels of a proposed application. If such a comparison indicates a vibration, noise or microphonic problem, immediate attention should be given to the question of suitable type selection. This should be followed by a study of mechanical design factors such as; locating the tube away from the source of vibration, providing a vibration absorber type of tube mounting (which may not be compatible with the best high level shock type of mounting), and providing other variations of acoustic and vibration attenuation within the equipment. Above all, consult with the tube manufacturer or the Panel on Electron Tubes at the time of the equipment design instead of waiting for the pilot production stage to surprise the component scheduling people.

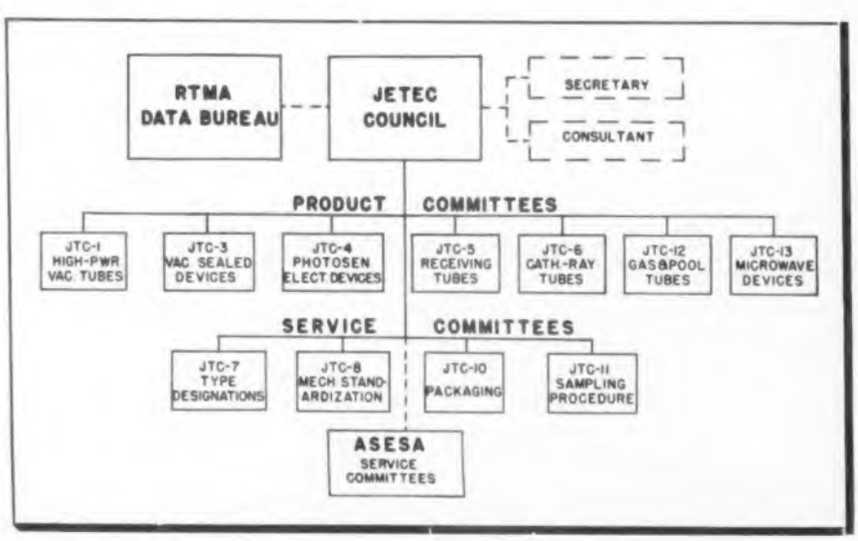
Tube Handling

In handling tubes at the electronic equipment manufacturer's plant, the first "DON'T" is to refrain from removing the egg crate separator from a layer of 100 miniature tubes by yanking it up in the air and letting half of the tubes drop one or two feet back into the pile. The nickel pins of the dropped tubes scratch the side of the bulbs of other tubes and, unfortunately, they don't crack immediately. A crack may take a week and four or five heat cycles to develop.

The second "DON'T" is to refrain from using the exhaust tubulation section of the tube as a handle, a

(*Continued on page 102*)

JETEC ORGANIZATION CHART



The Joint Electron Tube Engineering Council (JETEC) is sponsored by the Radio-Television Manufacturers Assn. (RTMA) and the National Electrical Manufacturers Assn. (NEMA). It is organized to develop standards material and to conduct engineering activities in the field of electron tubes and allied devices. Organizationally JETEC functions through the product and service committees shown in the chart above. Provision is also made for working with the Armed Services Electro Standards Agency (ASESA). Publication and distribution of JETEC technical data is handled through RTMA Data Bureau

Page from an Engineer's Notebook

Number 14 — Radar Power Measurements

Nomogram for determining peak power output when pulse width and repetition frequency, system loss, and average power are known

By CHESTER W. YOUNG

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IN checking a radar installation for specified output, radar power measurements are made many times. Use of the nomogram on the following page should prove to save time in the numerous measurements and calculations.

The general problem of r-f power measurement normally involves either of two techniques. In one, a cw source is calibrated on an average reading watt meter and the generator is then placed in pulse operation. It is assumed because of circuit design that the peak power in the pulse is the same as the cw amplitude. In the second method, an average power meter is used to measure the pulse power and then a correction is used to allow for the pulse width and pulse shape.

Normal measuring procedure would entail measurement or previous knowledge of pulse repetition frequency, a measurement of the pulse width with either a calibrated synchroscope or spectrum analyzer, a measurement of the system losses, and a measurement of the average power. With these values known it is easily possible to calculate the peak power of the radar without known losses. The calculation can be simplified with the nomogram.

The solution of the following problem will facilitate use of the nomograph. Given: PRF = 1000 pps, Pulse Width = 1 microsecond, System Losses = 35 db, and Average Power Measured = +15 dbm (db above 1 milliwatt). Required: Determine the Peak Radar Power without known losses.

Step 1: Starting on the right hand side of the nomogram, draw a straight line through the 1000 on the PRF scale and 1 on the Pulse Width scale extending this line to the Duty Cycle Loss scale. This point of intersection is 30 db.

Step 2: Draw a straight line from the 30 db point on the Duty Cycle scale through the 35 db point on the System Loss scale to its intersection with the Total Loss scale. This intersection is 65 db which is the sum of the Duty Cycle and System Losses.

Step 3: Join the 65 db point on the Total Loss scale with the +15 dbm point on the Power Measured scale. The point where this line crosses the Peak Power without losses scale is the desired Peak Radar Power.

Conditions of Use

1. P.R.F. scale: The Pulse Repetition Frequency scale is calibrated logarithmically in Pulses per Second. This can be measured by several methods including counting on an "Eput Meter" or synchronizing the display on oscilloscope using a calibrated signal generator for the sweep voltage on the horizontal deflection plates.

2. Pulse Width scale: The pulse width can be measured in any one of a number of ways two of which are as follows. The pulse can be detected and the envelope put on the vertical deflection plates of a calibrated synchroscope. A second method consists of using a spectrum analyzer and measuring the frequency difference between the first nulls on each side of the main lobe. Dividing 2 by the frequency difference in megacycles will give the effective square pulse width in microseconds.

By referring to page 450, Vol. 11 of the MIT Rad. Lab. Series, "Technique of Microwave Measurements," it can be shown that a good approximation can be made of the equivalent pulse width by the above spectrum measurement. This follows because as the pulse becomes triangular, the spectrum nulls separate which in turn would give a smaller energy content in the triangular pulse but at the same time the spread of the nulls would yield a calculation of a narrower equivalent square pulse.

It is this phenomenon which allows the calibration of the pulse width scale directly in spectrum nulls difference.

3. Duty Cycle Loss scale: The Duty Cycle Loss scale is the result of the arithmetic multiplication of the Pulse Repetition Frequency ($1000 = 10^3$) and the Pulse Width (1 microsecond $= 10^{-6}$ seconds). This product $10^3 \times 10^{-6} = 10^{-3} = 1/1000$, is equal to 1/1000 of the energy of a cw signal so it can be said that the pulse energy is 30 db below the cw power or there is a 30 db loss.

4. System Loss scale: The System Loss includes any known losses which reduce the power of the radar. These could be directional couplers, attenuators, rotating joints, or space radiation losses. However, in order to get a true measurement these losses must be known. Unknown losses will create errors.

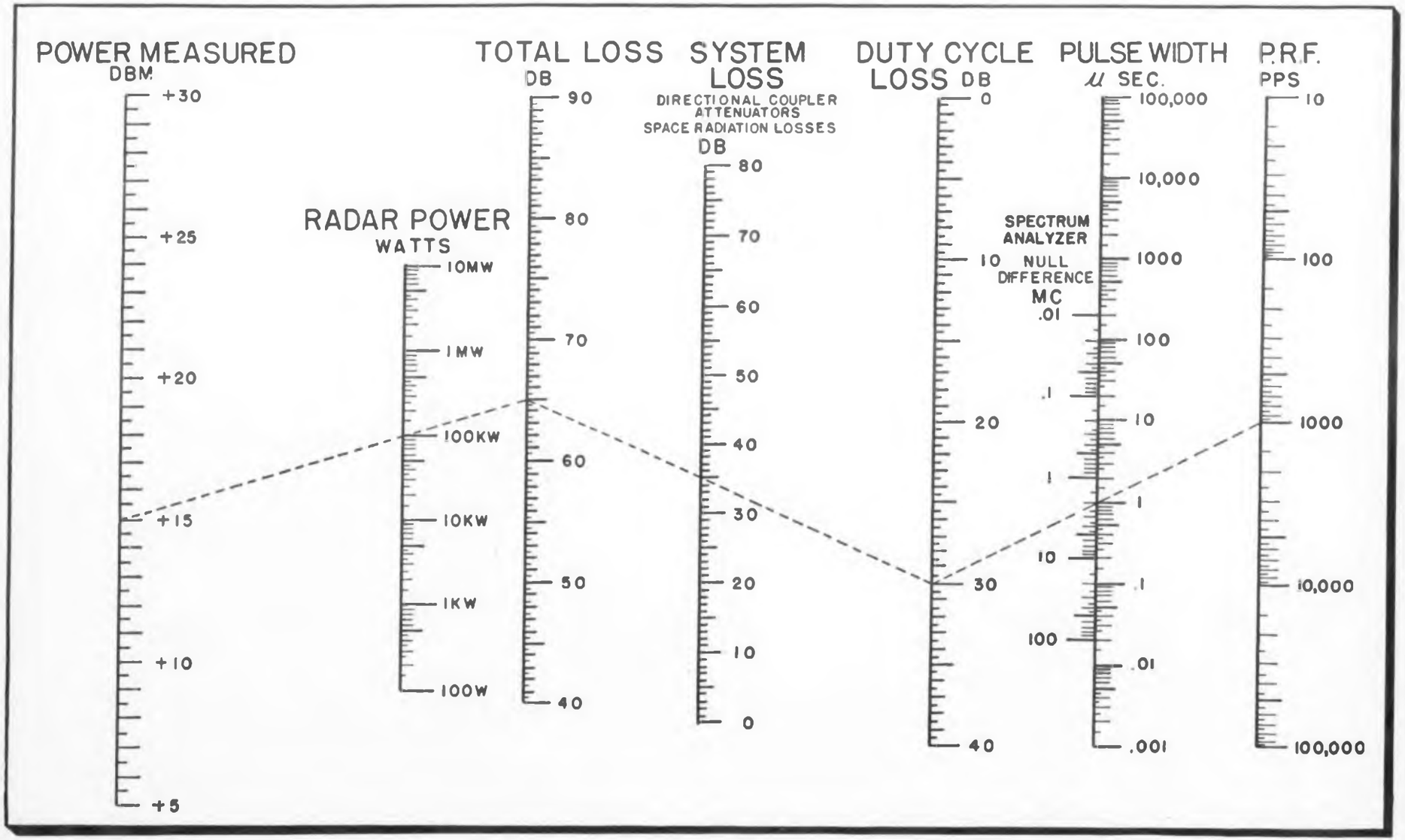
5. *Total Loss scale:* The Total Loss scale is merely the addition of the Duty Cycle Loss and the known System Losses.

6. *Power Measured scale:* The Power Measured scale is the reading in dbm (db above one milliwatt) on an average power measuring instrument.

7. *Radar Power scale:* The Radar Power scale yields the radar power measurements in watts, kilowatts, or megawatts, to as exact an answer as the factors are known and as close as the scales are read.

$$$ FOR YOUR IDEAS

Readers are invited to contribute suggestions which might make interesting Engineer's Notebook pages. Typewritten, double-spaced text is preferred. Our usual rates will be paid for material used.



Nomogram for Peak Power Output when Pulse Width, Repetition Frequency, System Loss, and Average Power are Known

The seven variables on this chart are handled in three steps. See text on preceding page for detailed instructions

Film Handling in TV Stations

Motion picture films to play increasing role in TV programming as more stations go on air. "Do's" and "Don'ts" for quality reproduction.

AS the number of operating television stations increases, the need for improved film reproduction becomes more important. Even the additional demand imposed by a single new station (WLTV, Atlanta, Ga., the nation's 108th) will amplify this need. And when two thousand-odd television stations envisaged in the FCC's proposed allocations plan go on the air, film demand will snowball to tremendous proportions.

Today, in most cases, transmitted films suffer from a variety of faults. Perhaps the only places where good quality is the rule are on stations owned and operated by the network. And even here on occasion there are exceptions. However, most network outlets are far above the average independent station, due to the large engineering development departments which they maintain.

Not all of the fault lies with the stations. Many times the films which are supplied are in poor condition, or improperly exposed. Most release prints received by television stations are standard theatre prints with a contrast range of as high as 50 to 1 and quite dense as well. These prints often have a density of as high as 2.7 or 2.9, although the average theatre print is probably in the order of 2.5 gamma. Despite this lower figure many television film projection units have difficulties in obtaining adequate lighting on the iconoscope mosaic due to low illumination which may be caused by a number of things. Little attention is given to the illumination of television film by some operators who continually complain that the film is no good. If the station has any choice in the matter improved results may often be obtained by ordering a release print with a gamma of 2.3. While there may be criticism of this value (due to the possibility of face detail dropping out), it will produce a pleasanter overall picture which, after all, is the main object.

The question of gamma is especially important in the case of reduction prints where a 35mm film is reduced to 16mm by means of an optical printer which operates in the opposite manner to an enlarger. In this case the film not only often goes through an extra printing step in the reduction from what may be a dupe negative, but also is enlarged again electronically in the television system. A peculiar kind of fault is often found in this operation which interferes with the reproduction of a first rate picture. This seems to occur only in connection with optically reduced prints. Sometimes the grain of the film combines with the grain of the kinescope screen to produce an enlargement which casts a very noticeable blemish over the whole picture.

Although the television film pickup camera does not require a tremendous amount of light (like the theatre projector) it does need a certain minimum if a good picture is to be obtained. Many times, in an effort to "save" the cost of a new projection bulb, a projection lamp will be run long after its useful life is over. Ten hours is the "normal" life of such a bulb; however, many of them run much longer before the filament burns out.

Many projectionists continue to use bulbs in this condition when the blackening of the glass is a sure indication of a renewal being due. Not only does the black glass decrease light passing through the film and falling onto the mosaic, but it also reduces the *value* light by filtering out certain colors whose presence improves the response of the iconoscope tube. Soot on the glass produces a reddish light which will not produce optimum conditions in the film pickup camera. Most projectors incorporate a lapsed-time indicator which tells the length of time a certain lamp has been used.

Reflectors and condensor lenses also need periodic attention. This is not required as often in incandescent and pulsed light projectors as in arc-light lamphouses where soot is produced from the open arc. Gentle cleaning according to manufacturer's instructions will help here. The same thing holds for projection lenses which are commonly found to suffer from fingermarks rather than soot.

(*Continued on page* 120)

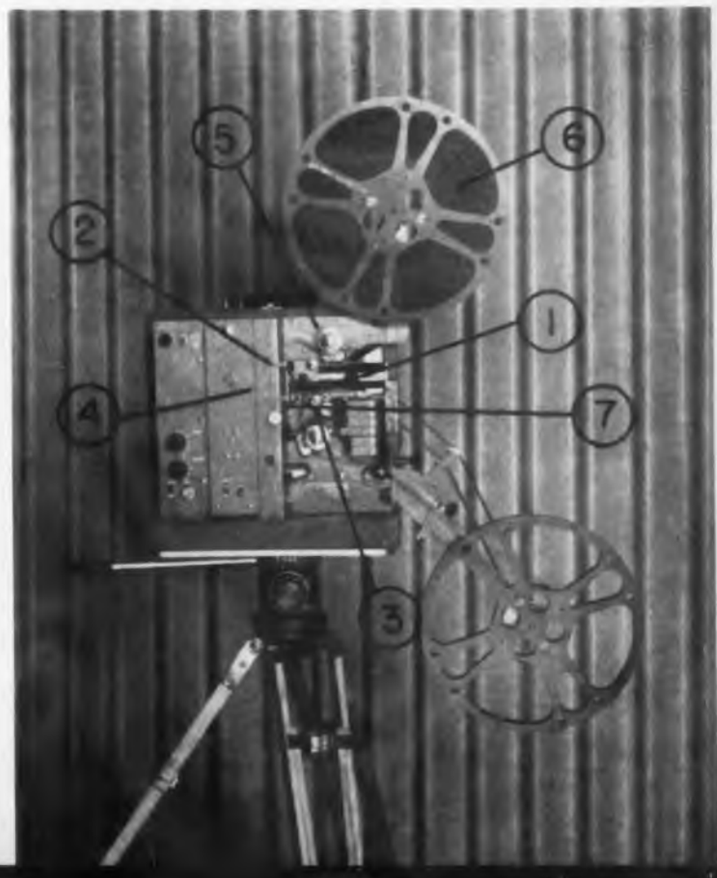


Photo of typical 16 mm projector showing places where trouble may develop. (1) dirty lens; (2) dirty condenser and gate; (3) sound head improperly adjusted; (4) blackened, worn-out lamp; (5) film dirty, green with curl (causes focus change as film runs) emulsion in nonstandard position, i.e., sound gets focus incorrect; (6) excessive oil on moving parts transferred to film; (7) shutter and/or pull down mechanism out of adjustment.

Multichannel FM-FM Telemetering

Frequency multiplexing system, widely used in mobile applications, has carrier channels. Equipment operates in 200 MC band, has 16 channels

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THE FM-FM telemetering system is a frequency multiplexing technique which to date has been, and is being, more widely used than any other telemetering system for mobile instrumentation. The basic circuit elements are shown in the block diagram of Fig. 1.

The present FM-FM system was evolved after a rather chaotic start in the mobile instrumentation field during which time some fifty odd systems were suggested, tested and a few of them used. The basic simplicity of the FM-FM system, combined with the relatively small pick-ups (and low primary power requirements in the case where variable reactance pick-up units were used) led to rapid progress and wide application of FM-FM telemetering systems.

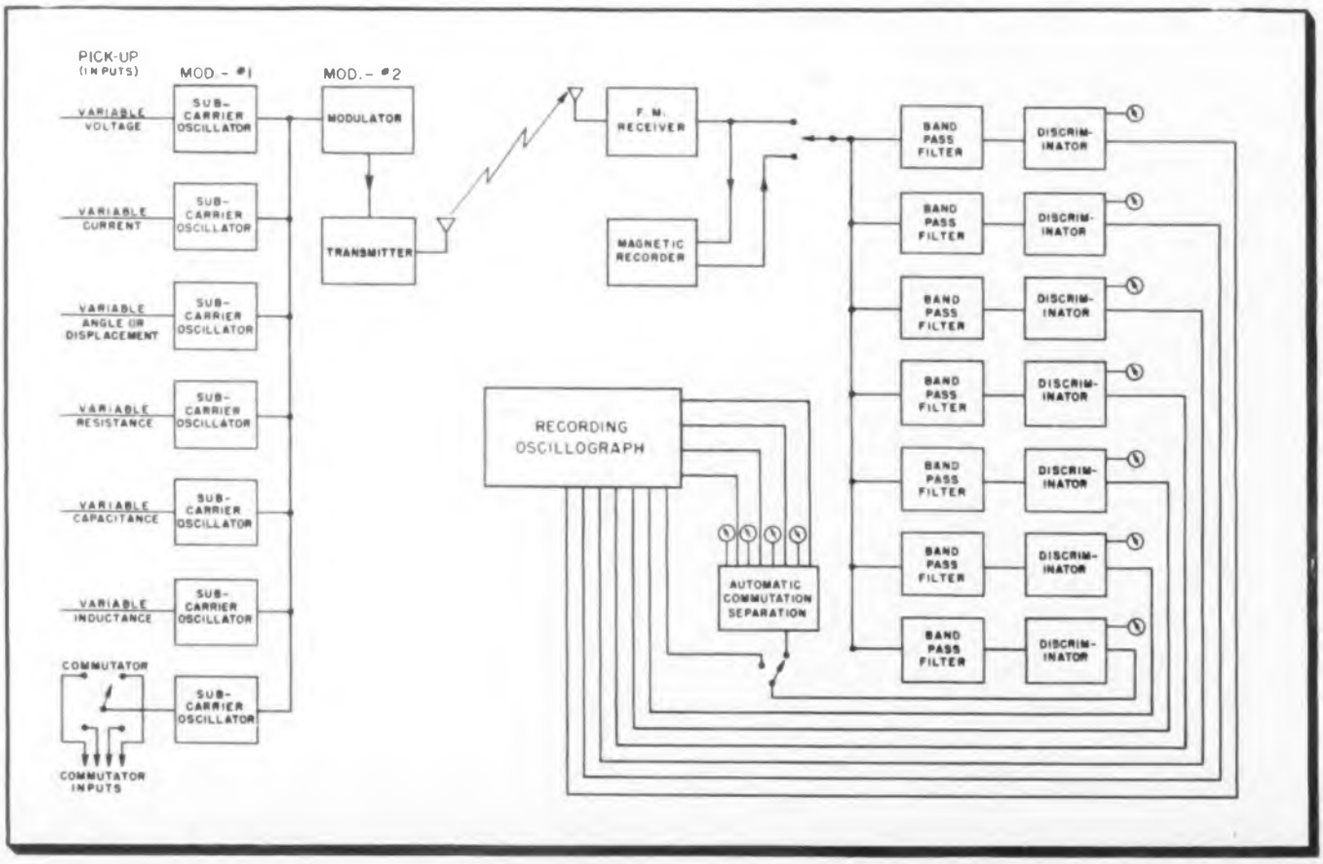
The attainable operational accuracy of the FM-FM system is in the order of ½ to 1%. The range is generally limited to the electrical (optical) horizon. For ranges of 1 to 20 mi., a 1-½ to 6 watt unit provides an ample power margin; for ranges of 25-175 mi., a 6 to 30 watt unit is ample. Fig. 2 emphasizes the point and indicates the value of altitude.

Sub-Carrier Channels

Originally the FM-FM systems employed sub-carrier channels so spaced that the major effects of system non-linearity fell outside the channel pass-bands such that 6 to 10% distortion at both the transmitting and receiving ends of the link would not result in a cross-modulation error of more than 1-½ to 3% when the individual sub-carrier output channel bandwidths were limited to 30 to 100 cps by means of the low-pass filter action of the recording oscillograph elements then employed in these systems.

The need for more channels of higher frequency response rapidly became manifest as the early FM-FM system proved itself to be simple, reliable and dependable. Fortunately the design of both the transmitting and receiving ends of the circuit had been improved in linearity until overall system distortion could be held under 2% on production equipment. This attainment of such low distortion permitted a closer spacing of the various sub-carrier channels. While the original systems generally used 4 sub-carriers, the latest systems now employ 16 sub-carriers and show cross-modulation errors to be under ¼ of 1%.

Fig. 1: Basic block diagram of FM frequency multiplexing telemetering system



System

PART ONE OF TWO PARTS

commutation arrangement to increase number of sub-operating with less than 0.25% cross-modulation errors

The government has assigned telemetering frequencies in a band just above 200 MC. While other frequency bands, below and above this, have been assigned and used, the majority of FM-FM installations employ the nominal 200 MC band.

The mobile transmitters normally employ an r-f deviation of ±125 KC with the carrier held to ±.08% center frequency tolerance over an ambient

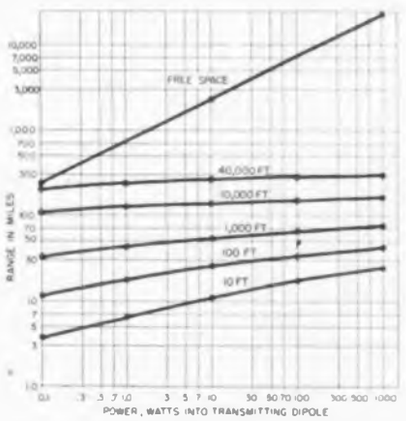


Fig. 2: Power-distance characteristics for different altitudes show increased FM-FM operating range attainable at higher altitudes

temperature range of —20° to 80° C. The FM sub-carrier oscillators normally employ a ±7-½% deviation on the lower sub-carrier frequencies, and a ±15% deviation on the higher sub-carrier frequencies. The deviation employed is a compromise between bandwidth limitations, frequency response and microphonic effects resulting from operation of the equipment in high vibrational fields.

The FM-FM telemetering system has several intrinsic characteristics that are somewhat unique and appeal to the application engineers' ideas of reliability and simplicity. First among these points is the fact that loss of a tube or circuit element will generally affect only one channel and not the entire system as is the case with most other multi-channel telemetering systems. Second is the point that the receiver output may be directly recorded on magnetic tape while simultaneously separating and

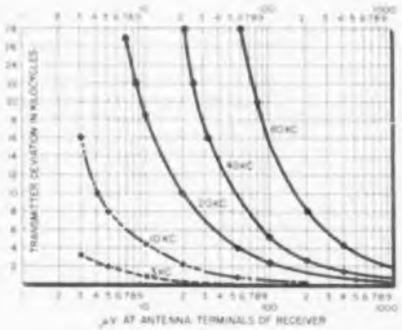


Fig. 3: Required FM sub-carrier deviation indicates relative pre-emphasis necessary

generally presenting the information for real time indication. In event of the failure of any ground or observing station sub-carrier or commutator separation equipment, the magnetic tape may then be used for reference and the test data still recovered with negligible loss of accuracy.

In considering engineering applications of an FM-FM telemetering system, due allowance must be made for two important factors; namely, frequency response of the sub-carrier channels, and the signal-to-noise ratios required on the various sub-carrier channels in order to secure satisfactory reading accuracy of the presented data.

For the first case, the same criteria holds for the detector of the frequency sensitive circuit as holds for the detector of an AM system. That is, the upper frequency response is limited to the most negative slope of intelligence signal that may be rectified and smoothed without clipping. Also related to this point is the required filter bandwidth for maintenance of linear phase shift and proper transmission of significant side frequencies over the pass band. As a result of this requirement, band-pass filters should be designed with a bandwidth of approximately 22.5% of the sub-carrier frequency, although most present systems hedge on this point and only provide 15 to 19% bandwidth with consequent deterioration in performance. As an approximate guide the sub-carrier channel frequency response may normally be 3 to 10% of the mean sub-carrier frequency.

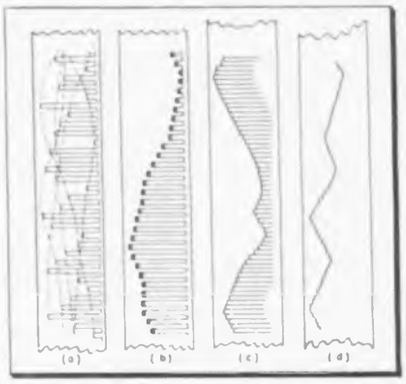


Fig. 4: Four types of commutated channel presentations; (A) unseparated sub-carrier; (B), (C) and (D) after automatic separation

Triangular Noise Spectrum

The second factor to consider in engineering an FM-FM system is the triangular noise spectrum. If all sub-carrier channels modulated the carrier an equal amount it would be noted that the high frequency channels "fell out" or deteriorated much more rapidly than the low frequency channels as the r-f carrier signal was decreased in level. Analytically, it may be shown that a 50 KC sub-carrier channel as compared to a 2.3 KC sub-carrier channel of equal side band energy, will be 22.6 db inferior to the lower frequency sub-carrier channel.

As in FM broadcasting, we can of course use phase modulation, or pre-emphasis, and thus secure equal performance on all sub-carrier channels, accepting the fact that this will of course reduce the transmission range of the system provided that the

TABLE I—MAXIMUM COMMUTATION RATES: UNSEPARATED DATA

Sub-Carrier Channel	Net Sample Lengths (Millisec.) Conservative	Min.	Sampling Rates (Samples/Sec.) Conservative	Max.
.5	535	135	1.86	7.5
1.0	269	67	3.72	14.5
3.0	89	22.2	11.2	44.8
10.0	26.9	6.7	37.2	145.0
30.0	8.9	2.22	112.0	448.0
100.0	2.69	.67	372.0	1450.0

FM-FM TELEMETRY (Continued)

carrier power is constant. Fig. 3 indicates the relative pre-emphasis, required on a typical system. This data is based on 1% reading accuracy of the received signals.

Commutation provides a means of increasing the number of channels available in an FM-FM link. In general, however, commutation results in uneconomic utilization of bandwidth due to the inherent ringing characteristics in the various filters and networks commonly employed in the system. That is, a material portion of each sampling interval is taken up by equipment transients which reduced the amount of "reading time" available per channel.

Fig. 5: Typical commutated wave train with long pulse frame reference followed by information pulses

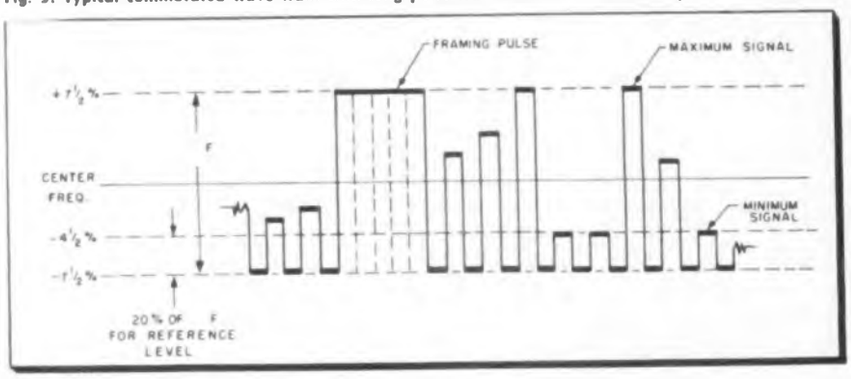


Fig. 6: Basic block diagram of automatic commutator separation circuits using sequential gating

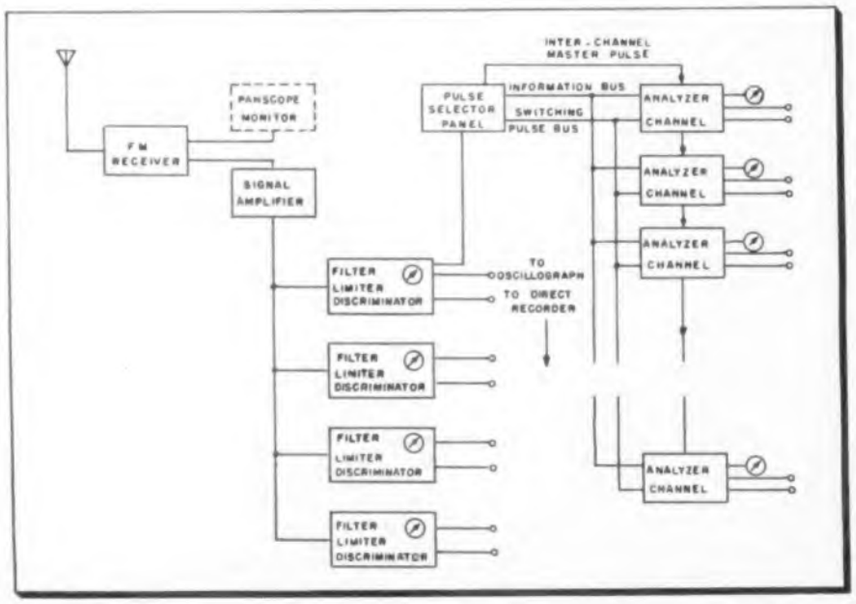
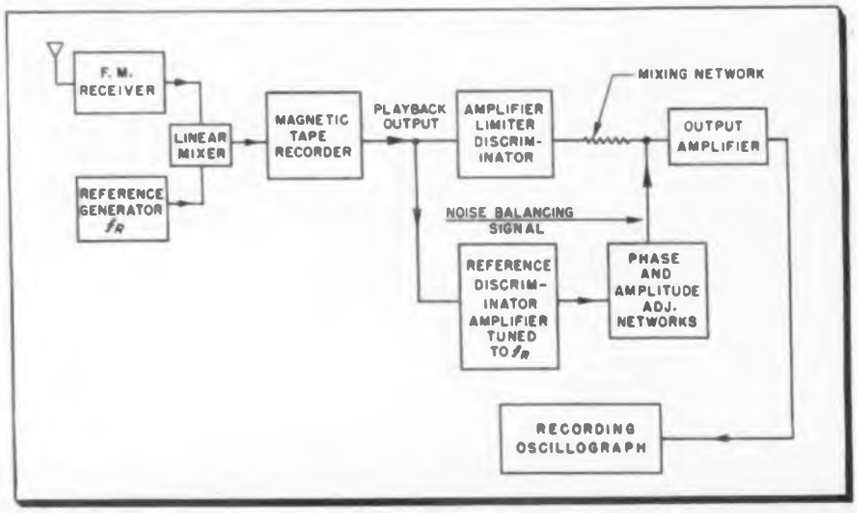


Fig. 7: Compensation system mixes reference signal with incoming signal before recording on tape



Types of Commutation

Two general types of commutation find wide application in FM-FM systems. In the first type of presentation, the sample duration is long and generally covers 1 to 4 or more cycles of the basic intelligence; and in the other system, the sample is short and represents but a point on the intelligence wave of the modulating signal. Long time or slow speed commutation is only practicable where manual data reduction is used and where the transmission period is generally short. High speed sampling requires that approximately 5.7 samples per cycle of modulating frequency be made in order to reconstruct the modulating intelligence. This latter type of system is amenable to presentation as an oscillographic record with manual data reduction, but more important, it is readily amenable to automatic commutated data separation or *decommutation*.

Fig. 4 illustrates the four general types of commutated channel presentation. (A) represents the case where the entire, unseparated subcarrier channel is directly fed into the oscillograph while (B), (C) and (D) show typical types of presentation after automatic separation of the commutated signal. Each tape thus represents but one channel of information as contrasted with (A) on which all channels are shown as a composite record.

Automatic channel separation and presentation automatically restricts the intelligence frequency to a relatively low value. This in turn permits integration of the received signals with the consequent improvement of commutated channel signal-to-noise ratios such that lower deviations of the r-f carrier are entirely practicable for the higher sub-carrier frequencies. It is generally the higher sub-carrier channels which are commutated and accordingly this technique provides a consequent increase in range of the system by requiring the lesser r-f deviation for a given reading accuracy of these commutated channels.

Studies and experience indicate that commutation considerably decreases the utilization efficiency of a

sub-carrier channel as a result of system transients or the relatively long pulse slopes in the case where non-ringing filters are used. In order to reproduce a commutated channel with an accuracy of 2%, it is necessary to use a sub-carrier channel whose frequency response is approximately 10 to 20 times the frequency response of the commutated channel.

Table I presents the maximum commutation rates of unseparated data which the maximum values assuming a deviation ratio of approximately 1.43.

The configuration of the automatic commutation separation equipment of course depends on the type of transmitted signal. In general, present systems employ a long pulse as a frame reference with the information following as a series of 50% duty cycle pulses. A typical pulse train is shown in Fig. 5.

The separation circuits are fed from one of the sub-carrier channels. The separation is brought about by sequential gating of a so-called "broken ring" type of circuit. The basic diagram is shown in Fig. 6.

Eccles-Jordan Circuit

Each analyzer channel consists of an Eccles-Jordan flip-flop circuit, a cathode coupled dual triode used for gating, a cathode coupled integrating circuit, a clamping circuit and the necessary power output stages. The first channel is turned on by the pulse selector as the master pulse is sensed, and turned off by the differentiated trailing edge of the information pulse. As each channel is turned off, an initiation pulse is fed to the following channel and so on to the end of the analyzer chain.

As previously indicated, FM-FM telemetering signals are readily recorded on conventional magnetic tape recording equipment. For immediate applications this provides three attractive features: Insurance against loss of telemetered information in event of equipment failure in units following the receiver; low storage space requirements for large amounts of test information; and convenient collection of telemetered test information with a minimum amount of physical equipment. Present magnetic recorders are not too good in so far as "flutter", "wow" and playing time stability are concerned. For example, 0.1% peak-to-peak "wow" introduces approximately 0.7% error in the recorded signals. No present commercial recorders appear to keep these peak-to-peak "wow" errors below 0.5 and 0.8% when measured over a 15 second interval. New developments now under way do indicate that these difficulties may be minimized. In the meantime, however, electronic compensation may be employed to improve this picture.

TABLE II

(Based on deviation ratio of 5 and 185 cps L. P. filter, ± 7½ % Dev.)

Channel	Without Compensation				With Compensation			
	ac Comp. of Wow Center to Peak Values		ac & dc Comp. of Wow Center to Peak Values		ac Comp. of Wow Center to Peak Values		ac & dc Comp. of Wow Center to Peak Values	
	1 Sec. Sample	15 Sec. Sample	1 Sec. Sample	15 Sec. Sample	1 Sec. Sample	15 Sec. Sample	1 Sec. Sample	15 Sec. Sample
12.3 KC (old tape)	2.17	3.55	4.17	5.55	1.35	2.17	1.52	2.34
12.3 KC (new 3M tape)	1.13	2.26	3.13	4.26	0.27	0.75	0.44	0.82

Electronic compensation (see Fig. 7) requires that a reference signal, generally above (or below) the FM-FM band being recorded, be mixed with the incoming signal and recorded. On playback the signal divides two ways. One path is through the conventional filter-discriminator channel, the other flows through the reference discriminator tuned to the reference frequency. The output of the reference frequency discriminator is fed out of phase to a resistive mixing network in the rectifier-filter output circuit of the conventional filter discriminator channel at a point located just ahead of the power output stage. Electronic compensation presupposes that anomalies occurring in recording the information channel, similarly occur in recording the reference channel and accordingly should be capable of cancelling out "wow".

Several effects prevent electronic compensation from actually completely achieving this ideal condition. "Skew" of the tape as it is transported across the heads and tape which is not magnetically homogeneous cause spurious phase modulation which prevents complete compensation. Very recent developments of one tape manufacturer has, however, eliminated this latter difficulty. Table II indicates the improvement brought about by the use of electronic compensation.

Part Two will appear in the April issue.

"SURE-SHOOTING" TV CAMERAS

Designed to aim anti-aircraft guns, the optical ring sight developed by Edwin H. Land, president of Polaroid Corp., now pin-points rapid action for the TV camera. RCA field cameras equipped with the sight show the cameraman a pattern of concentric circles at target distance in the field of view. The sight consists of a single glass-faced disc and requires no auxiliary illumination or front sight. The center ring is dark in color, while the outer rings are lighter in color and progressively are spaced closer with decreasing contrast to leave the field clear for observation.

"Split Channels" for More

Results obtained from field tests conducted in Syracuse, N. Y. show how an can be made to operate on adjacent channels when index of modulation and

By HUGH H. DAVIDS

General Electric Co.
Syracuse, New York

AS soon as a radio service receives public acceptance, the inevitable problem of too many users for too few channels arises. In the 25-50 MC and 152-174 MC bands the number of new users seeking authorization and the interference already occurring due to the sharing of channels by users in the same locality, such as taxi channels, make it imperative to seek an answer to the problem of how to increase utilization of these bands.

The solutions that have been suggested fall into three general groups or combinations of them.

1. Channel sharing using geographical separation to prevent interference.
2. Use of a system of modulation requiring less bandwidth than FM, such as single sideband AM.
3. Channel splitting; that is, reducing the index of modulation and the channel width so that more channels can be accommodated in the same band.

The first one would require reassignment of the frequencies on the 152-174 MC band, as they have been assigned on a block basis. Such a step is basically a problem for the FCC and the users and does not call for engineering analysis in this discussion.

The second would be far more drastic and would require the eventual replacement of all existing equipment and careful planning for the transition period.

The last is the solution that is most attractive as it would result in the least disruption of present frequency assignments, provided each existing channel is split into an integral number of channels. We will describe this method in detail, including the related factors of channel spacing and deviation, testing techniques, adjacent channel interference and intermodulation.

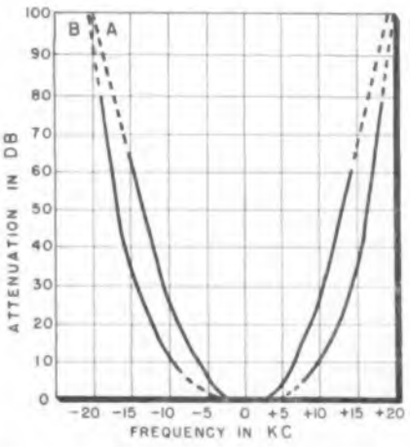


Fig. 1: IF selectivity of narrow band 152-176 MC receivers by 20 db quieting method

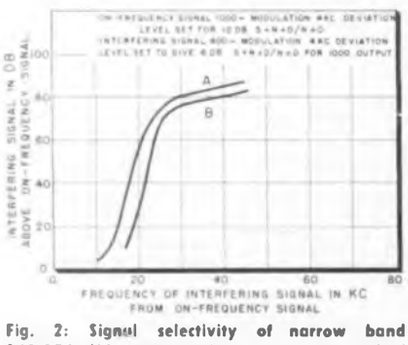


Fig. 2: Signal selectivity of narrow band 148-174 MC receivers by two signal method

Fig. 3: Signal selectivity of adjacent channel 148-174 MC receivers by two signal method

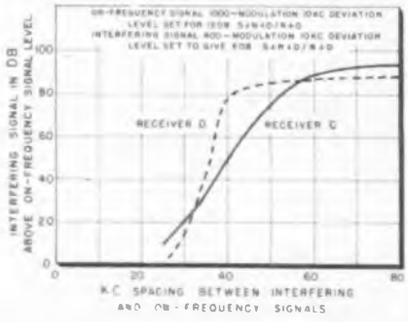
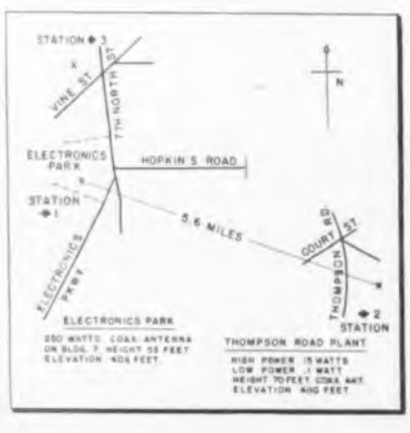


Fig. 4: Station layout for field tests



Channel Splitting

Proposals for channel splitting have usually been for 20 KC channels on the 25-50 MC band and 30 KC or 20 KC channels on the 152-174 MC band. Requirements are different on the two bands due to propagation differences. On the low band the sky wave produces skip interference at long distances. For instance, West Coast stations caused interference in Michigan, New York, and other eastern states. On the high band there is practically no skip interference.

Channel splitting on the low band to prevent skip interference has been advocated for several years and has been demonstrated to be practical with no measurable loss of range or intelligibility.[1] Under this plan, systems in areas which were subject to skip interference would be placed on 40 KC channels that were displaced 20 KC from the 40 KC channels used in the areas causing interference. However, it was not proposed to operate systems in the same area on 20 KC channels except where the adjacent channel stations are from 5 to 7 miles apart and operation is not required in the immediate vicinity of the adjacent channel antenna.

Generally, these restrictions cannot be applied to same area operation of high band equipment. Since skip interference is not a problem on the high band and because of the large number of users within small urban areas, channel splitting on this band to be effective must be applicable to systems in the same immediate area. Here, therefore, is where the real problems of split channel operation are found. For these reasons the balance of this

Mobile Radio Stations

PART ONE
OF TWO PARTS

increased number of stations channel width are reduced

Fig. 5A: Station wagon used in field tests

article will be restricted to high band operation.

A receiver, A, with a selectivity of about 100 db at ±20 kc, as measured by the 20 db quieting method, which will give acceptable adjacent channel operation on split channels even if the channel spacing is reduced to 20 kc was obtained. As an additional check, a second receiver, B, was modified to have approximately the same i-f selectivity using multiple tuned i-f transformers.

The 20 db quieting curves for these two receivers are shown in Fig. 1. The two signal selectivity curves in Fig. 2 were taken by the IRE Standard Method, but with 4 kc deviation instead of 10½ kc. These are a much better indication of the adjacent channel performance of these receivers provided signal generators with low noise level are used; that is, a noise level lower than that found today on standard station transmitters.

The two signal selectivity curves indicate that for adjacent channel operation on 30 kc and 20 kc channels with 5 kc peak deviation that receiver A would be superior, but that on 20 kc channels the rejection of adjacent channels for both would be poor.

For comparison the two signal selectivity curves on two high selectivity receivers for adjacent channel operation on 60 kc channels is given in Fig. 3. Receiver C has a nominal i-f selectivity of 100 db at ±45 kc as measured by the 20 db quieting method, and receiver D 100 db at ±30 kc.

To establish the effectiveness of the narrow band receivers A and B on split channels a series of field tests were performed.

Field Test Set-Up

A permanent field test system has been set up at the Syracuse plant of the General Electric Co. Station #1 has been set up at the Electronics Park plant, #2 at the Thompson Road plant, and #3 at a test area .9 mi. north of Electronics Park. See Fig. 4. 25-50 mc and 152-174 mc stations are installed at each location with remote control for the Thompson Road and test area stations located in the same laboratory as the Electronics Park transmitters.

Power outputs for the 152-174 mc stations are as follows: 250 watts at Station #1, 15 watts at Station #2, and 50 watts at Station #3. Coaxial dipole antennas are used at Stations #1 and #2 and a high gain antenna at Station #3 giving an effective output of approximately 175 watts. The power output at Station #2 can be switched by remote control from 15 watts to approximately .1 watt.

The elevations at Stations #1, #2, and #3 are 406, 400, and 450 ft., respectively, with no elevation greater than 480 ft. between them, and the antenna heights are 53, 70, and 52 ft., respectively. The area is suburban with residential areas and farm lands, and no high buildings.

A station wagon has been equipped as a test car as shown in Fig. 5. Up to five mobile control units are mounted on a bracket just below the roof to the rear of the front seat. Switches on the bracket provide selection of any four of these control boxes for connection to a transfer switch mounted on the panel. The transfer switch performs the following functions: Connects output transformer of set under test to speaker mounted on the dash panel; switches outputs of the other three to resistor loads; connects microphone push-to-talk switch to equipment; actuates coaxial relays at the equipment rack at the rear of the car to switch the antenna to the equipment under test; connects three metering leads from the receiver under test to meter box mounted under edge of dash. These leads are also brought out to phone jacks on the panel so that other meters can be used if desired. Additional meter leads and jacks that do

Fig. 5B: (left) Dash panel with (l to r) selector switch, transfer switch, speaker, and meter below Fig. 5C: (right) Bracket for control boxes.

SPLIT CHANNEL (Continued)

Fig. 5D: Test car equipment racks in rear of station wagon

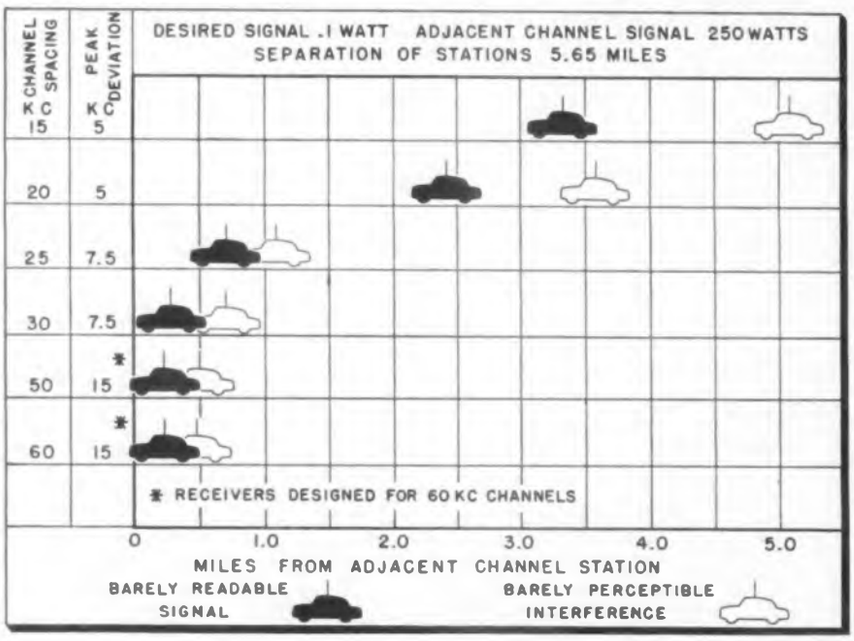


Fig. 6: Effects of interfering station in split channel field tests

not pass through the transfer switch are provided for any special metering requirements. A switch and a phone plug are provided so that an alternate speaker can be plugged in and the receiver outputs switched to it.

A series of adjacent channel performance tests were made using Station #2 as the desired signal and Station #1 as the adjacent channel interfering station. The equipments under test were mounted in the test car and the car run from Station #2 toward Station #1 until interference was experienced. Tests were made for normal adjacent channel separation (60 KC), for bisected channels (30 KC), and trisected channels (20 KC). Since, in the field, it is extremely difficult to set a station exactly on its nominal frequency and the FCC allows a .005% tolerance, tests were made with the transmitters set exactly on the nominal spacing and then later re-run at a closer spacing. The FCC tolerance would allow ±7.75 KC departure from nominal frequency at 155 MC, so that the extremes of separation between two stations could be 44.5 KC to 75.5 KC. 50 KC was selected as representing the extreme condition that could be expected in practice.

Likewise, considering that tighter tolerances would have to be held on split channels, 25 KC and 15 KC spacings were selected as extremes for 30 KC and and 20 KC channels.

The tests were made for both 50 and 250 watts power output from the adjacent channel station and 15 watts and .1 watt power output from the desired channel station.

On each test two locations were determined for each of the two receivers under test. One, the point where the interference from the adjacent channel was just perceptible, and the other where the desired signal could barely be read due to the interference. These represented the extremes of reception with interference present. In the first case, any increase in distance from the adjacent channel station resulted in reception without any trace of interference. In the second case, any approach nearer to the adjacent channel station would result in the desired signal becoming unintelligible. The actual point at which the interference would be considered objectionable would be between these, the exact point depending on the personal judgement of the user.

The split channel field tests verified the two signal selectivity measurements in that the adjacent channel performance in 20 KC or 30 KC channels of receiver A was better than that of receiver B. In presenting the data graphically, the point of just perceptible interference was plotted for receiver B, and the point of barely audible signal for receiver A, giving the extremes for the two conditions.

Field Test Results

Fig. 6 gives the results using 250 watts output for the interfering stations and approximately .1 watt and 15 watts for the desired signal. Voice modulation was used on both stations, text being read on the desired signal, and a tape recorded repetitive phrase used on the interfering station so that the two modulations could be readily identified. For 50 KC and 60 KC channel spacings the modulation controls were set for 15 KC peak deviation; for 25 KC and 30 KC channels they were set for 7½ KC peak deviation; for 15 KC and 20 KC channels they were set for 5 KC peak deviation.

With the output of desired signal Station #2 set for approximately .1 watt, the signal level in the vicinity of the interfering signal Station #1 is of the order of 1 microvolt at the receiver terminals.

(*Continued on page* 152)

Improved Television Camera Control

New method of clamping black reference level in live or film camera obtained by stabilizing the pedestal circuit

By C. J. AUDITORE,
TV Facilities Engineer
WOR-TV, New York City

IT is customary in the transmission of video signals to limit the maximum excursion of the picture signal in both the white and black directions. The level at the point of observation corresponding to the specified maximum excursion of the picture signal in the white direction, is known as the *reference white level.* The level at the point of observation corresponding to the specified maximum excursion in the black direction, is similarly known as the *reference black level.*

The operator controls the program level on a cathode-ray oscilloscope which has been calibrated so that a given deflection of the electron trace represents a specific voltage level for normal program transmission. A level of one volt has been adopted by most broadcasters as the standard for video transmission. This represents the full contrast range from absolute black (blanking level) to the reference white level (maximum useful white picture).

The peak white picture output of the camera is determined by the nature and the lighting of the scene being televised. Glossy objects in a studio pickup, such as diamonds and polished metallic surfaces reflect the light to a disproportionately greater degree than the major body of the scene. These peak whites restrict the useful contrast range of the overall picture if they are limited in amplitude to the *reference white level.* A white peak clipper allows for selection of a *white reference level* below the peak white output of the camera, with a subsequent improvement in the useful contrast range and without noticeable picture degradation.

The white peak clipper is usually built into the transmitter to prevent overmodulation, in accordance with the Rules and Regulations of the FCC. Overmodulation of the picture carrier is particularly objectionable in television receivers operating on the principle of inter-carrier sound and results in audio "buzzing." However, when it is desired to expand the useful video contrast range—as opposed in merely avoiding overmodulation of the RF carrier—the white peaks must be limited at the studio to prevent distortion in the video amplifiers forming the program link to the transmitter. A linear white peak clipper built into the studio stabilizing amplifier, common to all of the cameras, is a direct solution to this problem. Such a circuit has been developed by at least one manufacturer; and instructions for making this modification in the field are available upon request.[1]

The area between the reference black level and the blanking level is commonly referred to as *set-up.* This *set-up* is maintained in order to avoid the possibility of the picture waveform running into the blanking area, and thus giving rise to interference with the synchronizing pulses. The recommended *set-up* expressed in percentage of blanking to *reference white level,* varies between 5 and 10 percent. This minimum set-up must be maintained at the individual camera controls, because the camera signals are individually clamped and combined with synchronizing pulses at the studio output.

(*Continued on page* 134)

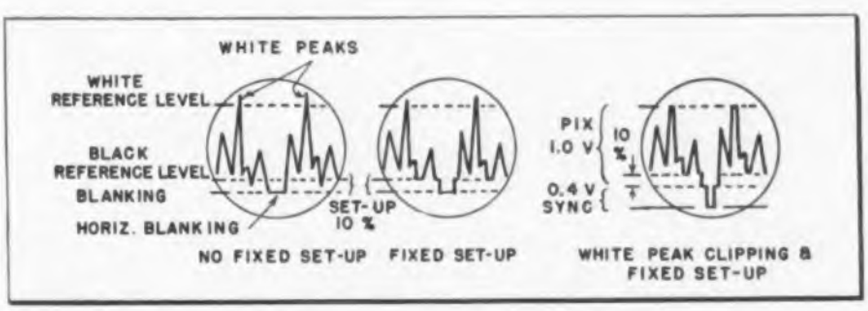


Fig. 1: Effect of fixed set-up and white peak clipping, minimum value about 10%.

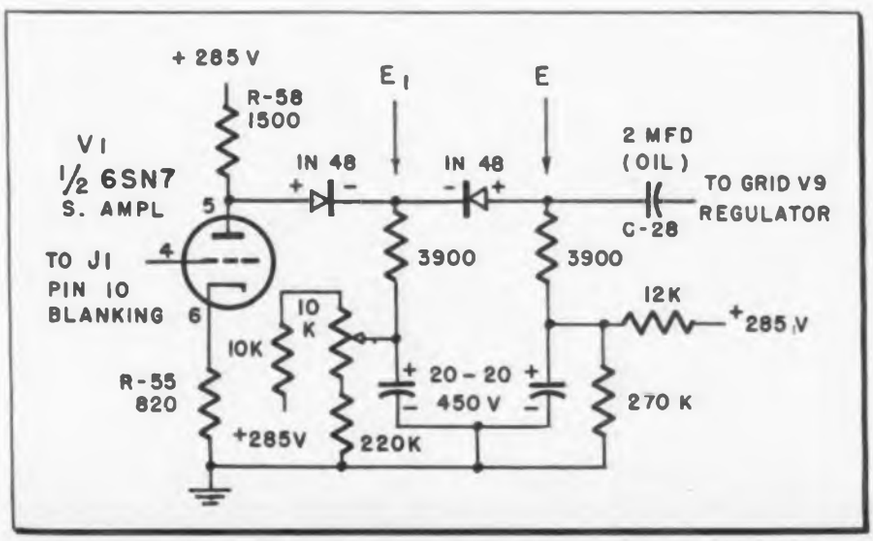
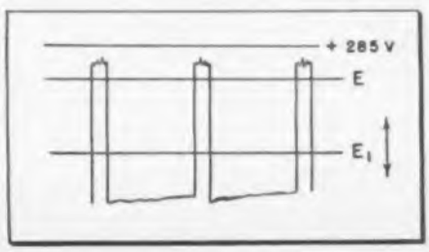


Fig. 2: (left) Changes in RCA TK-10A. (below) Clean clipping of blanking signal



Previews of New Equipment

Survey of latest developments featured in exhibits

BOOTH NUMBERS at which the equipment described will be on display in Grand Central Palace are indicated by the numbers in parentheses

(*Continued from page* 51)

out the use of any special gear. The heart of the instrument is a mechanical linkage which couples the moving arm to D'Arsonval motors. The electronic part employs a narrow audio band, and a single audio channel can be used simultaneously for both voice transmission and remote positioning signals. Also presented are a receiving system employing single-sideband, exalted carrier, triple diversity reception, miniature motors and switching systems for tele-type circuits. —**The Pioneer Electric and Research Corp., 7217 Circle Ave., Forest Park, Ill.**—TELE-TECH

Panoramic Analyzer (N-6)

Model SB-8a Panalyzor for spectrum or waveform analysis graphically indicates distortion, noise, spurious oscillation and modulation. Instrument has improved resolution down to 50 CPS for r-f analysis, sweep rates down to 1 scan/sec for pulsed signals with low prf, long persistence display, and continuously variable scanning width. Three types available are for maximum sweep-widths of 200 KC, 1 MC, and 10 MC, having input center frequencies of 0.5, 5, and 30 MC, respectively. Type T-200 image rejec-

tion ratio is better than 300:1, sensitivity 20 microvolts and has 75 ohm input impedance. Graph shows amplitude-frequency characteristics for different scanning widths. —**Panoramic Radio Products, Inc., 12 S. Second Ave., Mount Vernon, N. Y.**—TELE-TECH.

Network Recorder (314A)

Expressly designed for broadcast, recording studio and industrial installations, NWR-1 recorder operates completely from remote push botton control stations. Elimination of drive belts, clutches or idlers and a new self-adjusting disc braking system eliminates maintenance problems. Provision is made for installation of up to five magnetic heads and is supplied in portable cases or standard rack panel mounting. Frequency

response is ± 2 db from 40 to 15,000 cps at 15 in./sec., and ± 2 db from 50 to 9,000 cps at 7.5 in./sec. Signal-to-noise ratio is 55 db and harmonic distortion is 2% at zero VU. Flutter and wow is 0.1% rms at 15 in./sec. and 0.2% at 7.5 in./sec., with playback timing accuracy ±0.2%.—**Berlant Associates, 4917 W. Jefferson Blvd., Los Angeles 16, Calif.**—TELE-TECH.

Bridge Control Unit (354)

Model 1809 bridge control unit provides all balancing, calibration, and matching networks required for operation of 12 channels of resistance strain gages or bridge type transducers. Each channel has its own independent input voltage control and balancing network, including a ten turn precision potentiometer. Operation of pushbutton on front panel sets calibration cycle in operation, automatically placing calibration resistors across each channel. At the end of the cycle, excitation voltage is reversed to indicate displacement due to contact potential. Calibration may also be manual. Excitation voltage may be varied from 6 to 24 dc, and is reversed once per second. Unit is contained in aluminum alloy case 11 in. wide, 7¾ in. deep, and 4½ in. high. —**Century Geophysical Corp., 1333 N. Utica, Tulsa 10, Okla.**—TELE-TECH.

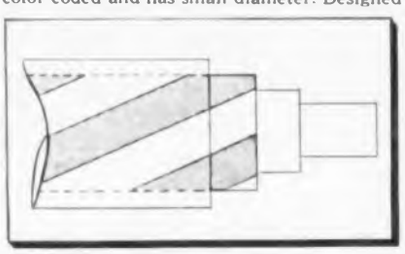
Function Generator (13)

Electronic Function Generator EFG-101 Mod 1 uses photographic glass slides, CR tubes and photomultipliers, along with as-

sociated push-pull direct-coupled amplifiers, to generate arbitrary single-valued functions. Auxiliary Camera Unit CU-101 Mod 1 is used to copy glass function slides from large graphs. Amplitude response of generator is uniform from zero to 10 cps within 0.25% and from 10-30 cps within 1.0%. Phase shift at 10 cps is less than 1° and at 30 cps, less than 5°. Phase and frequency responses up to 30 cps are independent of input amplitudes within computing range of ±100 v. Output is correct within 0.5 v. for slopes up to 80°, and drifts less than 0.25 v. Maximum output noise for dc inputs is less than 0.25 v. Also to be shown is Electronic Multiplier EM-101 Mod O, a similar six-channel cabinet which is a four-quadrant multiplier.—**Reeves Instrument Corp., 215 E. 91 St., New York 28, N. Y.**—TELE-TECH.

Insulated Wire (339)

Type **FJR** "Nonstrip" single conductor small guage wire is light weight, multi-color coded and has small diameter. Designed



to operate from -50°C to 125°C at 1000 v., the easily soldered conductors are available in sizes #18 to #32 AWG, solid or standard. Special insulation construction consists of an extruded synthetic polymide type thermoplastic covered by thermoplastic type marker threads (300 different color codes available), all encased in an extruded thermoplastic jacket. Also presented is a 200 v. wire in three colors, the Type JR. — **Rex Corp., 51 Landsdowne St., Cambridge 39, Mass.**—TELE-TECH.

Metering Pump (479)

Model 6100 metering pump is used for filling capacitors, transformers and switches with hot waxes and cements. The device has

a fixed temperature thermostat in the pump housing, a counter and liquid level indicator, a removable screen at the bottom of the tank, and an electrically heated insulated tank and gear housing. The pump is capable of 88 ejections/min., holds 1½ gal. of liquid, and can have its discharge varied within two seconds from 1/16 oz. to 5/16 oz. per injection in 20 equal increments. The wax may be held at 400°F. with the application of 1880 watts to the tank. — **Edward E. Robinson, Inc., 95 Park Ave., Nutley 10, N. J.** —TELE-TECH.

at the IRE Show, March 3-6

presented by 356 companies at Grand Central Palace

Phase Standard (101)

Type 7000-A primary phase standard system can set up known phase angles at 20 cps, 1,000 cps, and 20 kc to an accuracy of

0.05°, which, with proper operating techniques, can be extended to 0.01°. Phase shift is generated by a stable and continuously variable phase shifter over a range from zero to 360°. Voltage for the phase shifter is derived by means of frequency dividers from a primary signal source. By applying the voltage from the output of the phase shifter to an oscilloscope, and also the voltage of the primary signal source, a Lissajous pattern is established.—**Technology Instrument Corp., 531 Main St., Acton, Mass.**—TELE-TECH.

Tape Recorder (315)

CM-2 assembly, containing two tape recorder mechanisms, two amplifier channels with power supplies, and necessary switches and relays in cabinet type relay rack mount, is intended for communications monitoring. Operating at 1 in./sec, the unit has uniform response to 3000 CPS. With a total tape capacity of 4800 ft. on each mechanism, 32 hours of recording are available, requiring the operator's attention only at the 16-hour point.—**Presto Recording Corp., P.O. Box 500, Hackensack, N. J.**—TELE-TECH.

Lightweight Tape Recorder (320A)

Portable tape recorder for movie-TV use weighs 20 lbs., operates from 110 v. or vibrator supply, and can be run in synchronism with a camera. Commutator on camera shaft gives control pulses which hold vibrator in step even though camera may be off a few per cent in speed. Machine incorporates tight-loop tape drive with flywheel next to active magnetic heads so that flutter-free tape movement is accomplished. Another unit is the tape-to-film editor using ¼ in. tape played back synchronously against a

work print of the picture with facilities to maintain the two in step irrespective of speed or direction of film movement. Final mix from sound to the film for release is obtained from original tape. Regular line of tape recorders and synchronizers has been advanced by improvement in the synchronizer which gives lock-in of the order of 1/240th of a second. This is accomplished by the fact that the 60 cycle frequency as recorded on the tape is doubled in the synchronizer. Combination of tape-to-film editor and synchronizer means greater accuracy in TV lip-synchronization.—**Rangertone, Inc., 73 Winthrop St., Newark 4, N. J.**—TELE-TECH.

Self-Recording Oscilloscope (457)

Memoscope records signals non-photographically, allowing instantaneous reproduction of the wave shape after recording has been made. Basic unit in the instrument is a frequency converter which retains harmonics in their true relationship. Also shown are a toroidal power transformer which radiates an exceptionally small magnetic field, and Model MV-12A ac microvolt meter with a sensitivity of 300 microvolts for full scale deflection.—**Millivac Instrument Corp., 2806 Guilderland Ave., Schenectady 6, N. Y.**—TELE-TECH.

Pulse Generator (S-1)

A fast-rise pulse generator designed for testing transient response of wide-band systems, can also be used for the generation

of impulse or "continuous spectrum" noise for signal-to-noise ratio testing and for narrow-band receiver alignment. It produces a rectangular pulse having a rise time less than 10^{-9} seconds. The width of the pulse is controlled by the external "width" cable, and may be as short as 2×10^{-9} seconds. Pulse amplitudes from 0.1 to 100 v. of either polarity, may be selected. A single pulse, controlled by an external trigger, or internally controlled repetitive pulses, with repetition rates from 50 to 150 per second, may be produced.—**Spencer-Kennedy Labs., Inc., Dept. TT 186 Massachusetts Ave., Cambridge 39, Mass.**—TELE-TECH.

Dynamic Headphone (452)

Model D-7 Dynaset under-the-chin headphone consists of anodyzed aluminum tone arms, dynamic driver housed in molded tennite plug, exchangeable ear tips and flexible tubing, and weighs 1.25 oz. Frequency range is 50-8000 cps, impedance 6 ohms, maximum power input 25 mw, and sensitivity 105 db above 0.000204 dynes/sq. CM/mw. Also presented are two types of pillow speakers with flat, lightweight construction.—**Telex, Inc., Telex Park, St. Paul 1, Minn.**—TELE-TECH.

Noise & Distortion Analyzer (349)

Model ND-110 harmonic wave analyzer measures mean power of complex signals (broad band), frequency distribution of

power (narrow band), signal-to-noise ratio, distortion and intermodulation in 4 to 110 KC range. Broad band sensitivity is -80 dbm to +20 dbm with 1 db accuracy. Narrow band sensitivity is -110 dbm to +20 dbm with 2 db accuracy, and flat pass band is 3200 cps. Input impedance is 600 and 135 ohms, balanced and unbalanced, and oscillator drift is under 100 cps. Other features are gain calibrator, monitoring facilities, 115 v., 60 cps voltage regulation for 10% variations, and rack cabinet 22 x 28 x 15 in.—**Empire Devices, Inc., 38-25 Bell Blvd., Bayside 61, N. Y.**—TELE-TECH.

Push Button Switch (N-18)

A small push button switch assembly for panel mountings, the 1PB3, measures only 1-3/15 in. from the plunger button to the

switch terminals and has a 3/4 in. hex nut on the front of the panel. The push button plunger mechanism provides a seal through the panel, protecting the 0.06 lb. switch inside. The basic switch is catalogued as 1SM1 Subminiature, which handles ac loads of 125 to 250 v. at 5 amps and 30 v. dc at a motor load of 2 amps. The minimum contact break distance is 0.01 in. The push button actuated by a 2 lb. force, will not fail because of icing, since design prevents formation of ice where it might impair plunger operation. The unit consists of two assemblies which are easily and positively connected by means of a spring latch. The switch and bracket can be assembled to the plunger and bushing assembly after the switch has been wired. Also to be shown at the exhibit are the 6AT series of toggle switches which have similar electrical characteristics.—**Micro Switch, Freeport, Ill.**—TELE-TECH.

(Continued on page 76)

WASHINGTON
News Letter

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

SLOW GRANTS AFTER FREEZE END—After having completed its huge task of analyzing more than 1500 documents from the various segments of the television industry on the new national VHF-UHF television channel assignment table, the FCC is lifting its "freeze" (in existence since September, 1948) on new television stations. But the processing of applications for the new video stations by the FCC with its limited staff and small number of seven hearing examiners, will be extremely slow. Actually just a trickle of between 10 and 20 authorizations, FCC Chairman Wayne Coy recently disclosed, will in all probability be decided between the time of the freeze's end and the remainder of this year.

NEW UHF-TV STANDARDS—The FCC is establishing in its lifting of the TV "freeze" a period of between 60 and 90 days for the filing of new station applications or amendment of the 475 applications already submitted. Along with its new video assignment table, adding 70 channels in the Ultra High Frequency band, the FCC planned to announce its new UHF rules and standards for television operation in that area of the spectrum and the rules for the processing of the applications, especially in the case of cities where the applications exceed the number of channels. Hearings will have to be held in the latter situations so that the FCC can select the best qualified applicants. That will mean a long drawnout course because the hearing examiners will have to prepare initial decisions which in turn will have to be given final review by the FCC.

FCC FUNDS FOR TV INCREASED—Even though the present Congress has indicated its firm desires to slash to the bone appropriations proposals of the government agencies, the FCC with a recommended 24 per cent increase in funds for its broadcasting-television activities is expected to fare well in Senate and House action on its next fiscal year's budget which starts on July 1, 1952. The FCC budget submitted to Congress called for $8,075,000 for the fiscal 1953 period of which $1,131,339 would be for the Commission's functioning in broadcasting and television and the latter amount would be $202,303 more than was appropriated for the current 1952 fiscal year. For the fiscal year from July 1, 1952, to June 30, 1953, it is estimated that the FCC will dispose of 504 applications for new TV stations or major changes in TV facilities as contrasted with 81 during the current fiscal year and twenty-six and thirty-one respectively in the 1951 and 1950 fiscal periods. The increased funds will permit the addition of 180 employees on the FCC staff.

MILITARY PROCUREMENT HALVED—Because the Armed Services have contracted for the procurement of approximately $3 billion worth of electronic-radio-radar equipment for delivery during the 1953 fiscal year under their previous appropriations, the national defense mobilization budget for electronics-radio apparatus for the military forces during the upcoming 1953 fiscal period will be around half of the amount allocated for expenditure—approximately $4 billion—for the current 1952 fiscal year. The U. S. Air Force and Naval Aviation bill will have by far the lion's share of the funds for the next fiscal year starting July 1. While specific figures for their needs for electronics and radio equipment were not disclosed in the budget message to Congress, it is estimated that the military aviation procurement will be about two-thirds of the total amount appropriated. The Army Signal Corps is slated to receive about $230 million and Navy Bureau of Ships approximately $144 million.

FUTURE RADIO NEWSPAPER—FM as the broadcast medium for facsimile is going to receive greater interest from the FCC. It is envisioned that newspapers can utilize FM facsimile through the multiplex technique for the simultaneous publishing of editions in the different regions of the country. FCC Chairman Wayne Coy recently expressed confidence that "there is a radio newspaper in our future." Pointing out that this is a medium of record broadcasting completely unused at present, Chairman Coy declared that the print and pictures of facsimile can of course be transmitted simultaneously with the music or speech of a regular FM broadcasting program through the multiplex technique. It has been noted that the transmission of a four-page newspaper by FM facsimile had been conducted successfully last year by the Columbia University School of Journalism by FM multiplex over the Rural Radio Network of New York's five stations.

CONTROVERSIAL HEARING—One of the most controversial hearings in the history of the FCC is slated to start March 10 on the request of the motion picture industry for the allocation of channels for theatre television and for the assignment of microwave frequencies for the relaying of theatre video programs. The motion picture industry is going to challenge through its proposal for exclusive microwave relay channels the Bell System's nationwide network of coaxial cables and microwave radio facilities. The motion picture field also is to combat the industrial mobile radio services in seeking the reallocation of frequencies from those services to its projected exclusive microwave relay network. But the movie industry will not be able to get into operation in the exclusive channels for a long time, even if the FCC approves their plan, because of the lack of equipment and of "know-how."

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ROLAND C. DAVIES
Washington, Editor

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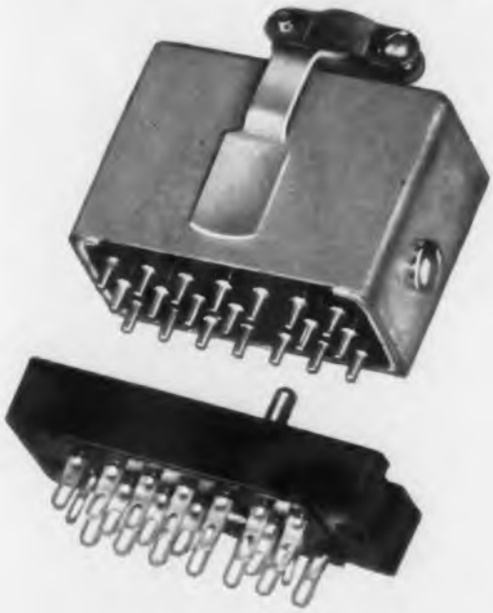

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TELE-TECH's NEWSCAST

Single Research Center Planned by Signal Corps

Scientific research, currently conducted in four widely separated laboratories by the Army Signal Corps., will be consolidated in a single $22 million hexagonal development center by 1954. Construction of the huge, 5-story, 6-wing building is expected to start this spring on the site of the former Watson Laboratories of the Air Materiel Command, Eatontown, N. J.

It will provide more than 700,000 square feet of working space for engineers, physicists, laboratory technicians and clerks.

In the new building will be centralized Signal Corps research and development work now performed at Evans Signal Laboratory in West Belmar, N. J., Coles Signal Laboratory in Middletown Township, N. J., Squier Signal Laboratory, N. J., and at Watson Laboratories in Eatontown. The last was taken over by the Signal Corps when the Air Materiel Command unit was transferred to Griffis Air Base at Rome, N. Y.

The first unit of the new buildings scheduled for completion at a cost of $5,000,000 will house a heating plant, auditorium, conference room and a sound apparatus testing center. It will have a frontage of 470 feet.

The modern Squier Laboratory building on the main post, which has been administrative headquarters for all laboratory work, is expected to be utilized for signal school administration work.

The plans for the huge research center are being drafted by Ballinger & Co. of Philadelphia.

JTAC on "Conservation of Radio Spectrum"

The Joint Technical Advisory Committee has approved the text of a tutorial paper entitled "Conservation of the Radio Spectrum." This paper was prepared by a sub-committee comprised of Donald Fink, chairman, Haraden Pratt and Philip Siling. Assisting the sub-committee were the following consultants: Trevor H. Clark, Dr. J. H. Dellinger, Dr. G. C. Southworth, Arthur F. Van Dyck and James P. Veatch. Other contributors to the paper were Austin Bailey, T. L. Bartlett, Dr. C. R. Burrows, I. F. Byrnes, A. J. Costigan, W. S. Duttera, H. H. Edwards, Dr. T. N. Gautier, Dr. A. N. Goldsmith, Raymond F. Guy, John Huntoon, Dr. C. B. Jolliffe, J. H. Muller, D. E. Noble, Mrs. M. L. Phillips, F. M. Ryan and Julius Weinberger.

The 200-page paper, while intended primarily for those interested in the future of frequency allocations, is written in layman's language so that it should prove valuable to anyone interested in any phase of this subject. Emphasis is laid upon methods of reducing congestion in the radio spectrum. Briefly, the

(*Continued on page* 90)

MOBILE TRANSMITTER-RECEIVER FOR 450-470 MC BAND

Fred M. Link, center, president of Link Radio Corporation, New York, points to new chassis of Link mobile radio equipment for operation in the 450-470 MC frequency band. Looking on are Norman E. Wunderlich, left, vice-president in charge of engineering and sales; V. Lee Cook, manager at Chicago where initial 450-MC mobile units were tested; and G. Sohne, right, of Link Engineering department.

Coming Events

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

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

March 31-April 2—NARTB Broadcast Engineering Conference, Conrad Hilton Hotel, Chicago, Ill.

April 16-18—Network Symposium, Polytechnic Institute of Brooklyn and Office of Naval Research, 33 West 39th St., New York, N. Y.

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

April 21-24—National Committee of the International Scientific Radio Union and IRE Professional Group on Antennas and Propagation, Spring Technical Meeting, National Bureau of Standards, Washington, D. C.

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

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

May 4-8—Electrochemical Society, 50th Anniversary Meeting, Benjamin Franklin Hotel, Philadelphia, Pa.

May 5-7—IRE-AIEE-RTMA Symposium on Progress in Quality Electronic Components, Dept. of Interior Auditorium, Washington, D. C.

May 12-14—IRE National Conference on Airborne Electronics, Dayton-Biltmore Hotel, Dayton, Ohio.

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

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

May 19-22—1952 Radio Parts and Electronic Equipment Show, Hotel Stevens, Chicago, Ill.

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

August 27-29—Western Electronic Show & Convention, WCEMA and IRE, Long Beach, Calif.

September 8-12—ISA, 7th National Instrument Conference and Exhibition, Sherman Hotel, Chicago, Ill.

September 22-25—NEDA, 3rd National Convention, Ambassador Hotel, Atlantic City, N. J.

September 29-October 1—Eighth National Electronics Conference and Exhibition, Sherman Hotel, Chicago, Ill.

AFCA: Armed Forces Communications Assoc.
AIEE: American Institute of Electrical Engineers
ASA: Acoustical Society of America
IRE: Institute of Radio Engineers
ISA: Instrument Society of America
NARTB: Nat'l. Assoc. of Radio & TV Broadcasters
NEDA: Nat'l. Electronic Distr. Assoc.
NEMA: Nat'l. Electrical Manufacturers Association
RTMA: Radio-Television Mfrs. Assn.
SMPTE: Society of Motion Picture & TV Engineers
WCEMA: West Coast Electronic Mfrs. Assoc.

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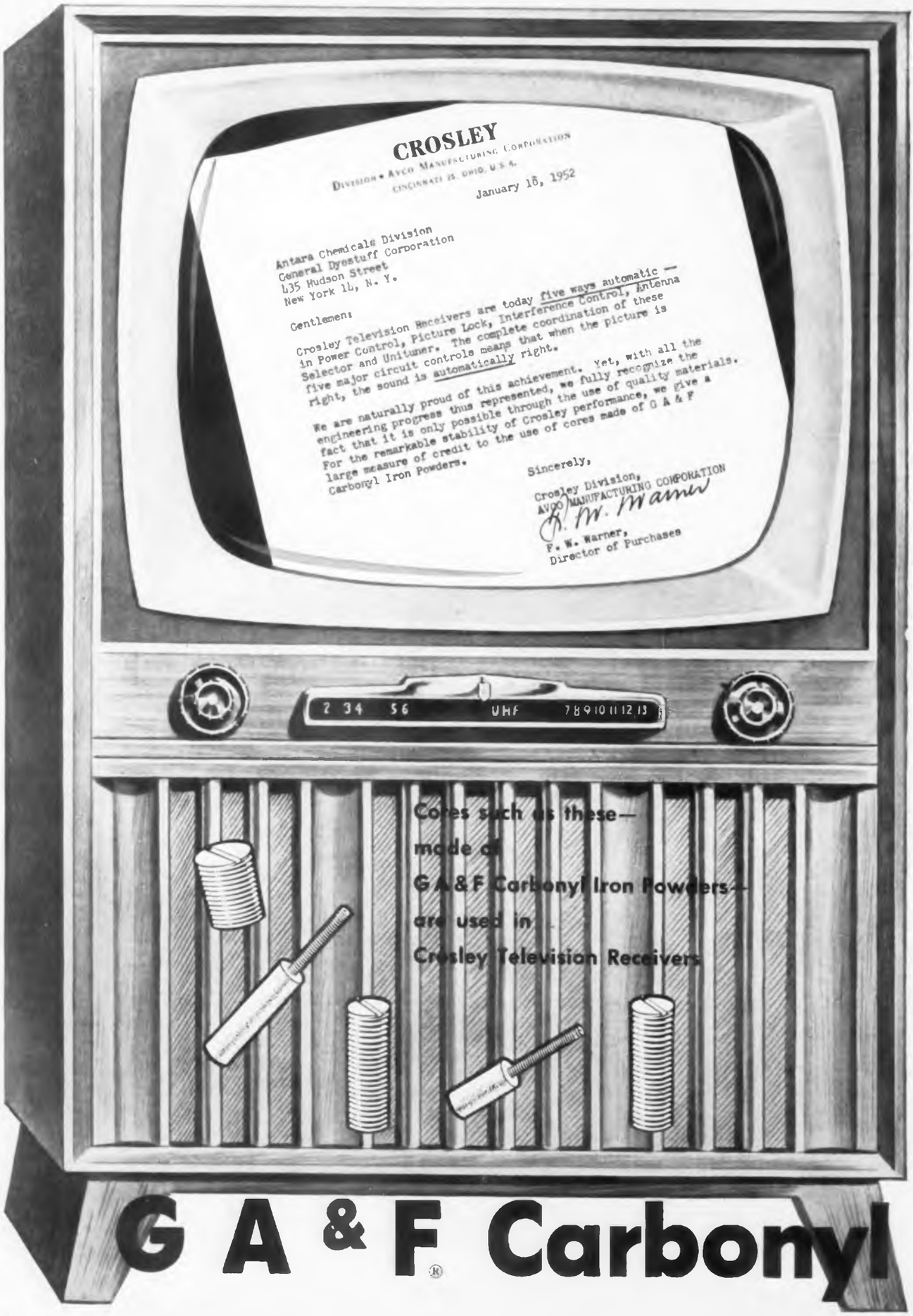
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January 18, 1952
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We are naturally proud of this achievement. Yet, with all the engineering progress thus represented, we fully recognize the fact that it is only possible through the use of quality materials. For the remarkable stability of Crosley performance, we give a large measure of credit to the use of cores made of G A & F Carbonyl Iron Powders.
Sincerely,
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AVCO MANUFACTURING COMPORATION
F. W. Warner,
Director of Purchases
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Cores such as these—
made of
G A & F Carbonyl Iron Powders—
are used in
Crosley Television Receivers
G A & F Carbonyl

IRE NEW EQUIPMENT

(Continued from page 69)

BOOTH NUMBERS at which the equipment described will be on display in Grand Central Palace are indicated by the numbers in parentheses

Leak Detector (397A)

The Veeco Model MS-5 mass spectrometer leak detector uses helium as a tracer gas to detect pressure or vacuum leaks. Sensitive

to one part of helium in 200,000 parts of air, or a leakage flow of less than 0.00001 standard cc/hr, presence of a leak is indicated by meter deflection or increase in pitch of an audio note. The unit is 22 in. wide, 21 in. deep, 52 in. high and weighs 350 lbs. Power consumption is about 800 watts at 115 v., 60 CPS. No cooling water is required. — **Vacuum-Electronic Engineering Co., 756 Third Ave., Brooklyn 32, N. Y.** — TELE-TECH.

Impedometer (FEDERAL HALL—135)

Rapid and reliable impedance measurements up to 500 MC may be made with the impedometer. Also shown are TV equipment such as monitors, flying spot scanners and sync generators for color and black-and-white. Microwave wiring system, aerial navigation direction finder and omnidirectional antenna, traveling wave tubes, and components developments are included in the exhibit.—**Federal Telecommunication Labs., Inc., 500 Washington Ave., Nutley 10, N. J.**—TELE-TECH.

Reproduction Process (430)

The Perma-Stat process makes possible the reproduction of anything that is photographed, written, drawn or printed onto plastic, metal, wood, glass, leather and many other surfaces. Applications include:

manufacture of printed circuits, dials, and instrument faces; wiring diagrams and schematics. The emulsion, which is a bichromate stabilized gelatin, is applied to the material which is to receive the reproduction. The copy that is to be reproduced is photographed and the negative placed against the treated surface. Because the emulsion is sensitive only to concentrated ultra-violet rays, the negative is exposed briefly to a carbon arc lamp or an ordinary sun lamp. A dip into the dye of the desired color, followed by a quick rinse in cold water, completes the reproduction. The emulsion has great affinity for the materials used and will not chip, fade or peel. — **Trans-Gel Products, Inc., 212-40 Jamaica Ave., Queens Village, N. Y.** — TELE-TECH.

Scintillation Detector (393B)

Directional gamma detector uses thalium activated iodide crystal for medical tracer applications. Unit includes 5819 photo-multiplier tube and 6AK5 cathode follower circuit.—**Nuclear Instrument and Chemical Corp., 223 W. Erie St., Chicago 10, Ill.**—

Wideband Tetrodes (10-12)

Types AX-9907/6075, water-cooled, and AX-9907R/6076, air-cooled tetrodes are wideband, have 3 kw plate dissipation, and op-

erate up to 220 MC. Tubes are compactly constructed with thoriated tungsten filament, disc type screen grid seal to minimize inductance, and two control grid pin connections with low capacitance and inductance.—**Amperex Electronic Corp., 25 Washington St., Brooklyn 1, N. Y.**—TELE-TECH.

Motor-Generator Set (407)

400 CPS motor-generator set with control cubicle containing a magnetic amplifier voltage regulator utilizing selenium recti-

fiers. Designed in a variety of sizes with direct-connected exciters, the sets utilize induction or synchronous motor drives. Operating speeds are either 1200, 1800 or 3600 rpm, and power capacities range from 0.5 kw to 100 kw. — **Bogue Electric Manufacturing Co., 52 Iowa Ave., Paterson 3, N. J.** — TELE-TECH.

Portable Tape Recorder (317)

Weighing only 9¾ lbs. with batteries, the compact Magnemite tape recorder has a playing time of two hours on a 5 in. reel

at 1⅞ in./sec. Monitored with earphones, the unit will pick up voices up to 100 ft. away. Frequency response is 100 to 3,000 cps, signal-to-noise ratio is 45 db, speed variation is ±0.2%, and battery life is 100 operating hours. Several optional accessories are available. Price is $177.00 — **Amplifier Corp. of America, 398 Broadway, New York 13, N. Y.**— TELE-TECH.

Microwave Kit (261)

Designed for model shops and microwave laboratories, this kit contains nine circular contact rings and six contact strips made

from beryllium copper, jig hardened to assure uniform contact pressure. The contact rings are used for tuning slides, tube sockets and other concentric applications. The contact rings, which may be easily soldered or spot welded, are useful in bonding and grounding uses, and can be formed into curves for use as conductors. Price is $10.00. — **Instrument Specialties Co., Little Falls, N. J.** — TELE-TECH.

Plug-In Components (N-3)

Accessibility and ease of replacement are featured in a line of units for plug-in construction of equipment. These parts include a basic chassis, terminal card mounting, rod and dowel arrangement for locking and ejecting the chassis, back plates and connectors, and various plug-in sockets, lights and fuses.—**Alden Products Co., 117 N. Main St., Brockton, Mass.**—TELE-TECH.

Pulse Transformer (361)

Several new transformer types feature mounting arrangement which permits unit to be mounted in manner similar to that used for conventional 9 pin miniature tube socket.—**Engineering Research Associates, Inc., 1902 W. Minnehaha Ave., St. Paul W4, Minn.**—TELE-TECH.

Color TV (266)

Color television equipment to be displayed include transmitting equipment for NTSC, RCA, Hazeltine and CBS systems, a universal color receiver for receiving these systems, and a color bar pattern generator. A microwave noise generator and inexpensive monochrome picture generator will also be presented. **Telechrome, Inc., 88 Merrick Rd., Amityville, L. I., N. Y.**—TELE-TECH.

Fuses (371)

The exhibit will present a full line of fuses for television and electronic equipment.—**Bussman Manufacturing Co., University at Jefferson, St. Louis 7, Mo.**—TELE-TECH.

(Continued on page 80)

C-D-F makes all three!

low cost Spiral Tubing

Designers, engineers, production men everywhere are changing their thinking (and specifications) over to economical C-D-F spiral tubing. Whether it's round, square, or rectangular, C-D-F tubing is stiff, sturdy, crush resistant. It has good tensile strength, along with good dimensional stability under varying atmospheric conditions.

Above all, it is low in cost. C-D-F experts in insulation, recommend spiral tubing for coils and structural spacers. For transformers, switches, selenium rectifiers.

The round tubing ranges from 1/8" to 6", with wall thicknesses from .0075" to 1/8". The minimum ID of the square and rectangular tubing is 3/8", with 2 1/8" the maximum ID. 1/16" is the maximum wall thickness. All tubing can be supplied in lengths from 2' to 4'. From our own fabricating experience, we know you will find this sturdy material easy to drill, tap, rivet, flute or thread.

Think it over . . . then talk to the man from C-D-F, a skilled plastics engineer. C-D-F has sales offices in principal cities with modern test laboratories at all plants. C-D-F spiral tubing. The man from C-D-F. *Both* are good to know!

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C-D-F puts notches in to make winding easy. Hard to crush, this tube withstands prolonged heat of 190° F., 240° F. intermittently. Write for samples and complete specifications. For availability, economy, adaptability . . . buy your spiral tubing from C-D-F.

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(*Continued from page 75*)

Gaussmeter (409)

Model D-79 gaussmeter operates on Hall effect to measure magnitude and direction of ac and dc magnetic fields. Flux densities from 10 to 30,000 gauss can be measured by inserting the 0.025 in. x 0.2 in. x 1.75 in. non-magnetic probe in flux field. Two probes are supplied. One is high sensitivity for low density fields, and one is linear for high density fields. Frequency response on ac measurements is flat to 400 CPS. Accuracy is ±2½% over measuring range and measurements can be repeated to ±1% at normal ambient temperature and humidity conditions. Tubes used are 1-6X4, 1-6AL5 and 1-12AU6. Power supply requires 75 watts at 105-125 v. 50-60 cycles. The 10.5 lb. instrument measures 13 in. x 6.75 in. x 10.5 in.—**Dyna Labs., Inc., 132 Lafayette St., New York 13, N. Y.**—TELE-TECH.

Variable Transformer (108, 110)

Type 10 powerstat variable transformer for variable ac voltage control is rated 120 v., 60 cps, single phase input with an output of

0-120/132 v., 1.25 amps, 150/165 va. This compact unit is intended for 50, 100 and 150 watt applications and operates cool. Type 10 is ruggedly designed for single hole mounting, has projection on its base for keying to panel, and may be installed under a 3 in. chassis.—**Superior Electric Co., Bristol, Conn.**—TELE-TECH.

FM Deviation Meter (137)

Type TF934 FM deviation meter has a frequency range from 2.5 to 100 MC in eight increments, three deviation ranges of 0-5, 0-25, and 0-75 KC, and a response characteristic within 0.5 db from 50 cps to 15 KC. Input is 50 mv minimum, and input impedance is 1000 ohms for high and 82 ohms for low. Accuracy is 1.5% below half scale. Also to be presented are the Type TF948 FM/AM signal generator for the 20-80 MC range, and TF890/2 r-f test set for 3 cm radar equipment. The test set consists of a wavemeter, power meter, signal generator, receiver and power supply.—**Marconi Instruments Ltd., 23-25 Beaver St., New York 4, N. Y.**—TELE-TECH.

Bimetal Thermostats (262)

Hermetically sealed and neoprene-protected, the disc and strip type thermostats may be incorporated in electrical appliances and electronic apparatus. Units are available in broad range of terminal arrangements, mounting brackets and adjusting stems.—**Stevens Manufacturing Co., Mansfield, Ohio.**—TELE-TECH.

Interference Filter

Quality line of fixed capacitors and r-f interference filters wil be shown at the Waldorf-Astoria.—**Astron Corp., 255 Grant Ave., E. Newark, N. J.**—TELE-TECH.

Mallory Expansion

A half-million dollar expansion program which will provide new facilities for the capacitor, and metals & ceramics divisions is announced by P. R. Mallory & Co., Inc., of Indianapolis, Ind.

An additional 35,000 sq. ft. of manufacturing space will be added to the capacitor division for the manufacture of electrolytic capacitors. The increased demand for capacitors by the Armed Forces made it necessary to increase production facilities, in order to maintain a sound balance between military and civilian production.

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TYPE W-HS-SERIES
60 Milliamperes DC

In 1¼" Phenolic Tube with stud mounting at each end. Circuit-Half-Wave. Overall length varies to 14", depending on DC Output Voltage rating. For many applications for heavier duty and inverse peak suppressor circuits.

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DC Output Voltage	Rectifier Part No.
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60	W3HS
100	W5HS
400	W20HS
800	W40HS
1500	W75HS
2500	W125HS
3500	W175HS
4500	W225HS
6000	W300HS

Over 500 other types

Type W248HS
4960 Volts DC Output
60 ma. Overall
length, 13"

Over 3,000,000 various types produced and in service during the past 4 years. Designed and built to meet Government Specifications. Manufactured for temperatures up to 100° C ambient —100% humidity. A recent month's production included Rectifiers to supply 40 microamperes, 1 volt and Rectifiers with a capacity of 140,000 amperes, 14 volts. Owned and managed by Engineers who are specialists in the design and manufacture of Selenium Rectifiers. Submit your problems for analysis and we will be glad to offer our recommendations.

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NEW EQUIPMENT

Preamplifier-Equalizers

Correct equalization is provided for all makes of microgroove records as well as for 78 rpm discs by models A100 and A100P

phonograph preamplifier-equalizers. Included are the original Columbia LP curve and the characteristic used by RCA-Victor on their LP's and 45's. Independently adjustable turnover and roll-off controls provide 24 different frequency characteristics; Turnover adjustable to LP, 300, 500 and 800 cps; Roll-off adjustable to 0 (flat response), 4, 8, 12, 16 and 20 db drop at 10,000 cps.; hum and noise level are more than 50 db below signal with 10 mv input (GE variable reluctance pickup). Gain control on back of chassis permits adjustment of gain to suit the pickup and amplifier used. Model A100 has integral power supply and is mounted on the same size chassis as Model A100.—**Brociner Electronics Laboratory, 1546 Second Avenue, New York 28, N. Y.**—TELE-TECH.

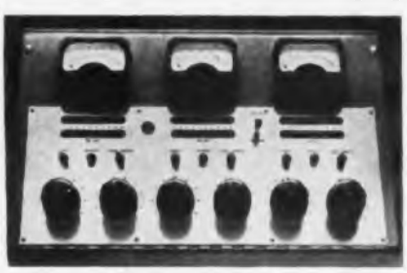
Waveguide Bender

A hand-operated tube bender and specially designed dies will bend waveguides. Capacity of the hand bender using the compound gear

is 2 in. standard pipe 8 in. radius. The dies shown on the photograph are for bending ½ x 1 in. .065 wall copper tubing. Dies for larger size tubing can be furnished. The machine is arranged to travel 210° for bending parts requiring 203°, allowing for springback on large radius.—**General Riveters, Inc., 785 Hertel Ave., Buffalo 7, N. Y.**—TELE-TECH.

Master Switching Consolette

A new master switching consolette, (type BCS-11A), provides complete master control of ten program sources to three outgoing



lines. Bridging-type input permits operation from any audio line of 600 ohms or lower. A separate master attenuator is provided for each outgoing channel. Other features include separate power switches. VU meters, and VU meter lamps for each channel. A relay power failure does not remove the program from the air, and return of power after the failure does not affect or alter the program switching. The equipment, finished in two-tone umber gray, is 22½ in. long, 11¼ in. high, and 21½ in. deep. It weighs 70 lbs.—**RCA Victor Div., Radio Corporation of America, Camden, New Jersey**—TELE-TECH.

SANGAMO
Paper Capacitors
"Fit in tight Spots!"

Type CP 25

Type CP 28

Type CP 40

Here is a compact high voltage filter capacitor, designed to conserve space. Type 40 is Diaclor* impregnated and filled and mounts easily to the chassis.

These Paper Can Types are produced to meet the physical dimensions and electrical requirements of JAN-C-25 specification.

Where exceptionally small hermetically sealed paper capacitors are required for filter, by-pass, or coupling applications, the Sangamo CP 20 Line is a sound choice. These capacitors are mineral oil impregnated for E Characteristic and assure excellent performance with long life at temperatures from − 55° to + 85° C. They are ideal for use in military equipment, aircraft, or industrial applications. Two typical units of the CP 20 Line are illustrated at left.

All approved for Armed Services Applications

Type CP 70

A fabricated can type, Diaclor* filled, power supply paper capacitor. Excellent for use in transmitting apparatus, portable communications equipment, sonar or radar sets, and ground control approach equipment.

Trade Mark Registered. (Chlorinated dielectric oil)

Your Assurance of Dependable Performance

SANGAMO ELECTRIC COMPANY

MARION, ILLINOIS

IN CANADA, SANGAMO COMPANY LIMITED, LEASIDE, ONTARIO

Microwave Components

Typical new units in a line of specialized microwave components are a lightweight, high efficiency waveguide switch; a compact

"twist and turn" elbow; and improved broadband shunt and series tees. These units are said to afford low absorption and reflection losses over a 10% bandwidth. Aluminum construction minimizes weight for airborne applications, and all units can be used in pressurized systems. The microwave switch is supplied in either brazed waveguide or solid block construction, with housing for a pressurized switch actuator motor. It presents a maximum VSWR of 1.10 in switched positions, and the VSWR during switching interim is a maximum of 1.50. Cross attenuation varies from -25 to -40 db over a 10% bandwidth. Emphasis on compactness is indicated by the fact that the block switch complete with motor weighs only 6 ounces. The "twist and turn" elbow provides both a bend and a modal rotation through 90°, in a unit no larger than a standard 90° bend alone.—**General Precision Laboratory, 63 Bedford Road, Pleasantville, N. Y.**—TELE-TECH

Power Supply

Model 3100 features a low voltage regulated power supply with excellent regulation, high stability, low ripple content and

low output impedance. The dc output voltage is continuously variable from 0-3 v. and delivers from 0-100 ma. In the 0-3 v. range, the output voltage variation is less than 5 mv for both line fluctuations from 105-125 v. and load variation from 0-100 ma. Ripple is less than 1 mv. The unit is designed for relay rack mounting or bench use, width 19 in., height, 7 in., depth, 11 in. —**Kepco Laboratories, Inc., 131-38 Sanford Ave., Flushing 55, N. Y.**—TELE-TECH.

Oscilloscope

Type 517 oscilloscope is a wide band high-voltage cathode-ray instrument designed primarily for the observation and photographic recording of very fast-rising waveforms having a low duty cycle. All critical voltages are electronically controlled to preserve the accuracy of the sweep and vertical amplitude calibrations. Fixed sweeps of 10, 20, 50, 100, 500 musec/cm and 1, 2, 5, 10, 20 usec/cm are provided, with a maximum displacement error of 2% for 8 cm sweep length. The amplitude calibrator provides continuously variable output voltages in six ranges, from 0.15v to 50v full scale, with an accuracy better than 4% of full scale. Distributed type vertical amplifiers provide a rise time of 0.007 usec, with a maximum sensitivity of 0.1v/cm. Sufficient time delay is incorporated in the vertical amplifier to permit viewing the leading edge of the waveform that triggers the sweep. An accelerating potential of 24kv on a metallized cathode-ray tube permits photographic recording of single sweeps at the maximum writing-rate permitted by the vertical amplifier and sweep circuits. A continuously variable trigger-rate generator operating from 15 to 15,000 cps in three ranges, with an accuracy of 5% of full scale, is incorporated in the instrument.—**Tektronix, Inc., P. O. Box 831, Portland 7, Oregon.**—TELE-TECH.

high-temperature metallized-paper capacitors

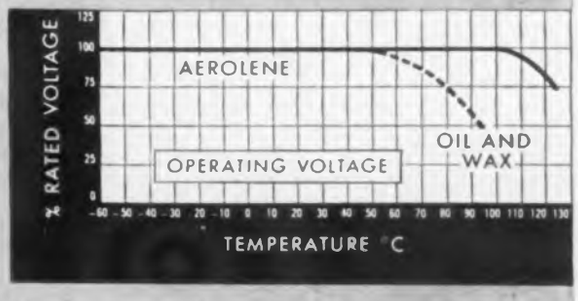
Series P92ZN Aerolene-impregnated metallized-paper capacitors are modified plastic-tubular duranite-end-sealed units in paper cases. Operating temperatures of −30°C. to +100°C. 200, 400 and 600 V. D.C. 0.01 to 2.0 mfd.

Series P123ZNG Aerolene-impregnated metallized-paper capacitors housed in tubular metal cases with vitrified ceramic terminal seal. Operating temperature range of −55°C. to +100°C. at full rating; to +125°C. at 75% of voltage rating. 200, 400 and 600 V.D.C. .0005 to 2.0 mfd.

Series P30ZN Aerolene-impregnated metallized-paper capacitors housed in "bathtub" metal cases with vitrified or glass terminal seals. Operating temperature range of −55°C. to +100°C. at full rating; to +125°C. at 75% of voltage rating. Capacitances available from 0.1 mfd. up to 15.0 mfd. at 150 V. D.C., and up to 3.0 mfd. at 600 V. D.C.

Once again, Aerovox is privileged to blaze the capacitor-development trail. For these high-temperature metallized-paper capacitors are definitely Aerovox "firsts" in *conception, production* and *application.*

Their truly phenomenal acceptance is due to (1) The *Space Factor,* especially when *miniaturization* is a prime consideration; (2) *Reliability,* particularly in meeting voltage peaks or surges, by taking advantage of their self-healing characteristics; and (3) *Wide Operating Range,* from sub-zero to elevated temperatures.



Let us quote on your metallized-paper capacitor needs. Or if you are not already familiar with metallized-paper advantages, our engineers will gladly show you how they can fit your functions and circuits.

THE HOME OF CAPACITOR CRAFTSMANSHIP

AEROVOX CORPORATION, NEW BEDFORD, MASS., U.S.A.

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SALES OFFICES IN ALL PRINCIPAL CITIES

Audio Oscillator

Model 510-B extended range audio oscillator, a precision instrument of miniature size, has a frequency range, 18 cps to 1.2 MC

in five overlapping scales. Distortion is less than 0.2% over most of useful range. Output ± 0.5 db is constant from 18 cps to 100 KC. Accuracy and stability are rated at ± 2% ± 1 cycle for all conditions of line voltage variation (± 10 volts to) 210 KC. Type T-10 matching transformer is available for operation with balanced output.—**Waveforms, Inc., 333 Sixth Ave., New York 14, N. Y.**—TELE-TECH.

High "Q" Traps

A new line of high "Q" traps, designed for use between the TV antenna and receiver to eliminate adjacent-channel and FM interference are available in four models. Model TLB covers the low-band VHF television channels 2 through 6, from 54 to 88 MC. Model THB is designed to trap adjacent channel interference on high-band TV channels 7 through 13, from 174 to 216 MC. Interference from FM stations is trapped by using model TFM, covering the range from 88 to 108 MC. The fourth new Jerrold trap is designated as Model "T Special" and is custom built, on order, to eliminate interfering frequencies in any bands other than VHF television and FM. These traps consist of bridged "T" networks with variable series and shunt inductance circuits. With both the series and shunt circuits tuned to the signal to be trapped, this undesired signal is attenuated by a minimum of 50 db. The TV channel to be received is attenuated by a maximum of only 2 db.—**Jerrold Electronics Corp., N. E. Cor. 26 & Dickinson Sts., Philadelphia 46, Pa.**—TELE-TECH.

Megohmmeter

Rapid measurement of insulation resistance as well as general resistance testing is possible with the type 1862-A Megohmmeter.

Six decade ranges are used from 0.5 megohm to 2,000,000 megohms, and each decade covers about 90% of the meter scale. A constant test voltage of 500 v. is applied to the resistance under test per A.S.T.M. Standards on Electrical Insulating Materials, D257-49T. The discharge position of the multiplier switch removes all voltage from the terminals. Separate guard and ground binding posts are also provided for making three-terminal resistance measurements.—**General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.**—TELE-TECH.

Polarad
PRECISION LABORATORY INSTRUMENTS

All Band, Direct Reading

SPECTRUM ANALYZER

10 MC to 21,000 MC

The Model LSA is the result of years of research and development. It provides a simple and direct means of rapid and accurate measurement and spectral display of an rf signal.

Outstanding Features:

- Continuous tuning.
- One tuning control.
- 5 KC resolution at all frequencies.
- 250 KC to 25 MC display at all frequencies.
- Tuning dial frequency accuracy 1 percent.
- No Klystron modes to set.
- Broadband attenuators supplied from 1 to 12 KMC.
- Frequency marker for measuring differences 0-25 MC.
- Only four tuning units required to cover entire range.
- Microwave components use latest design non-contacting shorts for long mechanical life.
- Maximum frequency coverage per dollar invested.
- 5 inch CRT display.

Model LSA

The instrument consists of the following units:

Model LTU-1 RF Tuning Unit—10 to 1000 MC.
Model LTU-2 RF Tuning Unit—940 to 4500 MC.
Model LTU-3 RF Tuning Unit—4460 to 16,520 MC.
Model LTU-4 RF Tuning Unit—15,000 to 21,000 MC.
Model LDU-1 Spectrum Display Unit.
Model LPU-1 Power Unit.
Model LKU-1 Klystron Power Unit.

BROAD BAND MICROWAVE ATTENUATOR

Model SIJ

4 kmc to 12.4 kmc

Polarad's Broad Band Microwave Attenuator is intended for use as an external attenuator in microwave measurements with signal sources, receivers and for power measurements. Its useful frequency range is from 4000 mc to 12,400 mc. Model SIJ can be used as a standard calibrated attenuator or to couple a small amount of energy from a high level source for circuit protection, or for monitoring and for measurement purposes without introducing discontinuities or to insure rf circuit isolation.

By its use a Polarad Microwave Signal Source or a laboratory oscillator is converted into a signal generator.

Features:

- Continuously variable attenuation.
- Stub tuned, 50 ohm impedance.
- Waveguide beyond cutoff attenuator.

WIDE BAND VIDEO AMPLIFIER

Model VT 10 CPS to 20 MC

Designed for use as an oscilloscope deflection amplifier for the measurement and viewing of pulses of short duration and rise time. Excellent for TV, both black and white and color applications.

Model VT

Features:

- Flat frequency response from 10 cps to 20 mc ±1.5 db.
- Uniform time delay of 02 microseconds.
- Gain of 50 db.
- Frequency compensated high impedance attenuator calibrated in 10 db steps from 0-50.
- Fine attenuator covers a 10 db range.
- Phase linear with frequency over entire band.

MICROWAVE SIGNAL SOURCES

Models SSR, SSL, SSS, SSM, SSX

634 MC to 11,000 MC

For use as a reliable source of microwave energy in transmission loss measurements, standing wave determination, etc. Unidial Control for accuracy and ease of operation. Direct reading (no mode charts to consult). Frequency determination accurate to 1% through use of present calibration and temperature compensated klystrons.

Five Microwave Signal Sources are available to cover the frequency range from 634 MC to 11,000 MC. Units ruggedly constructed, mounted on aluminum castings to insure mechanical stability. Klystron reflector voltage automatically tracked with tuning of the klystron cavity to provide unidial control. Signal sources supplied complete with klystron.

FREQUENCY MARKER

Model FM-L

950 mc to 2,040 mc

Polarad's Frequency Marker, Model FM-L, provides accurate frequency determination to within 10 kc over the frequency range 940 to 2020 mc.

The Frequency Marker produces calibration signals at precisely determined frequencies and these signals may be displayed and compared with an unknown rf signal, whose frequency can then be accurately measured.

Features:

- Frequency standard accurate to one part in 10^8.
- Frequency determination accurate to ±10 kc.
- Ten mc, 1 mc, and interpolation markers available.
- Markers throughout entire frequency range, 940 mc to 2040 mc.

See Us at Booth S-7, I. R. E. Show

Polarad Electronics Corporation

100 METROPOLITAN AVE., BROOKLYN 11, N. Y. • STagg 2-3464

Selenium Rectifiers

A new line of hermetically sealed selenium rectifiers in metal cases filled with inert gas are provided with standard tube terminals

to fit standard sockets. All standard tube mountings are available. The unit illustrated (no. W15CM) is rated at 390 v. rms input; 550 v. peak inverse; 120 ma., 160 v. dc output at 35° C. ambient. Half wave and bridge circuits are also available—**International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.**—TELE-TECH.

Resistors

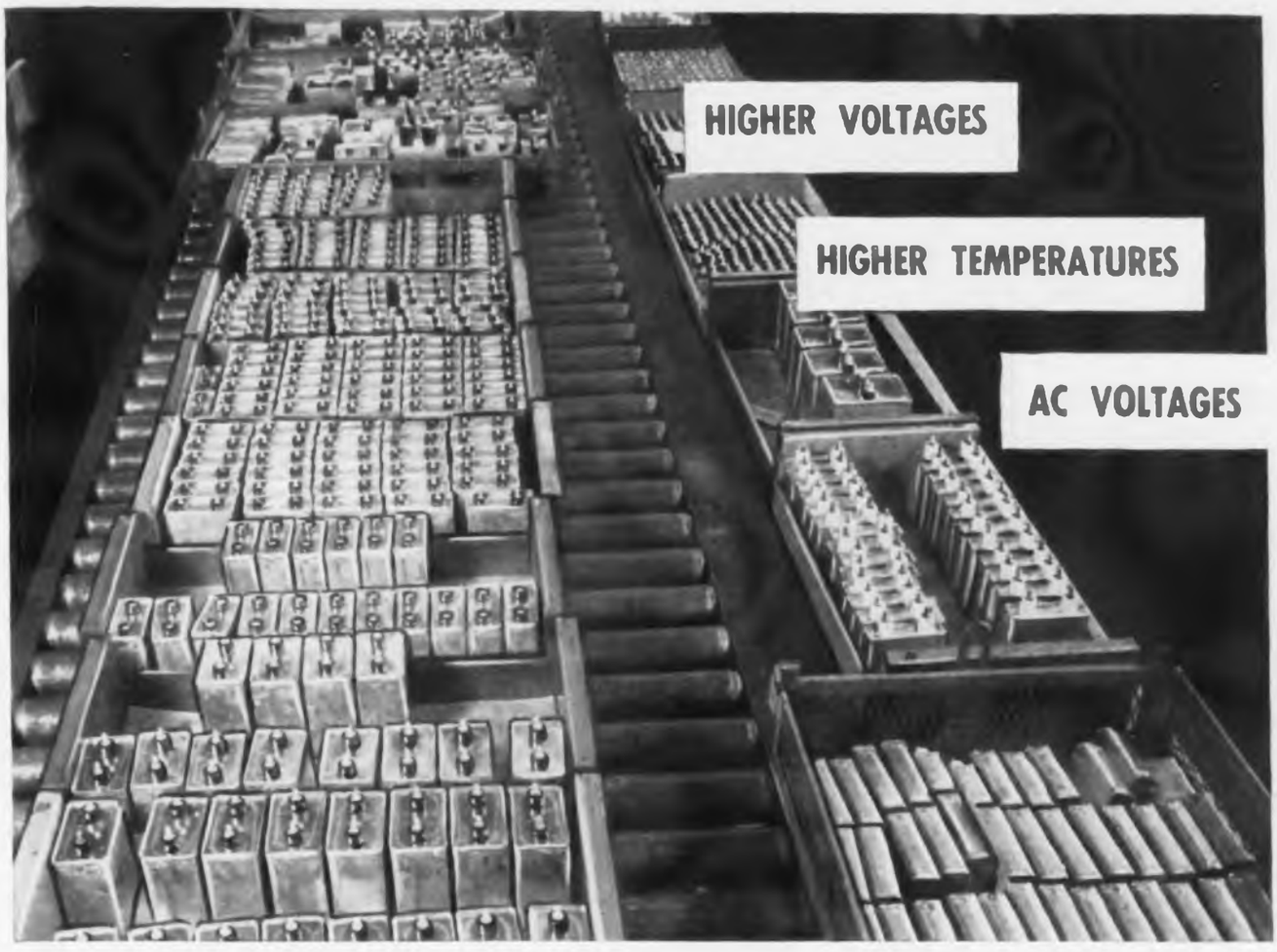
The two, five and ten watt sizes of the Dalohm miniature power resistor are completely welded from terminal to terminal. A

special silicone material seals the resistance element, making it impervious to moisture. Standard tolerance is 1%, but tolerances as high as 0.05% can be furnished if necessary. Temperature coefficient is practically flat. The resistance shift is less than 0.00002% C°. —**Dale Products, Inc., Columbus, Nebraska.**—TELE-TECH.

Toroidal Loading Inductors

Impedance matching between open wire lines and cables used in carrier communication may be achieved through the use of newly available Lenkurt toroidal loading coils. These are available in several values of inductance and in a number of physical arrangements. Coils are sound on Lenkurt-made high-stability iron powder toroidal

cores. Applicable to circuits using carrier frequencies of 3 to 35 KC, these coils in particular combinations form a tuned loading system which provides a substantially flat non-reactive impedance characteristic throughout most of this frequency range. Three different basic coils are available with inductances of 4.3, 2.6 and 4.1 mh. The 2.6 mh coil is also available with shunting capacitors connected across each winding of the coil. This coil is for end section loading of entrance and intermediate cables. Inductance of the coils is held within 0.02 mh of nominal value while the two windings on each coil are balanced to 0.1% of inductance value from 200 cps to 35 KC. Maximum resistance unbalance is 0.03 ohm, current rating is 300 ma. and insulation between the windings withstands 3500 volts rms.—**Lenkurt Electric Co., 1105 County Road, San Carlos, Calif.**—TELE-TECH.



General Electric can show you how to make wider use of JAN-C-25 capacitors

From years of experience in manufacturing paper-dielectric capacitors, General Electric can show you how to make wider use of your JAN capacitors.

These capacitors are used in thousands of applications—primarily d-c at rated voltages and temperatures. However, most JAN units can be operated at other voltages and under widely varying conditions.

For example, actual life tests have shown that a General Electric 1 muf. CP 70 unit rated for a minimum life of 10,000 hours at 1000 v. d-c and 40 C or 700 v. d-c and 85 C, can also be used at:

Higher voltages—1380 v. d-c at 85 C for 500 hours.
1300 v. d-c at 85 C for 1000 hours.

Higher temperatures—105 at 525 v. d-c for 500 hours.

AC voltages—440 volts, 60 or 400 cycles with normal JAN-C-25 derating.

General Electric has similar data for most of its JAN units, showing how each may be operated under a variety of conditions. For information on how these standard G-E capacitors may be applied in your circuits, consult your Apparatus Sales Office, or write to Specialty Capacitor Sales, General Electric Company, Hudson Falls, N.Y.

GENERAL ELECTRIC

407-307

JTAC Report

(*Continued from page 72*)

paper consists of six parts as follows:

Part 1—An introduction and brief resume of the history of allocation of the radio spectrum and of the growth of the present frequency allocation structure.

Part 2—Propagation characteristics of the spectrum consisting of a concise but definite statement of the properties of various frequencies from 10 KC to the near infra-red (300,000 MC and above).

Part 3—An ideal allocation based on present knowledge, current trends and present and prospective needs such as might be set up by one informed with the knowledge contained in Part 2, but who is not handicapped by having any existing allocations, equipment or facilities. In this Part, it is also assumed that there is complete peace throughout the world and all of the countries are working together in harmony.

Part 4—A critique of the present allocation in view of present knowledge, current trends, and present and prospective needs, consisting of a critical comparison of the properties of various regions of the spectrum and the uses to which they are put in the present frequency allocation lists.

Part 5—"Dynamic conservation" consisting of future guidance of allocations policy resulting from comparisons of Parts 3 and 4.

Part 6—Bibliography consisting of a selective list of books and periodical references.

Highspots of Spectrum Report

Other interesting points about recommendations in the JTAC paper, as released for general industry information by Chairman I. J. Kaar, are:

(1) "A (microwave) relay could be built from New York to the southern tip of South America, from New York through Alaska and across Bering Strait into Asia, Europe, Africa and via a chain of islands into Australia. The greatest overwater distance involved is approximately 90 miles."

(2) Ideal allocation would give 100-700 MC to TV, 180-1200 KC and 700-720 MC to radio. Practically speaking, AM at around 200 KC should be adopted wherever possible, and TV should be concentrated into not more than two continuous bands, instead of present 54-72 MC, 76-88 MC, 174-216 MC, 470-890 MC.

(3) TV transmitter powers should be 500 kw or more.

(4) International high-frequency broadcasting isn't sound, engineering-wise. Such program distribution should be accomplished via relays or recordings.

(5) "New phenomena, perhaps including biological effects" may possibly occur at top end of 3000-300,000 MC part of spectrum. Another eventuality around 300,000 MC: "Concentration of high power in very small area beams becomes possible. Such concentration . . . may have other applications than communication, as for example, mechanical operations such as the drilling of holes."

TELE-TECH . . . APPROVED BY TOP ENGINEERS IN SURVEY AFTER SURVEY!

1 - Chief engineers in broadcasting
2 - Consulting engineers in radio-TV
3 - Chief engineers in manufacturing

High praise for TELE-TECH in this new survey by

STANCOR

REPRODUCED here is a letter telling the results of a recent survey by a radio-television manufacturer—the second in a series of studies made independently of publishers.

STANDARD TRANSFORMER CORPORATION

STANCOR

ELSTON · KEDZIE AND ADDISON

INDEPENDENCE 3-7400 CHICAGO 18, ILLINOIS

January 16, 1952

Mr. S. M. Gaskins, Western Manager
Tele-Tech
201 North Wells Street
Chicago 6, Illinois

Dear Mr. Gaskins:

We at Stancor want to make every advertising dollar count and after you presented your story of market coverage, we thought we would go a step further and find out how Tele-Tech rated from a readership standpoint. We felt that the opinion of consulting engineers in the communications and broadcasting field would reflect the value of Tele-Tech to an advertiser.

The three questions listed below were asked the 55 consulting engineers listed in the 1951 Broadcasting Year Book.

1. Do you receive Tele-Tech regularly?
2. Do you read Tele-Tech regularly?
3. How do you rate Tele-Tech?

We were quite pleased with a return of 29 questionnaires for a 55% response. A copy of the questionnaire used is enclosed.

The fact that every one of these engineers receive Tele-Tech regularly and that 88% read it regularly, greatly impressed us. You can be proud of the standing of Tele-Tech among its readers since 91% were highly complimentary in their rating of the magazine. Statements such as "Excellent", "A required publication", "Valuable", and the like, were contained in almost every questionnaire.

Because of this we have realigned our advertising schedule and beginning with the March issue Tele-Tech will be used on a regular basis. The March insertion will be for two-thirds of a page in black and white.

Sincerely yours,

STANDARD TRANSFORMER CORPORATION

Harold M. Stral

Harold M. Stral, Advertising Manager

1 Made by Audio Devices, Inc. and addressed to AM-FM-TV broadcast stations. Gave impressive evidence of TELE-TECH'S high standing among broadcast engineers.

2 Made by Standard Transformer Corporation and addressed to consulting engineers. Again emphasizes TELE-TECH'S excellence as an engineering medium.

3 To be published in April. Will reveal a highly significant analysis made by one of the country's foremost parts manufacturers. And OTHERS are coming.

WATCH FOR THEM — MANUFACTURERS' SURVEYS—Mailed out BY manufacturers . . . mailed back TO manufacturers . . . tabulated BY manufacturers . . . the only kind of survey on which to base your technical magazine selection.

CALDWELL-CLEMENTS, INC.
480 Lexington Avenue, New York 17, N. Y.

for Smooth Voltage Control

Variac®

— the original continuously-adjustable auto-transformer — is the ideal device for controlling any a-c operated equipment.

VARIACS not only supply perfectly smooth control of voltage from zero, but also furnish output voltages 17% above line voltage. VARIACS are correctly designed for many years of trouble-free operation.

Illustrated below are the more popular units in the complete VARIAC line. Other models are available. VARIACS can be used singly, or in gangs for higher power and for polyphase operation.

Variac The trade name Variac is registered at the U. S. Patent Office. Variacs are patented under U.S. Patent No. 2,009,013 and are manufactured and sold only by General Radio Company or its authorized agents.

	OUTPUT — SINGLE PHASE DATA							
	Input Voltage	KVA	Output Voltage	Rated Amperes	Maximum Amperes	Type of* Mounting	Type	Price
Type 200-B	115	0.17	0–115 0–135	1	1.5 1.0	I	200-B	$12.50
Type V-5	115	0.86	0–115 0–135	5	7.5 5.0	I II III	V-5 V-5M V-5MT	18.50 20.50 25.00
	230	0.60	0–230 0–270	2	2.6 2.0	I II III	V-5H V-5HM V-5HMT	21.00 23.00 27.50
Type V-10	115	1.5	0–115 0–135	10	13.0 10.0	I II III	V-10 V-10M V-10MT	33.00 35.50 40.00
	230	1.2	0–230 0–270	4	5.2 4.0	I II III	V-10H V-10HM V-10HMT	34.00 36.50 41.00
Type V-20	115	3.	0–115 0–135	20	26.0 20.0	IV	V-20M	55.00
	230	2.4	0–230 0–270	8	10.4 8.0	IV	V-20HM	55.00
Type 50	115	5. 10.	0–115 0–115	40 80	45.0 90.0	IV V	50-A 50-AG2	140.00 310.00
	230	7. 14.	0–230 0–230	20 40	31.0 62.0	IV V	50-B 50-BG2	140.00 310.00

* I Unmounted model.
II Protective Case around windings.
III Protective Case, terminal cover, line switch, convenience outlet and line cord.
IV Protective Case, terminal cover and BX outlet.
V Two gang assembly — requires type 50-P1 choke — $12.00.

GR®

GENERAL RADIO COMPANY, 275 Mass. Ave., Cambridge 39, Mass.

Please send me the VARIAC BULLETIN. 520

Name .....

Address .....

(Street) *(City & Zone)* *(State)*

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Mass.

920 S. Michigan Ave. CHICAGO 5 1000 N. Seward St. LOS ANGELES 38

90 West Street NEW YORK 6

For Complete Information Fill-In Coupon

New German Lightweight Transmitter, Transceiver

Two new lightweight communication equipment designs have been perfected by Prof. Oscar Vierling, of Technisch Physikalische Werkstatten, Pretzfelderstrasse 174, Ebermannstadt, Oberfranken Bavaria, Germany (U.S. Zone). The transceiver, (B), operates in the 25-50, 82-88 or 150-162 MC ranges. FM modulation is employed and bandwidth is 15 KC. Unit requires input power of approximately 2 watts obtained from a battery source involving two 1.5 v "A" and two 67.5 v "B" batteries. Communicating range is said to be 20-30 miles. Design uses American tubes and bat-

Photo of new portable transmitter at (A), and portable transceiver unit at (B)

teries and weighs only 6 lb. 14 oz. Chassis measures 158 x 61 x 34 mm. Jack for earphones is included.

Transmitter unit, (A), has range of 1-2 miles; uses American tubes and hearing aid batteries (1.5 v and 22.5 v). It measures 19 x 4.1 (dia.) cm. Weight without batteries is 50 grams.

U.S. patent rights for both these designs are being handled by Mr. Fred Reis of Eve Car Inc., Room 1360, 11 West 42 Street, New York City, and include provisions for any subsequent improvements made by the German firm. Small quantities of these units can also be imported.

New VHF Propagation Theory Advanced

Developed by Dr. J. Feinstein of the National Bureau of Standards Staff, a new theory for the propagation of VHF radio waves accounts for VHF and microwave signals that have been observed at distances beyond the horizon.

Signals far beyond the radio-optical horizon have been explained by previous theories on the basis of unusual meteorological conditions or unusual inhomogeneities in the density of the atmosphere. For example, some investi-

(*Continued on page 94*)

gators have explained the phenomenon by the presence of "ducts" or "channels" in the atmosphere having a density which differs from the air above and below. Such theories have not accounted fully for the regularity of the phenomenon.

The theory developed at NBS suggests a new role for the gradual change in the refractive index of the atmosphere with height. This change, or gradient, leads to reflection as well as refraction of VHF waves as they travel out into space from the transmitter. The amount of reflection is small, but it is enough to lead to appreciable propagation of signals beyond the horizon.

This gradient-reflection theory appears to be corroborated in regard to frequency, angle dependence, range, etc., by experiments and by other research in the field. However, the new ideas are related to existing theories because all are based on the same fundamental hypothesis. This hypothesis assumes the earth to be a perfectly smooth sphere possessing an atmosphere which gives rise to a refractive index that changes exponentially with height. Several apparently minor approximations are necessary to adapt the ideal model to the conditions that actually apply. In light of the newer theory, there is a strong suspicion that these approximations have a much larger effect than previously assumed. Thus, efforts are being made at the National Bureau of Standards to develop a more complete theory that will justify the approximations or, alternately, to develop a new model that can be relied upon to predict propagation characteristics during any season and under all atmospheric conditions.

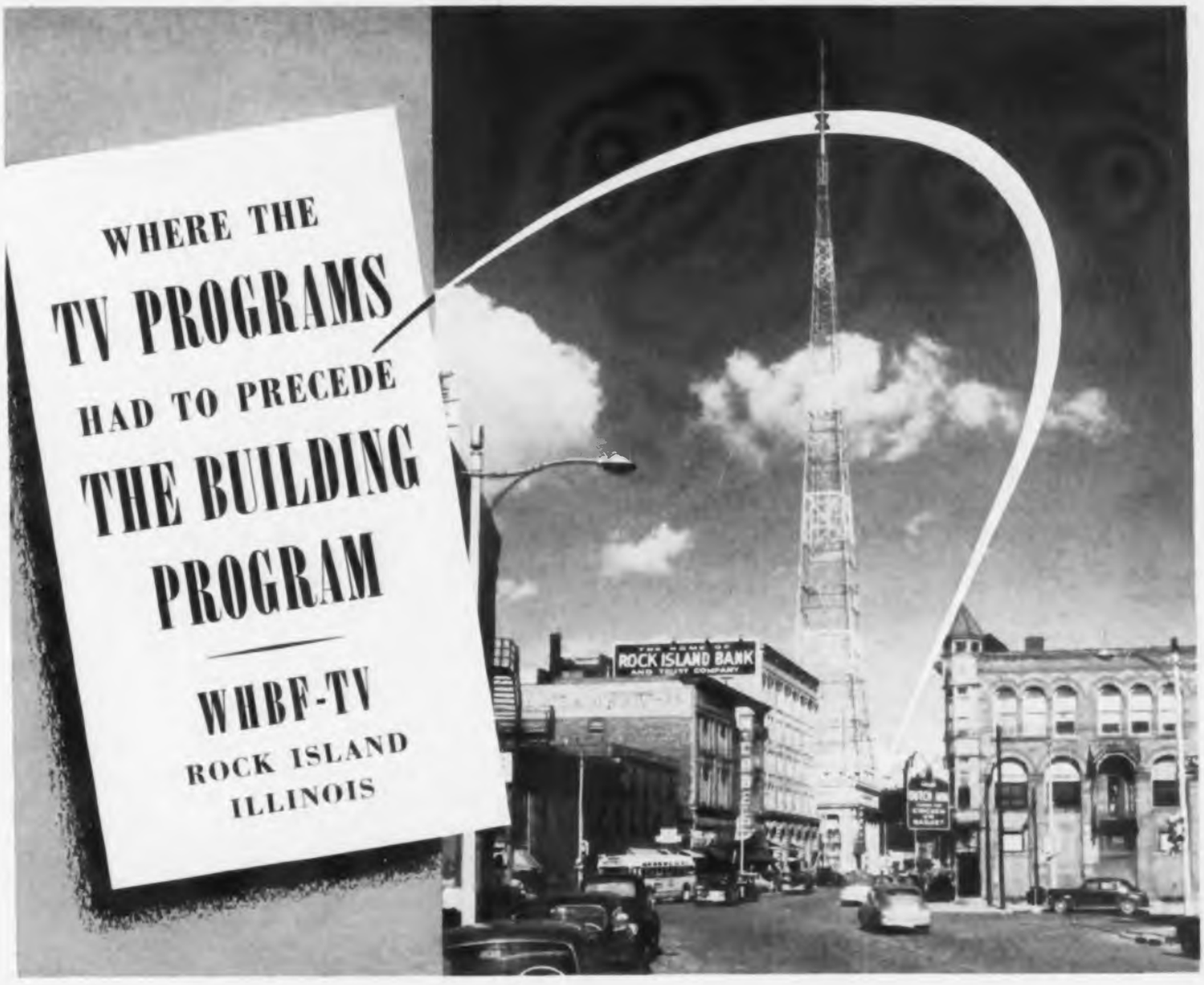
Further experimental verification will be sought using new NBS transmitters located at 9000 feet altitude on Cheyenne Mountain in Colorado and extra-sensitive receiving equipment placed on the gradually sloping plains eastward from the site.

Implications of the theory are many. For example, VHF communication at longer ranges than line-of-sight now appears feasible.

This increases the service possibilities for aircraft-to-ground transmissions and mobile radio telephony. It means, also, that high-powered TV stations located farther apart than line-of-sight distance may very likely interfere with each other.

Airborne Electronics Conference, May 12-14

The Institute of Radio Engineers is holding a National Conference on Airborne Electronics at the Dayton Biltmore Hotel, Dayton, Ohio, on May 12, 13 and 14, under the sponsorship of the Dayton Section, and Professional Group on Airborne Electronics, IRE. Gilbert H. Arenstein is president of the Conference, with Major Stuart M. Schram, Jr., USAF, as vice-president, and Garner P. Fanning as secretary. David G. Clute, in charge of publicity, may be reached at 2132 Meriline Ave., Dayton 10, Ohio.



WHBF's TV tower, with an overall height of 482 ft., was mounted on a specially constructed substructure 61 ft. high. Tower is designed to mount station call letters on all 4 sides, and carries an RCA custom-built, 5-section, Super Turnstile antenna.

Here is a situation that called for initiative and foresight—as well as unique design-engineering.

WHBF owns a downtown site on which they will erect a five-story building when material allocations permit. In the meantime, their TV license would be in disuse without proper antenna support. The problem was put up to Blaw-Knox . . . the solution is shown above—a permanent "tax-paying" base around which WHBF will eventually erect its new quarters.

BLAW-KNOX DIVISION OF BLAW-KNOX COMPANY
2070 Farmers Bank Building, Pittsburgh, Pa.

Distributed by GraybaR

BLAW-KNOX *Antenna* TOWERS

Network Synthesis to be Subject of Symposium

Modern network synthesis (audio to microwaves) is the subject of a Symposium to be held on April 16, 17 and 18, 1952 at the Engineering Societies Building Auditorium (33 West 39 St.) in New York City. This Symposium, jointly sponsored by the Polytechnic Institute of Brooklyn and the Office of Naval Research, will summarize the progress to date in the various fields of network synthesis and highlight new developments of current interest to engineers and physicists. American and European authorities, who have made original contributions to the art, will participate.

No registration fee will be charged for admission. Proceedings of the symposium will be published by September 1952 at a cost of $4.00 per copy. Orders for the Proceedings, accompanied by check or money order made out to "Treasurer, Network Symposium," will be accepted in advance. Copies of the detailed program, hotel accommodation information and registration forms are available on request. All correspondence should be addressed to: Polytechnic Institute of Brooklyn, Microwave Research Institute, 55 Johnson St., Brooklyn 1, New York.

NARTB Engineering Conference, March 31-Apr. 2

The dates for the sixth annual NARTB Broadcast Engineering Conference have been definitely set as Monday, March 31, Tuesday, April 1, Wednesday, April 2, reports Neal McNaughten, director of engineering for the NARTB. The Conference will be held at the Conrad Hilton (Stevens) Hotel, Chicago, in conjunction with the 30th annual convention of the National Association of Radio & Television Broadcasters, whose convention dates are Sunday, March 30, through Wednesday, April 2. Headquarters of the NARTB groups are at 1771 N Street, N.W., Washington 6, D. C.

RTMA COMMUNICATIONS HEAD

James D. McLean, general manager of Philco's Industrial Division, has been appointed chairman of the new General Communications Section of the Radio TV Manufacturers Assoc. It will absorb the Marine and Aviation Section of RTMA, as well as the former Communications Section

Use these cards to get data on ADVERTISED PRODUCTS

Here is a list of the major offerings by advertisers in this issue of TELE-TECH. If you want literature or further information on any of these products, simply enter the code numbers on the postage-free cards on the opposite page.

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316	Berland Assoc.	Tape recorders
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TELE-TECH — March 1952
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Caldwell-Clements, Inc.

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TELE-TECH has greatest percentage of gain in advertising in radio-TV-electronics publications

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Another important development from

Helipot *world's largest manufacturer of precision potentiometers...*

TINY in size—
the diameter of a penny!

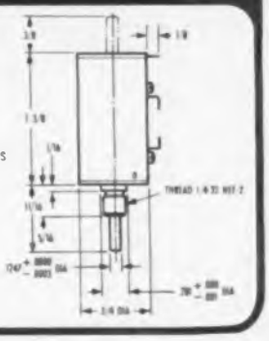
BIG in performance—
12 times the resolution of a conventional "pot."

THE MODEL AJ

Helipot

CONDENSED SPECIFICATIONS

Number of turns	10
Power rating	2 watts
Coil length	18"
Mechanical rotation	3600° + 12° − 0°
Electrical rotation	3600° + 12° − 0°
Resistance ranges	100 ohms to 50,000 ohms
Resistance tolerance	± 5.0%
Linearity tolerances:	
All values	± 5% (standard)
5000 ohms and above	± .1%
Below 5000 ohms	± .25%
Starting torque	0.75 oz. in.
Net weight	1.0 oz.



Miniaturization, weight reduction and circuit simplification are key design objectives in all airborne and many other electronics applications for precision potentiometers. Helipot's new Model AJ meets these needs with a compact potentiometer having over 12 times the resolution of conventional potentiometers of the same diameter . . .

- **SIZE AND WEIGHT: The AJ is only ¾" in diameter (small as a penny)—1⅜" long—weighs 1.0 oz. It requires only a minimum of valuable panel space!**
- **PRECISION, WITH CIRCUIT SIMPLICITY: On many applications the AJ replaces two conventional potentiometers, providing *both* wide range and fine adjustment in one unit. Its 18" slide wire gives a resolution of 1/3000 in a 100 ohm unit—1/6550 in a 50,000 ohm unit!**
- **RELIABILITY: The AJ is rugged and simple, is built to close tolerances with careful quality control. Its performance and reliability reflect the usual high standards of Helipot quality!**

MANY IMPORTANT CONSTRUCTION FEATURES: If you have a potentiometer application requiring light weight, unusual compactness, high accuracy and resolution, be sure to get the complete information on AJ advantages . . .

Here is a "pot" with bearings at *each* end of the shaft to assure precise alignment and linearity at all times. In addition, each bearing is *dust-sealed* for long life and is mounted in a *one-piece* lid and bearing design for exact concentricity.

Either single or double shaft extensions can be provided to meet individual needs —also, special shaft lengths, flats, screwdriver slots, etc.

Tap connections can be provided at virtually *any* desired point on the resistance element by means of a unique Helipot welding technique which connects the terminal to only ONE turn of the resistance winding. This important Helipot development eliminates "shorted section" problems!

BUILT TO HELIPOT STANDARDS

Helipot—world's largest manufacturer of precision potentiometers—has built an enviable reputation for highest standards in all its products, and the Model AJ is no exception.

The resistance elements themselves are made of precision-drawn alloys, accurately wound by special machines on a copper core that assures rapid dissipation of heat.

Each coil is individually tested to rigid standards, then is permanently anchored in grooves that are precision-machined into the case. Slider contacts are of long-lived Paliney alloy for low contact resistance and low thermal e.m.f. . . . and precious-metal contact rings are used to minimize resistance and electrical noise. All terminals are silver plated and insulated from ground to pass 1,000 volt breakdown test.

LONG LIFE: Although Unusually compact, the AJ is built throughout for rugged service. Potentiometer life varies with each application, of course, depending upon speed of rotation, temperature, atmospheric dust, etc. But laboratory tests show that, under proper conditions, the AJ has a life expectancy in excess of one *million* cycles!

Helipot representatives in all major cities will gladly supply complete details on the AJ—or write direct!

THE Helipot CORPORATION

South Pasadena 3, California

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

CUES for BROADCASTERS

(*Continued from page 53*)

position rotary switch and two 12-v. dc relays. Once the machines are set up the announcer at any one of the three locations can start or stop the machine for recording or playback.

For operation the tape is threaded into the machine and the gain and switch on the amplifier are set in the normal manner. Next the ganged switch is set for the type of operation (record or playback) to be used and finally the "Rewind-Stop-Forward" switch on the recorder is set on "Forward." A word of caution here. We do not set up the machine more than five minutes ahead of time in order to keep from having flat spots on the pressure roller.

If the machine is set up for playback on the air, relay #2 must be energized to start the forward motor. We did this by extending the control circuit to extra contacts on the remote channel key on the console. When the key is placed in the "on air" position it completes the control circuit to the relay and also connects the output from the recorder amplifier to the remote fader.

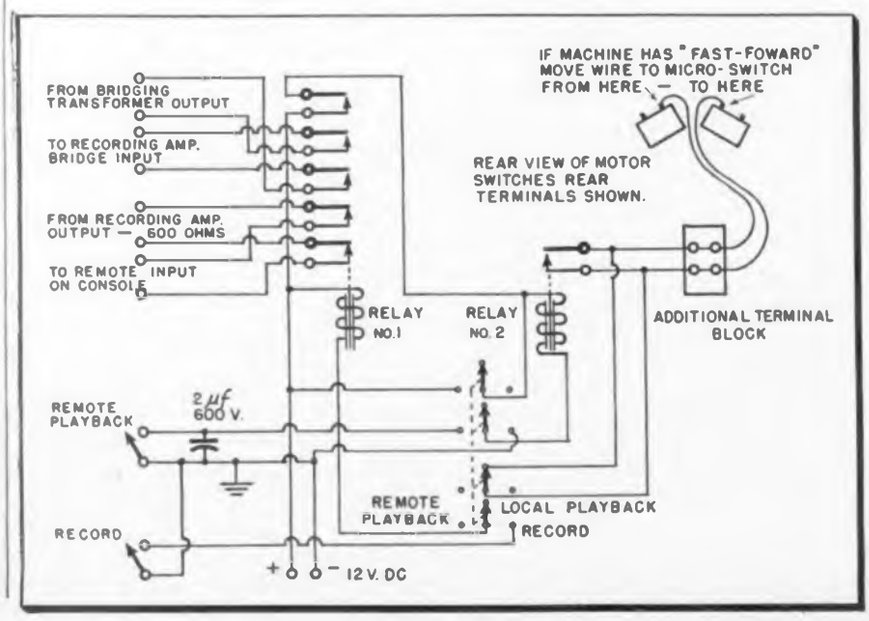
For recording, the control circuit is tied in to extra contacts on our studio switching unit. When the push button on the recording channels is depressed at the console, it automatically starts the recorder and connects the output of that console to the recorder input through relay #1. Relay #1, when energized, removes the output of the recording amplifier to the remote input and connects the program source to be recorded from the bridging transformer to the bridging input to the recorder amplifier, and energizes relay #2 to start the forward motor.

One side of the ac going to the forward motor must be disconnected and the contacts of relay #2 connected in series with it. An extra two-contact barrier terminal strip was added near the present terminal strip in back of the machine and the above connections made to it. This enables one to remove the unit from the rack for service or field use and use it in the normal manner just by bridging these two terminals. We mounted the rotary ganged switch on a panel between the tape transport and the amplifier so that only six wires need be removed to take the whole unit out of the rack. With the switch set in the local playback position complete control of the machine can be had for rewind and audition at the rack.

If you are not fortunate in having extra contacts at your console, control can be achieved by the addition of push button or other types of switches to perform the "on" and "off" functions. Two μf 600-v. transient filter capacitors should be added at the switches in order to keep out switch pops.

We have been using this system for about eight months and our operating personnel like it very much. In fact they can cue in and place the tape machines on the air with the same ease and precision that they do the turntables.

Relay connections for remote starting magnetic tape recorders with switched inputs



columbia LP records

mean maximum **L***istening* **P***leasure*

—thanks to the finest in modern sound recording methods and equipment

Music lovers everywhere know that Columbia LP records mean more listening pleasure—not in playing time alone, but in superb quality of reproduction. Yet few listeners outside the professional circle realize the degree of perfection which this record quality requires in every step of manufacture and processing. Take the original sound recordings and the processing masters, for example. Frequency response, signal-to-noise ratio, distortion and surface noise must measure up to standards which would have seemed entirely impractical a few years ago. But Columbia has found that Audiotape and Audiodiscs are an ideal combination for meeting all of these exacting requirements — Audiotape for recording the original sound and Audiodiscs for the masters from which stampers are made. In fact this same record-making combination is now being used with outstanding success by America's leading producers of fine phonograph records and broadcast transcriptions.

You can get this same sound perfection in *your* recording work, too — with Audiodiscs and Audiotape. Their superior quality is the result of more than 12 years of specialized experience by the only company in America devoted solely to the manufacture of fine sound recording media, both tape and discs.

The exclusive trade-mark of Columbia Long Playing Records—symbol of highest quality. Trade-Marks "Columbia," "Masterworks," ℗ Reg. U.S. Pat. Off. Marcas Registradas.

AUDIO DEVICES, Inc.
444 MADISON AVE., NEW YORK 22, N. Y.
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...including
audiotape*
for the original sound

...and **audiodiscs***
for the master recording

*Trade Mark

Tube Reliability

(*Continued from page* 56)

bumper guard or an ice pick. The exhaust tubulation section of the tube is most delicate. The next "DON'T", particularly for miniature tube pins, is to prohibit using the tube pins to align the socket contacts or to push extra lumps of solder out of the contact clips. Pin straighteners should be used on the miniature tube bases and socket "pronging" tools must be used on all new sockets to avoid the necessity of excessive tube insertion force.

The tolerances of the socket contact alignment are also important. We had an epidemic of cracked buttons on miniature tubes on a certain equipment three years ago. The same tube lots were found to be out of trouble in all other equipments, and extra controls on glass base strain characteristics did not eliminate the trouble. Very few of the tubes failed on installation. Most of the failures occured from the second to fourth heat cycle. The problem was solved when it was found that those particular sockets were outside of tolerances for the pin circle diameter by about 0.003 inches and thus the socket was holding the miniature base pins under a steady strain. The next prohibition should be against using screw drivers as tube tappers for noise testing. Cork mallets or masonite tappers will vibrate the tube with an intensity of tens of G's and no more adequate testing will be achieved by more violent pounding. The appropriate severity of the mallet and tapping force to use for noise testing can be readily determined by hitting yourself on the head, three blows in each of three directions.

The tube manufacturers are continuously being told by the military service and by the equipment manufacturers of the importance of reliable tubes and of the serious results of tube failures. Obviously, any wrong handling procedure on the part of the tube manufacturer, or on the part of the equipment manufacturer, which will produce more tube failures, particularly failures subsequent to initial equipment operation, should be eliminated. An equipment failure caused by mishandling of a high quality tube is just as serious as a failure caused by a poor quality tube.

The flexible leads on a subminiature tube create another problem of installation. These leads are made of .016 inches or .018 inches Dumet wire and should be handled with the

(*Continued on page* 104)

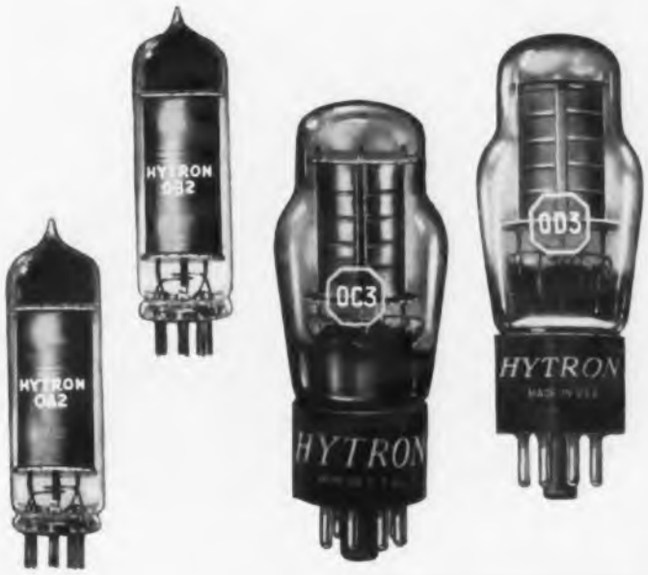
"When we think of V-R tubes, we think of CBS-HYTRON"

TUBES ARE KNOWN BY THE COMPANY THEY KEEP

It's automatic with scores of top-flight manufacturers. They turn to CBS-Hytron for the miniature OA2, OB2 and standard OC3, OD3.

That's only natural. They know CBS-Hytron has the know-how... know-how gained from making over 15,000,000 voltage regulators. They know CBS-Hytron supplies these apparently simple tubes to either JAN or commercial specifications. (In fact, CBS-Hytron's factory tests of VR tubes are much tougher than JAN.) And they know CBS-Hytron . . . top producer of VR tubes . . . can be depended upon for prompt delivery.

Follow the leaders yourself. Buy the best. Order *your* gaseous voltage regulators from CBS-Hytron.



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CBS-HYTRON voltage-regulator tubes

CBS HYTRON

HYTRON

A DIVISION OF COLUMBIA BROADCASTING SYSTEM, INC.

MAIN OFFICE: Salem, Massachusetts

Reads like the blue book of electronics... this list of famous companies who from long experience buy the best in voltage-regulator tubes... CBS-Hytron.

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In addition to many other prominent manufacturers, the U. S. Army, Navy, Air Force, Coast Guard, AEC, CAA, FCC, National Bureau of Standards, government development laboratories and other government agencies, well-known research laboratories and universities, foreign countries, and the nation's leading electronic parts distributors.

same precautions as soft drawn copper wire. In line with some of the previous discussion on shock and vibration, the leads should be wired in with enough slack to eliminate stress on the leads when the equipment is subjected to vibration. Excessive force on the leads is transmitted into stress on the glass and the tube will not usually fail immediately upon the application of the force, but will wait until this specialized Military equipment is airborne to finally produce the crack in the glass. Excessive heat on soldering of the leads also produces glass strain which may or may not show up initially. As a control on the tube manufacturers, there is a subminiature lead fatigue test which has been standardized for JAN tubes within the past few months. Recent experience indicates that tubes passing this test, will, with reasonable care taken in installation, be free from mechanical lead failures.

Destructive Mechanical Tests

Destructive Mechanical Tests are in the same category as sin—everyone is against such practices in principle, but everyone has different ideas as to what constitutes a transgression. A pertinent metaphor is the widespread prejudice against purchasing an apparently good second-hand automobile which may have been in an accident. In a vacuum tube there are many mechanical as well as electrical characteristics which can fatigue as a result of excessive mechanical tests. This is recognized in JAN specifications by the requirement that the sample tubes used for certain tests be destroyed. These sampling tests include life test, heater cycle test, shock test, fatigue, and lead fatigue. There have been many serious discussions between the tube engineers (concerning particular tube types) as to whether certain other standardized tests such as glass strain and high frequency vibration should be regarded as destructive. The most frequent destructive test is a new non-standardized test. The typical non-standardized test in the equipment designers plant is one of hundreds of ingenious attempts to accelerate a known or unknown type of field failure by some mechanical means. Frequently this test is applied for several months as a 100% incoming inspection procedure. There is no consultation with the tube manufacturer until a sudden change appears in the test results. At this point, the purchasing agent of the

(*Continued on page* 106)

NEW KESTER "44"
RESIN CORE SOLDER

**ESPECIALLY FOR TV . . . RADIO WORK . . .
EVERYTHING ELECTRONIC**

In speed of action for fast soldering, this product far surpasses anything in the Industry today. Unbelievably more active and mobile . . . absolutely non-corrosive and non-conductive.

For an actual demonstration in your plant, contact Kester's Technical Department.

KESTER SOLDER

Conforms with following specifications:
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equipment manufacturer advises the tube manufacturer that type XYZ has suddenly developed heart trouble. The purchasing agent does not include an accurate description of the test conditions and he exaggerates the percentage of defects. On the first examination, the rejected tubes prove to be defective, but it takes a third or fourth session to determine whether the tube test was appropriate or destructive.

The only answer to this dilemma, on the part of the equipment manufacturer, is to consult with the tube manufacturer on all existing and proposed 100% test and handling procedures which are not an obvious facsimile of an established non-destructive JAN test. There are few engineers, even in the employ of tube manufacturers, who have read all of the mechanical and electrical reference paragraphs on the JAN specifications of the vacuum tube types with which they are working. The time spent in becoming familiar with these paragraphs can be very helpful in avoiding misunderstandings in tube quality problems. It is important that you have your JAN book checked to include the 15 pages of Basic Section Revisions issued as of 13 June 1951, since many of the revisions were on mechanical tests.

The tube manufacturers are not against the consideration of new mechanical test procedures not already established in JAN form. Many of the important mechanical and electrical features of present tube types originated as a result of some new and ingenious test procedure developed by an equipment design engineer who was not buried in the forest of conventional vacuum tube tests. However, it is important to the reliability of the manufactured equipment that no destructive test procedures be applied to the individual tubes shipped as part of that equipment which might leave the tubes with any more latent defects than the tube manufacturer inserted. Destructive mechanical tests can contribute extremely useful engineering information when the tests are made on a sampling basis, and when the defective tubes and data are given to the tube design engineers with accurate descriptions. In addition, the test procedures must be reproducible in order to evaluate accurately all experimental tube design modifications.

This paper is one of the group presented at the Symposium on the Application of Tubes in Guided Missiles for Maximum Reliability, held recently in Washington, D.C., and Los Angeles, Calif. These symposiums were jointly sponsored by the Panel on Electron Tubes and the Committee on Guided Missiles of the Research and Development Board.

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Subminiature Tubes

(Continued from page 42)

output in a 400 MC oscillator.

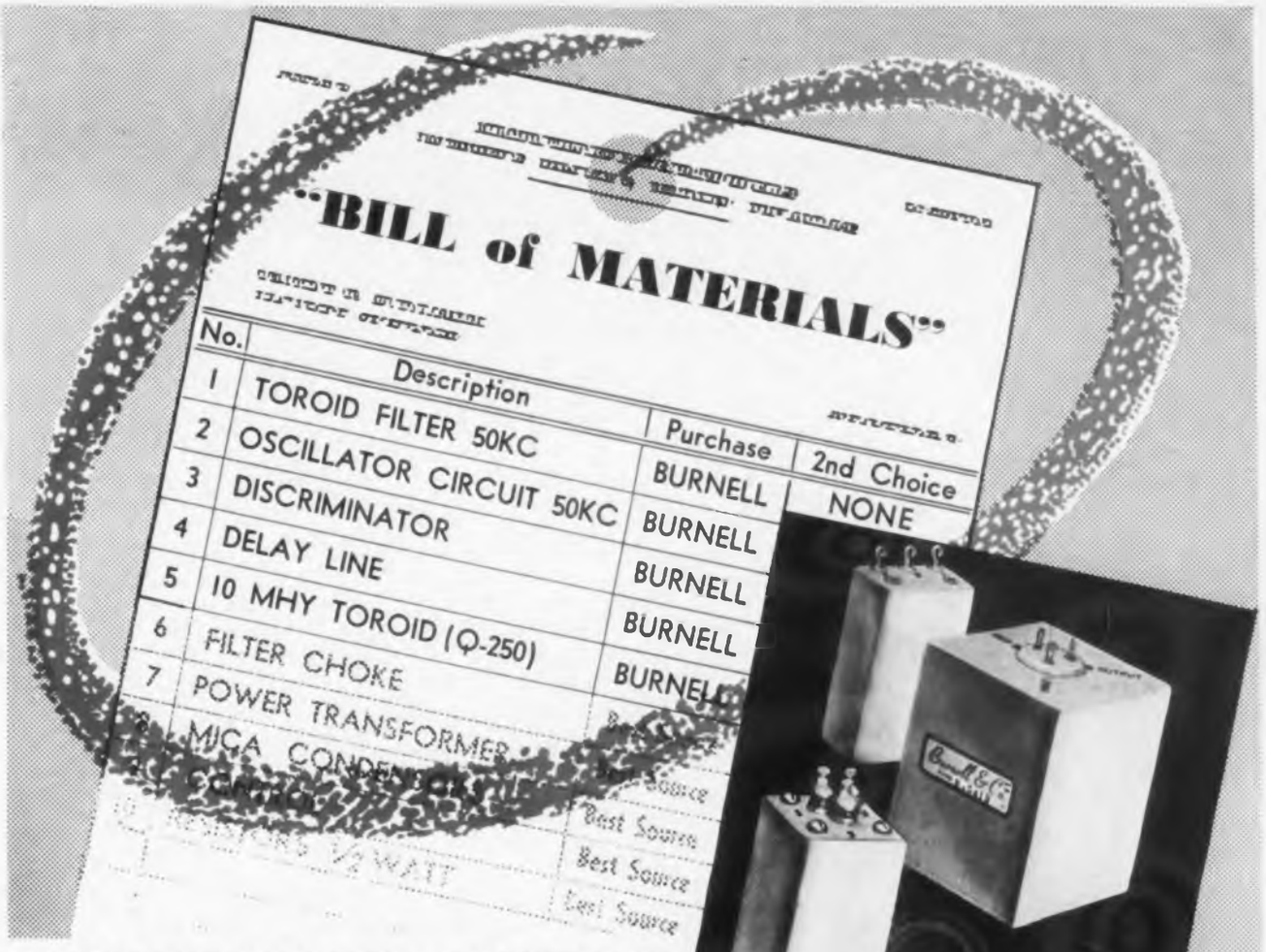
As the design was limited in cathode size, the only practical way of obtaining these currents was a considerable reduction in grid-to-plate spacing. In order to maintain a reasonable amplification factor, the grid projected area had to be increased to 24%. Average static plate current for the 5904 is 2.75 ma, transconductance 4700 micromhos, amplification factor 20. In an open line oscillator circuit the 5904 is tested for a minimum of 50 mw output at 400 MC at a plate current of 20 ma. In such a circuit, the grid bias is zero, and the only circuit adjustments allowable are feedback, coupling and tuning.

Resistance coupled amplifier data, with supply voltage varied from 21 to 30 v., are presented in Fig. 2. It is noted that the gain is remarkably stable over this wide range. These data represent an extreme range of filament voltage operation. Such operation is not recommended for applications where long life is desired. The upper curve of Fig. 3 shows average g_m for 69 tubes over 3000 hours of life. The curves of Fig. 3 are based upon life-test results of tubes made during 1951, and extend only to 3000 or 4000 hours because a large proportion of the tubes have not yet reached the 5000 hour point.

The 100 v. prototypes of the 5905 and the 5907 r-f pentodes were altered to get the highest possible combination of transconductance and plate resistance, together with the maintenance of a reasonable plate current to screen current ratio. It was found necessary to reduce the control grid to screen grid spacing by 18% and the control grid projected area by 10%. In addition, it was found that plate resistance could be raised by an increase in screen grid TPI. This is true, apparently, because the greater number of gaps in the grid produces a more uniform field which insures a higher percentage of electrons passing the screen grid plane at right angles. This greater uniformity of electron direction results in fewer critical velocity electrons. Plate resistance was found to be not at all critical to suppressor grid variations because of the very low quantity of secondary electrons released from the plate at low voltage operation.

Silver plating is used on control grid wires for manufacturing reasons, and has been found to reduce contact potential problems. Aging

(Continued on page 110)



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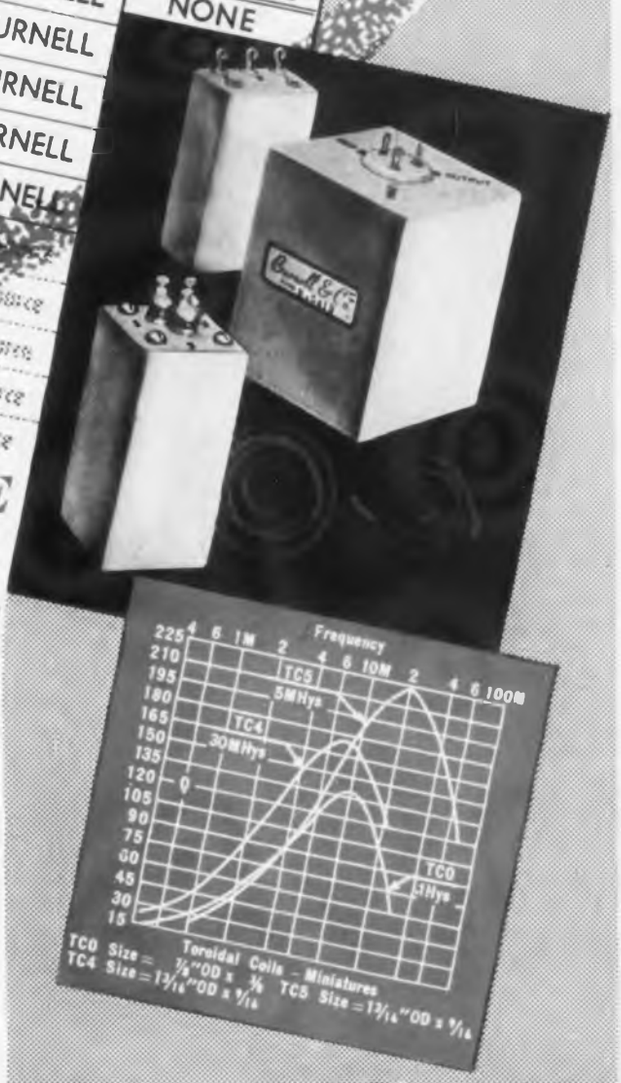

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schedules have been devised which avoid any #1 grid aging in order to prevent vaporization of the silver plating off the grid wire. Average characteristics for the type 5905 are: plate current 2.0 ma, screen current 0.75 ma, transconductance 2850 micromhos, plate resistance 150,000 ohms. The type 5907 carries a slightly higher rating, with a plate current of 2.7 ma, a screen current of 1.1 ma, a transconductance of 3000 micromhos, and a plate resistance of 100,000 ohms. The 5907 has a remote cutoff characteristic, and is rated for −4.5 v. control grid bias for a transconductance of 10 micromhos.

Resistance coupled amplifier data for the 5905, with supply voltage varied from 21 to 30 v., are presented in Fig. 4. As previously stated, this wide range of filament voltage is not recommended for long life. A circuit diagram for a 400 MC single-stage amplifier is shown in Fig. 5. The amplifier is fed from a 50 ohm source, and is driving a dummy load to simulate the loading of a second pentode. Voltage gains between 2 and 3 are obtained with a 26.5 v. supply, using either the 5905 or the 5907. This represents a power gain through the tube of 1.2 to 2.2. Bandwidth measured in this circuit was approximately 15 MC. The unique tuned circuits employed in this amplifier are shown in Fig. 6. Average g_m of 55 tubes of both types over 4000 hours of life is shown in the center curve of Fig. 3.

The type 5908 was required to operate efficiently as a mixer with #3 grid oscillator injection, and to be useful for gating applications. These functions required a high peak transconductance for maximum conversion transconductance, and sharp cutoff characteristics for the #1 and #3 grids. Plate resistance was not of major concern, since effective mixer plate resistance is several times that obtained in normal pentode operation.

In redesigning the 100 v. prototype of the 5908, it was found advantageous to reduce practically all the interelectrode spacings. The control grid-to-screen grid spacing was reduced by 24%, the screen grid-to-suppressor grid spacing by 37%, and the suppressor grid-to-plate spacing by 58%. More design freedom existed than in the case of the r-f pentodes because the normal pentode plate resistance was not a critical item. This allowed the development of a favorable set of static characteristics. Operated with a 2.2 megohm grid resistor and the #3 grid grounded, the plate current is 3.3 ma, screen current 2.0 ma, and transconductance 2200 micromhos. Normal pen-

(*Continued on page* 112)

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tode plate resistance is only 31,000 ohms, but effective plate resistance when the tube is operated as a mixer is 65,000 ohms. The conversion transconductance is 1000 micromhos when measured in accordance with standard JAN practice with 10 RMS oscillator injection on the #3 grid. The #1 grid cutoff occurs at −5.0 v., and #3 grid cutoff at −7.0 v.

The 5908 gives very satisfactory mixer performance at 400 MC. Operating from a 50 ohm source and feeding into a high impedance i-f transformer, the 5908 produces voltage gains as high as 28 with a bandwidth of 0.5 MC. Fig. 7 shows a circuit diagram and Fig. 8 a photograph of a typical receiver front end using 26.5 v. tubes. The lower curve of Fig. 3. shows average transconductance of 55 tubes life tested to 3000 hours.

Operating Life

For comparison purposes, Fig. 9 shows life characteristics over 3000 hours of life for types 5906 and 5916, the 26.5 v. heater, 100 v. anode counterparts of the 5905 sharp cutoff pentode and the 5908 pentode mixer, respectively.

Fig. 10 illustrates cumulative percentage failures for a group of 316 26.5 v. heater type tubes over a period of 4000 hours of life. The dotted curve shows similar failure percentages for a group of 507 similarly designed subminiatures with 6.3 v. heaters. These failures include all types of defects which are generally considered to end tube life, whether the tubes are completely inoperative or merely "out of limits."

All the tubes included in the curves of Fig. 10 were designed for a life expectancy rating of 5000 hours at room temperature and 1000 hours at 175°C ambient temperature, when operated at specified life test conditions. The "life expectancy" denotes the time at which a group of tubes is expected to have 80% minimum average life, as described in paragraph F-4b of the JAN-1A Specification for Electron Tubes. (Average life is the sum of tube operating hours completed without failure within specified life period divided by the product of the number of tubes started times hours of specified life period.) The life expectancy values given are based on an accumulation of data at specified life-test conditions. A replacement guarantee is not implied, but the long life characteristics of these tubes assure a high degree of reliability in operation. Acceptance life tests on a sampling basis are conducted at 175°C

(*Continued on page* 114)

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ambient temperature for a period of 500 hours, and must satisfy a minimum average life requirement of 90%.

The basic design features contributing to mechanical ruggedness and low noise output of the tubes described were adopted from their 6.3 v. prototypes. Such features as short mount height, tripod mount support, heavy-walled cathode sleeves, double cathode tabs, and oval grid construction all assisted in the achievement of a 450g shock rating. A sample group from each lot of tubes is shock tested at 500g in accordance with the JAN procedure. In addition, direct stem lead connection to the control grid, the use of pointed-outline micas, and careful control of the fit of the cathode and the grid siderods in the mica holes are employed to minimize vibration noise output. The tubes are tested 100% for noise output under 15g vibration at 40 CPS. The combination of mechanical ruggedness with high electrical performance makes these tubes suitable for applications where dependable operation is required.

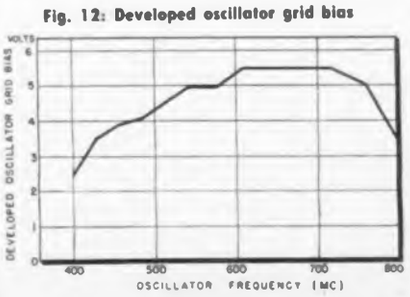
UHF Converter

(*Continued from page* 39)

is shown in Fig. 13. The small spread in the noise figure is due to the selection of crystals for good noise figure. The noise figure is about 21 db over the band. This is only slightly higher than the noise figure of most VHF tuners on channel 13 a few years ago. It is hoped that better crystals or a practical UHF r-f amplifier tube will make it possible to reduce the noise figure. The maximum and minimum overall voltage gain of four converters is shown in Fig. 14. It is seen that the average voltage gain is two and the input vswr is better than 1.5 over the band. (See appendix.)

Fig. 15 shows the maximum and minimum image rejection of four converters. Note the effect of the high pass filter at the low frequency

Fig. 12: Developed oscillator grid bias



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Type	Description	Controlled Characteristics: Shock	Fatigue vibration	Vibration output	Stabilization	Centrifugal acceleration	5,000 hour life	Heater cycle life	High temperature life	Median control	60,000 foot altitude	Prototype	Heater Volts	Heater Ma.	Plate Volts	Plate Ma	Grid Volts	Screen Volts	Screen Ma.	Amp Factor	Mut. Cond.
Reliable Miniatures																					
CK5654	RF Amplifier Pentode	✓	✓	✓	✓			✓		✓		6AK5	6.3	175	120	7.5	−2.0	120	2.5	—	5000
CK5686	AF-RF Output Pentode	✓	✓	✓	✓			✓				—	6.3	350	250	27.0	−12.5	250	5.0	—	3100*
CK5725	RF Mixer Pentode	✓	✓	✓	✓			✓		✓		6AS6	6.3	175	120	5.2	−2.0	120	3.5	—	3200
CK5726	Dual Diode	✓	✓		✓			✓		✓		6AL5	6.3	300	Max. Peak Inv. 330 volts. I_o = 9 ma. dc per plate						
CK5749	RF Amplifier Pentode	✓	✓	✓	✓			✓		✓		6BA6	6.3	300	250	11.0	R_k = 68 ohms	100	4.2	—	4400
CK5751	High Mu Dual Triode	✓	✓	✓	✓			✓		✓		12AX7	6.3 12.6	350 175	250	1.1	−3.0	—	—	70	1200
CK5814	Low Mu Dual Triode	✓	✓	✓	✓			✓		✓		12AU7	6.3 12.6	350 175	250	10.5	−8.5	—	—	17	2200
Reliable Subminiatures																					
†CK5702WA (6148)	RF Amplifier Pentode	✓	✓	✓	✓	✓	✓	✓	✓		✓	5702	6.3	200	120	7.5	R_k = 200 ohms	120	2.5	—	5000
†CK5703WA (6149)	High Frequency Triode	✓	✓	✓	✓	✓	✓	✓	✓		✓	5703	6.3	200	120	9.0	R_k = 200 ohms	—	—	25	5000
†CK5744WA (6151)	High Mu Triode	✓	✓	✓	✓	✓	✓	✓	✓		✓	5744	6.3	200	250	4.0	R_k = 500 ohms	—	—	70	4000
†CK5784WA (6150)	RF Mixer Pentode	✓	✓	✓	✓	✓	✓	✓	✓		✓	5784	6.3	200	120	5.2	−2.0	120	3.5	—	3200
CK6110	Dual Diode	✓	✓	✓	✓	✓	✓	✓	✓		✓	—	6.3	150	Max. Peak Inverse 420 volts. I_o = 4.4 ma. per plate						
CK6111	Low Mu Dual Triode	✓	✓	✓	✓	✓	✓	✓	✓		✓	—	6.3	300	100	8.5	R_k = 220 ohms	—	—	20	4750
CK6112	High Mu Dual Triode	✓	✓	✓	✓	✓	✓	✓	✓		✓	—	6.3	300	100	0.8	R_k = 1500 ohms	—	—	70	1800
CK6152	Low Mu Triode	✓	✓	✓	✓	✓	✓	✓	✓		✓	5975	6.3	200	200	12.5	R_k = 680 ohms	—	—	15.8	4000
Rugged Miniatures																					
6AK5W	RF Amplifier Pentode	✓	✓	✓				✓				6AK5	6.3	175	120	7.5	−2.0	120	2.5	—	5000
6AL5W	Dual Diode	✓	✓					✓				6AL5	6.3	300	Max. Peak Inv. 420 volts. I_o = 9 ma. dc per plate						
6AS6W	RF Mixer Pentode	✓	✓	✓				✓				6AS6	6.3	175	120	5.2	−2.0	120	3.5	—	3200
6C4W	RF Power Triode	✓	✓	✓				✓				6C4	6.3	150	250	10.5	−8.5	—	—	17	2200
6J6W	Dual AF-RF Triode	✓	✓	✓	✓							6J6	6.3	450	100	8.5	R_k = 50 ohms	—	—	38	5300
6X4W	Full Wave Rectifier	✓	✓					✓				6X4	6.3	600	Max. Peak Inv. 1250 volts. I_o = 70 ma. dc.						
Rugged GT Types																					
6J5WGT	General Purpose Triode	✓	✓	✓								6J5GT	6.3	300	250	9	−8.0	—	—	20	2600
12J5WGT	General Purpose Triode	✓	✓	✓								12J5GT	12.6	150	250	9	−8.0	—	—	20	2600
6SN7WGT	Dual Triode	✓	✓	✓								6SN7GT	6.3	600	250	9	−8.0	—	—	20	2600
6X5WGT	Full Wave Rectifier	✓	✓									6X5GT	6.3	600	Max. Peak Inv. 1250 volts. I_o = 70 ma. dc.						

The above listing of Controlled Characteristics is based on the requirements and test limits of the applicable JAN-1A test specification.
Note: All dual section tube ratings are for each section. *2.7 watts Class A output. 10 watts Class C input power to 160 mc.
†For simplicity of identification with the prototypes, the type numbers with a "WA" suffix were established at the request of the Armed Services to replace the type numbers in parenthesis previously announced for these types.

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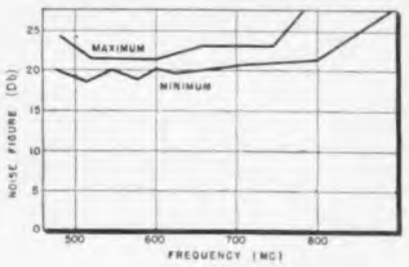

Fig. 13: Converter noise figure response

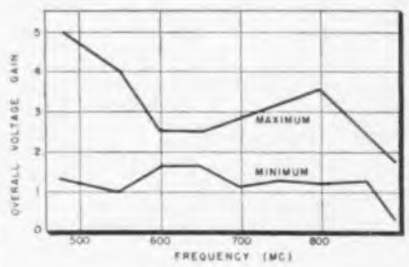

Fig. 14: Overall converter voltage gain

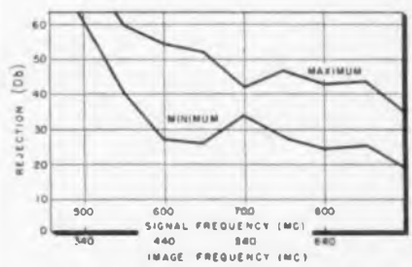

Fig. 15: Image rejection characteristic

end of the band. The i-f rejection is much greater than 60 db.

Fig. 16 shows the total frequency drift of a converter after two hours' operation in a small cabinet. The temperature rise was 27°C. The oscillator has been temperature compensated at 640 MC. The drift may require retuning on a separate sound type receiver, but not on an intercarrier type receiver. No microphonic howl has been encountered on any receiver under normal operation.

Reception Tests

These converters have been tested at Bridgeport and New Haven, Conn., on 530 MC and 850 MC from NBC experimental transmitters. At E. Paterson, N. J., 15 mi. from New York City, we monitor the new Du Mont 713 MC transmitter. The picture is good with only slight background noise "twinkle" with a signal strength of 140 μv at the converter input.

In conclusion, this converter has fulfilled the design requirements set forth in all respects except for some frequency drift. This may only

(*Continued on page* 118)

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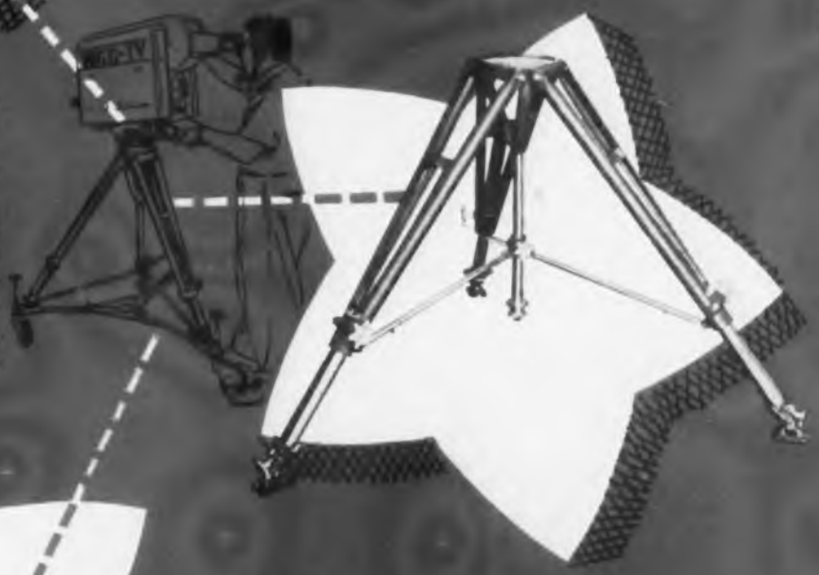

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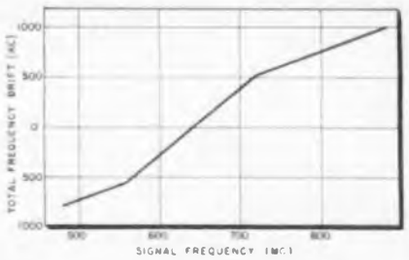

Fig. 16: Total frequency drift after 2 hours of operation and 27° C temperature rise

slightly inconvenience users of separate sound type receivers.

The author wishes to thank project leader C. D. Nestlerode, mechanical engineer D. Felt, engineer R. Gardner, and all his co-workers for their share in the project, and the P. R. Mallory Co., Indianapolis, Ind., for their development of the Mallory UHF Inductuner and collaboration to fit our needs.

APPENDIX

Fig. 11 shows oscillograph photos of the UHF preselector and crystal mixer response and reflection coefficient at seven frequencies throughout the UHF TV band. Each line of photos shows the response at a particular frequency, the left column shows the usual response curve measured through a short length of 72 ohm coaxial cable; the middle column shows the response curve as measured through a 50 ft. length of 72 ohm coaxial cable. The latter response curve, unfamiliar as it seems, more truly represents the response under actual operating conditions. In addition this curve also indicates the degree of impedance match, to one familiar with its interpretation. The right column shows the reflection coefficient, the measured variation of voltage across a 72 ohm termination of the sweep generator, connected through 50 ft. of 72 ohm coaxial cable to the input of the UHF converter. A comparison of the middle and right columns will indicate that the best reflection coefficient (match) is associated with the response curve having a minimum of jagged variations at its peak.

Two marker pips at 77.25 MC (channel 5 picture carrier) and at 87.75 MC (channel 6 sound carrier) visible on some response curves, show the good tracking achieved between the preselector tuned circuits and the oscillator circuit over the entire UHF TV band.

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Provides revolutionary remote control of camera focus, lens change, pan, tilt. Styled to match other components in the GPL TV line.

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General Precision Laboratory

INCORPORATED

PLEASANTVILLE NEW YORK

TV Camera Chains • TV Film Chains • TV Field and Studio Equipment • Theatre TV Equipment

HANDLING TV FILMS

(*Continued from page 59*)

Overlubrication in the case of projection equipment, or in fact, any kind of optical equipment can make trouble, especially one which seems to grow worse during the projection of a film. This is sometimes incorrectly referred to as focus drift. The latter is caused by green film which has a curl in it which produces a gradual change in focus during projection. In the case of overlubrication, oil is quite frequently deposited on the lens and results in a softening of the focus of a picture for no apparent reason. Because moving the lens will not correct the condition, the film is blamed when actually the over-ambitious operator has caused it by dousing the movement in oil.

Shading troubles are caused by unsuitable film, improper use of the shading controls at the film camera control console, or improper adjustment of the edge lighting and bias lights on the inconoscope camera. The proper method of adjustment of these is generally laid down by the manufacturer and once set in the initial warming up period they seldom require adjustment. If serious shading troubles are encountered which refuse to yield to normal control manipulation, it is worthwhile checking the illumination of these lights for even the low power bulbs used there burn out eventually. Of course, strict attention to iconoscope tube rotation and rest periods, will be good insurance picture-wise. A wornout iconoscope, like a blackened projection lamp, will ruin any film.

Projection Flaws

Happily, projection flaws occur rarely. However, some people seem to be more cognizant of optical faults than others. Therefore it often pays to get more than one person's opinion when checking projection or other optical equipment. Most optical flaws fall in one of two categories: loss of synchronization between pull-down and light pulse; and loss of synchronization between projection light and camera scanning pulse. The former is caused by the shutter slipping and allowing part of a frame to be observed during the time that the film is still moving. This produces a ghost which shows as a trailing figure on the screen. Normally this cannot occur unless some mechanical condition exists to allow the shutter to move with respect to the pulldown mechanism.

Light bars are caused by the second optical fault mentioned in the preceding paragraph and result in lines of light streaking across the frame which are very annoying to watch. In this case, the cause is again mechanical and can be cured by rotating the motor armature position with respect to the pulldown and shutter mechanism. Neither of these troubles is normally encountered after the equipment has been properly installed.

Misalignment of the multiplexer mirrors (if used), will result in unsatisfactory operation. These mirrors are usually front surfaced, and finger marks ruin them, even if cleaned at once. For the same reason cleaning should be done carefully, otherwise there is risk of damaging the reflector surface. Mechanical misalignment of these mirrors results in a picture which is off or improperly aligned with the iconoscope mosaic. After cleaning, the alignment of these mirrors should be very carefully checked.

Sound is one of the biggest causes of complaint with televised films today. This is partly due to lack of a "standard" emulsion position in 16

(*Continued on page 122*)

a complete line of

hermetically sealed oil-filled

HIGH-VOLTAGE COMPONENTS

Rectifiers

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

Pulse Transformers

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

Resonant Reactors

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

Filament Transformers

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

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

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

GENERAL ELECTRIC

401-63

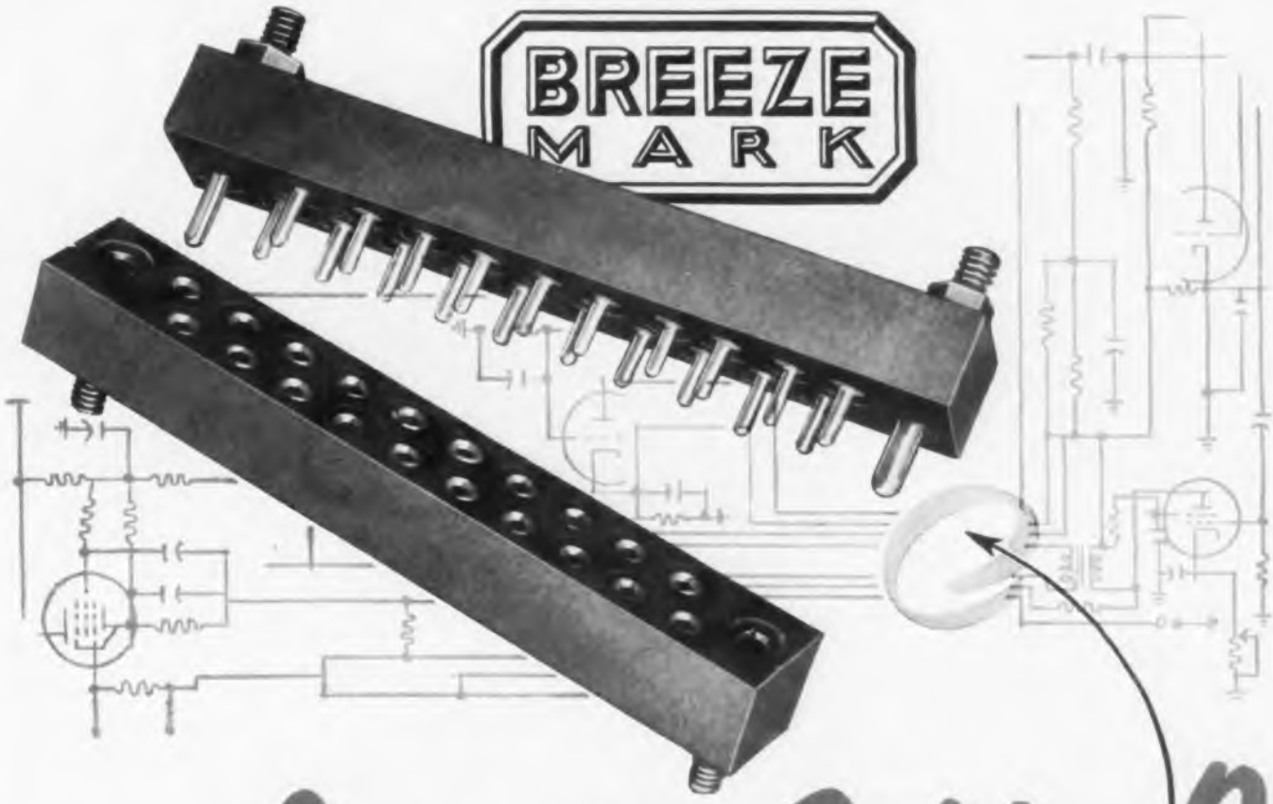
mm film. For instance, 35mm film has a standard position of emulsion toward the lamphouse for all release prints. But because reversal film is used quite frequently in television for 16mm work, and 16mm prints are not always made in an optical printer, the position of the emulsion may vary considerably. This means that the focus of the sound track will not be correct unless the projector is fitted with an adjustment which automatically refocusses the sound lens for each position—towards, or away from, the screen—of the emulsion. If the sound track image is out of focus there will be a decided loss of high frequency response due to the softening of the minute peaks and valleys which constitute a variable area sound track. Today, at last, television projector manufacturers are offering equipment with this very essential feature.

Oil can also cause the same trouble, and again, over-oiling will produce a very baffling trouble which seems to recur for no apparent reason. The answer here is obvious. However, under-oiling will cause even greater trouble. If the sound track runs erratically in the guides or the rollers stick or produce undue friction flutter or wow, both will be heard in the loudspeaker system. These are difficult to eliminate. Another simple, but very baffling fault is end play in the guide rollers near the sound head. In extreme cases, there will be so much play that the perforations will move far enough to modulate the sound head signal—producing a loud "Bronx" cheer!

In most cases conscientious attention to the manufacturer's handbook of preventive maintenance will reduce or eliminate most or all of these troubles. But there is always the temptation to allow equipment which is running satisfactorily to run a little longer because "it's a shame to disturb it, it's running so well." But false economy may stop the show later on and result in the loss of a sixty second commercial as well as a job!

New Appointment by Central Transformer Co.

Frank J. Gallagher has been appointed sales manager of the Central Transformer Co., 910 W. Jackson Boul., Chicago 7, Ill., announces M. R. Whitman, president. Mr. Gallagher was formerly assistant sales manager for the Thordarson Division of Maguire Industries, with which he had been connected for 15 years.



Connector Problem?

...We'll take it from HERE

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

Lightweight actuators for any requirement.

Job engineered, welded-diaphragm bellows.

Flexible conduit and ignition assemblies.

Aero-Seal vibration-proof hose clamps.

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

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Special CONNECTORS

BREEZE CORPORATIONS, INC.

41 South Sixth Street Newark, New Jersey

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

IRE Program

(*Continued from page 49*)

Complex Plane Scanner"—**J. R. Ragazzini and G. Reynolds**
"Resonance Characteristics by Conformal Mapping"—**P. M. Honnell and R. E. Horn**

INFORMATION THEORY II—NOISE STATISTICS AND SIGNAL DETECTION

"Discussion of a Method of Expanding Noise Autocorrelation Function in a Power Series"—**F. W. Lehan**
"A Proposal for the Determination of Coherence in a Signal Field"—**B. S. Melton and P. R. Karr**
"The Response of Linear Systems to Random Noise"—**B. Gold**
"Correlator for Low Frequencies"—**V. J. Guethlen**
"Optimum Techniques for Detecting Pulse Signals in Noise"—**D. L. Drukey**

MICROWAVES I—WAVEGUIDES A

"Microwave Wiring"—**D. D. Grieg and H. Englemann**
"Simplified Theory of TEM Propagation Along Conductor-Ground-Plane Transmission Systems"—**F. Assadourian and E. Rimai**
"Microwave Components for Conductor-Ground-Plane Transmission Systems"—**J. A. Kostriza**
"Method for Open Waveguide Standing-Wave Measurements"—**S. W. Attwood and G. Goubau**
"New Guided-Wave Technique for the Millimeter Wavelength Range"—**A. G. Fox**

INSTRUMENTATION II—ELECTRONIC MEASUREMENTS A

"Measurement of Impedance and Admittance"—**B. Salzberg and J. W. Marini**
"Accurate RF Microvolts"—**M. C. Selby**
"Automatic Switching Applied to Interelectrode Capacitance Measurements"—**R. E. Graham**
"Measurements of Millimeter Radiation with the Pneumatic Heat Detector"—**H. Theissing, H. J. Merrill, and J. M. McCue**
"Automatic Smith-Chart Impedance Plotter"—**K. S. Packard**

TELEVISION II—COLOR

"Requisite Color Bandwidth for Simultaneous Color-Television Systems"—**K. McIlwain**
"Colorimetric Electronics"—**F. J. Bingley**
"The Generation of Compatible Color Signals for Research and Field Testing"—**J. Fisher**
"A Universal Scanner for Color Television"—**G. R. Tingley, R. D. Thompson, and J. H. Haines**
"Vestigial Sideband Transmission of the Color Subcarrier in NTSC Color Television"—**W. F. Bailey**

CIRCUITS II AND INFORMATION THEORY III

"Networks for Determination of Power-Spectra Moments"—**S. H. Chang and W. H. Lob**
"Nonlinear Filter Design on Maximum-Likelihood Basis"—**T. G. Slattery**
"Optimum Linear Shaping and Filtering Networks"—**R. S. Berkowitz**
"A Generalized Theory of Filtering and Multiplexing"—**L. A. Zadeh and K. S. Miller**
"Filter Transfer-Function Synthesis"—**G. L. Matthaei**
"Filters of Maximum Bandwidth-Impedance-Ratio Product"—**T. J. O'Donnell and E. M. Williams**
"A Band-Pass Filter Using Simulated Transmission-Line Elements"—**A. D. Frost and C. R. Mingins**

MICROWAVES II—WAVEGUIDES B

"Nonuniform Transmission Lines"—**J. G. Gurley**
"The Optimum Piston Position for Coaxial-to-Waveguide Transducers"—**W. W. Mumford**
"Broad-Band Ridged and Flatguide Components 10-40 kmc/sec"—**S. Hopfer**
"Step-Twist Waveguide Components"—**H. Scnwiebert and H. A. Wheeler**
"Waveguide Matching Technique"—**W. C. Jakes, Jr.**

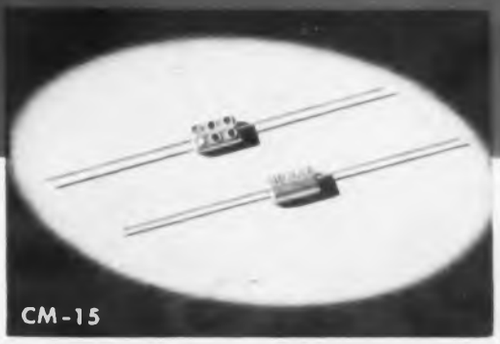
Symposium: TV STATION CONSTRUCTION AND THEATER CONVERSION

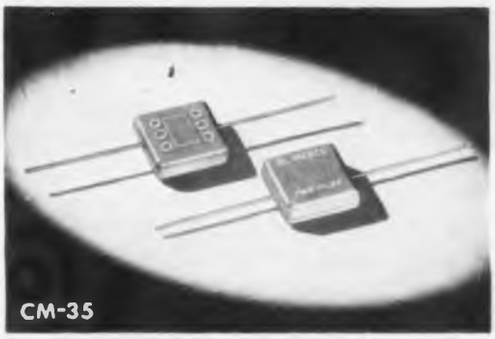
"The New WOR-TV Studio and Transmitter Building at 60th Street and Columbus Ave., New York City"—**J. R. Poppele**

(*Continued on page 126*)

- Every El-Menco Capacitor is factory-tested at more than *double* its working voltage, thus assuring a wide margin of safety, regardless of the nature of the application.

- From the midget CM-15 (2-525 mmf. cap.) to the mighty CM-35 (3,300 - 10,000 mmf. cap.) dependability is a predetermined certainty. That is why El-Menco's have won such universal acclaim in both military and civilian services.


CM-15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Write on your business letterhead for catalog and samples.

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Radio and Television Manufacturers, Domestic and Foreign, Communicate Direct With Factory—

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

"New Building and Technical Facilities at WCAU-TV, Philadelphia"—**J. G. Leitch**
"The WFAA-TV Plant, Dallas, Texas"—**C. L. Dodd**
"Theater TV Conversions
"NBC Program"—**Allen Walsh**
"CBS Program"—**A. B. Chamberlain**
"ABC Program"—**J. M. Middlebrooks**

MEDICAL ELECTRONICS

"New Electronic Techniques for Spectrophotometry"—**C. C. Yang**
"Application of Microwaves in Physical Medicine"—**J. F. Herrick**
"Design Problems in the Absolute Oximeter"—**R. H. Taplin**
"Television Microscopy in the Ultraviolet"—**V. K. Zworykin, L. E. Flory, and R. E. Shrader**
"Recording Multi-Axial Projection of Vectorcardiograms: the Axostat"—**B. P. McKay, W. E. Romans, D. A. Brody, and R. C. Little**
"Continuous Integrating Counting-Rate System for Radioactivity"—**M. Berman and S. Vacirca**

Wednesday, March 5

INSTRUMENTATION III—ELECTRONIC MEASUREMENTS B

"A Raster-Sweep Oscillograph for Precision Time Measurements"—**H. B. Steinhauser**
"Precision Automatic Time-Measurement Equipment"—**D. W. Burbeck and W. E. Frady**
"A Rotating-Beam Ceilometer System"—**R. H. Guenther and L. W. Foskett**
"A Polar-Co-ordinate Cathode-Ray Oscillograph for Use with the Rotating-Beam Ceilometer"—**M. T. Nadir and M. B. Kline**
"An Electronic Fringe Interpolator for an Optical Interferometer"—**R. D. Huntoon**

TELEVISION III—GENERAL B

"The Problem of Interlace in Television Receivers"—**J. de Leon**
"A Method of Evaluating the Performance of a Television Picture Tube and Its Associated Components"—**J. Green**
"Characteristics and Performance of Television Clamping Circuits"—**A. J. Baracket**
"Color-Television Synchronizing—Generator Circuits"—**I. Krause, A. J. Baracket, and H. Dell**
"Printed Unit Assemblies for Television"—**W. H. Hannahs and N. Stein**

CIRCUITS III

"The Effective Bandwidth of Video Amplifiers"—**F. J. Tischer**
"Transient Response of Cathode Peaked Video Amplifiers"—**J. H. Mulligan, Jr. and L. Mautner**
"Variable Bandwidth—Amplifier Design for High Rate of Cutoff and Large Bandwidth Variations"—**M. Dishal**
"Coupling Circuits Having Flat-Amplitude Characteristics"—**A. B. Macnee**
"Oscillator Systems Controlled by Phase-Detector Reactance Tube"—**J. C. Tellier and G. W. Preston**
"Essential Insertion Loss"—**D. R. Crosby**

MICROWAVES III—FILTERS AND CIRCUITS

"Further Transmission Analysis of Hybrid Rings"—**H. T. Budenbom**
"Resonant Cavity Band-Pass Filters—Practical Adjustment to Predicted Performance"—**D. DeWitt, M. Klein, and T. J. Potts, Jr.**
"Synthesis of Narrow-Band Direct-Coupled Filters"—**H. J. Riblet**
"On High-K Dielectric Cavities"—**H. M. Schlicke**
"A Dual-Channel Colinear Rotary Joint"—**E. O. Hartig**

ANTENNAS I—GENERAL

"Optimum Patterns for Arrays of Nonisotropic Sources"—**G. Sinclair and F. V. Cairns**
"A Geometrical Method of Analyzing the Effects of Site Reflections on Direction-Finding Systems"—**G. A. Deschamps**
"The Radiated Fields of Pulse-Excited Dipole Antennas"—**C. S. Roys**
"An Experimental Investigation of the Corner Reflector Antenna"—**E. F. Harris**
"An Omnidirectional Slot Antenna Array"—**A. J. Hoehn and S. I. Cohn**

Symposium: UHF RECEIVERS I

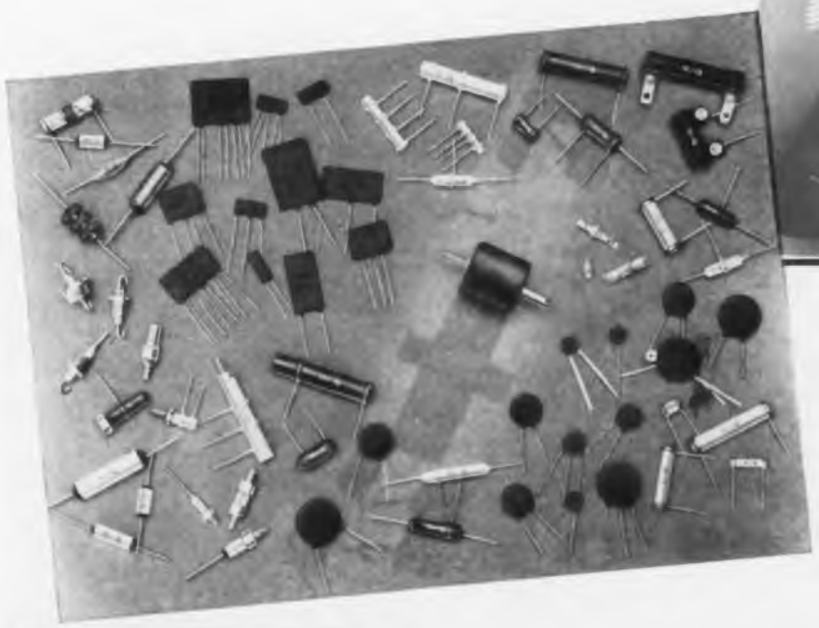
"UHF Hybrid Ring Mixers"—**W. V. Tyminski and A. E. Hylas**
"UHF Tuners"—**M. F. Melvin**
"The Design and Performance of a Compact UHF Tuner"—**H. F. Rieth**

(*Continued on page* 128)

HI-Q SERVES NATIONAL DEFENSE

Wherever Electronics Scan the Skies

On land, on sea and in the air, radar has given our armed forces long-distance vision the thought of which, a comparatively few years ago, would have seemed fantastic. Here, certainly, is one of the most vital applications of electronics in national defense. Here too, as throughout the entire electronics field, you will find **HI-Q** Components...ceramic capacitors, trimmers, wire wound resistors and chokes...widely used and favorably known for their dependable long life and strict adherence to specifications and tolerances. Whether your needs are for ceramic disk capacitors of either the by-pass or temperature compensating types...for tubulars, plates or the new high voltage units...or for specially designed components, **HI-Q** is ready to place its engineering and production resources at your disposal.



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The ceramic slug types are available in capacities of 500 mmf ± 20% and working voltages of 20,000 V. D.C. Piercing pressure of the dielectric material is greatly increased by an exacting jacketing procedure in conjunction with a newly developed plastic with excellent arch-resistant properties. **HI-Q** high-voltage tubular capacitors are available in capacities from 25 mmf to 250 mmf with working voltages up to 7000 V. D.C. and **HI-Q** Disks are available in capacities from 50 mmf to 10,000 mmf with working voltages of 7500 V. D.C. Write for new engineering bulletin on **HI-Q** high-voltage units.

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SALES OFFICES IN ALL PRINCIPAL CITIES

"A UHF-VHF Turret Tuner for Television Receivers"—A. Cotsworth, M. Beier, J. Bell, and J. White
"An 82-Channel Turret Tuner"—A. M. Scandurra
"RF Performance of a New UHF Triode"—H. W. A. Chalberg

CIRCUITS IV

"Dispersion in Transmission Systems"—M. J. Di Toro
"Network Synthesis for Specified Transient Response"—W. H. Kautz
"Transformers for Linear Time-Varying Network Functions"—J. A. Aseltine and D. L. Trautman
"Parallel-Tuned Circuit Periodically Switched to a DC Source"—L. J. Giacoletto
"A Highly Accurate Variable Time-Delay System"—Y. P. Yu
"RC Time-Delay Circuit of Very High Time Constant"—R. G. Roush

ELECTRON TUBES I—POWER AND GAS TUBES

"Method for Prediction of Magnetron Characteristics Relating Frequency and Operating Anode Voltage to Power Output"—H. W. Welch, Jr.
"A New Pulse Klystron Amplifier for the 960-1,215 MC Region of Air Navigation Aids"—C. Veronda
"UHF Power Tubes"—P. T. Smith
"High-Frequency Performance of Electron Multipliers"—R. R. Law, D. A. Jenny, and F. H. Norman
"Factors Affecting Life of Hydrogen Thyratrons"—M. R. Zinn

RADAR AND RADIO NAVIGATION

"Design of Small Radar Line-Type Modulators with AC Charging Circuits"—J. F. Clayton and S. J. Krulikoski, Jr.
"High-Quality Picture-Display Unit"—R. T. Petruzzelli
"Analysis of an Automatic Radar Range-Tracking System"—E. F. Grant
"The Wind-Finding Radar System"—A. D. Emurian
"Power Requirements for Long-Range Narrow-Band Navigation Systems in the Low-Frequency Bands"—N. Marchand, A. Jacobs, and D. Cawood

Thursday, March 6

ANTENNAS II—MICROWAVE A

"Gain of Electromagnetic Horns"—E. H. Braun
"A Rapid-Scan, Circularly Symmetrical Pillbox Antenna"—W. Rotman
"Method for Side Lobe Reduction"—C. J. Sletten
"Tolerances on Paraboloidal Reflectors"—J. Ruze
"Design of Dielectric Walls for Optimum Transmission"—R. M. Redheffer and B. Galvin

Symposium: UHF RECEIVERS II

"Practical TV Antennas for UHF Reception"—E. O. Johnson and J. D. Callaghan
"Amplifiers for UHF Distribution Systems"—T. Murakami
"Comparison of Present-Day UHF and VHF Television Receivers"—R. A. Varone
"Round-Table Discussion: Relative Aspects of the Various Methods of UHF Tuning"—Introductory Remarks—W. B. Whalley; Moderator—L. Winner

ELECTRON TUBES II—UHF SMALL TUBES

"A High-Gain Klystron Amplifier for Relay Systems"—G. Bernstein
"FM Distortion in Reflex Klystrons"—T. Moreno and R. L. Jepsen
"The Measurement of Cathode Interface Impedance"—H. B. Frost
"UHF Amplifier Tube for Television Tuners"—C. E. Horton and H. Hsu
"Microwave Conversion and Detection Employing Electron Tubes"—A. Bronwell, J. May, and C. Nitz

ELECTRON TUBES III—CATHODE-RAY TUBES

"The Anatomy of Contrast Range in Cathode-Ray Tubes"—J. H. Haines and R. E. Mueller
"The Selfocus Picture Tube"—A. Y. Bentley, K. A. Hoagland, and H. W. Grossbohlin
"A New High-Speed Cathode-Ray Tube"—H. J. Peake and R. W. Rochelle
"The Deflectron—A New System for Electrostatic Deflection"—K. Schlesinger

(*Continued on page* 131)

DUMONT

VIDEO SWITCHING
MIXING EQUIPMENT
type TA-178-A

SIMPLIFIED FINGER-TIP CONTROL FOR VIDEO SWITCHING

Comprising the Nine-Channel Switch Unit (5262-A), Mixer Line Amplifier (5263-A) and Low Voltage supply (5019-A).

Variety of special effects, achieved quite simply with the provisions in the Mixer Amplifier, can be previewed before being put on the air. Single Mixer Control at Switching unit permits smooth transition from one channel to another. Again, another control at Switch Unit determines bus cutoff voltage cross-over point, so that any degree of fading, lapping or superimposing of two signals an be accomplished. Provision is made available in the Mixer Amplifier for insertion of special blanking to create special effects such as wipes, montages, etc.

While main line is feeding transmitter, the mixer amplifier output can be used to feed, simultaneously, a different mixed studio show to an audition circuit. The Mixer Amplifier has three identical program outputs which may be fed to transmitter, network cable and master line monitor.

First with the Finest in Television

TELEVISION TRANSMITTER DIVISION
ALLEN B. DU MONT LABORATORIES, INC.
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FEATURES

Switch Unit available for mounting in standard 19" relay rack or in console. Mixer Line Amplifier and its power supply are rack-mounted.

All channels take either local or remote signals.

Lap, fade or super are achieved with single control. Facilities for inserting special blanking (horizontal wipes, montages, etc.). Preview for special effects.

Sync insertion on local signals, controlled by pushbuttons. No switching transients on main-line switching. Automatic pedestal setup incorporated in mixer amplifier.

Frequency response of preview monitor No. 1 amplifier, mixer amplifier and main-line amplifier flat within 0.5 db to 8 MC: less than 6 db down at 10 MC. Preview Monitor No. 2 amplifier flat with in 0.5 db to 6 MC: less than 6 db down at 8 MC.

Lucite, pushbuttons lighted internally when button is pressed.

FURTHER DETAILS and QUOTATIONS ON REQUEST

Rauland - the Original

LOW FOCUS VOLTAGE ELECTROSTATIC TUBE

Perfected in Rauland Electronics Laboratories, this tube that gives edge-to-edge sharpness of focus without coils and magnets is proved and ready as the materials pinch becomes painful

BETTER in all ways! Gives better over-all focus—hair-line sharpness from edge-to-edge —with NO critical materials for focusing . . . and STAYS SHARP under considerable variation in line voltages.

REQUIRES NO re-engineering of present television chassis . . . NO added high voltage focus circuit . . . NO added receiver tubes . . . NO additional components except an inexpensive potentiometer or resistor.

FOCUSES by using D.C. voltage already available in the receiver.

ELIMINATES focusing coils and magnets . . . saves critically scarce copper and cobalt.

• • •

This new Rauland development is now available in substantial quantities in 17 and 20 inch rectangular tubes. For further information, address . . .

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"Field Plotting as a Tool in Deflection-Yoke Design"—**E. Sieminski**

Symposium: WHAT'S NEW IN MOBILE RADIO

"Mobile Radio Problems Resulting from New Techniques"—**E. L. White**
"Application of Voice-Frequency Tone Signalling to Mobile Radio Systems"—**C. L. Roualt**
"Dispatcher's Wayside-to-Train Radio-Control System"—**S. D. Burton**
"New Developments in Army Mobile Communication Equipment"—**J. H. Durrer**

Symposium: RELIABILTY OF MILITARY ELECTRONIC EQUIPMENT

"Discussion of the Complexity and Unreliability of Military Equipment and the Need for Simplification and Increased Life"—**A. S. Brown**
"Maintenance Minimization in Large Electronic Systems"—**W. D. McGuigan**
"The Reliability Problems in Missile Development"—**A. C. Packard and R. Weller**
"Application Engineering for Improved Electronic Reliability in Guided Missiles"—**W. T. Sumerlin**

Titeflex Establishes Electronics Division

Titeflex, Inc. of Newark, N. J., manufacturers of flexible metal tubing and aircraft ignition harnesses, has established an "Electronics Division" to coordinate the manufacture and sale of flexible and rigid waveguides, electronic parts and special equipment.

During World War II, the company pioneered in the development of flexible waveguides, marketed as "Waveflex"—a precision made rectangular tube used for the transmission of high frequency electrical waves by radar and micro-wave relay systems.

Robert G. Brazenor will direct the new division and William W. Buckley will assist as electronics sales supervisor; the division will remain under overall direction of Titeflex sales management. James Nickerson and John Bales, specialists in electronics equipment, have joined the staff as sales engineers.

Chicago Group Expedites Government Procurement

Leslie F. Muter, president of Radar-Radio Industries of Chicago, Inc., announced the appointment of S. I. Neiman as executive secretary and K. C. Prince as general counsel. The trade organization, representing 61 of the leading radio-electronic components and equipment manufacturers in the Chicago area, is located at One N. LaSalle St. Its function is to coordinate activities and act as liaison between government procurement agencies and the Chicago companies to obtain military contracts for research and production. The need for such an organization was indicated to the Chicago firms by the fact that they have been able to account for only about 12% of the military contracts now available. During the last war Chicago plants report that they produced 40% of all communication equipment used by the military.

PERSONAL

Ferdinand W. Schor has been made chief engineer in charge of military engineering for Motorola Inc., Chicago, Ill. He comes to Motorola from Hallicrafters Co., where he was chief engineer in charge of all government equipment engineering and communications equipment engineering for a period of fourteen years.

M. Jelin has been named chief engineer of the Wilcox-Gay Corp., 604 West Seminary St., Charlotte, Mich.

James Dale has been named chief television and radio engineer of Hoffman Radio Corp., Los Angeles, Calif.

Otto C. Bixler has been named director of engineering of Magnecord, Inc., Chicago. He was formerly electrical development engineer for Airesearch Manufacturing Co. and prior to that was in Western Electric's electrical products div. as systems engineer on electronic equipment.

Irving G. Rosenberg has been appointed Director of Operations, responsible for Allen B. Du Mont Laboratories, Inc.'s television receiver and cathode-ray tube divisions.

Dr. Ralph Bown, Director of Research for Bell Telephone Laboratories since 1946 and a member of the Bell System for more than 30 years, has been appointed Vice President in charge of research. Other organization changes at the Laboratories include the appointment of **Dr. J. B. Fisk** as director of research — physical sciences; **Dr. H. T. Friss,** appointed director of research in high frequency and electronics; **Dr. W. H. Doherty,** appointed director of research in electrical communications; and **Dr. R. M. Burns,** appointed chemical coordinator in addition to his duties as director of chemical and metallurgical research.

Kenneth A. Hoagland has been appointed assistant engineering manager of the cathode-ray tube div., Allen B. Du Mont Laboratories, Inc. He will assist Alfred Y. Bentley, the division's engineering manager, in supervisory and administrative duties for the engineering department in addition to being in charge of design and development of cathode-ray tubes.

David S. Rau has been appointed vice president and chief engineer of RCA Communications, Inc. **C. W. Latimer,** formerly vice president in charge of engineering, was appointed vice president and chief technical consultant of RCA Communications. Mr. Rau, who joined RCA as a student engineer upon his graduation in 1922 from the United States Naval Academy at Annapolis, has served since 1950 as assistant vice

president and chief engineer. In World War II, he became a Captain on the staff of the Director of Naval Communications. Returning to RCA after the war, he was appointed assistant plant design Superintendent, and, in 1948, he was promoted to assistant to the vice president in charge of engineering. Mr. Latimer has been with RCA since its formation in 1919.

Frank J. Gallagher, formerly with Thordarson Electric Manufacturing Div. of Maguire Industries, is the newly-appointed sales manager of Central Transformer Co., Chicago 7, Ill.

Audio Fair in Chicago, May 23-24

To give manufacturers and distributors an opportunity to reach the huge audio-high fidelity market in the middle west, the "Audio Fair in Chicago," (counterpart of the Audio Fair held annually in New York in conjunction with the Audio Engineering Society convention) will be held at the Conrad Hilton Hotel, Chicago, May 23 and 24.

In setting the Chicago dates for the Friday and Saturday immediately following the 1952 Electronic Parts Show, the "Audio Fair in Chicago" will occupy the 5th, 6th and 7th floors of the Conrad Hilton. Manufacturers who participate in the Parts Show early in the week may remain in their 5th and 6th floor display rooms for the Audio Fair at a reduced participation fee. Manufacturers and distributors who do not exhibit in the Parts Show may reserve display rooms in the Audio Fair on the 7th floor of the hotel.

Last year's Audio Fair in New York attracted eighty-three exhibitors and eight thousand visitors, a figure which the sponsors expect the "Audio Fair in Chicago" to surpass. Products displayed will include high fidelity amplifiers, audio oscillators, tuners, speakers, transformers, kits, capacitors, microphones, wire and tape recorders, recording discs, magnetic recording film, meters, test equipment, chassis, cabinets, pickups, technical manuals and trade publications. Space reservations are being made by the Audio Fair in Chicago, Inc., 1 No. LaSalle St., Room 815, Chicago 2, or at Room 510, 67 W. 44th St., New York 17, N. Y.

Two TV Stations Apply for NARTB Membership

Application for active television membership in the National Association of Radio and Television Broadcasters has been received from WXEL (TV), Cleveland, Ohio, and WPTZ (TV), Philadelphia. Admission of WXEL and WPTZ increases NARTB Television membership to 82 stations of the 108 TV outlets now in operation in the nation. All four television networks—American Broadcasting Co., Columbia Broadcasting System, Du Mont Television Network and National Broadcasting Co.—are members of NARTB Television.

TV Camera Control

(*Continued from page* 67)

clamped and combined with synchronizing pulses at the studio output. The effect of fixed *set-up* and white peak clipping is illustrated in Fig. 1.

A convenient means of fixing the reference black level (*minimum set-up*) in the RCA TK-10A Studio Camera Control was developed at WOR-TV. The modification is shown in figure 2. (The identical circuit modification may be installed in the RCA TK-20A Film Camera Control;

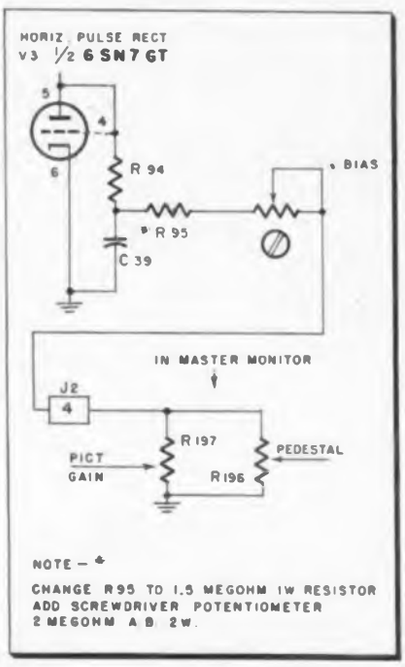


Fig. 3: Reduction of potential across pedestal and gain controls by use of resistor

however, the circuit components have different designations on the respective schematics.)

The sync amplifier, VI, is bridged across the blanking signal. The positive and negative peaks of the blanking signal are clipped "clean" in the plate circuit through the use of biased type 1N48 germanium diodes. The positive peaks correspond to the picture blanking interval, and the clipping level is fixed—since a clean blanking trace is the only requirement. The negative peaks correspond to the active picture scanning interval. In this case the clipping level is variable, under control of a potentiometer, at the operator's discretion in the amount of minimum fixed *set-up* in the picture. The clipped *set-up* signal is mixed with the picture in the output

(*Continued on page* 136)

Motorola 2-way radio

Weather Exposure

After eleven months of exposure, through one of the toughest winters on record, the two Permakay units (photographed on the roof of Motorola plant) showed no significant change in selectivity characteristic.

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

In laboratory torture tests Permakay goes through blistering +90° centigrade test without effect on selectivity readings.

Motorola first with Sealed-Unit Selectivity

In the exclusive *Sensicon* design of the Motorola *Permakay* wave filter, 15 nuisance tuning adustments are removed and permanent selectivity is guaranteed for the life of the set!

More tuned circuits and superior performance with *fewer* tuning adjustments in the SENSICON Receiver are achieved by using the PERMAKAY IF Wave Filter. The modified constant-K, m-derived band pass filter contains 15 tuned circuits . . . BUT . . . you are not burdened with field alignment and complex tuning adjustments. The filter, tuned and sealed during manufacture, requires no further adjustments . . . *ever*. This combination provides over 100 db signal rejection at the *edge* of the adjacent channel while providing a broad band-pass at 6 db for full modulation deviation acceptance.

Motorola's unique Permakay system of linear phase shift adjustment solves the problem of reflection and pulse noise control to provide maximum signal-to-noise ratio for the phenomenally high interference-rejection.

The PERMAKAY Filter characteristics are made permanent by casting the entire unit in a solid block of polyester-styrene plastic. Never can the precisely tuned circuitry be affected by water, dirt, heat, cold or mechanical shock. Temperature compensation insures constant performance even at extreme temperatures as demonstrated in all rigid laboratory torture tests. Motorola's *unconditional* guarantee of the PERMAKAY Filter for the life of the set again demonstrates that Motorola is still your best investment.

Over 22 Years of Leadership in Mobile Radio . . .

Year in and year out, Motorola installations number more than twice those of all other manufacturers combined and more than five times those of the nearest competitor.

Motorola

Communication and Electronics Division
4545 Augusta Blvd., Chicago 51, Illinois

DUST AND HEAT-PROOF

WATER AND COLD-PROOF

TAMPER AND SHOCK-PROOF

Motorola 2-way radio

6AG7 via the voltage regulator stage. The coupling capacitor C28 was changed to μ 400 v. in order to reduce the tilt in the 60 cps vertical component of the blanking signal. Because of the increased bulk in the larger coupling capacitor, it had to be relocated on the middle terminal board. With this modification the *reference* black level may be adjusted through a wide range, providing at the same time an automatic minimum *set-up* of from zero to approximately twenty percent.

The camera control operator is responsible not only for the proper alignment and setting-up of the studio cameras during rehearsal, but he has the added responsibility for the proper matching of picture levels between different cameras during the show. This can be very trying if the pedestal and gain controls produce large changes in level for small mechanical adjustments.

It was found at WOR-TV that the voltage supplied to the TK-10A studio camera pedestal and gain controls was too great, and that the desired range of control was concentrated at one end of each potentiometer. The addition of a bias control potentiometer made it possible to reduce the voltage across the pedestal and gain potentiometers with resultant improved operation. The circuit changes are shown in the accompanying schematic drawing, Fig. 3. The added potentiometer may be conveniently mounted on the camera control unit between the sync gain and monitor gain potentiometers.

[1]RCA-Linear White Peak Clipper for TA-5C Stabilizer Amplifier.

Motorola Communications Expansion

To house its rapidly growing Communications and Electronics Division, Motorola Inc., Chicago television-radio manufacturer, has purchased a new 200,000-square-foot plant for $1,250,000 and has now completed the division's relocation.

Paul V. Galvin, Motorola president, announces that the firm's 2-way radio division is now operating from its new quarters, at 4501 Augusta Boulevard, Chicago. The new plant is immediately adjacent to Motorola's main radio and television plant. It formerly was the home of Tropic Aire and the Greyhound Bus Company offices and factory. The 10-year-old building has been renovated to consolidate exclusively all activities of Motorola's Communications and Electronics Division, Mr. Galvin said, including 2-way mobile and fixed-station radio, microwave relay, and carrier-control engineering, production and sales. About 1000 persons are already working in the new plant.

Ultrasonic Delay Lines

(*Continued from page* 45)

This can be justified on the basis that the termination impedance is low compared to the mechanical impedance of the delay line material. This circuit is now the same as that for the input crystal except for interchanging Z_q and $-j2Z_s \cot a$. The characteristic is identical and from the Reciprocity Theorem, can be written

$$\left|\frac{I_{R_0}}{I_R}\right| = \sqrt{(1-\cot^2 a)^2 + 4\left(\frac{Z_s}{Z_q}\right)^2 \cot^2 a} \qquad (9)$$

(F_s constant)

The third section is the tuned termination for which the voltage ratio is:

$$\left|\frac{E_{R_0}}{E_R}\right| = \left|\frac{Z_0}{Z}\right| = \left|\frac{R}{Z}\right| \qquad (10)$$

$$= \sqrt{1 + \frac{R^2}{X_0^2}\left(\frac{f}{f_0} - \frac{f_0}{f}\right)^2}$$

(I_R constant)

and is plotted for the crystal and terminations previously assumed, with stray capacitance added to bring C_0 to 40 μμf.

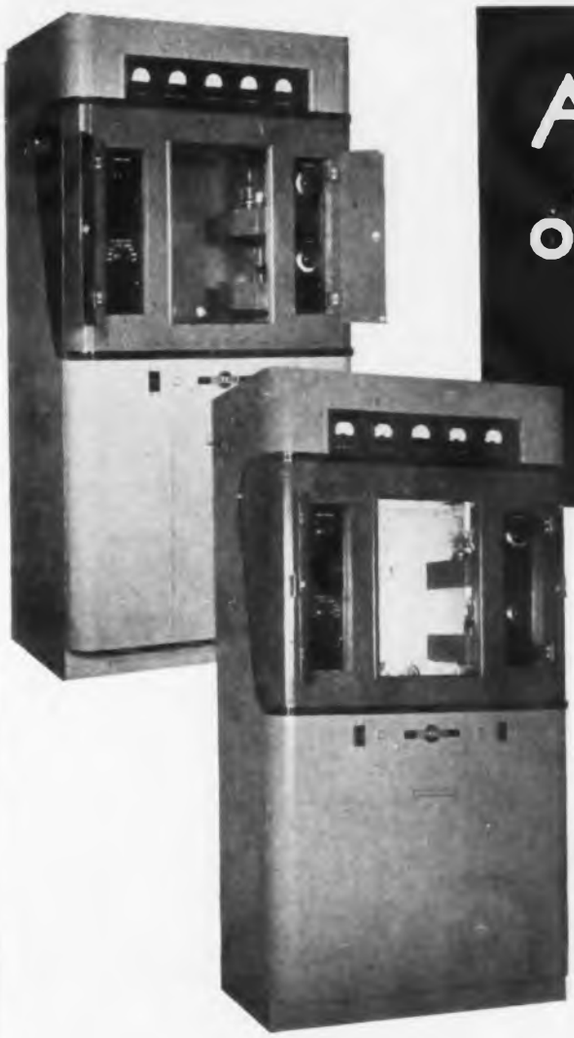
Fig. 6 is a summation of the three transmission characteristics to give the calculated overall bandwidth performance for the delay line with 75 ohm, 390 ohm and 1000 ohm terminations. It is seen that increased bandwidth is obtained with lower terminations but at the expense of increased midband loss indicated on Fig. 4.

In the foregoing discussion, operation at the fundamental frequency has been assumed. Inspection of the equivalent circuit shows that similar pass bands can occur at odd overtones of the crystal frequency. However, the percentage band width will be reduced in ratio to the overtone order due to the lower electromechanical coupling for the overtone.

Experimental Results

The elements of the measuring circuit are shown in Fig. 7. The voltage applied to the transmitting crystal is an r-f. pulse variable in width from 2 to 10 microseconds and in repetition rate from 100 to 2000 p.p.s. This is obtained by pulse modulating a radio frequency carrier of about 5 volts amplitude, variable in frequency from 5 to 80 MC. The detector system consists of a converter, i-f amplifier, rectifier and a limiter to prevent overloading of the oscilloscope amplifier. Loss is

(*Continued on page* 140)



A triumph in the art of transmitter design..

made possible through the use of Eimac tetrodes.

Collins 300J 250-watt and 20V 1kw AM broadcast transmitters employing Eimac 4-125A and 4-250A power tetrodes.

The Collins 300J 250-watt and 20V 1kw AM broadcast transmitters are a tribute to the art of transmitter design. Performance, circuit simplicity and economy of operation highlight the many features Collins Radio has incorporated in these modern transmitters.

Through the use of high-gain, long-life Eimac tetrodes, Collins has achieved considerable simplification in circuits associated with the modulator and power amplifier stages. These highly efficient tetrodes also permit the use of low drain receiver-type tubes in the driver stages. Spare tube inventory can be kept small and representing a minimum investment. As an example; the 300J employs only 16 tubes of but 7 types in the entire transmitter.

In your own equipment . . . enjoy the advantages and economies made possible through the use of Eimac tetrodes. Write our Application Engineering Department for the latest information and technical data.

Follow the Leaders to Eimac TUBES The Power for R-F

EITEL-McCULLOUGH, INC.
San Bruno, California

Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

measured between input and output terminals of the delay line by inserting attenuation to match the input pulse to the output pulse amplitude. The low impedance attenuator is connected to the buffer amplifier through a relatively high resistance with the object of increasing the plate load impedance in order to achieve some voltage gain in that stage. The appropriate correction is made to the attenuator readings in the determination of insertion loss. The measurement accuracy of the circuit is ± 0.5 db.

Performance Characteristics

Fig. 8 shows the results obtained for an actual vitreous silica line of approximately 700 μsec delay with 10 MC Y-cut quartz crystals 3.84 cm^2 in area for which the total C_o is 110 μμf. The crystals are symmetrically loaded by Z_{oi} on both faces which has the effect of adding 6 db of loss for each crystal at midband in comparison to the case of unsymmetrical loading which was previously considered. The figures for bandwidth at points 6 db down are 4.5 MC, 3.8 MC, and 2.8 MC for terminations of 75 ohms, 390 ohms, and 1000 ohms respectively. Principally because the bond between the crystals and the line is not ideal, the bandwidth is less than the theoretical value for symmetrical loading.

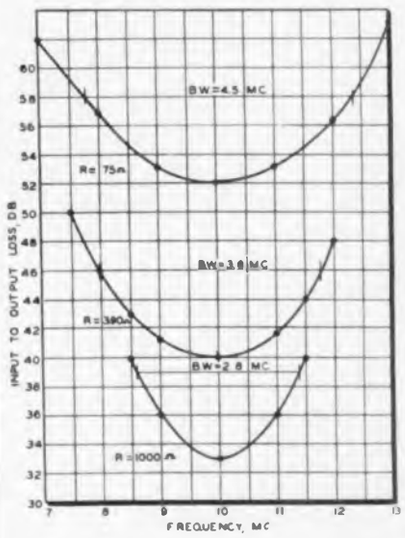


Fig. 8: Performance characteristics of 10 MC shear wave delay line 254 cm long, 3.84 cm^2 in cross-section. C_o = 110 μμf

It is seen that low values of terminating impedance yield wide bands at the expense of high insertion loss and that higher termina-

(*Continued on page* 142)

tions approaching the characteristic impedance of the delay line transmitting medium lead to progressively lower losses and narrower bands.

The circuit designer must establish the relative importance of loss and bandwidth in any particular application.

Fig. 9 is the characteristic for a delay line approximately 10 μs in length with 20 MC X-cut quartz crystals operated at 60 MC, the third overtone. The bandwidth 6 db down is 18 MC which represents 30% of the midband frequency. In comparison, the data of Fig. 8, at approxi-

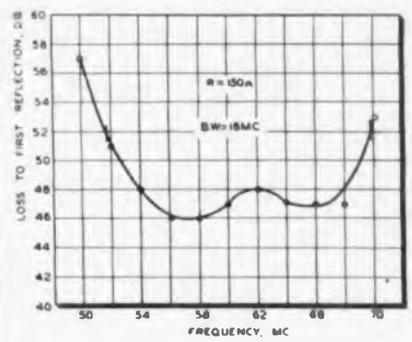


Fig. 9: Performance characteristic of 60 MC compressional wave delay line

mately the same termination, is 40%. Theoretically the percentage bandwidth varies inversely with the overtone number and special techniques are required to achieve the bandwidth indicated in Fig. 9.

The effect of the electromechanical coupling coefficient of the transducer on loss and bandwidth is shown by data obtained using a barium titanate ceramic element with a coupling coefficient of approximately 40%. It was found that midband losses of 10 to 20 db could be obtained with a bandwidth of 5 MC at points 6 db down.

The essential performance of an acoustic delay line depends on the electromechanical properties of the transducer and the transmitting medium and on the Q of the termination tuned circuit. The midband loss, equation (6), is controlled by the mechanical impedance and the attenuation coefficient of the transmitting medium, the electromechanical coupling coefficient and thickness of the transducer, the cross-sectional area of the line and the termination resistance. The bandwidth, equations (7), (8), (9), (10), is controlled by the ratio of the mechanical impedance of the transducer to that of the transmitting medium and by the Q of the termi-

(*Continued on page* 144)

Eight ML-5682's mounted in a Doherty high efficiency linear amplifier designed for 500 kW output.

The ML-5682

A High-Power Coaxial Triode for Full-Power Operation to 88 mc/sec.

The development and commercial production of the ML-5682, a new water- and air-cooled coaxial triode for very high power operation, is an important contribution to all phases of modern electronic development. It is of particular significance in the present effort to provide the highest possible power in international broadcast applications. It finds wide application in high power AM, FM and TV broadcasting, in particle accelerators and in electronic heating. It is the key tube type in the highest power AM transmitters being built today.*

The ML-5682 is an unusually compact, rugged, high-power electron tube ideal for all high-frequency applications. It is an all-ring-seal triode capable of long-life operation at 9kVdc plate voltage and 170 kW plate input at a frequency of 88 mc/s. Operation at 16 kVdc plate voltage and 300 kW plate input is permissible up to 30 mc/s. This tube is ideal for cavity operation and its low impedance makes it advantageous for broad-band service.

*Includes State Department's Voice of America Transmitters.

Outstanding design features include:

- High-conductivity, gold plated kovar glass-to-metal seals.
- Sturdy electrodes.
- Integral anode water jacket.
- Quick-change water coupling.
- High-conductivity, heavy-wall copper anode designed to dissipate in excess of 100 kw.
- Multi-strand thoriated-tungsten filament cathode completely balanced and stress free throughout tube life.
- Grid capable of unusually high heat dissipation contributing to maximum stability of tube performance and circuit operation.

For full technical information on the ML-5682 or other Machlett tube types write to Machlett Laboratories, Inc., Springdale, Connecticut, or contact your nearest Graybar or Westrex office.

Machlett Industrial and Broadcast Tubes will be exhibited at the 1952 I.R.E. Show — Booth 96-97

MACHLETT — OVER 50 YEARS OF ELECTRON TUBE EXPERIENCE

Compilation of Analog Transducers

The need for an easy-to-use reference of transducers for use with cathode-ray oscillographs has been filled by a compilation made by the Instrument Division of Allen B. Du Mont Laboratories, Inc., 1500 Main Ave., Clifton, N. J. The new compilation contains over 500 different types of analog transducers.

In order to employ the versatility and accuracy of the cathode-ray oscillograph in the investigation of non-electrical research, development and industry, it is necessary that the effect in question be converted into an equivalent electrical signal by means of an appropriate "transducer."

For each transducer, the following pertinent information is given as available from the manufacturer: function; principle of operation; accessories required; transfer characteristics; power required; amplitude range; sensitivity; ouptut characteristics; bandwidth; resonant frequency; resolution or precision; linearity; weight; range; sturdiness; temperature limitations; mounted; size; remarks; and model designation. The complete compilation is available from the Instrument Division of Du Mont for 50 cents a copy.

Ultrasonic Delay Lines

(*Continued from page* 142)

nation. Beam spreading, equation (5), is controlled by the wave length in the medium and the dimensions of the transmitting crystal. The delay time is a function of the acoustic velocity and the length of the line.

The author is greatly indebted to Mr. H. J. McSkimin, who suggested the method for analysis of the equivalent circuit and contributed generously of his advice in the course of its development; to Mr. G. W. Willard, who provided the basic information on the diffraction of ultrasonic waves, and to Miss Lee Hilles who performed the calculations.

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This paper was first presented before the National Electronics Conference in Chicago, Ill. Oct. 22-24, 1951

Forty Years — Sets the Pace . . .

1912 1952

is the theme of the 1952 IRE National Convention and Radio Engineering Show, marking the progress of IRE's first forty years' service.

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To the Member and Visitor:

The Conference and Show provide a refresher course on the progress and pace of the science and engineering application of radio in television, broadcasting, electronics and defense.

In no other way can one feel the pulse-beat of a great industry as easily, and learn as much as in the four days of this meeting. From theory in the technical papers, to practice in engineering demonstrations of the exhibits, this is the modern, fast way to keep up-to-date.

So convinced of this is our industry that last March 5,082 different firms sent their engineers and executives to this conference. 15,258 attended sessions of their choice. Of the 22,919 who registered, all but ¼ of 1% visited the exhibits. 7,924 were IRE Members. This means that nearly 30% of the total membership of this engineering society attended its annual national convention.

Skillfully grouped technical papers map the advances in every field of radio, from guided missiles to television, and from communications to industrial electronics. This year, more than 200 papers will be presented, using five lecture halls—giving engineers an equivalent coverage of five conferences in one.

△

Audience at Technical Papers Session

To the Radio Industry:

What is the significance to an industry when 277 exhibitors meet in one place for four days to show their technical products to engineers? It means that IRE has produced through its meeting an economically sound market-place.

These exhibitors are the top 15% of the manufacturers supplying the field, who produce 90% of the products engineers buy! Is it any wonder that the audience comes to such a concentration of equipment, component and instrument exhibits? Think of the time saved!

Here is the record:

1947—177 firms met 12,013 visitors
1948—180 firms met 14,459 visitors
1949—225 firms met 15,710 visitors
1950—253 firms met 17,689 visitors
1951—277 firms met 22,919 visitors
(More than 300 firms in 1952)

When the manufacturer's engineer meets the buyer's engineer, problems are solved and sales are made. In a technical industry, only the engineer can "set the specs" and he is the man usually too busy to see a salesman. But at the Radio Engineering Show, he comes to see what's new.

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New Process Doubles Life of Dry Batteries

Through research and industrial mobilization planning sponsored by the Army Signal Corps, the country is in a much stronger position in regard to the manufacture of essential dry batteries than it was during WW II.

Manganese dioxide is the most important single constituent of a dry battery, from the standpoint of its life and capacity. The quality and availability of manganese dioxide are of vital importance to military communications. Almost all natural manganese dioxide of sufficient quality to use in military dry batteries has come from the African Gold Coast. However, the Signal Corps has found a way to convert low-grade, domestic manganese dioxide into a quality so high that it is almost twice as effective in dry batteries as the best natural material.

This means: 1) Batteries of the future will last twice as long on the battlefield, where their use is of tremendous importance; 2) Even though the improved manganese dioxide is presently a little more costly than the natural, battery requirements could ultimately be cut in half—with great resulting economies; and, 3) With considerably fewer batteries being used, the logistical problem—manufacture, purchase, storage and shipment to using troops—would likewise be reduced considerably.

Manganese in U.S.

On the basis of the abundant supplies of low-grade manganese ores within the U.S., it was decided to study methods of improving the quality of low-grade domestic ores as replacements for the African Gold Coast battery-grade ore. A contract was placed with the research institute of a university, to investigate methods of improving the quality of domestic manganese dioxide. Another contract was awarded to a second university to investigate the physical properties of the oxides of manganese, in order to determine a ready means of identifying battery-grade ore. As a result of these studies, a pilot plant process was developed for the production of a high quality, battery-grade, manganese dioxide. Batteries made from this product were capable of delivery about twice the amount delivered by existing military battery types.

Production Line Basis

The next step was to establish the process on a production line basis, whereby a high-quality, battery-grade manganese dioxide could be obtained by converting low-grade domestic ores. Production progress has been most satisfactory, with recent samples meeting initial specification requirements. The major phase—production of battery-grade manganese dioxide from domestic ores at a satisfactory production rate—has been accomplished.

Seletron can furnish hermetically sealed selenium rectifiers to your order...

OF COURSE, this type of rectifier is usually for military and naval installations . . . and the occasional uses where the extra cost of sealing is justified by the extra results achieved.

For some time now we've produced oil filled, hermetically sealed rectifiers on order in a variety of ratings . . . so if you have an application in mind that calls for the utmost in protection against atmospheric conditions or unusual shock, send us your specifications. We'll gladly supply engineering data and quotations.

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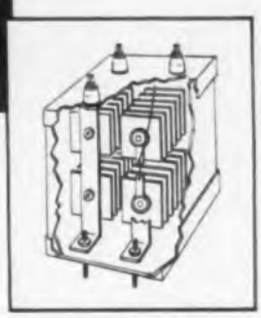

Cutaway view of typical internal mounting arrangement of a multiple stack, hermetically sealed rectifier assembly.

Regular SELETRON selenium rectifiers are the choice of an ever increasing number of manufacturers in diversified fields because they are so thoroughly dependable under all types of grueling conditions. They're available in the miniature sizes for radio, TV and other electronic circuits, all the way up to heavy duty power stacks used in industrial applications. Write us today for Bulletin No. 104-T-2.

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BOOKS

Fundamentals of Radio Communications

By Abraham Shrimgold. Published 1951 by D. Van Nostrand Co., Inc., 250 Fourth Ave., New York 3, N.Y. 442 pages. Price $5.25.

This book, written at an intermediate level, presents in comprehensive form the principles and techniques employed in modern radio-communication systems. The text material has been selected with a view towards familiarizing the reader with the important characteristics of the basic components and circuits used in radio equipment, and with the operational features of such radio systems as AM and FM sound communication, television, facsimile, multiplex systems, radar and loran. The last four chapters of the book are of especial interest in presenting discussions on basic pulse circuits; UHF techniques, including waveguides, cavity resonators, magnetrons and traveling wave tubes; image transmission systems, in facsimile, in television; special communication techniques, including frequency and time division multiplexing; radar and radio navigation systems.—BFO

Principles of Radio (6th Ed.)

By Keith Henney and Glenn A. Richardson. Published 1952 by John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 655 pages. Price $5.50.

Composed of 24 chapters, this reference book comprehensively covers the fundamental aspects of the radio field. One notable and helpful feature is the extensive series of detailed numerical problems, commonly encountered in practice, which have been worked out as examples. Keeping abreast of technological trends which have become manifest in the seven years since the fifth edition was published, the completely revised book contains material on transistors, color TV, and high speed shaping circuits, as well as introductory information in Chapters 1-9 covering basic circuit elements.

Chapters 10-17 include a lucid description of vacuum tubes, amplifiers, oscillators and AM. The topical scope of Chapters 18-21 encompasses transmission lines, antennas, FM, UHF and measuring instruments. More advanced material is included in Chapters 22-24 on transients, TV and radar.—AJF

Theory of Electromagnetic Waves

Collected papers from The Symposium on Electromagnetic Waves (June 1950), jointly sponsored by the Geophysical Research Division of the Air Force Cambridge Research Laboratories and New York University. Published 1951 by Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N.Y. 393 pages. Price $6.50.

The compiled articles presented here represent a valuable contribution to the physical and mathematical approach to the study of electromagnetics. The scientist interested in the theoretical or analytical aspects of electro-

(Continued on page 150)

Help to Engineers

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ARE YOU IN A "DEAD END" JOB with no chance to move forward?

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magnetic waves, their propagation, shapes, spectra and fields, will find the work of its 23 authors singularly informative. Mention of some representative titles included in this work will indicate the scope it encompasses: On Systems of Linear Equations in the Theory of Guided Waves; On the Diffraction Theory of Gaussian Optics; Vector Waves Functions; The Theory of Magneto Ionic Triple Splitting; and Propagation in a Non-homogeneous Atmosphere.—AJF

The Electronic Musical Instrument Manual

By Alan Douglas. First published 1949 by Pitman Publishing Corp., 2 W. 45 St., New York, N.Y. 143 pages. Price $3.50.

Encompassing the area where the boundaries of art and science blend, this sharply concise handbook should prove a valuable asset to any electrical engineer interested in the theory and design of electronic musical instruments. Well written and amply illustrated, this work gently leads the reader from the fundamentals of sound, music and noise, through the practical aspects of oscillators, amplifiers, tone controls, and loudspeaking equipment. More complex circuitry and performance is shown in the chapter on representative commercial instruments. The informational journey ends with a brief observation of experimental methods of simulating musical tones. Neophyte and old hand will find this manual serving both as a basic text and reference.—AJF

BOOKS RECEIVED

High Frequency Transmission Lines

By Willis Jackson. Published 1951 by John Wiley and Sons Inc., 440 Fourth Ave., New York, N.Y. This is another in very useful and informative series of monographs put out by Methuen and Col., Ltd., London, England. It was first published in 1945 and has been republished three times since then. Some very concise and useful information concerning the operation of high frequency transmission lines and their propagation characteristics has been included and all engineers engaged in work on lines should find this useful.

Broadcast Operator's Handbook

By Harold E. Ennes. Published 1951 by John F. Rider Publisher Inc., 480 Canal St., New York 13, N. Y. Pages 440. Price $5.40. This is the latest in the series of handbooks brought out by Mr. Ennes, the first was published in 1947. The book details all the regular and emergency methods of operation in AM and FM radio stations. A complete bibliography is also included. This book should be of value to all broadcast engineers.

FCC's 17th Annual Report

The seventeenth annual report of the Federal Communication Commission to the Congress of the United States has just been published in book form measuring 6 x 9 in. and comprising 180 pages. The period covered is for the Fiscal year ending June 30, 1951. Price is $0.40 and copies are available through the Supt. of Documents, Washington, D. C.

Bell to Try Aluminum Wire if NPA Permits

An appeal has been made by the Bell System to the National Production Authority for an allotment of aluminum during the first quarter of 1952. If the NPA permits, the metal will be used in test installations of aluminum wire. Ability to produce aluminum wire cable in quantities large enough to make a substantial response to the demand for telephone service will depend, however, on future availability of increased quantities of aluminum, as well as steel, polyethylene and other materials used in its manufacture.

James Knights Changes Corporate Structure

The James Knights Co., Sandwich, Ill., has announced the reforming of their corporate structure concurrent with their purchase of the Frequency Modulator Monitor Div. of Doolittle Radio, Inc. Under the new organizational setup, manufacturing will be grouped under three main divisions.

The Crystal Division will develop and manufacture all types of crystals; the Manufactured Products Division will produce plumbing equipment, benders and lapping machines; and the Electronics Products Division will make "JK" FM monitors and frequency standards.

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Model 940

Frequency Range	920 to 960 Mcs.			
Input Impedance	52 ohms nominal			
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Power Rating	1 kw. continuous			
Polarization	Either vertical or horizontal available at time of installation.			
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Gain (db, approx., over isotropic radiator)	19	23	26	28
Half Power Angles (H plane)	17.75°	11.75°	8.6°	6.9°
(E plane)	19.75°	12.9°	9.6°	7.8°
Side Lobes	17 db down or better			
Pressurized	Feed can be pressurized to 10 lbs. p.s.i.			
Input Connection	Weatherproof type "N" fitting; special fittings are available for RG-8 U, RG-17 U or 7/8" copper line. Specify when ordering.			
De-icing	Available for all models. Capacities range from 400 to 4000 watts.			

FREE SLIDE RULE

This packet size slide rule quickly computes diameter, wavelength, angle and gain for parabolic antennas. Reverse side carries FCC frequency allocations conversion tables and other data. Write for your copy.

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7000	5925–7425	36.0–43.0	3.24–1.36	2.86–1.21

*Gain and Half Power Angles are dependent on size and frequency of parabolas, — 4, 6, 8 or 10 foot diameter.

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SPLIT CHANNEL OPERATION

(*Continued from page* 66)

If the midway point between just perceptible interference and barely readable signal is taken arbitrarily as the point of maximum tolerable interference, then it is apparent that this point moved from .35 mi. for good adjacent channel receivers such as C and D, in 60 kc channels, to .5 mi. for narrow band receivers such as A and B, on 30 kc channels, while for 20 kc channels with the latter receivers it moves out to 3.0 mi.

It should be remembered that as the distance from the interfering station is increased, the desired signal increases while the interfering signal decreases so that at the 3.0 mi. point the desired signal at the receiver input is about 3 uv and the interfering signal about 20 db higher.

The effect of departure from nominal spacing is very greatly increased as the channel spacing is reduced. There is no appreciable difference between operation on 60 kc and 50 kc spacing, but for 25 kc spacing the point of maximum tolerable interference moves from .5 mi. to .9 mi. as compared to 30 kc, while for 15 kc spacing it moves from 3.0 mi. to 4.15 mi. compared to 20 kc spacing.

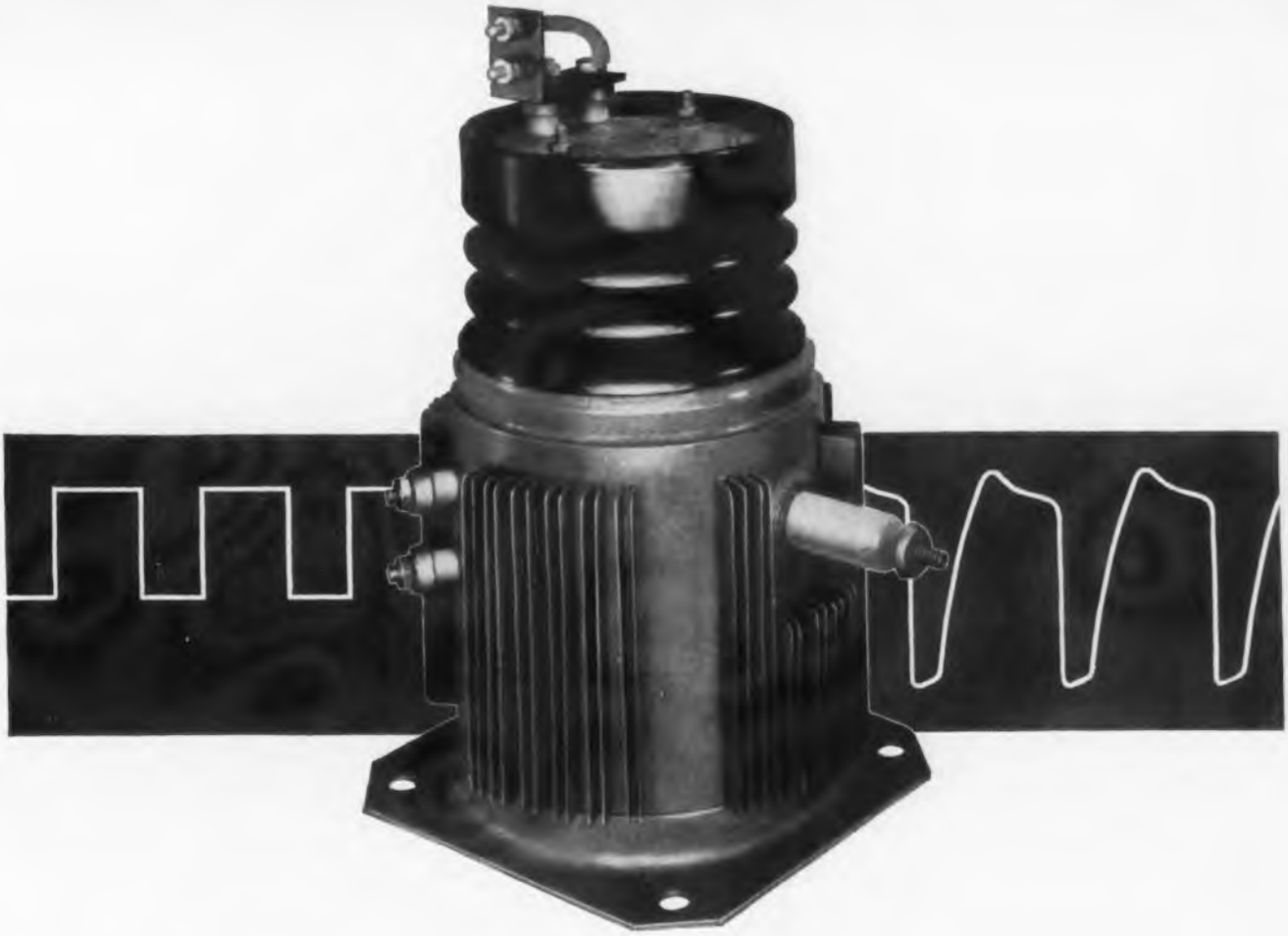
This points out the need for improved methods of setting the stations on frequency and on very great frequency stability of equipment for split channel operation. Even if the frequency setting was maintained with 1 kc for both stations and the frequency stability of all equipment was ±1 kc (.00065%) over the extreme temperature range to be encountered, there would still be a very considerable impairment of adjacent channel performance even on 30 kc channels if these tolerances happened to add together to reduce the spacing to 26 kc.

The importance of the degree of accuracy in setting the station on exact nominal frequency for split channel operation is highlighted by the problem encountered in setting up the field test. At first, the stations were set on frequency for 15, 20, 25, and 30 kc spacings using high quality commercial frequency meters and FM monitors. The results of the field tests then were completely inconsistent. The spacing of the stations was checked by setting a station receiver on the desired frequency and tuning in the low i-f with an accurately calibrated, very low frequency receiver loosely coupled to it. The desired signal was then switched off and the interfering signal put on and the shift in the low i-f measured.

This measured the frequency separation very accurately and the inconsistencies previously experienced were found to be due to the fact that we had not been able to set the stations closer than ±2 kc using the commercial measuring equipment. While monitoring the i-f provided a very satisfactory method of setting station frequencies for the field tests, it is practical for general use. To set up stations on 20 or 30 kc channel spacings will require commercial measuring equipment of moderate cost with greater accuracy than those currently used for the average mobile communication system.

Millivac Instrument Moves to Larger Quarters

Millivac Instrument Company, precision measuring equipment manufacturers, have moved to quarters three times larger than their old quarters. Their new address is 444 Second Street, Schenectady, N. Y.



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

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

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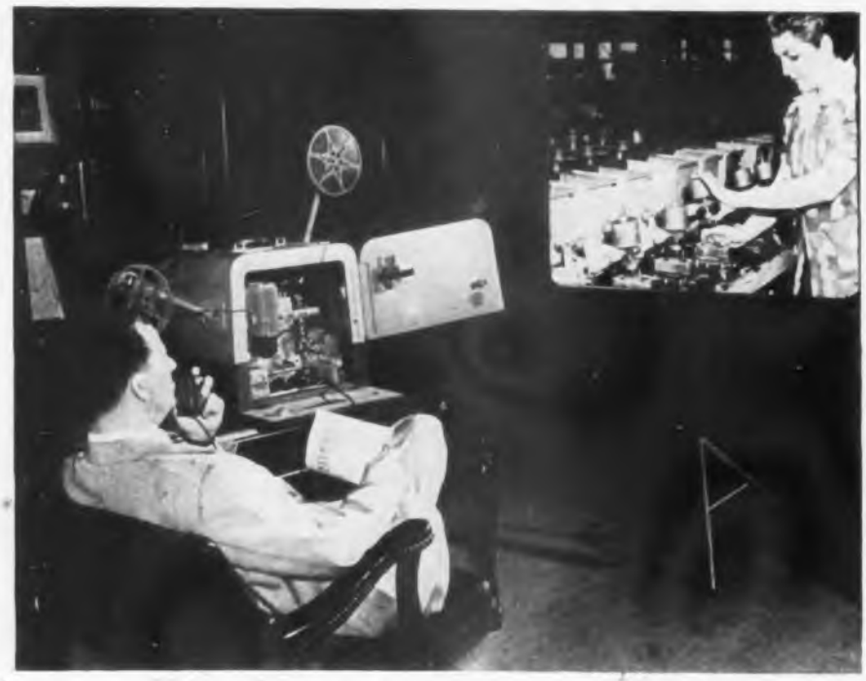

Executive adding a new sound track to new magnetic-stripe 16mm single sprocket hole film as it is projected by Bell & Howell's new model 202 optical-magnetic Recording Projector. With a different sound track for each audience, the film may be used to train new employees and foremen, teach salesmen how a company's product is made, and show customers the fine materials and precision workmanship which goes into it. With the new Recording Projector and Bell & Howell's "70" camera, small manufacturers can make ten-minute sound films for an out-of-pocket cost of about $200.

Transmitter Production Problems

Limiting factors in transmitter production—not only TV, but AM & FM and all other types—are delays in delivery of components and lack of engineering and technical personnel. That was consensus of 9 transmitter makers who recently met with NPA. Allotments of controlled materials haven't held up manufacture of transmitters and related military projects as much as shortage of components, they said. Unanimously, the manufacturers agreed scarcest item is Mu-metal, high nickel content alloy used as shielding. Hardest-to-get components include relays, nickel-bearing transformer laminations, small electric motors, mica and gas capacitors, crystals, meters, coils and special tubes for military work. Manufacturers agreed most serious manpower headaches resulted from shortage of senior engineers, layout draftsmen, technicians (testers or troubleshooters), wiremen, toolmakers, machinists. J. Bernard Joseph of NPA Electronics Div. presided at meeting attended by:

R. H. Hollister, Collins Radio; Lester H. Carr, Continental Electronics, Washington, D. C.; C. E. Williams, DuMont; E. Labin, Federal Telecommunications Labs; Parker S. Gates, Gates Radio; Frank P. Barnes, GE; T. A. Emith, RCA; William Zillger, Standard Electronic Co., Newark; C. W. Miller, Westinghouse.

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A. Eisencramer (L), staff engineer and R. T. Capodanno (R), Director of Engineering, Emerson Radio and Phonograph Corp., view new removable bezel and safety glass assembly developed by former. Unit enables owner to clean any dust accumulation on picture tube face or behind safety glass. No tools are required, and no chassis parts are exposed when glass is removed.

Bose Heads Radio Club

John H. Bose, an engineer associated with Edwin H. Armstrong, has been elected president of the Radio Club of America for 1952. Other officers elected are: vice-president, Ralph R. Batcher, engineer for the Radio-Television Manufacturers Association; corresponding secretary, Frank H. Shepard, Jr., president of Shepard Laboratories; recording secretary, Frank A. Gunther, vice-president of Radio Engineering Laboratories, Inc.; treasurer, Joseph Stantley, president of the Continental Sales Company. In addition, the following were elected directors: Ernest V. Amy, Edwin H. Armstrong, George E. Burghard, Alan Hazeltine, Harry W. Houck, Jerry Minter, and Harry Sadenwater.

Coast Show at Long Beach, Cal., Aug. 27-29

This year the West Coast Electronic Show and Convention, conducted under the auspices of the West Coast Electronic Manufacturers' Association and western sections of the Institute of Radio Engineers, will be held in the Municipal Auditorium at Long Beach, Calif., (in the Los Angeles area) August 27, 28 and 29.

Members of the controlling board of directors are: Chairman, R. G. Leitner (WCEMA), Packard-Bell Co.; Vice-

(*Continued on page* 159)

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(*Continued from page* 156)

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Business Manager is Heckert Parker, 215 American Avenue, Long Beach 2, Calif.

Bendix To Inspect British Radar Systems

Under the terms of a contract with the British Government, three radar engineers from the Bendix Radio Division of the Bendix Aviation Corp., will inspect some 24 radar aircraft landing systems located in England. The equipment, which Bendix manufactured and Great Britain acquired during World War II, has become partially inoperative due to lack of spare parts. The Bendix engineers, C. W. Hicks, J. C. Fritz, and F. L. Koch, will work with British electronic experts in an effort to adapt radar components, which are made in England, to the American sets.

They will also recommend steps necessary for modernization of the sets and incorporation of the latest designs developed in the Bendix laboratories.

BULLETINS

Relays

A new relay catalog describing the complete line of Amrecon relays, has just been published by American Relay & Controls, Inc., 4939 W. Flournoy St., Chicago 44, Ill. A section is included on the selection of relays, giving the method and data required to choose a relay for any specific application. The new catalog also describes the complete line of Amrecon relays, with illustrations and data on ten basic models (including both ac and dc types) and their many variations. Also discussed in the catalog are snap-action and latching relays; screw-terminal type relays; plug-in mountings; and hermetically sealed models.

Grounding Sheath Connectors

Complete technical information on a new grounding sheath connector is contained in data sheet S5, recently issued by the Thomas & Betts Co., Butler St., Elizabeth, N. J. This T&B grounding sheath connector is a two piece compression type connector made for terminating and grounding braided shields on wire and cable used in radar, critical radio and audio frequency circuits and for UHF work—for any electronics use requiring shielded conductors.

Phantom Repeater

A new 4-page bulletin describing the model 102 phantom repeater has been released by Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio. This special test instrument is a bridging amplifier with an extremely high input impedance, and is used to increase the accuracy of vacuum tube voltmeters and oscilloscopes on high impedance circuits. The bulletin lists complete specifications, includes diagrams of typical applications, including simultaneous measurement of voltage, shape inspection, and aural monitoring with negligible loading of test circuits.

TV Interference

The booklet "Television Interference" is a collection of articles by Mr. Phillip S. Rand, of Remington Rand, Inc. The articles are the result of extensive research in the Remington Rand Laboratory for Advance Scientific Research, at South Norwalk, Conn. Those who desire a copy may write direct to Mr. Rand at the Remington Rand Laboratory, Wilson Avenue, South Norwalk, Conn.

Flexible Shaft Handbook

The S. S. White Industrial Division, 10 East 40 St., New York 16, N. Y., has announced the publication of the third edition of the company's flexible shaft handbook. This 256-page reference manual provides a comprehensive and authoritative picture of the range and scope of flexible shafts in transmitting power and remote control and gives full details on their construction, selection and application. The current edition covers changes and developments that have been made in the flexible shaft field since 1944. Requests for copies should be made on company letterhead.

Coaxial Connectors

Leaflet TR-7B published by Transradio Ltd., 138A, Cromwell Road, London S.W.7, England, deals with a new series of precision coaxial connectors. Components of this standard of quality and precision have not hitherto been obtainable. The new series also includes a few types of U.S. JAN connectors.

Capacitors

Cornell-Dubilier Electric Corp., South Plainfield, N. J. has just released catalog 200C, believed to be the most complete and comprehensive catalog of service replacement capacitors ever published. This catalog supersedes Catalog 200B.

Rotary Solenoids

The many production applications of Ledex Rotary Solenoids are described in a bulletin issued by G. H. Leland, Inc., Dayton 2, Ohio. Six Ledex Rotary Solenoid models are manufactured. Diameters range from 1⅛ to 3⅜ inches.

Insulating Materials

The various types of electric insulating materials produced by the General Electric Company's Chemical Division, Pittsfield, Mass., are described in a new bulletin, CDL-35. Properties and applications of G-E varnished, Glyptal alkyd resin insulating finishes, varnished cloths and tapes, sealing and filling compounds, and G-E silicone insulating materials are described, with accompanying photographs.

Ceramic Products

A new 52-page catalog on Steatite Ceramic Products has been published by Stupakoff Ceramic and Manufacturing Co. Included in this brochure are drawings and dimensions of principal steatite products such as tubing, coil forms, stand-offs, strains, assemblies, appliance parts, bushings and a variety of others. More than 500 steatite parts are cataloged, and photographs illustrate many of them. A special feature of the catalog is a chart which shows 18 technical characteristics of 14 typical Stupakoff ceramic products. Also included is a nine-page section devoted to the General Standards for Steatites and other Electronic Grade Ceramics, as adopted by Steatite Research Council.

Price List

Universal Motor Co., Oshkosh, Wisconsin, has just released a new Electric Plant Price List, Form SE-3, covering their lines of air cooled and radiator cooled, and true marine water cooled electric generating plants. The complete line includes models of from 250 to 25,000 watts in gasoline models, and from 2,000 to 36,000 watts in diesel plants. A copy can be obtained by writing to the Universal Motor Co., 465 Universal Drive, Oshkosh, Wisc.

Tele-Tech

Advertisers—March 1952

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