TELE-TECH

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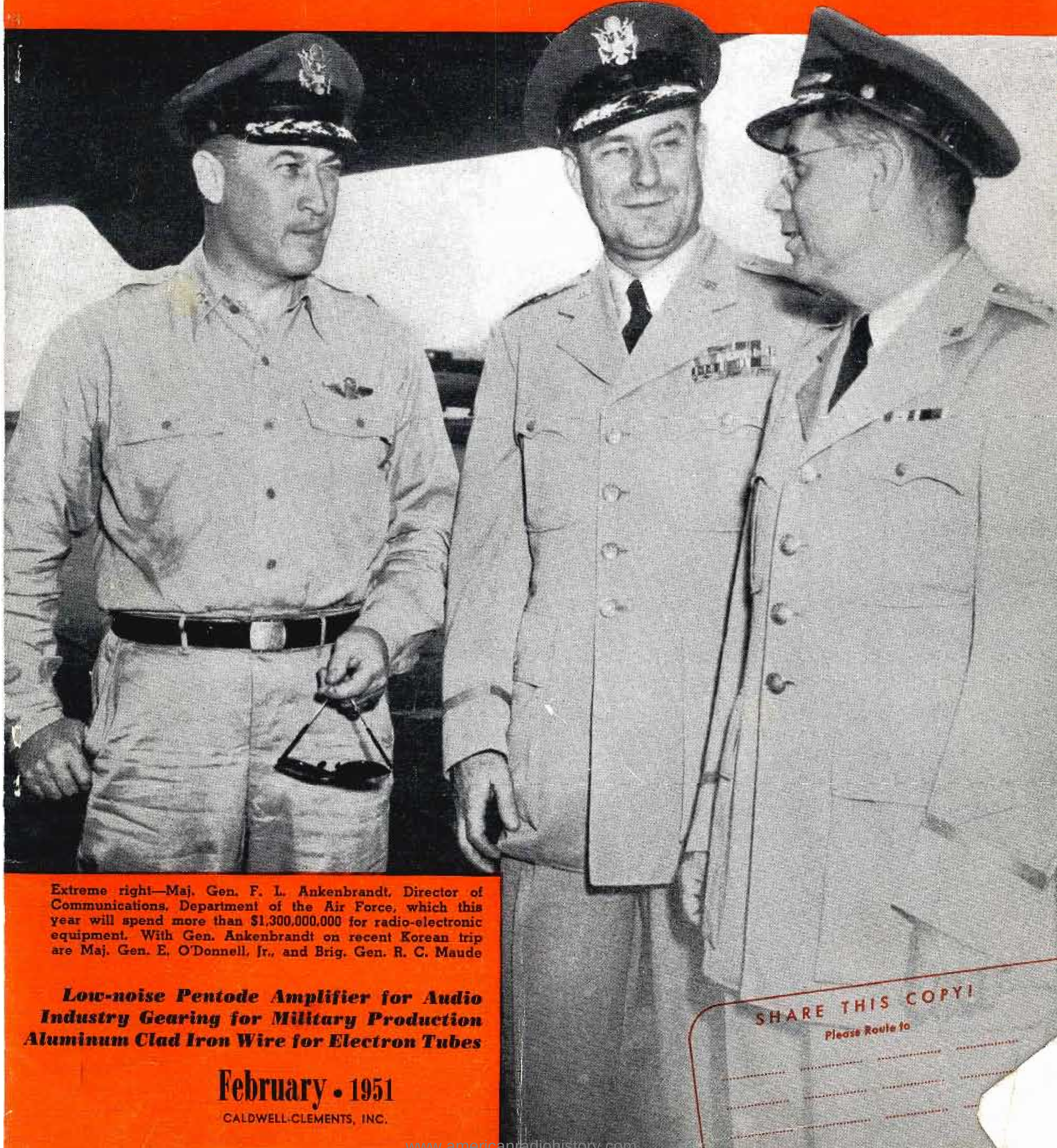
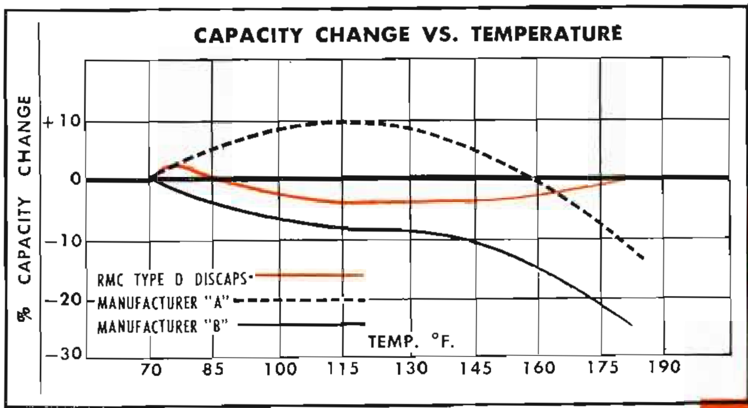


Extreme right—Maj. Gen. F. L. Ankenbrandt, Director of Communications, Department of the Air Force, which this year will spend more than $1,300,000,000 for radio-electronic equipment. With Gen. Ankenbrandt on recent Korean trip are Maj. Gen. E. O'Donnell, Jr., and Brig. Gen. R. C. Maude

Low-noise Pentode Amplifier for Audio
Industry Gearing for Military Production
Aluminum Clad Iron Wire for Electron Tubes

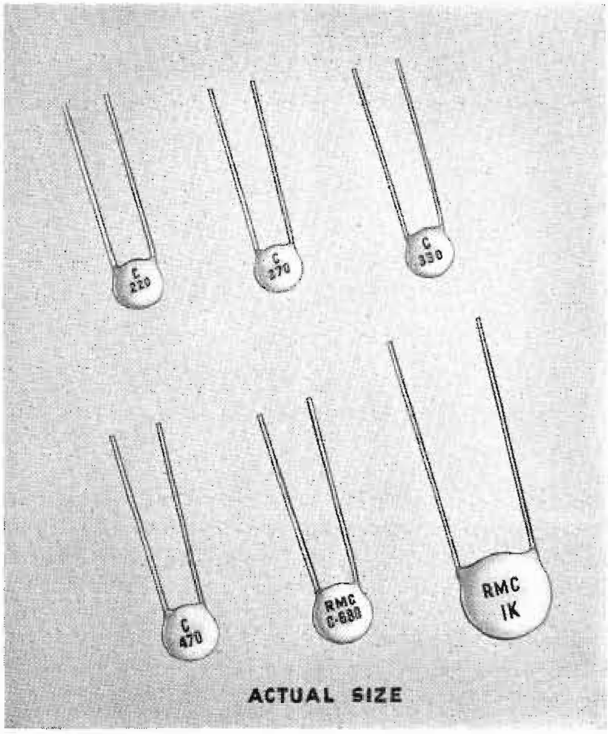
February • 1951

CALDWELL-CLEMENTS, INC.



ANOTHER *RMC* FIRST!

NOW... *a Really Stable* Condenser for Coupling and Filter Network By-passing



ACTUAL SIZE

Every DISCAP is 100% Tested for Capacity, Leakage Resistance and Breakdown

RMC Type D "Stable Capacity" DISCAPS

Specify RMC Type D DISCAPS when a more stable capacity is required for coupling and by-passing in filter networks. The actual capacity between +75°F and +185°F is +1% at 75°F, −4% at 130°F and ±0% at 185°F.

These new Type D DISCAPS, available in a capacity range between 220 MMF and 1000 MMF with a tolerance of ±20% at 25°C offer the advantage of low self inductance, small size and low cost.

POWER FACTOR	1.5% at 1KC
WORKING VOLTAGE	600 V.D.C.
TEST VOLTAGE	1200 V.D.C.
INSULATION	Durez Phenolic—Vacuum Waxed
RESISTANCE	Initial 5000 Megohms After Humidity 1000 Megohms
LEADS	#22 tinned copper (.026 DIA.)
BODY SIZE	220 MMF to 330 MMF 1/4" DIA. 330 MMF to 800 MMF 5/16" DIA. 800 MMF to 1000 MMF 1/2" DIA.
CAPACITY TOLERANCE	±20% at 25°C.

SEND FOR SAMPLES AND TECHNICAL DATA

DISCAP CERAMIC CONDENSERS

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RADIO MATERIALS CORPORATION

GENERAL OFFICE: 1708 Belmont Ave., Chicago 13, Ill.

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Two RMC Plants Devoted Exclusively to Ceramic Condensers

TELE-TECH

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Edited for the 15,000 top influential engineers in the Tele-communications industry, TELE-TECH each month brings clearly written, compact, and authoritative articles and summaries of the latest technological developments to the busy executive. Aside from its engineering articles dealing with manufacture and operation of new communications equipment, TELE-TECH is widely recognized for comprehensive analyses and statistical surveys of trends in the industry. Its timely reports and interpretations of governmental activity with regard to regulation, purchasing, research, and development are sought by the leaders in the many engineering fields listed below

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Manufacturing

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LONG & SHORT WAVE RADIO
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Research, design and production of special types
TUBES, AMPLIFIERS, OSCILLATORS, RECTIFIERS, TIMERS, COUNTERS, ETC. FOR
LABORATORY • INDUSTRIAL USE
ATOMIC CONTROL

Operation

Installation, operation and maintenance of telecommunications equipment in the fields of

BROADCASTING • RECORDING
AUDIO & SOUND • MUNICIPAL
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FEBRUARY, 1951

COVER: **Major General Francis L. Ankenbrandt at Haneda Airport in Tokyo while enroute to Korea to inspect communication systems.** With General Ankenbrandt (l to r) are Major General Ennett O'Donnell, Jr., Commanding General, Far East Air Force Bomber Command; Brigadier General Raymond C. Maude, Assistant for Developing Programming, Headquarters United States Air Force.

CALDWELL-CLEMENTS, INC., 480 Lexington Ave., New York 17, N. Y., Tel. Plaza 9-7880. Publishers also of RADIO & TELEVISION RETAILING

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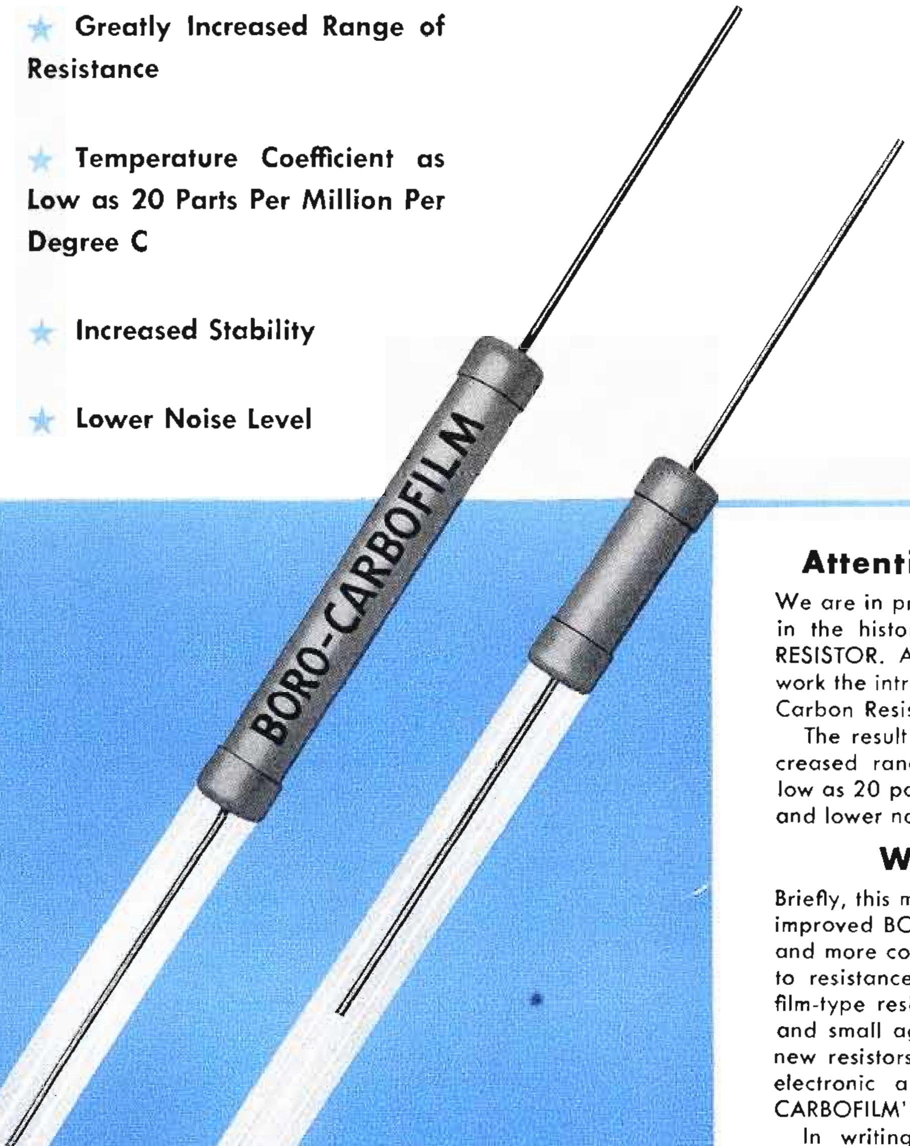
AND NOW

FIRST AGAIN WITH BORO-CARBOFILM RESISTORS

- ★ Greatly Increased Range of Resistance
- ★ Temperature Coefficient as Low as 20 Parts Per Million Per Degree C
- ★ Increased Stability
- ★ Lower Noise Level



Attention All Electronic Engineers

We are in production on the most advanced development in the history of resistors. It is the BORO-CARBOFILM RESISTOR. After over two years of intensive laboratory work the introduction of Boron in the making of Deposited Carbon Resistors has been perfected.

The result of this new development assures greatly increased range of resistance, temperature coefficient as low as 20 parts per million per degree C, greater stability and lower noise level.

What This Means to You

Briefly, this makes it possible for you to use the new, much improved BORO-CARBOFILM RESISTOR in place of larger and more costly wire-wound types. It also provides access to resistance ranges heretofore impossible to attain in film-type resistors. With their low temperature coefficient and small aging you will find wide-spread use for these new resistors in communications and nearly all types of electronic applications. Remember the name "BORO-CARBOFILM". Available in ¼, ⅓, ½, 1 and 2-watt sizes.

In writing, kindly give your requirements in sizes and volume.

BORO-CARBOFILM RESISTORS are made under license arrangement with Western Electric Co., Inc.

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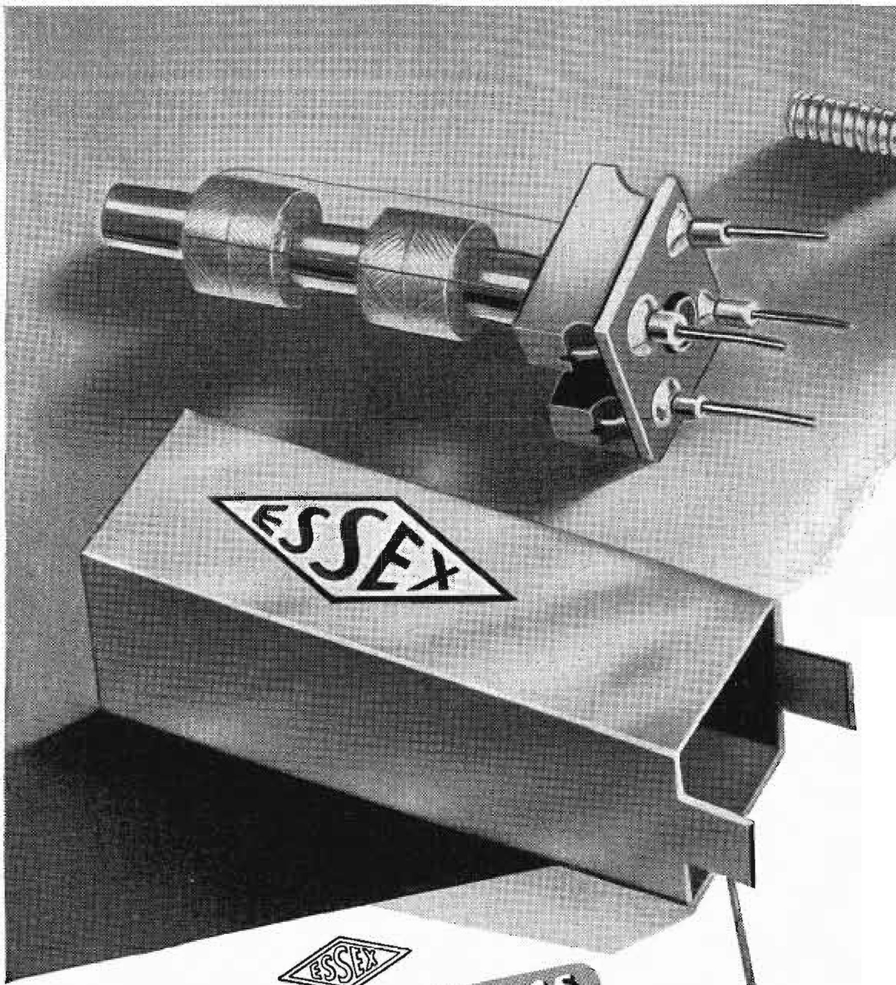

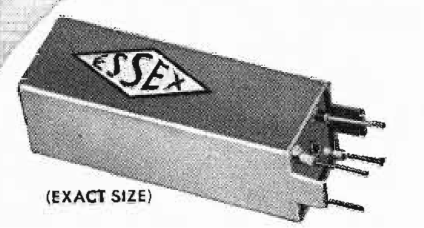

(EXACT SIZE)

ESSEX PERMEABILITY-TUNED I.F. COIL for personal radio (455 kc.)—measuring ½" x ½" x 1½". In spite of its small size, there is no sacrifice in performance.

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Manufacturers of coils, chokes and transformers
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December 21, 1950

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Gentlemen:

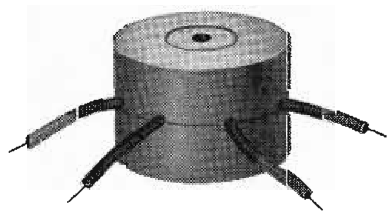
Miniaturization is a word that has become ever more important in our business. Over the past four years we have received one assignment after another of this type. Ths solutions to these problems do not alwsys go by formula; they are not exactly simple. But -- on each and every occasion -- G A & F Carbonyl Iron Powders have been one of our major tools in the successful completion of these assignments.

A typical application was for the translation receivers which permit a United Nations delegate to select the language in which he wishes to hear any talk.....Another was for the tuning coils on a hearing-aid, radio-receiving attachment. Another was for I.F. coils for a tiny personal receiver. And the nation's armament program -- to which we hope we are making full contribution -- calls for sub-miniature coils. These, too, we are developing with the help of your product.

At all times, our design work is aimed at top quantity production of top quality items. In every assignment of this type, we rely on the fully dependable properties of Carbonyl Iron Powders.

Sincerely yours,
ESSEX ELECTRONICS

Bernard M. Goldsmith
President



ESSEX PERMEABILITY-TUNED R.F. TRANSFORMER for United Nations translation receiver—measuring ⅞" in diameter and ⅝" in height. Same type of construction has been made in 262 kc. I.F. Transformer—measuring ½" x ½".

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MINIATURIZATION

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CARBONYL IRON POWDERS

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Other makers—of both cores and coils—have testified that *it costs less* to work with these top quality materials and that major gains are effected in both weight reduction and increased efficiency. We urge you to ask your core maker, your coil winder, your industrial designer, how G A & F Carbonyl Iron Powders can improve the performance of the equipment you manufacture. It will cost you nothing to get the facts.

THIS FREE BOOK — fully illustrated, with performance charts and application data — will help any radio engineer or electronics manufacturer to step up quality, while saving real money. Kindly address your request to Department 23.

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TELE-TIPS

CONSERVATION of scarce materials has been worked out by Philco engineers in designing new TV set with 85% less cobalt, 85% less nickel, 67% less silicon-steel, 25% less copper, and 25% less aluminum. Set could be in production in three months, Engineering Vice-president Leslie Woods is quoted as promising.

LITTLE KNOWN FACTS—Railroad use of radio has increased over 16-fold in the last five years. A total of more than 5,337 railroad radio stations is now in operation including base and mobile units. Inductive carrier operations also include over 1,173 installations. In the event of emergency or internal trouble these would prove invaluable to the government in coordinating defence operations.

DUAL POWER FREQUENCY operation of TV receivers, such as is required of installations used in South America, and some European countries, poses problems for the designer. In many sets which are built down to a price there is insufficient iron in the power transformer so that it heats up at the lower frequency of 50 or even 25 cps. Additional shielding is also required to prevent the 60-cycle field of the supply from interacting with the 50-field repetition rate of the television system. Filtering is also needed.

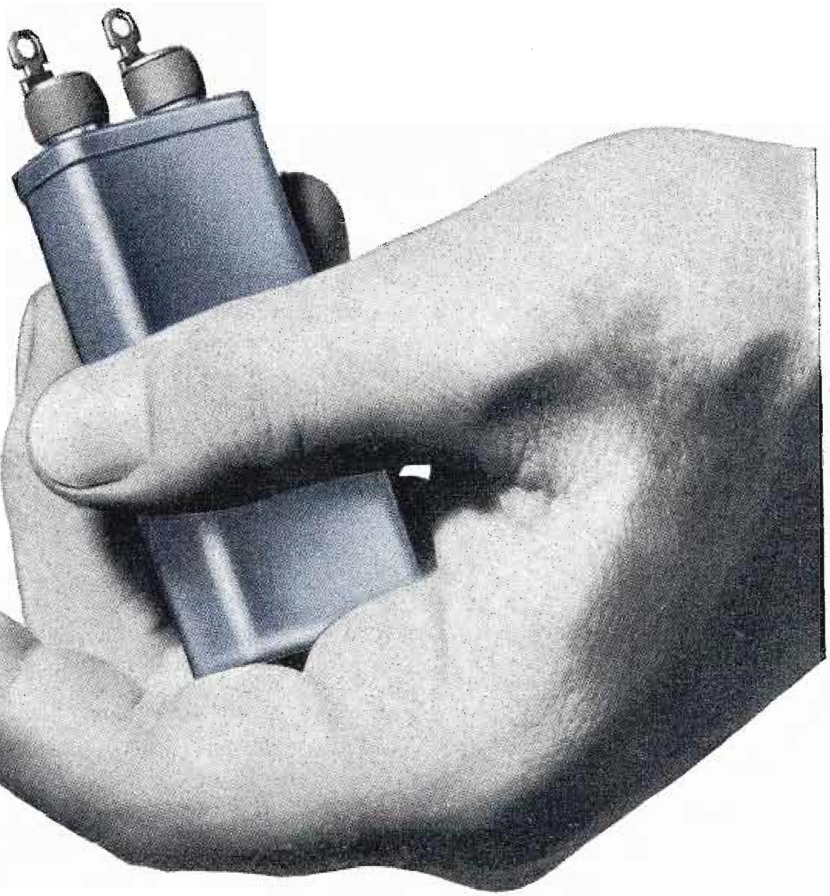
OCT. 14, 1920, was the date regular broadcast programs began over Station W2XQ, Union College, Schenectady, N.Y., according to a 30-year celebration just held by the present Union College campus carrier station WRUC. Even in the Spring of 1920, irregular concerts were broadcast, and names on the old log include Glenn Mercer, Leo Freedman, Ralph Bennett, William J. Mc Caig, W. T. Meenam, E. D. Cook, R. D. Stevenson and Clyde D. Wagoner. In 1922 WGY went on the air, sharing until 1924, the 360-meter channel of WRL, which was the new call of the Union College station assigned in 1921. Present campus broadcast station WRUC was launched Sept. 22, 1941, by G. B. Houck, Myron Mills and Paul Yergin.

ELECTRONIC EMBALMING is a new development of U. A. Sanabria, of American Television, Chicago. When a corpse is dehydrated by dielectric heating it will keep indefinitely, and can then be wrapped in a glass cloth and sealed in an evacuated glass tube. Corning Glass is offering glass envelopes to last two million years, and undertakers are getting set to handle the new process.

GOVERNMENT WORKERS were unfairly maligned in item "Happy Sickleave" appearing in our November issue, according to several letters received from Washington, including a protest from Chairman H. B. Mitchell of the U.S. Civil Service Commission. Chairman Mitchell points out that when this "vacation" compilation originally appeared in a U.S. Chamber of Commerce bulletin, it was traced back to vague origins at an Arizona airfield in 1943. So we hasten to apologize for any reflections cast on the great body of conscientious and devoted Washington workers.

(Continued on page 11)

How to be sure you get the Best Capacitor



Need square waves?

Pulse-forming networks are used where the normal capacitor discharge wave shape is not suitable, and where an impulse must have definite energy content and duration. Their design involves several tricky problems—one being suitability for high temperature operation. Nevertheless, networks are one of our specialties—we have built them by the thousands, and our experienced and capable engineers will be glad to discuss any of your design problems. We invite your inquiries.

YOU CAN test the paper for density . . . thickness . . . porosity . . . power factor . . . chloride content . . . dielectric constant . . . dielectric strength.

And then test the foil for thickness . . . purity . . . softness of the anneal . . . freedom from oil . . . cleanliness of surface . . . absolute smoothness.

And then test the liquid dielectric for specific gravity . . . viscosity . . . power factor . . . color . . . acidity . . . flash point . . . dielectric strength . . . dielectric constant . . . insulation resistance . . . water content.

And after that, test every single finished capacitor for shorts, grounds, and opens at overvoltage between terminals and between terminals and case . . . and measure the capacitance of every single unit . . . and then check every single capacitor to see that it has a leak-proof hermetic seal.

OR YOU CAN buy General Electric capacitors . . . product of outstanding research and know-how . . . which have already passed every one of these tests

. . . on the materials when they were made.

. . . and again before they were used.

. . . and on the capacitors during manufacture.

. . . and then, finally, on every single capacitor before shipment.

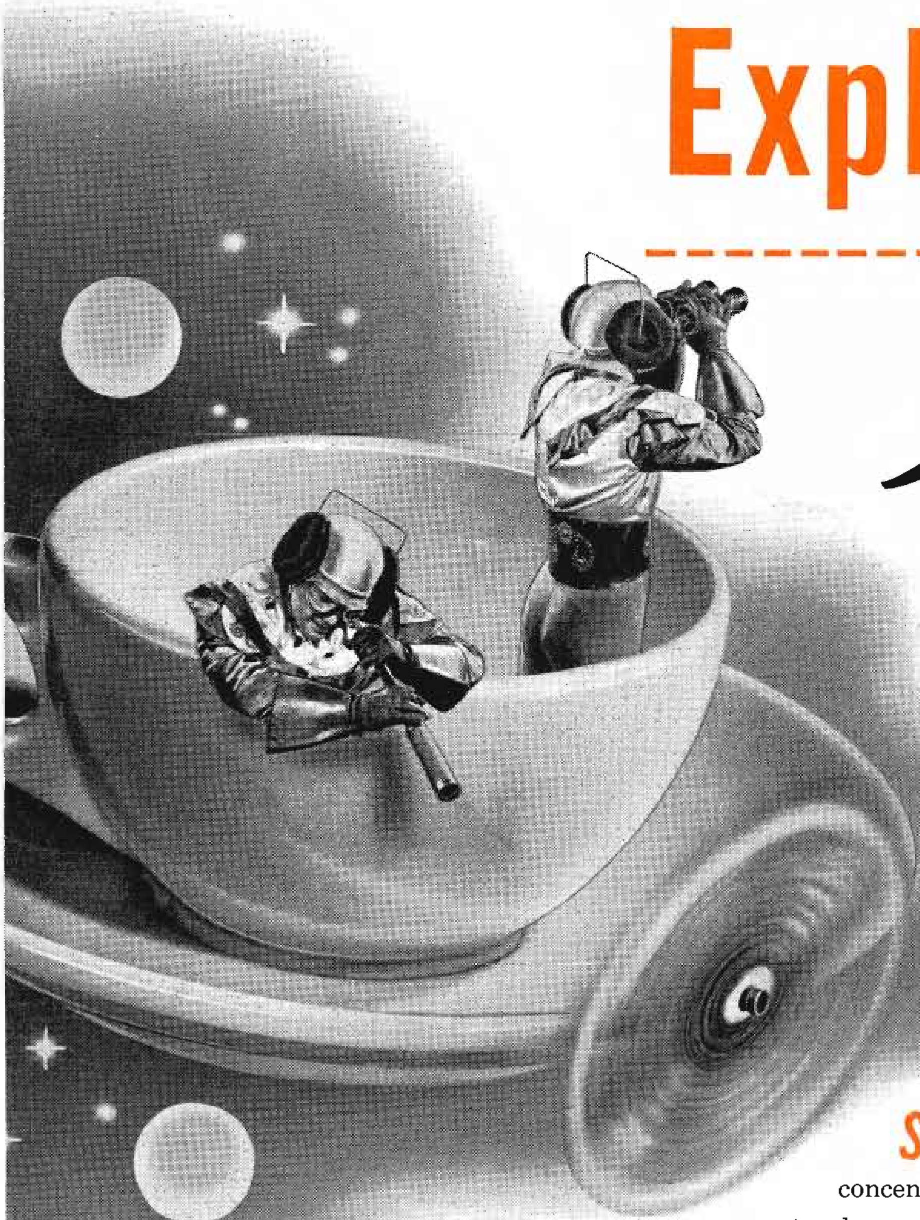
For full information on types, ratings, dimensions, types of mounting, and prices of capacitors, address the nearest *General Electric Sales Office or Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

407-170

Exploration

for resistors too!



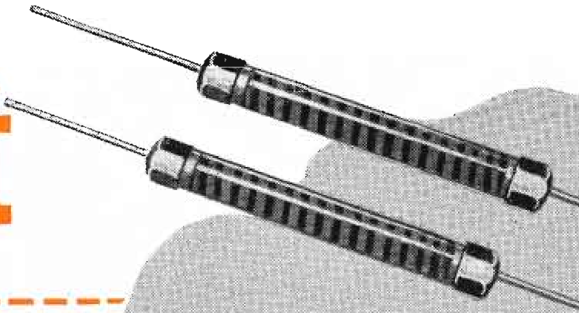
Specialization in resistors lets IRC concentrate on research and quality control to a greater degree than any other supplier.

Result:—IRC exploration *anticipates* future resistor needs—*improves* existing products—and *controls* quality and uniformity in every IRC unit. Largest resistor manufacturer in the world, IRC attracts the finest of engineering talent. We're using more of such talent than ever, now, to keep step with today's electronic requirements—while we plan for tomorrow's advances.

FLAT POWER WIRE WOUND RESISTORS

For high-wattage dissipation in limited-space applications, IRC Type FRW Flat Wire Wound Resistors have higher space-power ratios than standard tubular units. FRW's can be mounted vertically or horizontally—singly or in stacks. Non-magnetic mounting brackets permit easy, economical mounting, aid in heat distribution along the entire length, and transfer internal heat to the chassis. Available in 9 sizes—fixed and adjustable. Send for full details in Bulletin C-1.

is important



HIGH OHMIC RESISTORS

Engineered for high voltage applications where high resistance and power are required, IRC Type MVX Resistors are particularly suited to many types of television and electronic circuits. Unique application of IRC's proven filament resistance coating in helical turns on a ceramic tube provides a conducting path of long, effective length. Result: A unit of high resistance value with resistance materials having relatively low specific resistance. Type MVX's have 2 watt rating, are exceptionally stable—permit the use of high voltage on the resistor while keeping voltage per unit length of path comparatively low. Send coupon for complete details in Bulletin G-2.

DEPOSITED CARBON PRECISTORS

A unique *combination* of accuracy, stability and economy makes IRC Deposited Carbon PRECISTORS ideal for applications where carbon compositions are unsuitable or wire-wound precisions too expensive. Instrumentation, advanced electronics and critical television circuits also benefit from their wide range of values, low voltage coefficient, excellent frequency characteristics, predictable temperature characteristics, high voltage rating, low noise level and small size. Coupon brings full particulars in Bulletin B-4.

VOLTMETER MULTIPLIERS Sealed-precision IRC Type MF Resistors are completely impervious to moisture—have proved themselves dependable voltmeter multipliers for use under the most severe humidity conditions. Each multiplier consists of a number of IRC Precision Resistors, mounted, interconnected, and encased in a glazed, hermetically sealed ceramic tube. MF's are compact, rugged, stable, easy to install, and may be used with very little drain on the power supply. Individual precision resistors may be either inductive or noninductive, so that they may be used on AC as well as DC. Mail coupon for full data in Bulletin D-2.

IRC

Wherever the Circuit Says -\/\/\/-

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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- ☐ Flat Wire Wound Resistors (C-1)
- ☐ Deposited Carbon PRECISTORS (B-4)
- ☐ High Voltage Resistors (G-2)
- ☐ Voltmeter Multipliers (D-2)
- ☐ Name and address of local IRC Distributor

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ALSO USED WIDELY BY MANUFACTURERS OF ELECTRICAL EQUIPMENT . . . FOR ITS HIGH DIELECTRIC STRENGTH . . . LOW MOISTURE ABSORPTION . . . STRENGTH, LOW LOSS AND GOOD MACHINEABILITY.

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Grade E . . . Improved post cure fabrication and stapling.
Grade EX . . Special grade for TV deflection yoke sleeve.
Grade EE . . Improved general purpose.
Grade EEX . Superior electrical and moisture absorption properties.
Grade EEE . Critical electrical and high voltage applications.
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Grade SP . . . Post cure fabrication and stapling.
Grade SS . . . General purpose.
Grade SSP . . General purpose—punching grade.
Grade SLF . . Thin wall tubing—high dielectric and compression strength.

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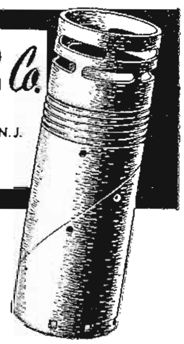

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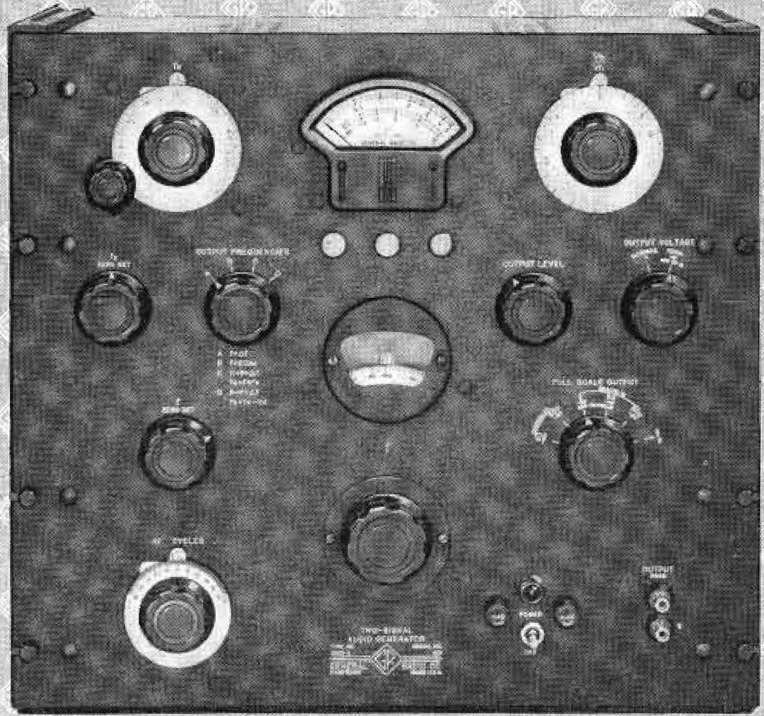
TELE-TIPS (Continued)

CBS SEEMS TO BE overwhelmed by the response to its color-television system. We hear that eager inventors are being turned away in droves—inventions unseen! This is probably just as well since at this stage it is better for a company not to examine unpatented schemes for fear of later suits in case a staff engineer has similar ideas.

SUNSPOT-CYCLE LOW—The solar cycle (averaging 11.6 years) is now recognized to have considerable effect on radio transmission thru changing heights of the radio reflecting layers. As 1951 opens, the sun's spots are still diminishing in number. Estimates of the date of the coming minimum, made by various authorities, are: Bureau of Standards, early 1955; Greenwich (Eng.) Observatory 1954-55; Princeton 1955-6; Dr. C. W. Cartlein, Cornell, 1954.7-1955.3.

COBALT AND COPPER CONSUMPTION will be greatly reduced in future TV picture tube designs according to recent RCA announcement. Development has now progressed to where electron gun assemblies will use electrostatic focusing thus eliminating alnico magnets or copper wire coils for focus. First application will probably be in 21-in. metal-glass rectangular to be introduced next May. While new gun design conserves critical raw materials, attendant difficulties are encountered and include: obtaining round spot, maintaining regulation and ratio (about 1:5) between focus and anode supply voltage, and providing means for spot centering. If high efficiency autotransformer type flybacks are used, centering may have to be done with some type of external magnet.

RAINCOATS FOR RADOMES—Rain is anything but "gentle" when you hit it at modern plane speeds of 400 miles an hour. At such speeds, it takes only a few minutes for rain to erode the radomes housing the plane's radar equipment. These radomes are of plastic laminate construction, layers of fabric bonded together with a heat-hardening resin. Air Force tests now show that a thin coating of neoprene, the synthetic rubber made by Du Pont, furnishes remarkable surface protection against "rain blasting." A coating only 10 thousandths of an inch thick has prevented damage to laminates for 10 hours in test flights through rain at 400 mph. Coating can be built up again, by spraying.



TYPE 1303-A
TWO-SIGNAL GENERATOR
$1050

a *New* Two-Signal Audio Generator

Ideal for Non-Linear Tests On: ☆ *Audio Amplifiers* ☆ *Hearing Aids* ☆ *Filter Networks* ★ *Noise Suppressors* ★ *High-Efficiency Speech Reproducing Systems* ★ *Loudspeakers* ☆ *F-M Systems with Pre-Emphasis* ★ *Recording Systems* ★ *Any System of Restricted Frequency Range*

The new G-R Type 1303-A Two-Signal Audio Generator supplies signals by the beat-frequency method. Three oscillators and three mixers are used to provide a number of output-signal combinations. The output of the mixers are combined in a linear adding network and then amplified through a very low-distortion power amplifier. The output from the amplifier is fed into a 600-ohm attenuator system, with a voltmeter to monitor the level at the input of the attenuator. The harmonic content and inter-modulation products in the final output are at a very low level. High stability of voltage and frequency are provided. The frequency drift from cold start is only a few cycles.

This A-F Signal Generator will supply the following signals:

- A single low-distortion sinusoidal voltage, adjustable in frequency from 20 cycles to 40 kilocycles, in two ranges.
- Two low-distortion sinusoidal voltages, each separately adjustable, one to 20 kc and the other to 10 kc.
- Two low-distortion sinusoidal voltages with fixed difference in frequency maintained between them as the frequency of one is varied. The fixed difference frequency is adjustable up to 10 kc, and the lower of the two frequencies is adjustable up to 20 kc.

The output is continuously adjustable and is calibrated both in volts and in db with respect to 1 mw into 600 ohms. The frequency calibration can be standardized within one cycle at any time. Its accuracy is ± (1% + 0.5 cycle).

This generator is an excellent and versatile signal source for the three standard non-linear distortion tests:

1. The widely used harmonic distortion test.

2. The intermodulation method that evaluates distortion in terms of the resultant modulation of a high-frequency tone by a low-frequency tone.

3. The difference-frequency intermodulation test, which evaluates distortion in terms of the amplitude of the difference-frequency components produced by intermodulation of two sinusoidal test signals of equal amplitude.

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GENERAL RADIO COMPANY

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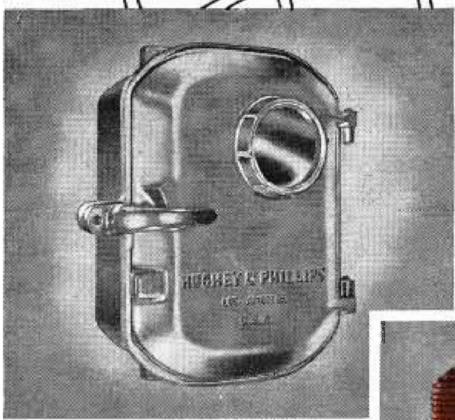
Everything Needed for any Tower, 150 to 900 feet!

H & P *Complete* Tower Lighting Kits include every item essential to the completed installation — every bolt and fitting . . . H & P Complete Lighting Kits, in today's critical market, will save you on purchasing, erection, and completion time . . . The H & P 300 MM Code Beacon (shown left) has 10 exclusive features, is CAA approved.



Single and double Obstruction Lights
below

Bases ruggedly constructed of heavy aluminum alloy castings. Precision machining insures proper light center when used with specified lamp. Prismatic globes meet CAA light specifications. Relamping accomplished without removing prismatic globes. Mounting base designed for standard A-21 traffic signal lamps.

above
"PECA" Series Photo-Electric Control

Factory-set to turn lights on at 35 f.c.; off at 58 f.c. as specified by CAA. Low-loss circuit insulation. High-wattage industrial type resistors. Tube ratings well over operational requirements. Fail-Safe: if any parts fail in service, lights automatically turn on.

above
Mercury Code Flasher

Only four moving parts which run in lifetime lubricated ball bearings. No contact points to wear out. Speed adjustment, 14 to 52 flashes per minute. Motor separately fused for continuous operation of lights in event of mechanical failure.

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For Negative Resistance-Voltage Characteristics

GLOBAR

TRADE MARK

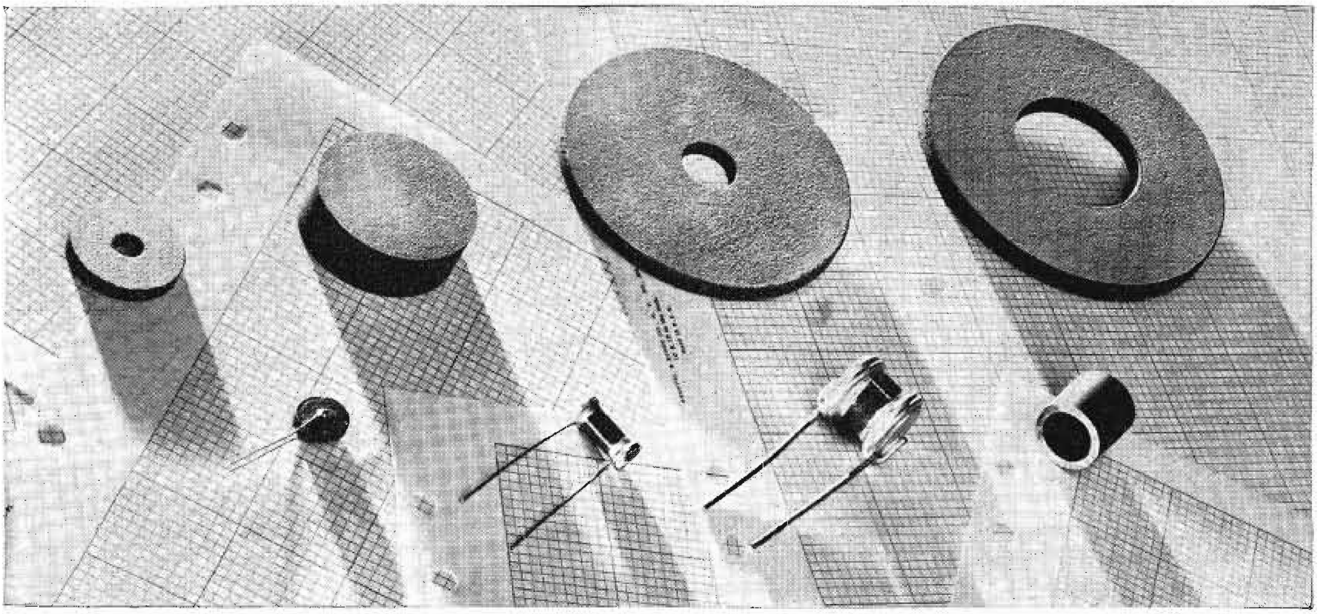
TYPE BNR RESISTORS

Responding instantly to voltage changes, GLOBAR type BNR Silicon Carbide Resistors provide increased resistance as a potential is decreased. Conversely, as a potential is applied, resistance decreases. These resistors are what is commonly referred to as voltage sensitive. They are used to dampen the effect of transient voltages and provide instant protection for electrical circuits.

Typical applications where these resistors operate successfully include:

1. Small motors to prevent arcing of governor contact points.
2. Stabilizing rectifier circuits by limiting peak voltages.
3. Voltage control circuits in electronic devices.
4. Protection of solenoids in direct current circuits.

Bulletin GR2 contains useful engineering data on GLOBAR BNR Ceramic Resistors. Copies will be supplied immediately upon request. Write Dept. T-21, The Carborundum Company, GLOBAR Division, Niagara Falls, N. Y.



Resistors of this type are readily made to meet exact specifications. Working samples are available when necessary. To be sure of receiving resistors made to correct specifications, the following information should be furnished:

- **a.** Type of apparatus in which resistors are to be used.
- **b.** Method of mounting and space limitations.
- **c.** Normal operating voltage and peak voltage if available.
- **d.** Resistance and inductance of the circuit if available.
- **e.** Ohmic resistance of the resistor and allowable plus or minus tolerance.
- **f.** Maximum voltage applied continuously or intermittently.
- **g.** Duration of load and elapse of time between applications.

Furnishing these data will also avoid unnecessary delay and confusion.

GLOBAR Ceramic Resistors

BY CARBORUNDUM

TRADE MARK

"Carborundum" and "Globar" are registered trademarks which indicate manufacture by The Carborundum Company, Niagara, Falls, N. Y.

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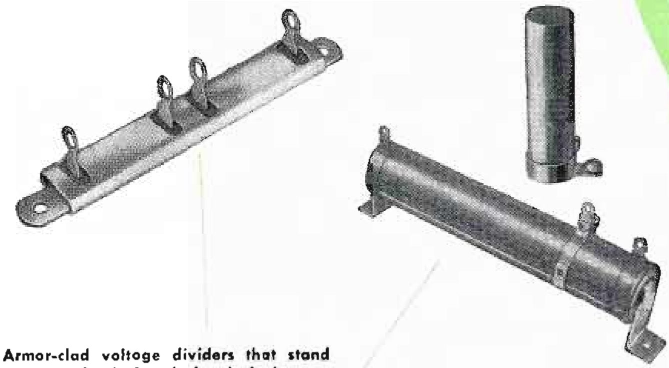
More Rugged Electrically
More Rugged Mechanically
More Rugged in Safety Factor
More Rugged for Longer Life



Armor-clad voltage dividers that stand up to mechanical and electrical abuse.

The toughest wire-wound power resistors in use today — Greenohms and Standees.

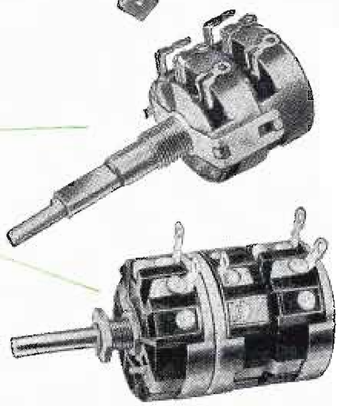
Dual carbon-element controls with single shaft or with dual concentric shaft.

Constant-impedance L- and T-pads for distortionless volume control of sound systems.

Plug-in ballasts and line-voltage regulators for smoother set operation and protection.

Wire-wound potentiometers with that velvety-smooth mechanical and electrical precision.

Power rheostats "built like a battleship" for dependable control functions.

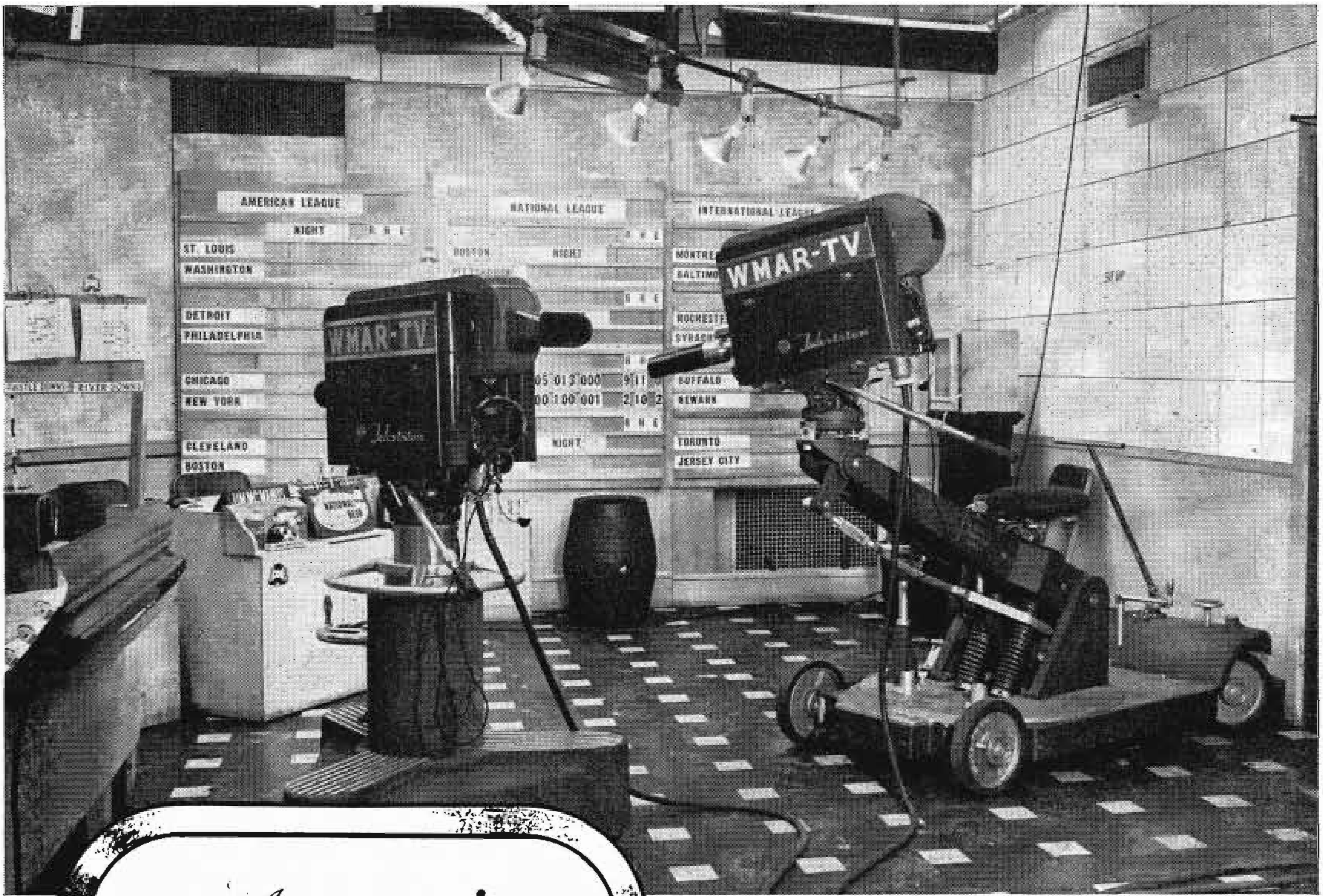


★ A dependable control or resistor costs but a few cents. But an *uncertain* control or resistor that fails out in the field can cost you thousands of dollars by way of impaired reputation.

The fact that Clarostat controls and resistors are used in the majority of today's TV, radio and electronic assemblies, speaks for itself. Clarostat not only supplies such initial equipment but also the service replacements for the further protection of the manufacturer's good name and good will.

Designed for Service! That's precisely what you are demanding and getting, when you simply specify CLAROSTAT for controls and resistors.

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



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For complete camera mobility, smooth pan effects, angle shots, running shots, tilts, dolly shots...most television stations rely on Houston-Fearless equipment . . . standard of the motion picture industry for 20 years. Houston-Fearless dollies, cranes, camera pedestals, tripods and heads combine brilliant engineering, superb quality, precision craftsmanship and proved dependability that assure perfect, reliable performance at all times.

More and more television stations and film producers are discovering the many advantages and economies in operating their own film processing labs. Whatever your needs, Houston-Fearless film processing equipment will do the job faster, better, automatically and with complete dependability.

Write for information on specially-built equipment for your specific needs.

The HOUSTON FEARLESS Corporation

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

Now Corning gives You...

20" all-glass television bulbs!

When television was still a laboratory curiosity, Corning made the *first* experimental bulbs. All during the early stages of television set production, Corning was the principal manufacturer of television bulbs. In keeping with this tradition, and in answer to demands from the Television Industry, Corning has introduced the *all-glass 20" rectangular bulb!*—the largest television bulb in volume production today.

The first of this size on the market, the new 20" bulb combines all the improvements developed through years of research at Corning. Among these are light-weight, lead-free glass ideally suited to electronic applications, stronger bulb assemblies from electric sealing, and constant quality and color transmission from improved glass melting and forming techniques. The new Corning 20" all-glass bulb is the last word in quality, durability and size.

CORNING GLASS WORKS **CORNING, N. Y.**

Electronic Sales Department, Electrical Products Division

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Corning means research in Glass

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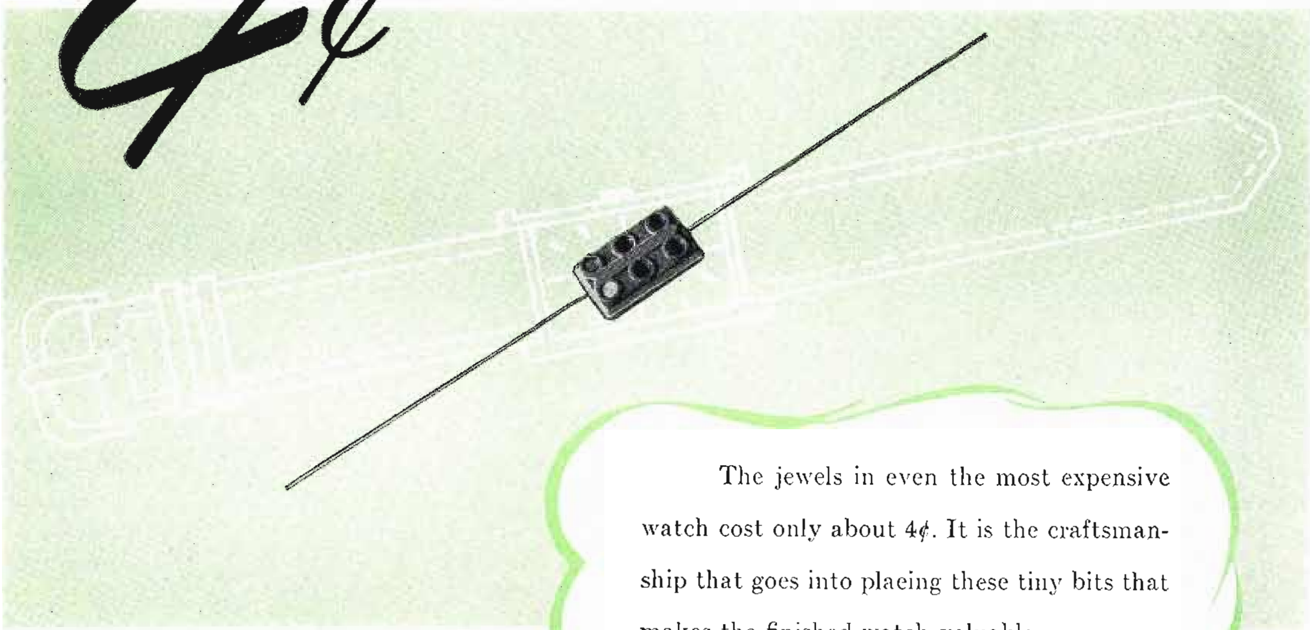
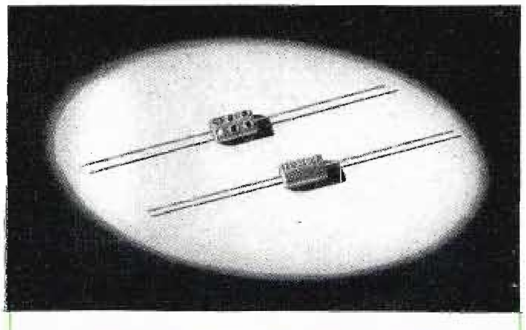
4¢ WORTH OF JEWELS



The jewels in even the most expensive watch cost only about 4¢. It is the craftsmanship that goes into placing these tiny bits that makes the finished watch valuable.



CM-15 MINIATURE CAPACITOR

Actual Size 9/32" x 1/2" x 3/16"

For Television, Radio and other Electronic Applications.

2 mmf. to 420 mmf. cap. at 500v DCw.

2 mmf. to 525 mmf. cap. at 300v DCw.

Temp. Co-efficient ± 50 parts per million per degree C for most capacity values.

6-dot color coded.

The same may be said of the El-Menco CM-15 Capacitor. Tested for dielectric strength at *double* its working voltage, this mighty mite surpasses the strictest requirements of the Army and Navy. It withstands extraordinary strain under the most critical operating conditions — in any climate. Put it in your product — for peak performance.

A COMPLETE LINE OF CAPACITORS TO MEET EVERY REQUIREMENT

THE ELECTRO MOTIVE MFG. CO., Inc.
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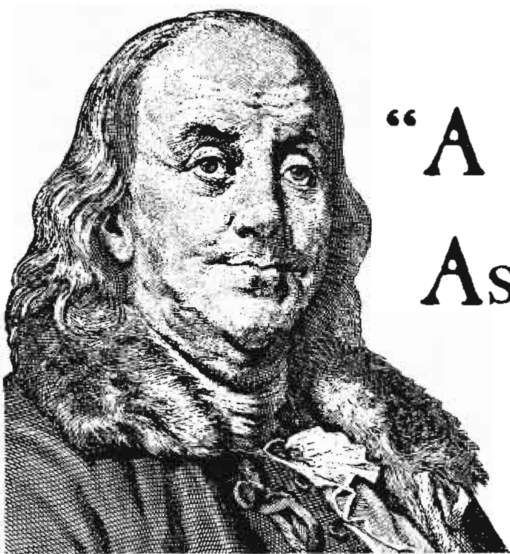
Write on your firm letterhead for Catalog and Samples.

MOLDED MICA **El-Menco** MICA TRIMMER

CAPACITORS

FOREIGN RADIO AND ELECTRONIC MANUFACTURERS COMMUNICATE DIRECT WITH OUR EXPORT DEPT. AT WILLIMANTIC, CONN. FOR INFORMATION.

ARCO ELECTRONICS, INC. 103 Lafayette St., New York, N. Y.—Sole Agent for Jobbers and Distributors in U.S. and Canada

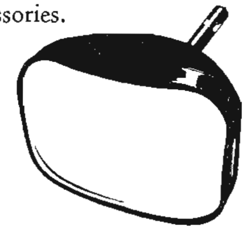


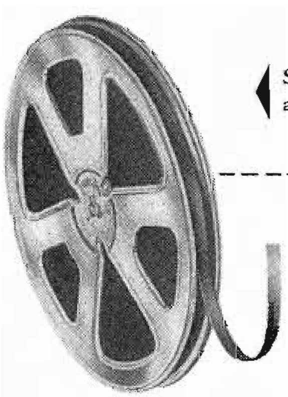
"A Craftsman Is Only As Good As His Tools!"

—*Benjamin Franklin*

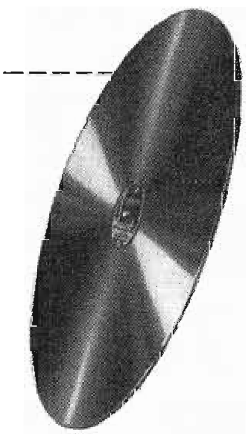
YOU will find the best in Television Picture Tubes and recording apparati come from the Reeves Soundcraft Laboratories. Magnetic tape with ten distinct features that contribute to its higher efficiency and fidelity; an assortment of recording discs to answer every requirement — a sensational line backed by the greater integrity and experience of the Reeves name, foremost manufacturer of recording and electronics accessories.

Soundcraft rectangular neutral-density filter tubes available in 16", 17" and 20" sizes.





Soundcraft tape is made in all types and lengths to accommodate all tape recorders.



Soundcraft recording discs available in a variety of sizes, single and double face.

Soundcraft

REEVES Soundcraft CORPORATION

REEVES—"20 YEARS WITH SOUND RECORDING MEDIA"

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Look into this
PROFESSIONAL
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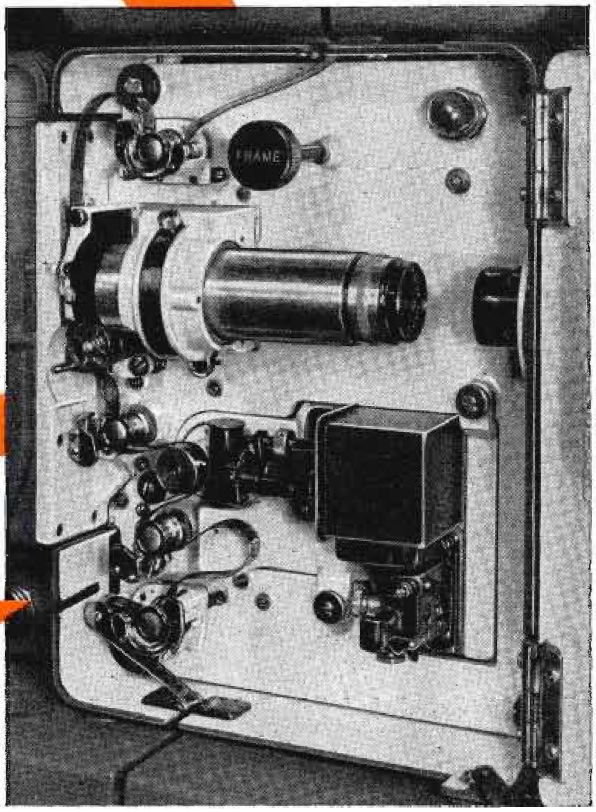
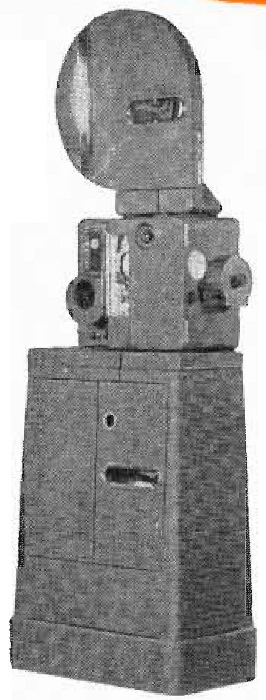
and see years of Dependable Service

The GPL Model PA-100 — a 16-mm Studio Projector with the basic features and performance reliability of the famous Simplex 35-mm Theatre Projectors.





The Model PA-100 is a 16-mm projector consistent with the professional character of television station operation. Its enclosed 4,000 foot film magazine provides for 110 minutes of projection — an entire feature.

Sharper Pictures . . . Finer Sound From Any Film in Your Studio

The importance of 16-mm film in television programming has called for new standards of projection quality and dependability. The GPL Model PA-100 is the first projector designed and built specifically for television studio use. It is a heavy-duty film chain projector for operation with any full-storage type film pick-up.

The professional, sprocket-type intermittent, similar to that used in the finest 35-mm equipment, is quiet and trouble-free. It provides a vertical stability of better than 0.2% over years of service. Film is protected — tests show more than 4,000 passages without noticeable film wear.

The high quality optical system resolves better than 90 lines per mm, with illumination so uniform that corner brightness is at least 90% of center. With a 1,000 watt light source, the projector delivers 100 foot-candles to the camera tube. The sound system provides a frequency response truly flat to 7,000 cps, with flutter less than 0.2%.

The Model PA-100 is one of a complete line of GPL 16-mm television studio and theatre projectors built to highest 35-mm standards.

WRITE, WIRE OR PHONE FOR DETAILS

GENERAL PRECISION LABORATORY INCORPORATED

General Precision Laboratory
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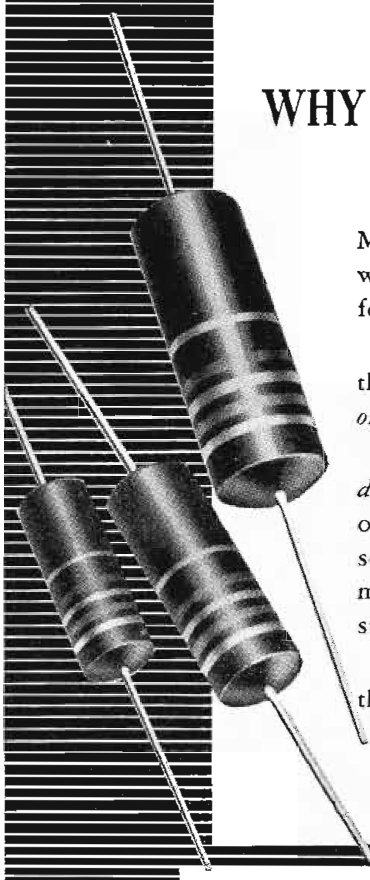
TV Camera Chains • TV Film Chains • TV Field and Studio Equipment • Theatre TV Equipment

THE INSIDE STORY:

WHY SPRAGUE MOLDED TUBULARS OUTPERFORM ALL OTHERS!

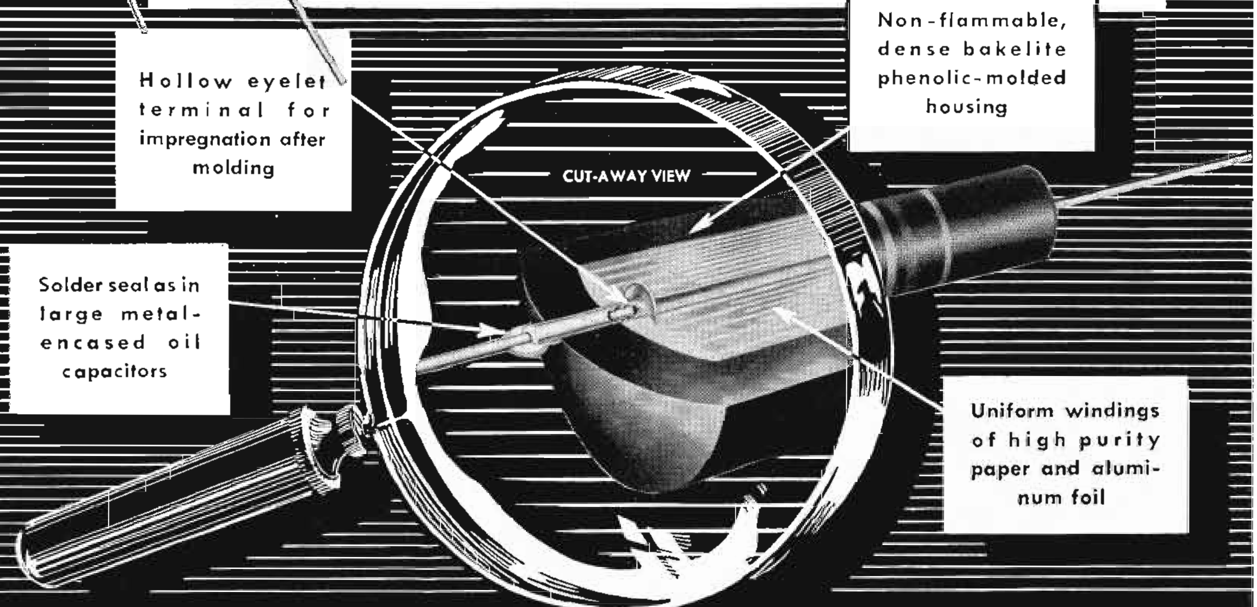


Molded paper tubulars may look alike from the outside. But there's a whale of a difference inside—the part that really counts in the performance of your products.

The *exclusive* difference in Sprague molded phenolic tubulars is that: *each is made by the same dry-assembly process as large metal-encased oil capacitors.* They cannot be contaminated during manufacture!

Every Sprague molded tubular from 200 to 12,500 volts is molded *dry*. After molding it is impregnated under high vacuum through an opening in the eyelet terminal. A lead is then inserted and the terminal solder sealed. Result? A capacitor that offers you superior heat and moisture protection . . . top insulation resistance . . . high capacitance stability and retrace under wide temperature variations.

Small wonder then why Sprague molded tubulars are preferred for the toughest television and auto radio applications. Take advantage of this superiority by calling in a Sprague representative today. Or, write for Engineering Bulletins 210B and 214.



SPRAGUE®

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

SPRAGUE ELECTRIC COMPANY
North Adams, Massachusetts

TELE-TECH

TELEVISION • TELECOMMUNICATIONS • RADIO

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

All Hands for Defense!

This year, over $2 billions of military radio-electronic equipment must be built. And in 1952, the defense production rate will be stepped up to $4 billions. Such tremendous quotas mean that the whole radio-TV industry must share the load.

But government has been slow to provide immediate military orders for the smaller manufacturing units,—for the scattered plants and shops which, in the aggregate, must turn out the bulk of this huge production.

These plants are already facing material and parts shortages and some are slowing down; meanwhile their employees seek jobs elsewhere. It is these present well-integrated working organizations which must be held together intact, so that they will be ready to take over military production. And the transition must come promptly, or cutbacks will have crippled the very outfits we count on most. This problem will become even more acute in the second quarter of 1951.

Spread the Work!

Secretary Marshall has already wisely ordered procurement officers "to spread contracts across industry as widely as possible in order to broaden the scope of the military procurement program, to obtain urgently needed goods faster and to take up the slack in industries now facing cutbacks because of materials shortages."

President Truman's declaration of the Emergency permits negotiation of contracts by the military branches, without the securing of bids. This move will speed-up the slow processes that blocked military procurement up to a few weeks ago.

Smaller concerns can get into military production by taking subcontracts, (a plan which also has the advantage of monthly payments instead of the 90 to 150-day delays the prime contractors suffer!) Application of the "leadership" plan, by which an experienced military-electronic producer trains and guides factory organizations unfamiliar with military specifications, should also be tested out at this time.

Large and Small—All Needed!

Every group and every individual possessing radio-manufacturing know-how and facilities must be marshalled into the present effort.

For, as pointed out by Ray Ellis, WPB official who supervised the vast $6-billions radio-electronic production program of 1943-45, "the smaller companies do not have the sales facilities of the larger companies and so do not know as well the avenues of approach to the military. It is the larger companies in case of emergency that get started first, because of their heavier development programs, but "—

(And these are the words of a man who knows)—

"Eventually the medium and smaller companies will have to carry the *major parts* of the military production program."

* * *

TELE-TECH is doing its part by making a realistic effort to assist radio-TV manufacturers with their procurement problems. We are providing specific, down-to-earth information on procurement procedures — where to go, whom to see, what different government agencies buy, planning for subcontracts, etc. We are pin-pointing this information, in detail. We are makng it as definite, as clear, as plain, as factual, as is humanly possible. This is part of TELE-TECH's contribution of material, concrete assistance, at a time when—

ALL HANDS ARE NEEDED FOR DEFENSE!

The RADARSCOPE

Revealing at a Glance

THE PENTAGON

MILITARY PROCUREMENT TO SPEED UP—With military procurement orders for electronic and radio equipment finally and at long last being placed with manufacturers in increasing volume during the latter part of January and this month, the radio manufacturing industry now is traversing the troublesome period of transition from the successful mass production of television and radio sets (handicapped by shortages of materials and components) into its national defense task—an assignment in which the industry achieved a most notable record of production for the armed services in World War II.

CUT-BACKS

MATERIAL SHORTAGES—The drastic cutbacks of supplies of cobalt, copper, nickel and other vital metals for the production of television and radio apparatus is forcing an estimated reduction of sets during this first quarter by more than 30 percent, and the slash will go even deeper by midsummer. But the miltary procurement, coupled with the materials' shortages for civilian items, to the amount of $1.5 billion to $2 billion, should take up the gap of the curtailed TV-radio set production, and the electronic-radio manufacturing industry during 1951 will be kept extremely busy in its paramount role of providing the "eyes, ears and nerves" equipment for the Armed Forces.

On Korean battlefront a Signal Corps operator keeps ground forces in continuous radio contact with U. S. planes bombing the enemy's concentrations of infantry, tanks and supply lines.

MILITARY RADIO

SOLVE KOREAN WAR LESSON—A lesson of the Korean war, faster and more flexible radio communications from the battlefield to the command headquarters, is being solved by the Army Signal Corps with the issue to troops starting Jan. 1 of a new series of 30 different radio sets. Expedited by the radio manufacturing industry for military use, the new sets can be connected together to accomplish longer distance communications than has been possible from the short-range, low-power apparatus in use in South Korea. The new Signal Corps sets can be utilized both in vehicles and by troops in transported field kits and can also be interconnected with the walkie-talkie and other portables.

SOUND

AUDIO ENTHUSIASTS in past years have sought those equipments which featured uniform response throughout the widest audio frequency range possible. Now that modern tubes, components, and circuits have made this desired full-frequency range coverage possible, many are finding that there is still "something lacking." The present trend seems to center on improving low-frequency response to overcome this situation, with the output transformer (Peerless) and speaker to air-column loading (FAS system) receiving considerable attention. The new loudness control network (IRC) recently introduced has also created interest, since it permits bass accentuation at low volume settings and where it is usually conspicuous by its absence.

TRANS-OCEANIC TV

OVERSEAS TELEVISION may become a possibility sooner than most people think, if current developments in wire and radio transmission of pictures prove successful. Although direct television pictures require wide bandwidths and consequently special cables and radio links, still-picture transmission can be done via ordinary undersea cables. The latest suggestion it to break movie film frames into smaller units and transmit them by a modification of the wire news process. In this manner a film might be sent clear across the Atlantic or the American Continent in a few hours. Watch this development in 1951.

COLOR-TV

ON THE SHELF "for the duration" of the Emergency—is the probable fate of all color-television on any commercial scale, now that the latest and wholly satisfactory compatible system has been demonstrated at Washington. Industry executives and engineers to the number of several thousand witnessed these showings in December and came away determined to put no manufacturing support behind a non-compatible system. Meanwhile the Supreme Court and the Pentagon will block any authorization moves for incompatible operations. Engineers and materials are now needed for defense. When the Emergency has passed, color television will be ready to "start right" on a fully compatible basis.

MOBILE

RAILROADS, OIL — Railroads' reports have brought out that their radio services are growing substantially. The Erie Railroad recently presented to the Army Signal Corps and Navy and Air Force a complete description of its mainline radio system before an audience which crowded the Pentagon Auditorium. The Petroleum Industry's Central Committee on Radio Facilities submitted a special report to the President's Communications Policy Board on their radio systems' vital role in the defense economy. These activities indicate that this field of equipment manufacturing can continue for a long time in supplying mobile radio services.

REPLACEMENTS

SUBSTITUTE MATERIALS for the civilian products of broadcast sets and particularly television receivers for which the U. S. public has an ever-growing and almost insatiable demand (despite the higher costs due to the Federal excise tax) were tested by the leading manufacturers long before the advice from the NPA and the prospect of the scarce metals and materials limitation orders.

MANUFACTURING

WITH THE INDUSTRY being called upon to divide its productive output between military and civilian goods, and with the attendant difficulty of having to comply with directives on the conservation of critical raw materials, it should be noted that industry's output will not be the 65%-35% (Civilian to Military) figure often quoted unless the division of raw materials follows in the same proportion. Current restrictions on raw materials (cobalt and copper) show that his ratio will not be maintained. In reality, therefore, 65% represents only productive capacity. The manufacturers of civilian goods must now strive to use every available substitute material in order to make this limited productive facility 100% effective. One way to help achieve this would be by providing an agency through which the techniques and processes employed to manufacture military components could be declassified and made available to producers of civilian goods. In turn, research staffs for these manufacturers might find ways of using substitutes.

SIMPLIFICATION

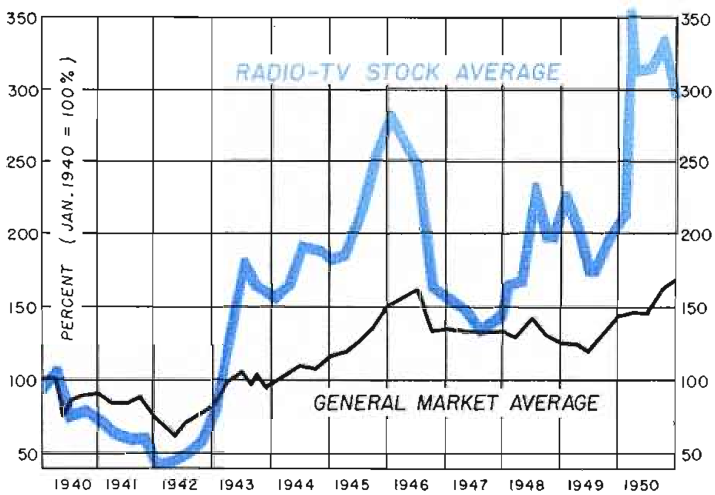
THE EMERGENCY and rearmament now call emphatically for prompt action on every proposal that has been made to simplify and standardize radio-TV components and parts. Standardization of military supplies is of course a top necessity.

And in the civilian field, in such products as TV-picture tubes, simplification is badly needed. In the 16-in. size, for example, we now have some 25 different non-interchangeable types, all of which could be simplified into two "rounds" and two "rectangulars". New larger CR tubes are appearing in diverse models, all non-interchangeable. This multiplicity wastes materials and factory effort. Simplification all along the line should begin at once.

RADIO-TV STOCK VALUES

PHENOMENAL ADVANCES in security values in the radio and television industry in the last few years are graphically illustrated in the comparative chart here shown. Congress has recognized the inequities that exist in excess profits tax legislation as applied to television manufacturers by providing special methods for determining the excess-profits tax credit for companies which qualify as growth companies under the new tax law signed by President Truman on January 3rd. Much credit is due Dr. Allan B DuMont and his National Conference of Growth Companies for leading the fight for more liberalized treatment of new and growing companies.

For a detailed survey of stocks in the radio and television industry, see pages 80 and 81 of this issue.



How radio-TV stock prices outran the general stock market during the past eleven years, is shown by this chart comparing price averages of six representative radio-TV stocks with the general market average as represented by the 540-stock price index compiled by Merrill Lynch, Pierce, Fenner & Beane, New York. (For 6-year record of 120 radio-TV stocks, prices and dividends, see pages 80 and 81, this issue).

Aluminum-Clad Iron for Electron

"P-2 Iron," a European development, can be used in vacuum a substitute material for nickel and thus aid conservation of

W. ESPE
Tesla Electronic National Comp.
Prague, Czechoslovakia

and

E. B. STEINBERG
Advanced Research Lab., Remington Rand, Inc. South Norwalk, Conn.

ASIDE from metals with extremely high melting point (tungsten, molybdenum and tantalum) nickel, without doubt, can be considered the most important metal in the electron tube industry.[1] For most applications nickel has a sufficiently high melting point, low vapor pressure, excellent fabricating characteristics, good corrosion resistance and still further, it may readily be degassed in vacuum by r-f or electron bombardment. The somewhat low coefficient of heat radiation of plain nickel sheets may be improved by carbonizing, thereby approaching the radiation coefficient of a black body. By virtue of these traits, nickel has become an indispensable raw material in the construction of radio receiving and transmitting tubes.

Search for Substitute

Since the European electron tube industries are dependent on the American or Canadian nickel supply, great efforts have been expended by these organizations to find a cheaper and more available substitute material. After many years of intensive research, shortly before World War II, the German metal industry developed a suitable material which became known as "P2-Iron." A first report on this development was published in 1948[2] simultaneously with the introduction of a similar material on the American market. The American counterpart consists of hot-rolled, low carbon rimming grade steel 0.080-in. thick which is cold-reduced to 0.040 in. The strip of this steel then is coated with an alloy of aluminum and 8% silicon in molten state and rolled to 0.125 mm (0.005 in.). Thereafter it is annealed in H_2 giving it a black finish and rendering it ductile and formable.

This American material, somewhat different from the European P2-Iron, is being used in several selected tube types by at least one manufacturer, and the production of this aluminized steel now is several tons per month.

Since aluminized steel has not as yet found the more wide-spread application that appears warranted, the following detailed story on the European development should help to clear up some of the issues still under consideration.

When considering substitute materials it is advisable to compare some of the other materials with respect to the properties of nickel. See Table I.

Aluminum, although readily available, has too low a melting point which prevents proper outgassing in vacuum. Its mechanical strength drops fast at elevated temperatures and further, its high chemical affinity to mercury vapor precludes its use in mercury vapor tubes or vacuum systems with mercury vapor diffusion pumps.

Oxygen-free *copper* (deoxidized or OFHC) [3,4] has acquired an important role in the construction of water-cooled transmitting power tubes, X-ray tubes and magnetrons. It is characterized by vacuum tightness, good adherence to glass and excellent heat conduction. However, for the construction of anodes of small and medium size radio tubes, copper is inferior to nickel as regards to vapor pressure, melting point, hot mechanical strength and coefficient of heat radiation. Also it is rather expensive and can be carbonized only with difficulties.

Disadvantage of Iron

Iron at a first glance appears as an inexpensive and readily available substitute for nickel. Its melting point is higher, its vapor pressure comparable to that of nickel and low carbon iron lends itself to deep drawing and spot welding. The coefficient of heat radiation is higher than that of nickel, but in a similar manner, iron surfaces like aluminum cannot be blackened by carbonizing. In spite of many favorable characteristics, iron is afflicted with an important disadvantage. Even after several days of degassing at high temperatures, iron continues to liberate at operating temperatures in the range of several hundred C° a small but ever-continuing amount of gas. It is obvious therefore, that iron cannot be used for small and medium size permanently-sealed vacuum tubes.

Since it was found that the gas content in iron diminishes with decreasing C-content, iron anodes and other electrode parts could be made by the powder metallurgy technique using sintered carbonyl iron powder.[6] However, the high manufacturing cost coupled with easy rusting of the cleaned and degassed parts rule out iron as a substitute for nickel, except for use in large tubes such as mercury-arc rectifier tanks.

For many years *graphite* has been used successfully for anodes of medium power-size transmitting tubes.[5] Graphite is endowed with a high melting point, low vapor pressure and excellent coefficient of radiation. However, its low mechanical strength requires heavier wall thickness. Its high gas content and high electric resistivity cause almost insurmountable difficulties in the construction and processing of small mass-produced radio receiving tubes.

P2-Iron was discovered by chance when carrying out tests aiming at the development of an iron without occluded gas. It was an occasional practice to insert aluminum into the liquid iron bath in the form of an aluminum-clad iron sheet.[9] Such bimetallic material has been used in Europe for packaging of canned goods, thereby reducing the amount of aluminum required. When inserting this bimetallic sheet it was observed that the color of the aluminum changed from a shiny to a very dark color. Upon closer examination it was found that this blackening is caused by a reaction between the iron base and the aluminum cladding, having a composition originally identified as $FeAl_3$. More recent X-ray diffraction investigations point to the probability of Fe_2Al_5. Depending upon the annealing conditions Debye diagrams reveal the

Tubes

tube manufacture as critical raw materials

presence of a still further composition tentatively identified as $Fe_2Al_4 = FeAl_2$.

At elevated temperatures there occurs an exothermic reaction which results in a coarse, opaque, dark-bluish surface of the aluminum covering. This dark surface is created not only by heating in air or by heating in a protective atmosphere, but also in vacuum. In fact, the cleanest surface can be produced by heating in the latter medium. When testing this aluminum-clad sheet as anode material in radio tubes an undesirable residue was found to deposit itself on the interior of the glass envelope. A further analysis showed this residue to be zinc. As a next step, a zinc-free aluminum was substituted and no further troubles were experienced. This new material consisting of an iron core with aluminum covering rolled on both sides, especially manufactured for vacuum purposes, was named P2-Iron. It was found to be usable without predegassing and being corrosion resistant, permitted storage without special provisions. The somewhat expensive carbonizing process[7] for nickel is very much simplified when using the P2-Iron, inasmuch as a blackening of the surface can be obtained merely by heating. In view of these characteristics the aluminum-clad iron material was used most extensively for anodes of radio receiving tubes in the European countries during the recent war.

Production of P2-Iron

The production of P2-Iron for radio receiving tubes in sheet form of 0.15 mm thickness can be seen in Table II. The oxygen content and absence of silicon of the iron base is important. Also, the Si-content and absence of zinc in the aluminum is of greatest concern for the reasons explained above. The annealing temperature of the finished product must be held within the close limits shown on Table II. If standard iron is used for base material and non-alloyed aluminum for the covering, the blackening Fe-Al compound occurs at 430°C, which is lower than the

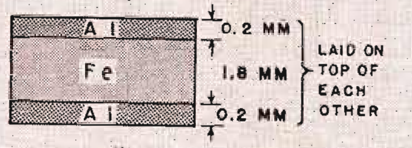
Table I: Properties of Nickel and Metals Used in Vacuum Technic

Properties		Ni	Al	Cu	Fe	P2-Metal
Specific Gravity	gm/cm^3	8.85	2.7	8.9	7.87	7.65
Melting Point	C	1452	658	1083	1528	1450①
Vapor Pressure at 800 C	mm Hg	$< 10^{-8}$	10^{-6}	10^{-4}	10^{-8}	10^{-6} (Al)
Tensile Strength annealed	Kg/mm^2	32-45	7-11	21-24	20-35⑤	35③ 25④
Max. Temperature for const. load of 2 Kg/mm^2	C	600	80	270	450	420
Erichsen Ductility Test 0.5mm sheet	mm	11	9	13	8-10 11⑥	7③ 3-4④
Coefficient of Radiation at 6650 Å plain " carbonized	%	37.5 to 75	18-28 —	17 to 75	40-44 —	20-25 85
Spot welding	—	good with all metals incl. Mo.	bad	medium bad with Mo.	not as good as Ni	somewhat difficult
Corrosion Resistance without protection	—	very good	good in dry storage	good	very bad	same as Al
Degassing in Vacuum	—	good	very bad	bad espec. O_2	very bad with high C②	excellent
Degassing in H_2-Oven	—	good	very bad	possible if O_2 free	very bad with high C②	—

① Approx. Melting Point of Fe-Al compounds.
② Except with Al content.
③ Prior to Annealing-Blackening } sheet thickness, 0.15mm.
④ After Annealing-Blackening }
⑤ Depending upon C-content.
⑥ Carbonyl Iron

Table II: Manufacturing Procedure of P-2 Iron for Vacuum Use (0.15mm Total Thickness)

A. Iron Base and Its Preparation	
1. Iron Analysis % Balance Fe	C: 0.04-0.08 Mn: 0.1-0.6 S: 0.037 P: 0.039 Cu: 0.06 Si: none* O: 0.007 (in solid solution not as Oxide)
2. Ribbon Dimension (mm)	150 x 3.5
3. Pickling	H_2SO_4 10% concentr.
4. Rinsing & Cleaning	Washing, dry wire brushing
5. Cold Rolling	down to 1.8mm
6. Annealing	in closed pots
7. Surface Cleaning	wire brushing
B. Preparation of Aluminum	
8. Analysis of most important constituents %	Si: 1.0-1.5 Fe: 0.3-0.6 Zn: none
9. Dimensions (mm)	150 x 0.6
10. Rolling	without intermediate annealing to 0.2mm thick
11. Surface Treatment	brushing with steel wire brush on side contacting Fe
C. Cold Rolling Process	
12. Assembly prior to Rolling	
13. Cold Rolling without preheating of sheets	one pass, down to 0.9mm
14. Rolling Temperature due to cold working	180-200° C
15. Further rolling in convenient passes	Without intermediate annealing to 0.15mm : 5 vol. % Al per side, Al layer thickness about 7.5 μ (limits 5-20 μ)
16. Annealing in Electric Furnace	535° C ± 5° C in air 4 to 6 hours



* Standard commercial sheets showed 0.01-0.03% Si.

final annealing temperature of above 500°C. Such a material could not be annealed after rolling without creation of the Fe-Al compound a reaction which is undesirable until after final forming, spot welding, and degreasing of the electrode parts. By using iron and aluminum with compositions indicated in Table II, the reaction temperature between Al and Fe is raised to 680°C. Practice has shown that annealing of the P2-Iron material is necessary prior to fabrication of electrode parts in order to avoid deformation of such components during the outgassing and processing of vacuum tubes. Attention must be paid also that during the "cold rolling" process a temperature of 600°C is not exceeded such as may occur by too great a reduction or too fast a feed. In general, it was found that an equilibrium temperature of 180° to 200°C is sufficient for rolling and cold welding of the iron core with the aluminum cladding.

The thickness limits for the aluminum cladding was found to be 5 to 20 μ. If the aluminum layer is too thin, the aluminum may tear during wire brushing (see below), while with too thick a layer the aluminum may flow off in molten particles during final r-f heating inside the vacuum tube under simultaneous creation of Fe-Al compound flakes.

Further Handling of P2-Iron

Prior to using the P2-Iron, it is to be observed that there is an aluminum oxide layer on the surface of the P2-Iron which was produced during the preceding annealing process in air or in a protective atmosphere. If this oxide layer is not removed, the Fe-Al compound surface to be created later will not be as dark as it could be. Consequently, the P2-Iron is cleaned by wire brushing; for anodes the surface radiating toward the exterior only, both sides for radiating fins. The material thereby obtains a silky appearance on the cleaned side. It is important of course, that the aluminum cladding is not broken through. There is still another reason why sheets to be used for anode material are not wire brushed on the inside surface which faces the cathode. Without protective aluminum layer, oxygen might escape from the iron base and injure the oxide cathodes. Such oxygen may come from minute spots laid bare during brushing.

The P2-Iron ribbon usually is wire brushed automatically, followed by conventional shearing, punching, forming, drawing, etc., always watching the brushed side to face the exterior. The P2-Iron is somewhat harder and more resilient than nickel. Spot welding creates no difficulties, but the adjustment of the welder relative to current, pressure and time is different from the settings used for nickel and plain iron.[8] The welding electrodes should be cleaned more often to remove deposits of Al and Al_2O_3. When spot welding P2-Iron parts to other objects in vacuum Al-sputtering must be carefully avoided. It may be mentioned that welded P2-Iron sheets may readily be joined by spot welding with other metals (Ni, Cu, etc.) in fact, by using smaller currents than P2 sheets without blackened surface.

There is some difference of opinions as to the best method of blackening the finished formed and welded parts made of P2-Iron. The original method consists of degreasing the finished parts in trichlorethylene and then mounting them without predegassing inside the vacuum tube. Blackening is carried out by r-f during the final exhaust period by raising the anode temperature above 690°C which is slightly above the melting point of the aluminum (658°C). In spite of this temperature the aluminum will not flow off the iron core provided the aluminum layer is within the prescribed thickness limits and the r-f heating is not done too fast. Using the conventional bombarders, the r-f field penetration is considerably greater than the thickness of the aluminum cladding which results that the iron core is heated quickly and uniformly. Parts that are to have a good black surface should be kept below a temperature of 900°C because at this temperature, the degree of blackening diminishes whereby the coefficient of radiation drops from 85 to 60%. Manufacturers using above described method feel that during the blackening process more gas is absorbed than liberated, and as a result thereof the vacuum of the tube improves. The getter action is attributed to an increase in surface when creating the Fe-Al compound.

Table III: Most Important Bi-Metallic Iron Combinations Developed During 1938-45

NAME	ARRANGEMENT
P2	15 μ Al 120 μ Fe 15 μ Al
PN	15 μ Al 120 μ Fe 15 μ Ni
$P1_a$	15 μ Al 15 μ Fe 120 μ EA-Fe
$P1_b$	15 μ Al 120 μ Fe 15 μ EA-Fe

AL COMPOSITION PER TABLE II
Fe COMPOSITION PER TABLE II
EA-Fe IRON WITH 0.05 % C IN FORM OF SPHERISODIZED CEMENTITE, SEE FOOT NOTE 1

P-2 Parts Blackened

Others blacken the P2-parts prior to mounting them inside the vacuum tube by applying heat in vacuum or H_2. It is obvious, of course, that the temperatures are held between 680° and 900°C for the reasons stated above. This procedure may be necessary for small assemblies which when mounted inside of the vacuum tube cannot be reached by r-f, and also in the case where the Fe and Al alloy does not correspond with specifications given in Table II, causing the blackening temperature to be below the annealing temperature.

The blackened surface. if performed in H_2 has not as uniform an appearance as if carried out in vacuum. Moreover, using H_2 the aluminum is unnecessarily charged with H_2 which is difficult to remove.

The detrimental gas content of an anode made of P2-Iron is only a fraction of that of an anode made of carbonized nickel and same dimensions. Consequently there is a saving in processing time and temperature. The carbonizing process is much simpler than with Ni-anodes. It was for these reasons that P2-Iron became very popular for the production of small mass-produced radio receiving tubes. Experience showed that P2-Iron cannot be used in tubes with distillation cathodes. It appears that under the influence of H_2 a reaction occurs between the Ba-vapor and Al. Further, it was found that P2-Iron should not be employed in tubes with very small distances between anode

(*Continued on page 72*)

Low-Noise Miniature Pentode for Audio Amplifier Service

Structural design provides for minimum interelement leakage and inductive, capacitive, or conductive coupling between heater and other tube parts

By D. P. HEACOCK and R. A. WISSOLIK,

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A MAJOR requirement for a tube in the input stage of a high-gain audio amplifier is that it generate little extraneous signal. Unless such signals are originally very small, the amplification of these signals by the succeeding stages may result in an objectional amount of noise output. This extraneous output can be broken down into three general types of disturbance—hiss, hum, and microphonics. Hiss may be defined as the undesired output generated by thermal effects in the resistive component of a control-grid circuit, plus the shot and leakage effects in a tube. Hum is the unwanted audio signal caused by coupling between the AC heater supply and some other part of the circuit. Microphonics is the output caused by changes in the spacing between tube elements. This microphonic effect may, in extreme cases, produce a sustained output due to regenerative feedback between the loudspeaker system and the microphonic tube.

In addition to low-noise quality, an input tube for an audio amplifier should have relatively high gain. Small physical size is also desirable, and cost should be comparable to that of standard receiving types. RCA type 5879 is a tube designed to have these features.

The 5879 is a sharp-cutoff pentode having characteristics similar to those of type 6J7. It is a single-ended tube with a miniature envelope and a nine-pin base. The major electrical characteristics of the tube are given in Table I.

The ratings of the tube permit its use either as a pentode or as a triode-connected pentode. The pentode characteristics of the tube are such that high gain may be obtained in resistance-coupled amplifier circuits. With a plate-supply voltage of 150 volts or more, a gain of greater than 100 can be obtained. When triode operation is desired, the triode amplification factor of 21 is adequate to provide moderate gain.

In the design of the 5879, every effort was made to incorporate all features which minimize the production of any type of tube noise. As mentioned above, hiss is one of the primary sources of noise. One component of hiss is the noise caused by the resistive element associated with the grid circuit of the input tube. This noise voltage is produced by the random motion of electrons in conductors and is generally referred to as the noise due to thermal agitation. This noise is distributed uniformly over the entire frequency spectrum. A similar hiss-type of noise is caused by the random emission of electrons from the surface of the cathode. Hiss is also produced by leakage effects between the various elements of the tube.

Little can be done in the design of the tube to minimize noise due to the first two causes because random fluctuations are inherent whenever there is a flow of current. However, hiss due to random leakage between tube elements is reduced in the 5879 by several structural features. An extra mica is used as a shield be-

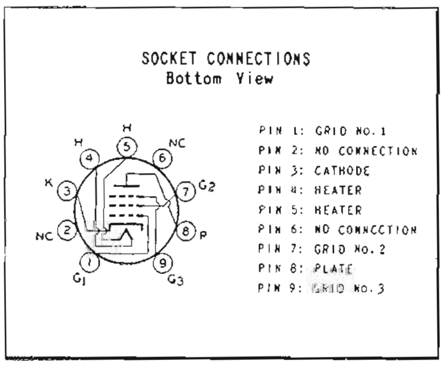
TABLE I

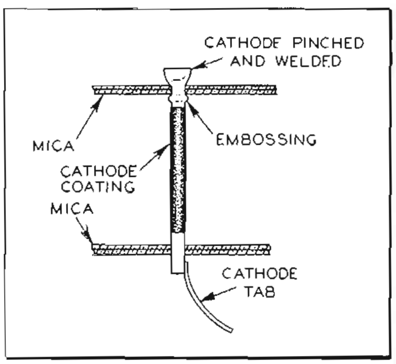
Major electrical characteristics for the 5879 sharp-cutoff pentode

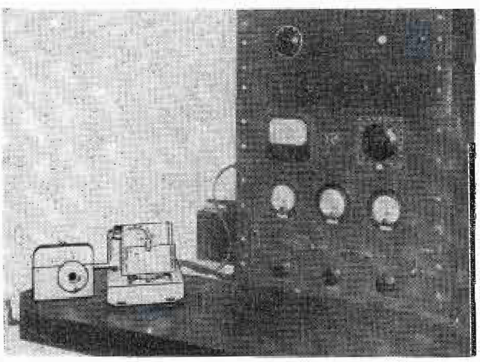
Maximum Ratings	As Pentode	As Triode*	
Plate Voltage	300	250 max	volts
Grid-No. 2 Voltage	150	– max	volts
Grid-No. 2 Supply Voltage	300	– max	volts
Grid-No. 2 Input	0.25	– max	watt
Plate Dissipation	1.25	1.5 max	watts
Characteristics			
Plate Voltage	250	250	volts
Grid-No. 2 Voltage	100	–	volts
Grid-No. 1 Voltage	–3	–8	volts
Amplification Factor	–	21	
Plate Resistance	2	0.0137	megohm
Transconductance	1000	1530	μmhos
Plate Current	1.8	5.5	ma
Grid-No. 2 Current	0.4	–	ma

*With grids No. 2 and No. 3 connected to plate.

Fig. 2: (Left) Socket connections for 5879. Fig. 3: (Center) Diagram of inverted, pinched and welded cathode assembly employed. Fig. 4: (Right) Test equipment and arrangement used in checking tube for leakage currents, hum, microphonics, and hiss level.







tween the tube mount and the getter in order to prevent metallic getter particles from settling on the tube-mount micas when the getter is flashed. Furthermore, the processing of the tube is carefully carried out at low temperatures in order to prevent the vaporization of metallic parts and subsequent condensation of the vapor upon the micas of the tube. In addition, the micas are sprayed with a rough aluminum-oxide coating in order to lengthen any possible leakage paths between the tube elements. Finally, the cathode is designed to operate at a relatively low temperature to minimize vaporization of cathode material throughout the life of the tube.

Causes of Hum

Hum in a tube is usually caused by one or more types of coupling—inductive, capacitive, or conductive—between the heater and other parts of the tube structure. Inductive (magnetic) hum may result if the heater design is such that an alternating magnetic field is produced inside the tube structure. Electrons in the tube will be deflected by such a field, and a modulation of the plate current at a rate of 60 or 120 cycles per second may result. In type 5879, hum is minimized by the use of a double-helical heater. In this heater design, two inter-wound helical coils carrying opposing currents occupy essentially the same space. The magnetic field produced by one helix is opposed by the field of the other, and the magnetic field around the heater is therefore virtually eliminated. In addition, the heater current required by the tube is reduced to as low a value as practical in order to further reduce magnetic effects.

Hum may also be caused by capacitive coupling between the heater and other elements of a tube. Very little of this coupling is present in a tube electrode structure because the cathode acts as an electrostatic shield between the heater and the other elements. Most of the coupling is caused by capacitance between the stem leads of a tube. In the 5879 a great reduction in this capacitance has been accomplished through proper design of the stem and arrangement of the base pins. The basing of the tube (Fig. 2) is such that one base pin not connected to any active element inside the tube is provided between the base pins for both grid and heater, and plate and heater. These pins may be grounded to serve as electrostatic shields between the heater pins and the grid and plate pins. Furthermore, since the cathode and screen are frequently at ac ground potential, the pins for these elements then serve as additional shields between the grid and plate pins and the heater pins.

The basing of the tube lends itself conveniently to the triode connection since the screen, suppressor, and plate are brought out on adjacent pins in the base. Moreover, the grid and plate pins are sufficiently separated to permit the grid-to-plate capacitance to be maintained at a low value. The nine-pin noval base is used in this type so that all the above features could be suitably provided.

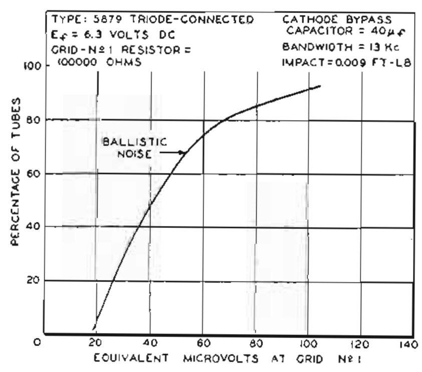
Conductive coupling between the heater and other tube elements exhibits itself most commonly as a leakage current between the heater and cathode of the tube. If a cathode resistor is used which is inadequately bypassed for the hum frequency, the leakage current will produce a voltage across the cathode impedance and a hum component will be present in the output of the tube. Because the heater insulation has a nonlinear resistance characteristic, the voltage produced across the cathode impedance is rich in harmonics which are clearly audible. Unfortunately, heater-cathode leakage cannot be completely corrected by basic design, but must be kept to a suitably low value by continuous process control during manufacture. It is necessary to use as pure a material as possible for the heater insulation; care must be taken not to chip or damage the heater coating during the assembling of the tube; and finally, the tube must undergo suitable processing after sealing and exhaust.

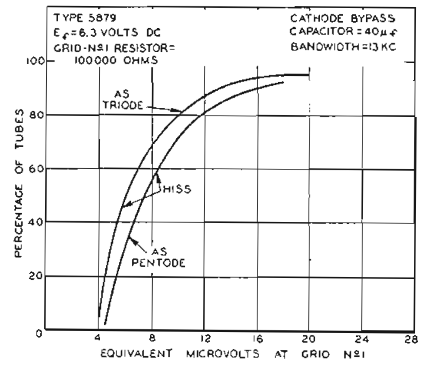
Microphonic Effects Minimized

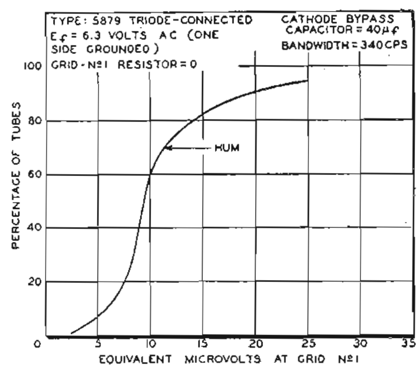
Microphonic effects in a tube are caused by vibration of tube elements. This motion produces a momentary change in the spacing of the tube elements and thereby causes a variation in the plate current. In the 5879 these effects are minimized by many design features.

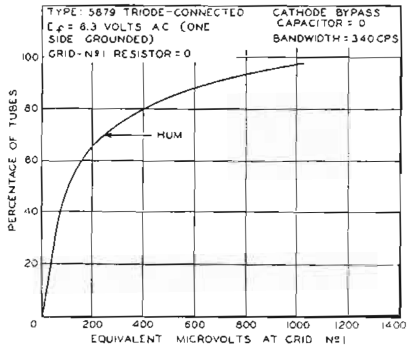
First, there is a close tolerance on holes in the mount support micas and the diameter of the holes is such that a tight fit is obtained with the tube elements. Second, two micas are used at the top and two at the bottom of the mount structure. Because the micas are never exactly the same, the effective diameter of the hole in the micas is smaller when two micas are used and the tube elements are more firmly wedged into place. Third, an inverted, pinched, welded cathode assembly is used (Fig. 3). The cathode has an emboss directly below the top mica. The cathode above the mica is pinched flat and welded so as to wedge it tightly into the top mica and prevent motion of the cathode at this point. The bottom of the cathode cannot be held tightly because the cathode must be free to expand. The cathode tab, however, serves to restrain motion of the cathode at this point. Fourth, the tube is designed with a short mount structure. Because the distance be-

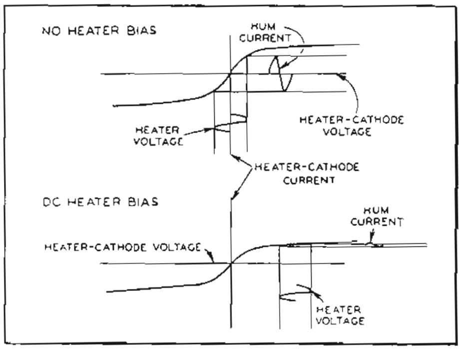
Fig. 5: (Left) Distribution of tube microphonic output. Fig. 6: (Center) Curves showing noise output due to hiss. Fig. 7: (Right) Hum data taken with typical circuit for medium-priced audio equipment; one side ac heater grounded, cathode bypassed











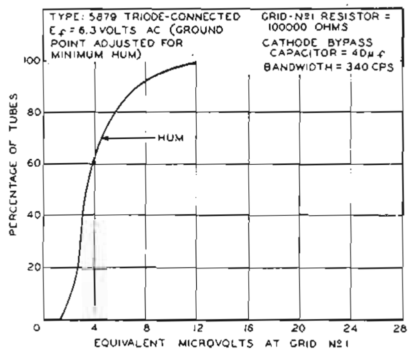


Fig. 8: (Left) Effect of operating tube with one side of heater supply grounded and cathode resistor unbypassed. Fig. 9: (Center) Effect of dc heater bias to reduce hum. Fig. 10: Medium hum value is less than 4 microvolts with all precautionary measures

tween the top and bottom micas is relatively small, the rigidity of the tube elements is increased. Motion of the tube parts in the center of the mount is thereby restricted. Fifth, the spacing between the grid and cathode is relatively wide. Because the plate current varies inversely as the square of the distance between grid and cathode, a given displacement of the grid will produce less plate-current variation in a wide-spaced tube than in a close-spaced tube.

Many standard receiving tubes use one or several of these features in order to obtain certain desirable performance characteristics. In type 5879, however, the design has been concerned solely with the production of a good tube for audio service without particular regard for other, more general applications. Thus, it has been possible to incorporate all of these features into a single tube capable of giving superior audio performance. Production tests on the tubes serve mainly to reject "wild" tubes having characteristics unlike those of the majority of the product. The yield of good tubes from the final production test is high and, as a result, the cost of the tube is relatively low and the quality of the outgoing product is good. Some equipment manufacturers attempt to select good audio tubes from regular receiving types, but this procedure usually results in low yield, high testing costs, and complications due to the difficulty of supplying suitable tube replacements. Use of the 5879 eliminates the need for this costly expedient.

Test Equipment and Procedures

In order to check the performance characteristics of the 5879, it is tested, triode-connected, in the first stage of a high-gain audio amplifier (Fig. 4). The triode connection is chosen so that leakage currents in the screen or suppressor circuits can be detected in the output of the tube. The grid resistor is 100,000 ohms in value and bias is provided by a cathode resistor. Tests can be made with this resistor unbypassed or bypassed with a 40-microfarad capacitor. Both ac and dc heater supply voltages are available, and the ground point of the ac supply can be varied by means of a potentiometer across the heater transformer. A shock-mounted standard phenolic socket with a grounded center eyelet is used. Good wiring practice is observed in the wiring of the preamplifier but no special shielding is employed.

For hiss tests, an overall system bandwidth of 13 KC per second is used. For hum tests, the bandwidth is restricted to the range of 40-380 cps so as to pass only the heater supply frequency and its major harmonics. The microphonic test is made with full bandwidth. For this test, a weighted arm is dropped onto the preamplifier chassis in order to excite the tube. The kinetic energy possessed by this arm, at the instant of impact, is about 0.01 foot pounds

Test Data

A distribution of the microphonic output of the tube based on tests of 100 tubes selected at random from regular production is shown in Fig. 5. The abscissa indicates the peak noise output of the tube caused by the impact of the arm on the chassis, expressed in microvolts referred to the grid of the tube under test. The ordinate indicates the percentage of tubes in the lot reading less than the corresponding abscissa value for microphonic output. The median value of microphonic output is about 42 microvolts.

The noise output due to hiss is shown in Fig. 6. For these data, the tube is operated with a dc heater in order to eliminate hum. The data are taken for both triode and pentode connection. The pentode connection gives rise to somewhat more hiss because of noise produced by random variations in the division of the current between the plate and screen (partition noise). The curves do not approach zero because the thermal agitation noise produced in the 100,000-ohm grid resistor is about 3.8 microvolts when the amplifier bandwidth is 13 KC.

Fig. 7 shows hum data taken with a typical circuit for medium-priced audio equipment. One side of the ac heater supply is grounded and the cathode resistor is bypassed. For this test, the grid resistance is made equal to zero to eliminate hum due to capacitive coupling between the heater and the control grid. The hum present is caused in part by an imperfect bypass of the cathode resistor. Some magnetic hum is also present. An additional hum voltage is caused by coupling between the heater and the grid when a grid-circuit impedance is used. The magnitude of this voltage is proportional to the grid circuit impedance. For example, with a resistor of 100,000 ohms in the grid circuit of the 5879, an additional hum voltage of about four microvolts results.

In some applications, the tube may be operated with an unbypassed cathode resistor. Such operation is definitely not recommended in low-level audio equipment because of the hum produced by heater-cathode leakage. Fig. 8 illustrates the effect of operating the tube with one side of the heater supply grounded and the cathode resistor unbypassed. The hum is increased 20 to 50 times over the hum present with the cathode bypassed. If it is absolutely essential that the tube be operated with an unbypassed cathode resistor, several expedients can be used to reduce hum. First, the heater supply should be center-tapped. The center tap, in effect, forms part of a bridge circuit in which leakage currents from one-half of the heater to the cathode are opposed by out-of-phase leakage currents from the other half of the heater. As a further expedient, the

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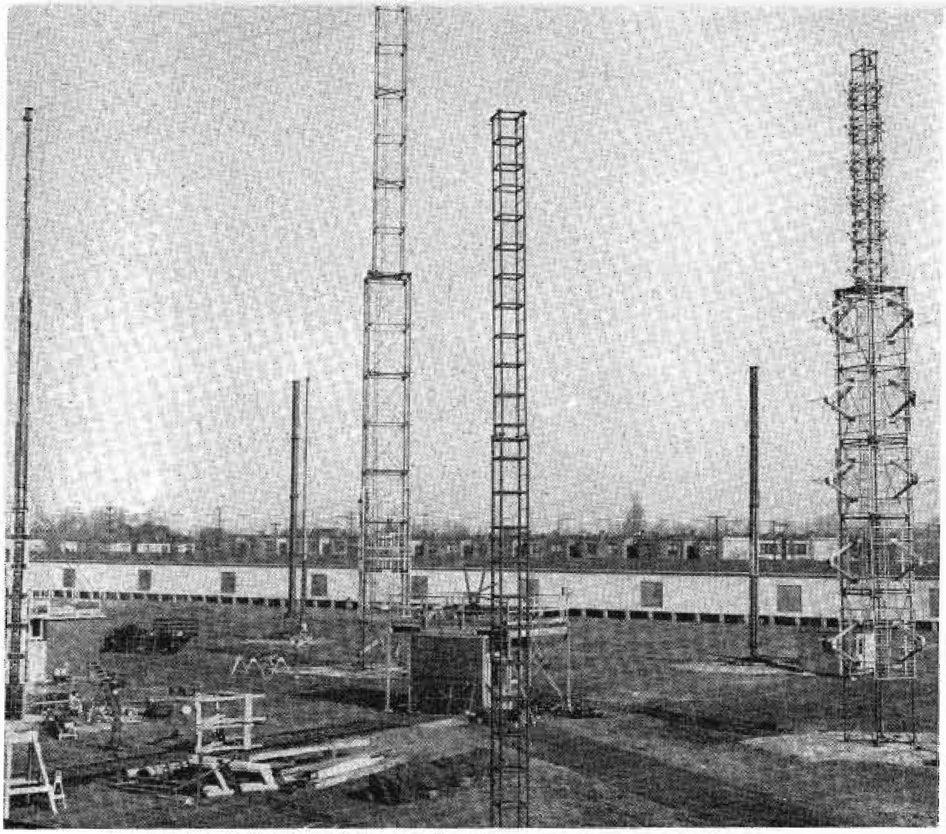
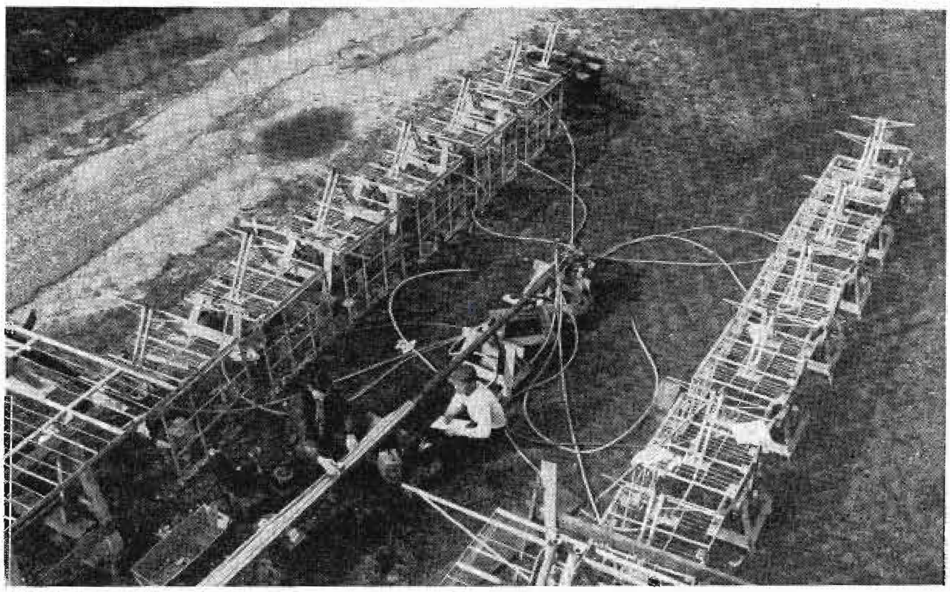
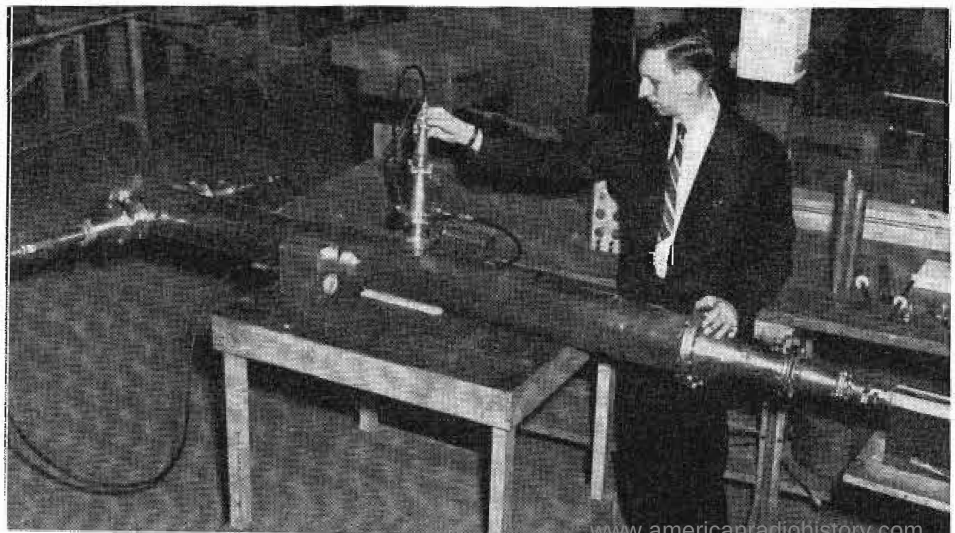


Fig. 1: Test towers at RCA, Camden. Foreground tower will support antennas for channels 7 and 11; left to right are antennas for channels 11-4, 2-5, and 5-7.

Fig. 2: SWR. measurements made on ch. 7 radiator with ch. 5 antenna adjacent to it.





Designing

By *JOHN H. BATTISON*
Associate Editor

WHEN the decision to install more than one television station on the Empire State Building was made, the primary consideration was interaction between stations. The first expectation was that four telecasters would share the new tower; however, later this figure was increased to five. In the antenna design only interaction between antennas can be considered. To date some preliminary tests have been made on the coupling between adjacent antennas which indicate that a decoupling of the order of 26 db can be achieved. This figure was obtained on the basis of previous experience.

Probably the only good feature of the late November and early December hurricanes experienced in the east was the very thorough workout and lifetest it gave the test antennas at the Camden plant of the Radio Corporation of America. Fig. 1 shows a general view of the test ground with the antennas mounted on towers to simulate the actual proximities to be encountered in practice. Rain, snow, heat and cold as well as fumes and corrosive air about as bad as that encountered in New York have impinged on these radiators but they have withstood all that the elements can do. In New York City, also, the steelwork received a workout when the hurricane hit town, but from all reports no trouble was encountered.

The location of the antennas has already been discussed in the November issue of TELE-TECH (cover), it is their close proximity which was expected to present many difficulties in connection with isolating the antennas. Many tests have been carried out to determine the amount of interaction between the adjacent antennas.

In order to simulate actual conditions on top of the Empire State Building as nearly as possible, four test towers were built on which each pair of adjacent antennas will be mounted. This test will yield impedance data over the channel as well as the amount of interaction. It also simulates assembly problems on top of the building. Four towers

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Fig. 3: 20 Kw diplexer and equalizer unit for the lower channel radiating system.

World's Highest TV Antennas

Many problems concerning interaction between adjacent antennas are solved in the TV-FM transmitter installation on Empire State Building

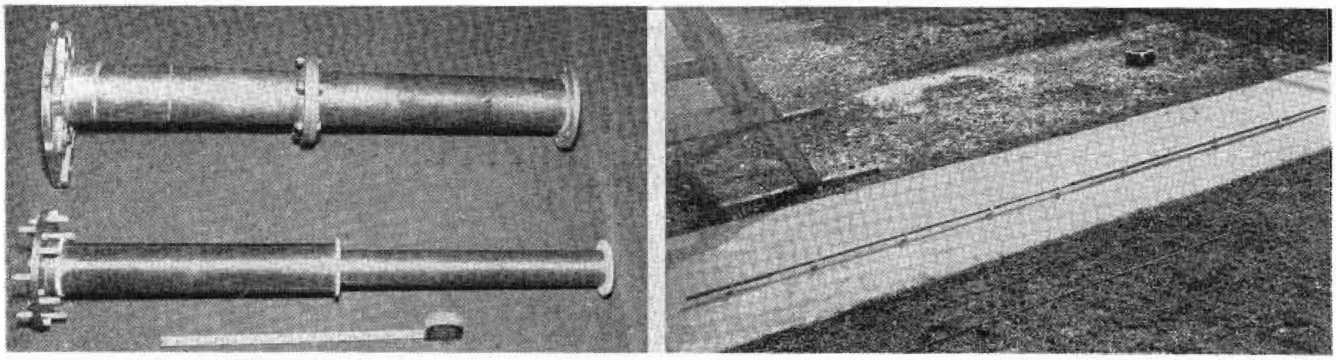


Fig. 4: Left, closeup of a feed line transformer and junction box. Right, triplexing transformer for channel 4 radiator.

are needed for Channels 2 and 5, 5 and 7, 7 and 11, and 11 and 4.

In each test operation signals at the visual and aural frequencies were fed into the deplexer and passed through the power equalizer (if required) and then to the antenna. In the antennas tested both antennas are assembled completely. An Oscillator is fed into one antenna and a field intensity meter is connected to the other to determine the amount of coupling. When the proper frequency is applied to the transmitting antenna the amount of power pickup by the adjacent antenna is measured. A figure of 26 db down is considered satisfactory.

Types of Antennas

The antennas used are of two types; channels two, five, seven and eleven use the RCA U Super gain antenna while channel 4 uses the RCA Super Turnstile antenna. For stations WCBS-TV and WABD special emergency antenna switching arrangements are used so that the antennas can be operated as either 2, 3, or 5 bay radiators. The reason is presumably to allow emergency operation in the event that trouble occurs in the whole system. The antennas are split and separate transmission lines, diplexers, and power equalizers, are used for each section. In normal operation the power is divided as shown in Fig. 5 and all sections are used, but if trouble develops in either section it can be cut out and the transmitter operated into the good unit. Switching is manual and carried out simply. It is understood that the other stations have different emergency facilities so that this feature will not be used.

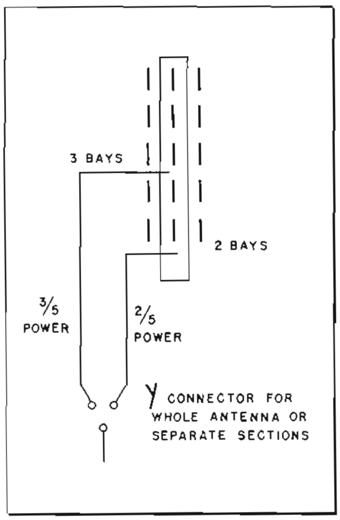
Stations using the Super Gain antenna were given their choice of single-line or double-line feed. The low band stations chose single-line feed while the high band chose double-line feed. Low-band stations will use a bridge-type power equalizer which tends to broad-band the antennas. Broad banding problems are more severe on the low bands since Channel 2, for instance, occupies a 10% band width compared to 3% for Channel 11.

For most of the antennas the feeders running from the junction boxes illustrated in Fig. 7 are RG 35/U with the metal armour removed. However in some of the illustrations RG 35/U with the braid still on it is shown. The impedance is 75 ohms.

Few of the mechanical details of tower construction appear to have interfered with the electrical design of the antennas, in fact that the only one which has been discussed was the need to reduce the width of the channel 11 reflectors due to the small size of the latter, and the large (about 8 inch) steel angle which comprises the sides of the tower at this point. Thus it became necessary to simulate these solid reflectors by the use of sheet metal during the tests.

The pole for mounting the channel 4 Super Turnstile presented a problem inasmuch as it had to be cut into ten foot lengths to get it in the elevators and up to the top of the Empire State Building. The connections to the Super Turnstile Antenna are unusual in that flexible RG 35/U is used rather than the normally used rigid copper transmission lines. The turnstile type of antenna had

(Continued on page 70)



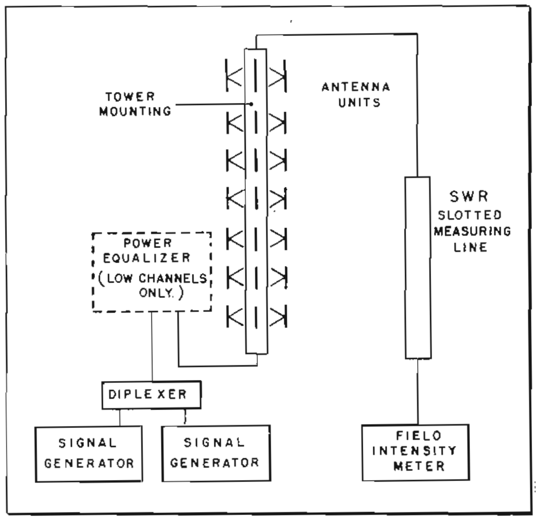


Fig. 5: (Left) Switching system provides whole or partial operation of low band antennas. Fig. 6 (Right) Set-up to measure degree of interaction between antennas.

Improved Communication

Sensicon receiver features new engineering for controlling i-f and Design aimed at increasing spectrum loading by permitting full channel

By *DANIEL E. NOBLE,*
Vice President, Motorola
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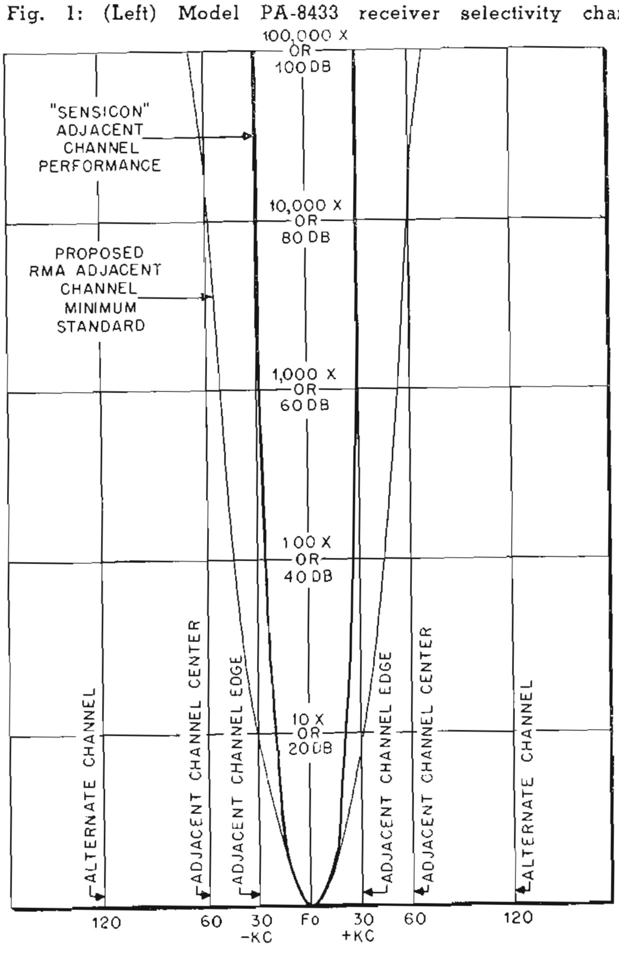
Chicago 51, Ill.

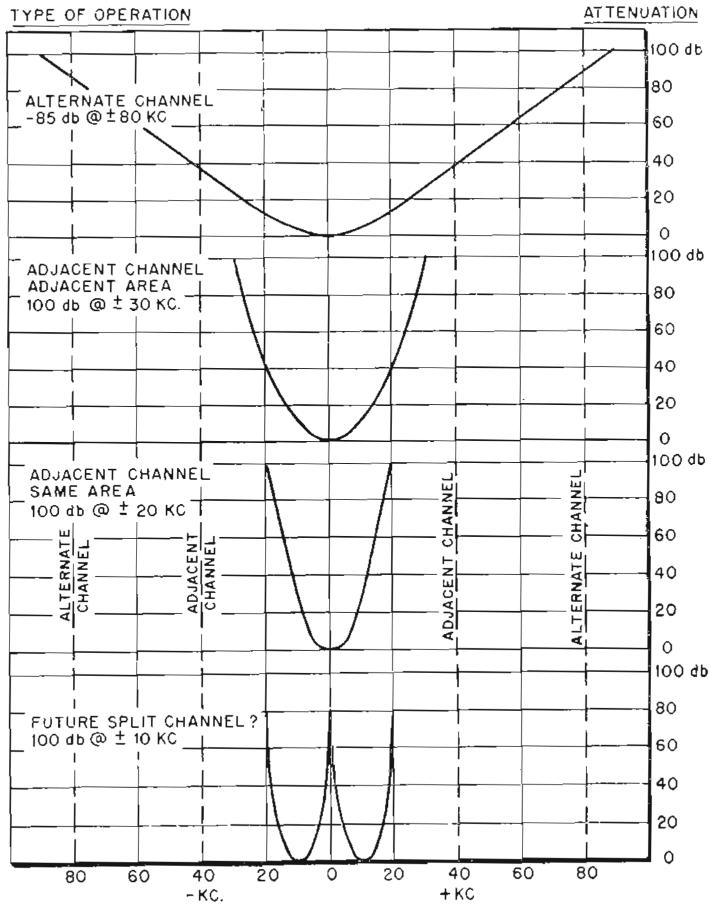
RADIO-voice communication between cars and base station started with the development of police, and emergency service communications for forestry service, power companies and municipal fire departments. Early 2-way communications was confined to the 30-40 Mc band, and prior to 1938, amplitude modulation was used. With the successful development of the first 3-way FM system (that is, a system providing station-to-car, car-to-station, and car-to-car communications) for the State Police of Connecticut over the period 1938 to 1940, there was a complete swing from AM to FM modulation for mobile communications above 25 Mc.

Back in 1940, and earlier, the interference control problem was not serious. With adequate spectrum space available for the small number of systems in operation, unintentional guard bands were provided by unoccupied governmental frequency band assignments interspersed between the police and emergency service assignments. Under such conditions, the receiver selectivity and spurious responses, and transmitter spurious radiation, were minor problems.

Since 1940, the growth of the mobile service applications has been phenomenal. The FCC has assigned substantial spectrum space in the 25-50 Mc band, 72-76 Mc band, and 152-162 Mc band for the exclusive use of mobile services. Licensed radio applications in this spectrum space has been extended beyond the limits of public safety and emergency services to the land-transportation services and into industrial communications applications. Train and bus communications, communications in the fields of mining operations, road construction, bridge building, and large scale manufacturing plant operations are included as a permanent part of the mobile and portable radio communications service. No longer are there unoccupied governmental bands available to serve as guard bands for the non-governmental assignments. The number of transmitters regularly licensed has grown from a few hundred to substantially more than

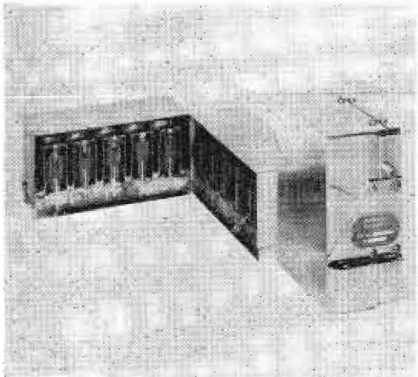
Fig. 1: (Left) Model PA-8433 receiver selectivity characteristic, 152-174 MC band. Fig. 2: Evolution of i-f selectivity

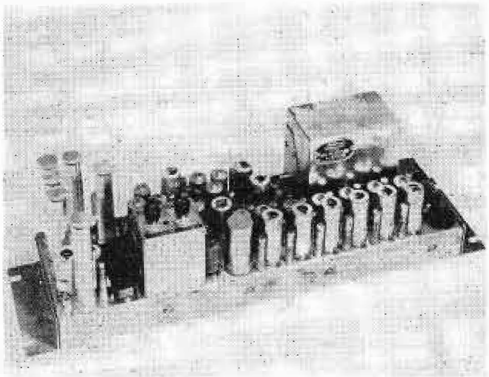




Equipment for Mobile Use

r-f selectivity, desensitizing, intermodulation, and spurious responses loading and further frequency division of available spectrum





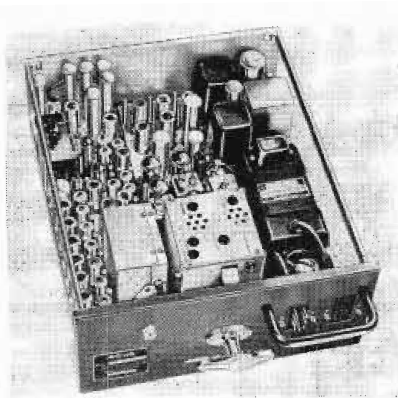


Fig. 3: (Left) Cutaway view of Permakay filter shows all components completely imbedded in insoluble polyester-styrene resin. Fig. 4: (Center) Filter mounted in Sensicon receiver strip. Fig. 5: (Right) Receiver strip and filter mounted in mobile chassis

one hundred thousand units in daily operation. The problem of interference control has become a severe one. The growth of the mobile services will continue; the interference problems will multiply. Obviously, the saturation of all channels in metropolitan areas can be predicted. The spectrum space is not expandable; we must look to improved engineering design of equipment to provide increased spectrum loading and more efficient utilization of the assigned channel space.

Receiver Design Problem

Increased spectrum loading can be achieved:

1. By full channel loading; which means that adjacent channel operation in the same area must be achieved without serious interference limitations.
2. By further frequency division of the spectrum space, to permit the operation of additional systems in the same area. Time division of channels among systems has been rejected as impracticable. Both adjacent channel operation and further frequency division with adjacent channel operation have the same receiver design problems to consider.

They are:

a. i-f Selectivity
b. r-f Selectivity
c. Desensitizing
d. Intermodulation
e. Spurious Receiver Responses

The present FCC standards provide 60 Kc channel widths in the 152-160 Mc band, and 40 Kc channel widths in the 25-50 Mc band. These standards will be accepted in this initial discussion of the requirements for adjacent channel operation in the same area.

Fig. 2 is a recapitaulation, in the sense that it illustrates the trend in i-f selectivity requirements, as outlined above. Our requirements have changed from a nominal ±80 Kc bandwidth at 85 db down to the present standards for full adjacent channel operation in the same area of ±20 Kc bandwidth at 100 db down for 40 Kc bandwidth operation in the 25-50 Mc band. We may anticipate the requirement for 100 db attenuation at ±10 Kc when the channels are split in two. In the 152-162 Mc band, where the channel width is 60 Kc, the adjacent channel same-area operation standards call for 100 db attenuation at ±30 Kc, or at each edge of the channel. Field tests have shown that with the standards indicated, satisfactory adjacent channel operation may be achieved with interference limited to a tolerable level, at locations within less than a block of opposing 250 Watt stations on adjacent channels.

To attain the high order of i-f selectivity required for adjacent channel same-area operation, it was felt that the conventional i-f design technique should be abandoned. The addition of more and more i-f coils would achieve the necessary skirt attenuation, but unless over-coupling methods were used, the bandwidth at the nose, or at the 6 db attenuation point, would become needle-sharp and thus limit the practicable modulation deviation and increase the problem of controlling drift in crystal oscillator and in circuits under normally encountered conditions of wide temperature variations. It was an engineering decision also, that the increase of adjustable i-f coils increased the vulnerability of the system to maintenance problems and to aging and to selectivity degradation. It was, therefore, decided that the i-f selectivity determining element of the receiver should be a temperature compensated, sealed passive network, free from all adjustment and servicing problems. The decision was also made that the band-pass characteristics of this filter at 6 db down should be such as to accept the full FCC instantaneous modulation deviation standard of ±15 Kc. All of these considerations led to the conclusion that the filter should be a modified form of constant-K design with M-derived matching sections. While such filters are well known in the art, their use has been confined largely to the audio end of the spectrum and there has been no known commercial application, of such filter design to receiver i-f systems. As every engineer might readily anticipate, the first research receiver prototype made use of a filter nearly as large and as costly as the balance of the receiver structure. Field tests, however, proved that the basic approach was correct and that the high level of adjacent channel attenuation was most effective in controlling interference from opposing adjacent channel stations. A long, disciplined developmental program yielded a filter sealed in polyester resin, fully temperature compensated over the range of —20 to +100°C, with the size and cost within commercially tolerable limits.

Fig. 1 shows the charactertistics of this filter. You will note that while the filter provides the attenuation of 100 db at the edge of the channel, or at ±30 Kc, the proposed RTMA Proposed Standards for adjacent channel operation provide only 80 db attenuation at ±60 Kc, or at the center of the adjacent channel, rather than 100 db at the edge of the channel. Such attenuation standards are inadequate for adjacent channel operation in the same area.

Fig. 3 shows the physical structure of the Permakay Filter. The name "Permakay" is derived from the fact that the tuning adjustments are permeability adjustments, and the filter itself is derived from the constant-K network.

Fig. 4 shows the Permakay filter mounted in place on the Sensicon Receiver strip and Fig. 5 shows the receiver strip with the filter mounted in the complete mobile chassis with the transmitter strip and the power supply.

The selectivity characteristic of a slightly modified, lower cost version of the filter is shown in Fig. 6. This unit provides 100 db attenuation just beyond the edge of the channel, but well within the guard band between the two channels. Fig. 7 shows this smaller size filter mounted on the Uni-Channel Sensicon Receiver strip.

Permakay Filters have been in use in the field for more than a year, and there has never been a field failure. The use of the specialized wave filter art as applied to i-f bandpass determination provides an adequate technical solution for the problem of i-f selectivity. Whether the bandwidth required be 10 Kc, 20 Kc, or 60 Kc, the construction of practical filters is well within the known design limitations. The i-f selectivity requirement for receiver design is no longer a limiting factor in channel utilization.

In the past, where receivers were used with inadequate i-f selectivity, serious interference was encountered in the field, but it was impossible to isolate the nature of the interference because the broad band-pass characteristics of the receiver obscured all other possible elements of the problem. So soon as the i-f selectivity problem was solved, new sources of interference, and other

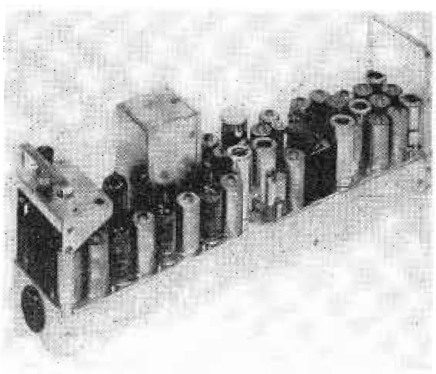


Fig. 7: Photograph showing the Uni-channel Sensicon dispatcher receiver chassis

limitations relative to the adjacent channel operation problem were exposed. Saturation and desensitizing of the receiver by strong signals was one of the first defects noted. Early in the work, it was discovered that it was impracticable to maintain a high selectivity characteristic where interspersed amplifier stages provided the highest possible gain, and

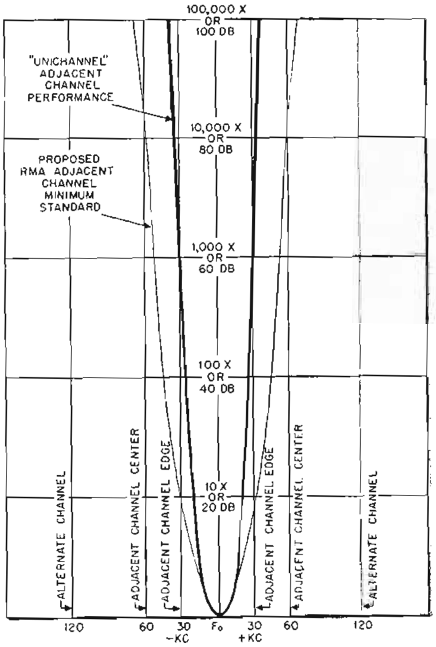


Fig. 6: Uni-channel receiver selectivity constant limiter method. (152-174 MC)

resulted in grid current saturation on strong signals. With conventional i-f design as soon as the grids of the i-f tubes draw current, the selectivity characteristics of the receiver change markedly. Further, it is obvious to any engineer that strong signals mixing in saturated grid circuits provide beats which may occur within the band-pass of the receiver, and once such beats are created, no amount of selectivity will remove the undesired signals. It follows, therefore, that saturation must be avoided in a receiver, if the selectivity characteristic is to be preserved and if undesired heterodyne signals are to be eliminated.

Two design factors of basic importance to the Sensicon receiver design have been introduced:

1. All gain in the receiver ahead of the filter must be limited to the minimum required to protect the signal-to-noise ratio.
2. AGC must be introduced to control and limit saturation on strong adjacent channel signals.

Here we have the fundamental Sensicon principles: Gain and selectivity must be separated so that gain may be introduced after the receiver selectivity has successfully eliminated the undesired signals. The gain or sensitivity is controlled to avoid saturation in any stage, since intermodulation, or mixing of signals, will take place in any non-linear circuit. From these principles, the name "Sensicon" is derived. The word is intended to mean "constant, or controlled, sensitivity before the introduction of the selectivity de-

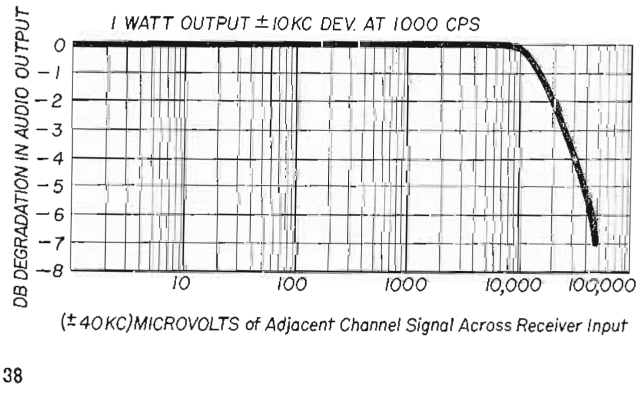


Fig. 8: Effect of a strong desensitizing signal on the adjacent channel. With a receiver of improper design and poor selectivity, the adjacent channel signal will take over completely as soon as it reaches an amplitude of about twice the on-channel signal

termining elements in the receiver".

Fig. 8 shows the effect of a strong desensitizing signal on the adjacent channel. Obviously, with a receiver of improper design and poor selectivity, the adjacent channel signal will take over completely, so soon as it reaches an amplitude of approximately twice the on-channel signal. This curve shows that the degradation is tolerable even out to an opposing signal level of 30 or 40 thousand microvolts on the adjacent channel, opposing a desired signal of less than half a microvolt. The major limiting factor in this case is the saturation of the grid of the first mixer. Fig. 9 shows the noise quieting characteristic of a 25-50 Mc Sensicon receiver.

Intermodulation

So far, we have dealt with selectivity and saturation as primary problems. When the same-area operation embraces the simultaneous transmission for more than two stations in the area, a new and very important problem is introduced. This is the problem of r-f or front end, intermodulation in the receiver. If a mobile unit is operating in the immediate neighborhood of a powerful adjacent channel base station, saturation in the r-f or mixer stages will occur and a second harmonic of the adjacent channel frequency will be produced. The signal from an alternate channel station operating in the same neighborhood will mix with the second harmonic of the adjacent channel signal to produce a beat exactly on the desired signal. Where the adjacent and alternate stations are operating from the same geographical location and strong signals are received simultaneously from both stations, the magnitude of the undesired product of intermodulation on the desired frequency may be on the order of 10 mv. for 250-watt installations. If the desired station is located some distance from the opposing stations and the signal level is the order of 5 or 10 microvolts, it is clear that reception will be impossible. Separating the two opposing stations geographically will reduce the level of the undesired signal and, to a large extent, the interference will be found only in the neighborhood of the adjacent channel station. In practical field tests, it has been shown that if the three stations involved are separated in an approximate triangle from one to three miles, the interference encountered will be limited to approximately one block from the opposing adjacent channel when all three stations are on the air simultaneously. While the terrain and the effect of building shielding will alter this pattern from installation to installation, it may be said that with suitable attention paid to systems design and geographical separation of systems for all systems operating in the same area, the Sensicon receiver design permits same-area adjacent channel operation without significant interference. The perfect control and elimination of the front end intermodulation could be achieved only:

1. By introducing r-f selectivity to attenuate adjacent and alternate channel stations to prevent front end tube saturation.
2. By designing the r-f and mixer stages of the receiver so that the stages would remain linear over a wide range of high level signal inputs.

The first solution is impossible with the present state of the art, since a large size cavity measuring approximately 12 x 18 in. will provide attenuation on the adjacent channel of no more than a fraction of a db. The second approach is impracticable because transmitter tubes would be needed as r-f amplifiers and mixers to provide the linear operation into the high voltage input regions. A combination of careful design of the mixer-r-f stages plus the introduction of AGC, brings the in-

(*Continued on page* 66)

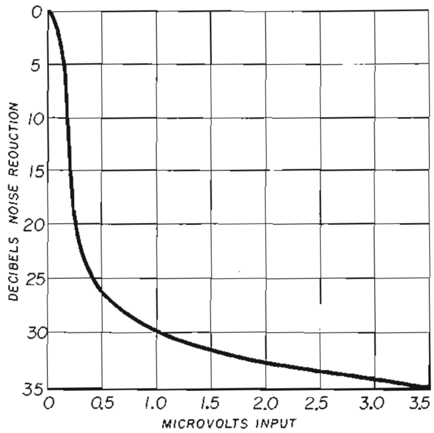


Fig. 9: Noise quieting characteristics Uni-channel Sensicon receiver (25-50 MC)

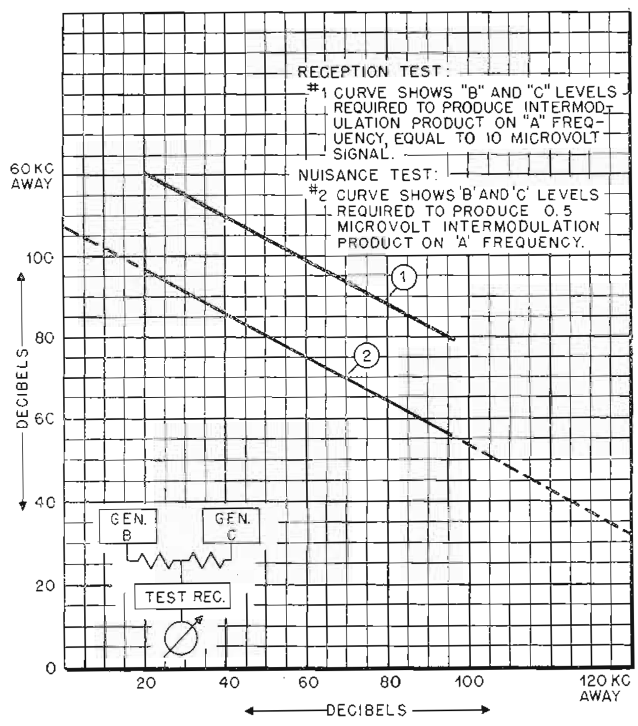
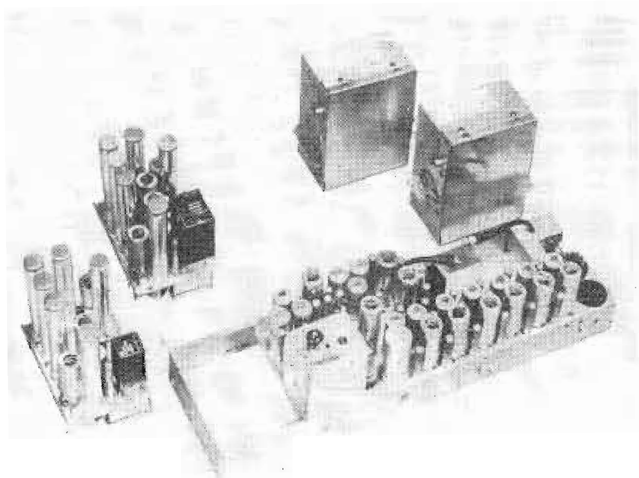


Fig. 10: (Left) Intermodulation nuisance and reception interference test. Receiver frequency = A, A plus 60 KC = B, A plus 120 = C. Reference level is 0.5 microvolt

Fig. 11: (Below) Exploded view of 152-174 MC Sensicon receiver showing single-frequency and two-frequency RF tuner decks at left and plug-in Permakay IF wave filters for adjacent channel and split-channel operation at the right



CUES for BROADCASTERS

Practical ways of improving station operation and efficiency

Edited by John H. Battison

Increasing Remote Cue Level

L. RUSSELL ARTUS, Assistant Chief Engineer, KELO, Sioux Falls, S. Dak.

IT is often difficult to hear clearly the cue from the studios when the remote equipment is set up in a noisy location—for example in the judges' stand at auto races. All of our remote amplifiers are RCA type OP-6 and it was found that the cue level was reduced about 14 VU when the amplifier power was turned on.

Cue audio is fed into the output transformer as well as the 'phones. The negative feedback loop then feeds the cathode of the second amplifier stage. The cue is amplified by the second and third stages, and returned to the output transformer 180° out of phase, thus giving the 14 VU drop in level at the 'phones. The setting of the volume control pad has no effect on this gain reduction.

Several circuits were tried to re-insert the 14 VU cost, the one illustrated worked best. All that is needed is a good push-button switch, (normally open), and about eight inches of wire. The push-button is installed on the OP-6 panel and connected between ground and the "top" of R 12, (grid of the third stage 1620).

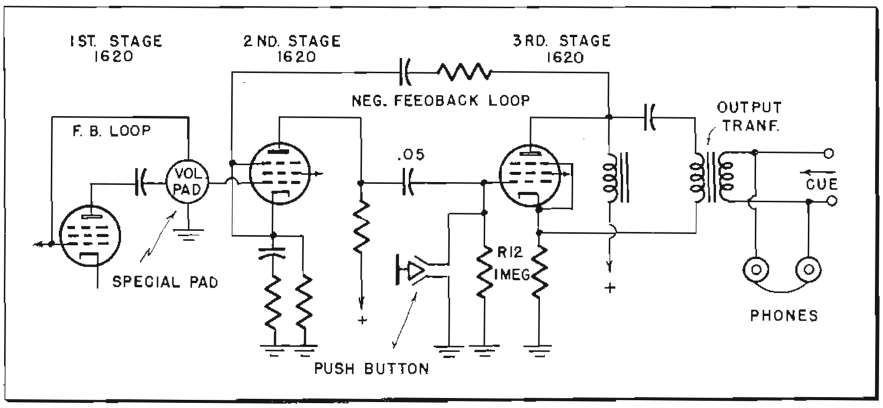
This arrangement is simple to connect, does not produce clicks, has no dc voltage across the push-button, and the cue level jumps 14 VU when the button is pushed. It is also useful as a "push to listen" button when talking over the line to the control room.

This circuit is not limited to use in the RCA OP-6. It can be used to advantage in any remote amplifier which uses negative feedback around the stages following the volume control. The photograph shows the location of the push-button on the OP-6 panel.

$$$ 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.

Modification to RCA OP-6 Remote Amplifier to raise cue level without switch clicks

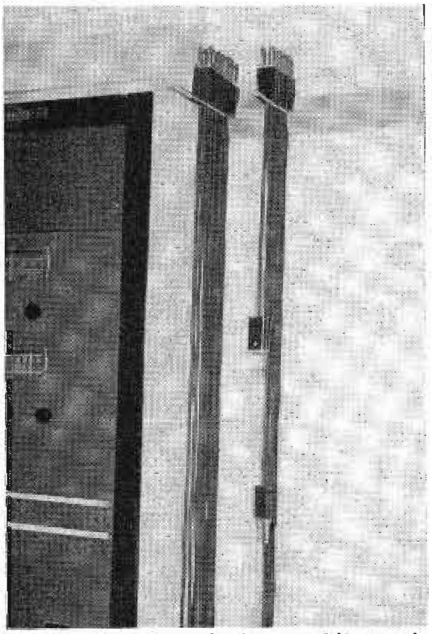


A Patchcord Rack

By HERBERT G. EDISON Jr., Chief Engineer, Radio Station WIS, Columbia, S. C.

PATCHCORDS are something that every radio station owns but of which seeming few take proper care. The usual position of the patchcord is hanging at its mid-point over the back door handle of the speech rack or over a nail in a nearby wall. This rough treatment allows the plugs to bang together thus chipping them, and loosing screws therein. The hanging tends to damage the cloth covering and breaks the finely twisted wires inside. Besides this, the arrangement is far from neat and is purely makeshift.

A ¾ in. thick wooden board, having a width of 3 in. is rounded on each front edge, sanded and painted to match the wall where it will be placed. Into this wood are drilled two ¼ in. holes for each rack section desired. The holes are spaced slightly greater than the diameter of the cord which is to be used. The racks are made from ¼ in. welding rods, eight in. long and rounded smoothly on the exposed ends. These rods are chrome plated and pressed tightly into the holes by using a block of soft wood and hammer, (making certain that they remain parallel throughout their entire length). Each section accommodates 12 patchcords.



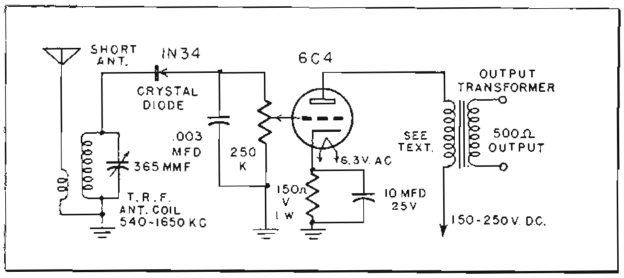
Patchwork rack made from welding rods

"Off the Air" Monitoring Tuner

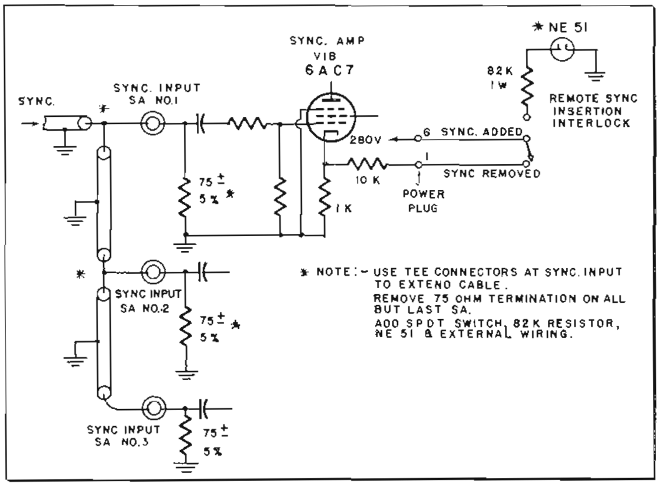
HUGH G. CHASTAIN, Chief Engineer, WULA, Eufaula, Alabama

IF the studios and transmitter are at the same location, this easily constructed tuner will prove worthwhile. It can be used for control room monitoring or for feeding "Off the Air" audio to speakers in studios or reception rooms. When it is used close to the transmitter a short length of antenna wire will provide plenty of pickup.

At WULA a short piece of No. 10 wire was mounted on stand off insulators on the side of an audio rack cabinet. It provided plenty of high quality audio to feed an amplifier with a 500 ohm input. The power



Simple high quality "off-air" audio station monitor



Right: A sync convenience interlock for the TA-5B and TA-3C amplifier

for the tuner may be obtained from the amplifier it is used with, or from the power supply for the control console. The current drain is only 10 or 15 Mils. for the plate supply and .15 amps for the filament supply. The output transformer used is a U.T.C. #A 24. However, others (such as U.T.C.—#0–9, or other similar type that may be on hand) may be used, with good results.

Parabolic Microphone

GEORGE A. DODGE, Chief Engineer, WFOX, Milwaukee 2, Wis.

A useful and handy gadget to have around the station is a parabolic microphone. It can be put to good advantage at outdoor remotes where a field termination is unobtainable and eliminates handling lengthy and cumbersome cable.

However, a true parabolic requires considerable thought and design; also it is expensive to spin. This writer spied the wife's bathroom spot electric heater and smuggled it down to the station. A W.E. 633 mike was connected to a bracket and anchored to the front of the bowl of the heater. After various tests to locate the focal point, a surprisingly high gain was obtained. (Test tone at 400 to 2000 cps was used.) The response was good. When first tried out at a football game, band pick-ups and various cheers from the far side of the field were quite satisfactory.

Sync Convenience Interlock

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

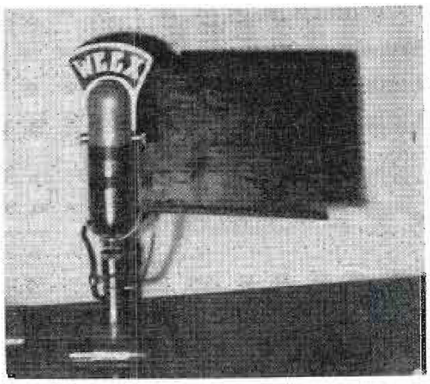
THE stabilizing amplifier is employed throughout the video system to restore sub-standard sync pulses, control the sync to picture ratio, provide the specified peak to peak voltage output signal, remove hum and transient disturbances, and in some cases to mix local sync to produce a composite video output.

In the usual installation, the picture inputs and outputs to the *SA* are located on the jack panel where they may be conveniently rearranged. Local sync is terminated at the *SA Sync Input* directly, and is only provided at those *SA's* handling non-composite video inputs. This makes the problem of substituting one *SA* for another complicated when some *SA's* are provided with sync input signals and others are not.

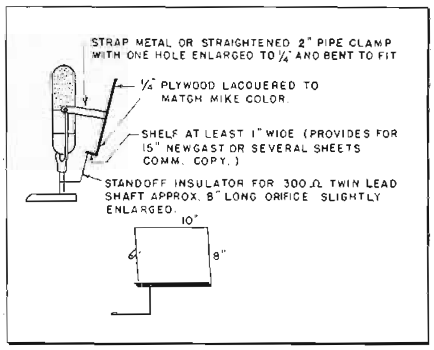
A sync interlock circuit has been provided in the RCA stabilizing amplifiers for controlling sync insertion remotely at switching consoles where both non-composite, and composite, video signals are available for programming. A simple parallel extension of this circuit will make sync insertion available at all *SA's* at the flip of a switch, at the same time simplifying the emergency patching procedure. This involves the use of a bridging sync line to feed a string of three to four *SA's* from one sync source, and a suitable located toggle switch and neon indicator lamp for each *SA*. The necessary modification is shown in the accompanying diagram. The sync convenience switch may be incorporated on the *SA* chassis if desired.

Script Rack

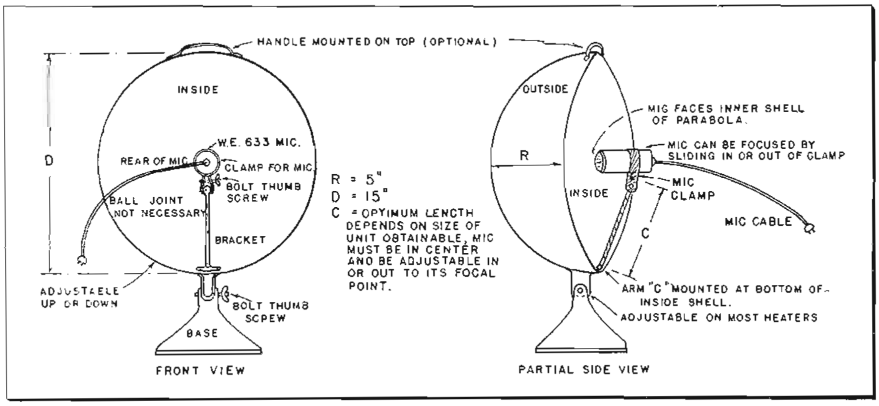
WILLIAM AHLES, Engineer, WEEX, Easton, Pa.



Cure for off-mike announcers. Construction details are given in illustration below.



Parabolic reflector microphone improvised from obsolete spot electric heater



Convenient Methods for

How the variables in Richardson's equation may be determined through

By H. F. IVEY and C. L. SHACKELFORD,
Lamp Division, Westinghouse Electric Corp., Bloomfield, N. J.

THE thermionic electron emission from various materials is generally represented by the Richardson equation:

$$J = AT^2 e^{-\epsilon\phi/kT} = AT^2 e^{-b/T} \qquad (1)$$

where J is the current density, T the absolute temperature, A the emission constant, Ø the work function, ε the electronic charge, and k is Boltzmann's gas constant. The quantity b, the "temperature equivalent of the work function", is given by b = 11,605 Ø

It is frequently necessary to determine one of the four quantities J, A, Ø (or b), and T in terms of known values for the other three. This calculation can, in general, be easily performed from Richardson's equation, but proves laborious and time-consuming if a large number of such determinations are required. An additional complication arises if it is desired to calculate the temperature at which a given emission will be obtained from a certain emitter. In this case, the presence of the quantity T both in and outside the exponential factor in equation (1) makes it impossible to solve the equation explicitly for T. The general procedure in this case has been that of repeated trials and interpolation.

The purpose of this discussion is to present four simple and rapid methods of making calculations of this type. The first of these is algebraic and involves a reduction of Richardson's equation to a simpler form. Two of the methods are graphical in nature, while the fourth consists of a nomographic solution.

Since the difficulty in solving Richardson's equation for the temperature T arises from the presence of the T^2 term, it is more convenient to work with the simplified expression:

$$J = A_0 e^{-b_0/T} \qquad (2)$$

Although equations (1) and (2) cannot be made to agree over a wide temperature range, it can easily be shown that they will give the same values of J and of dJ/dT at an arbitrary temperature T_0 if the quantities b_0 and A_0 satisfy the relations:

$$b_0 = b + 2T_0 \qquad (3)$$

$$A_0 = A\,(eT_0)^2 \qquad (4)$$

The simplified emission equation (2) can easily be solved for the temperature

$$T = \frac{b_0}{\ln (A_0/J)} \qquad (5)$$

where the symbol in ln indicates natural logarithms. This solution is not exact, however, because b_0 and A_0 are both functions of the temperature T_0 assumed for fitting purposes above, or substituting equations (3) and (4) in (5),

$$T = \frac{11605\,\phi + 2T_0}{2 + 2.303\left[2 \log T_0 - \log (J/A)\right]} \qquad (6)$$

For an exact solution, T and T_0 must therefore coincide. The following procedure of successive approximations is thus suggested:

1. guess at a value for T_0
2. with this value of T_0 and the known constants, solve equation (6) for T,
3. substitute this better approximation for T in place of T_0 and solve again,
4. repeat the process until a limiting value of T is obtained.

In practice, however, it will be found that the long series of approximations described above will not be necessary. Since b_0 and log A_0 do not vary rapidly with T_0, the

Fig. 1: Plot of Richardson's equations

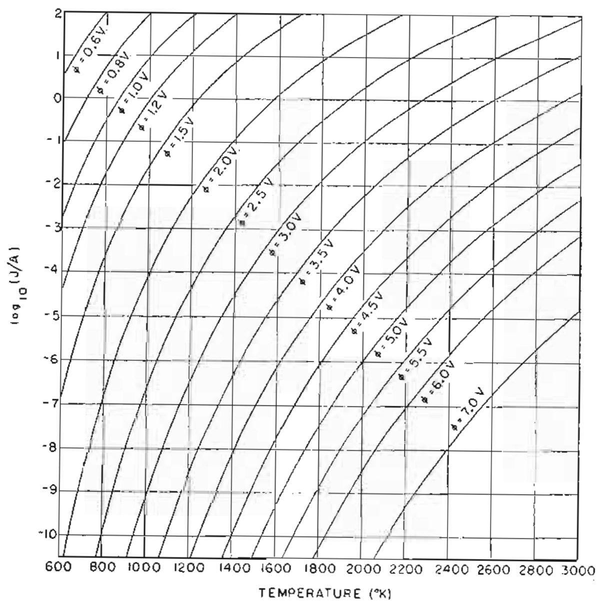
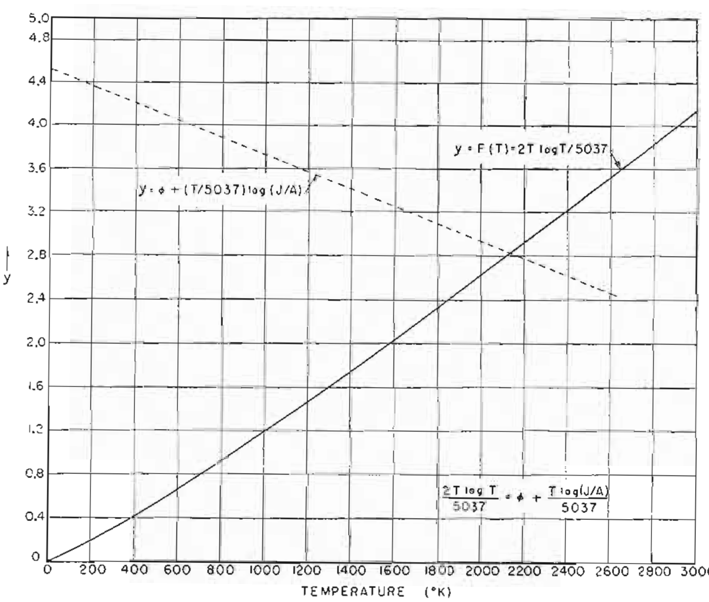


Fig. 2: Chart for calculation of temperature



Thermionic Emission Calculations

algebraic simplification, use of graphs, or use of nomograph

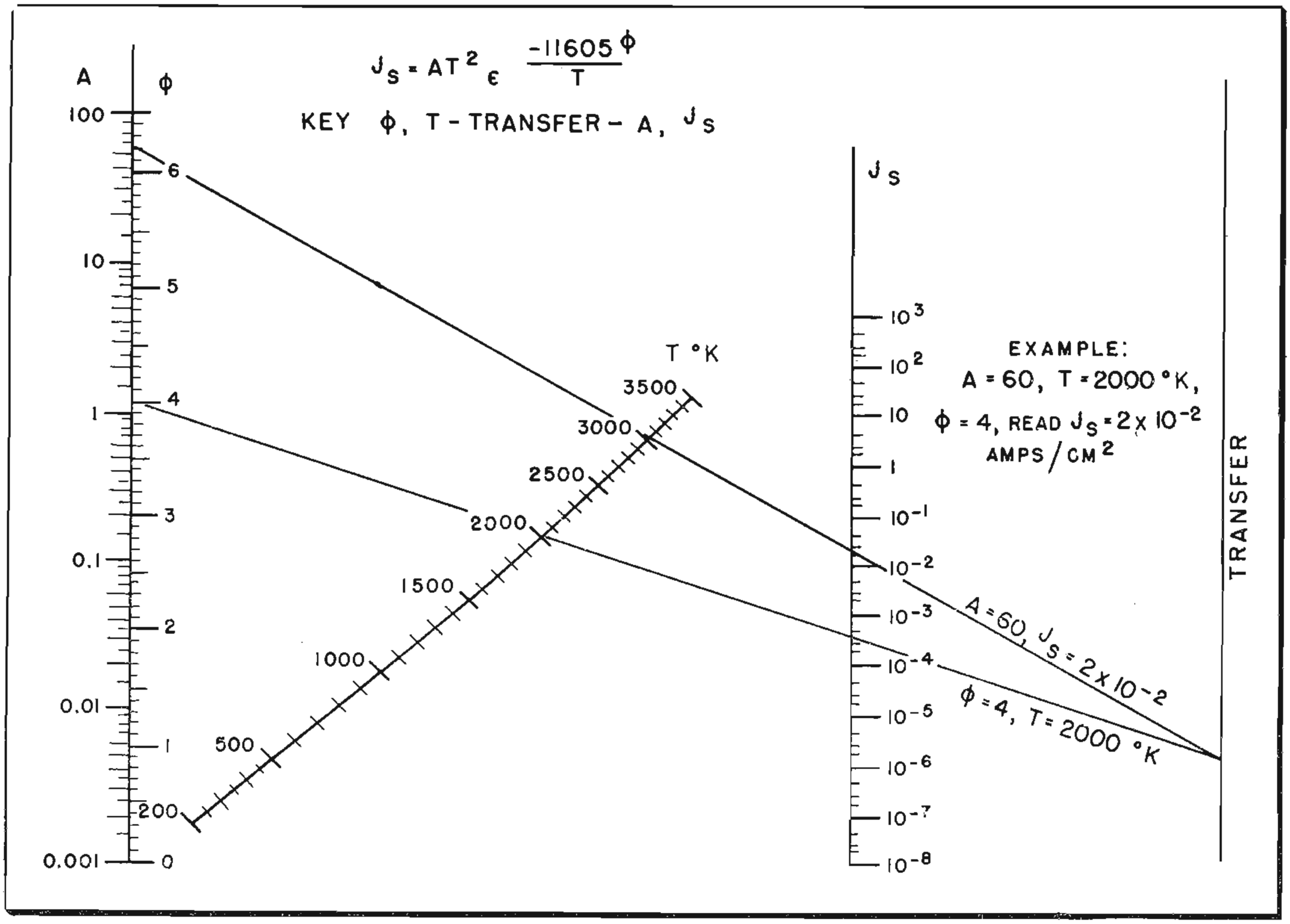


Fig. 3: Nomographic solution of Richardson's equation permits easiest and most rapid means of obtaining any of four variables

desired value of T will be found after, at most, two successive solutions of equation (6). To illustrate the small effect of the assumed T_0 on the value of T_1 (the value obtained after the first solution of equation 6), Table I has been prepared. Here two cases, one typical of a tungsten emitter and the other of an oxide-coated cathode, have been used. It is seen that an error of several hundred degrees in T_0 will produce an error of only a few degrees in T. The calculation of the desired temperature by this method will therefore be quick and straightforward. If T is known and it is desired to calculate one of the other quantities, however, Richardson's T^2 equation will generally be preferable to the simplified form (2).

Graphical means also offer a convenient method for obtaining values of the various variables in Richardson's equation. The size of the plots which would be required to obtain high accuracy (say 1° out of 2000°) limits their application to less critical situations, but where the accuracy is acceptable, their use is very easy and rapid. The first approximation to the temperature, T_0, used above in the analytical method can be found by the graphical methods so that equation (6) need be solved only once.

One graphical method is illustrated in Fig. 1. Here values of log (J/A) as calculated from Richardson's equation have been plotted as a function of the temperature, with various values of the work function, Ø, as a parameter. The procedure for determining any one of the four variables, J, A, Ø, or T if the other three are known is obvious. The accuracy is not very great because of the scale used in plotting, and also because of the necessity for interpolating between the curves for various values of Ø.

An additional graphical method which is capable of greater accuracy, although not as easy to use, has also been devised. This method is particularly useful for calculating the temperature. Richardson's equation can be rewritten:

$$\text{Log} \frac{J}{A} = 2 \log T - (0.4343) \frac{11605\phi}{T} \quad (7)$$

or

$$\frac{2T \log J}{5037} = \frac{T \log (J/A)}{5037} + \phi \quad (8)$$

(Continued on page 68)

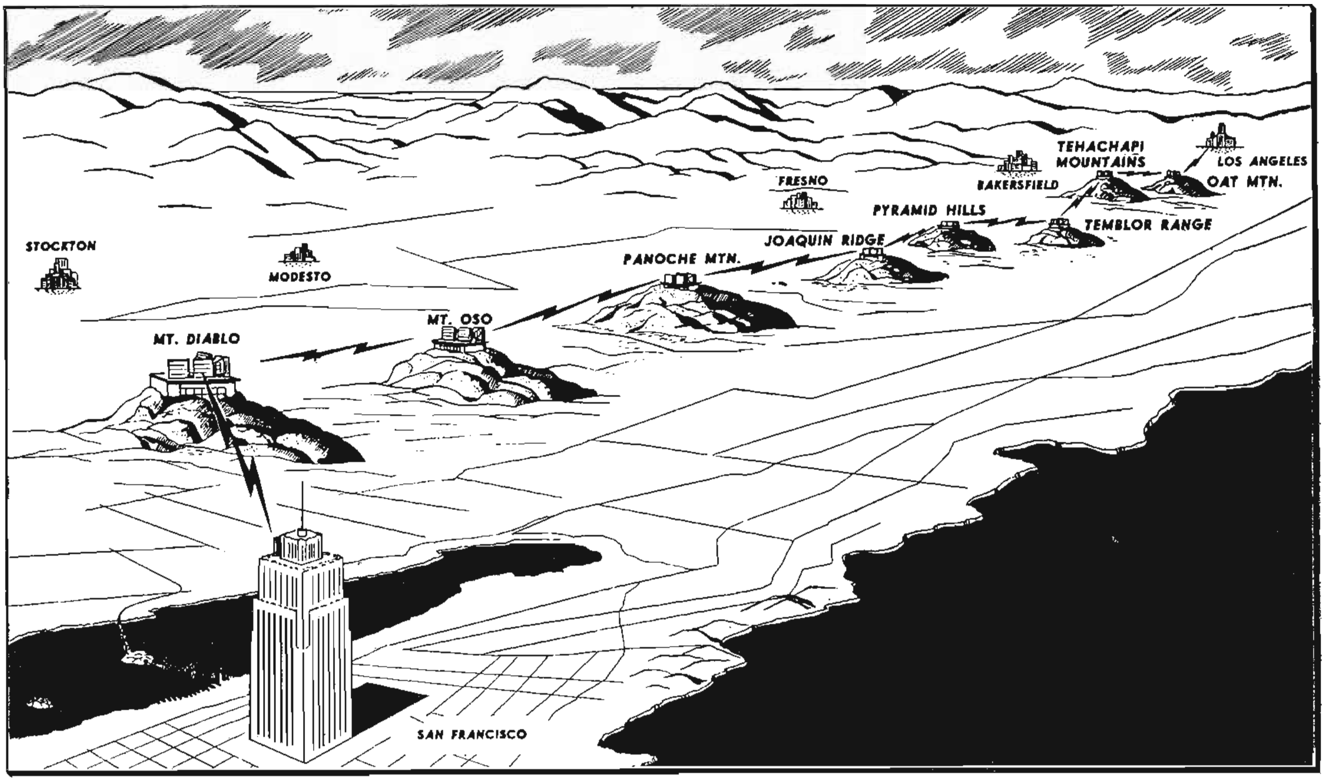


Fig 1: Route of the Los Angeles-San Francisco relay uses mountain tops to obtain maximum line of sight between stations

Los Angeles to San

Eight repeater stations provide path for television and rolling countryside; unattended relays report

By B. W. SOUTHWELL,
Engineer, National Broadcasting Co., Dixon, Calif.

TELEVISION interconnection between Los Angeles and San Francisco has been made possible by a microwave relay system operated by the Pacific Telephone and Telegraph Co. The new California system consists of eight repeater stations erected on mountain tops running along the west side of the inland valleys. These repeater stations pick up the microwave beams, amplify them and retransmit them to the next station in line of sight. Terminating stations are located at the headquarters building in San Francisco and on a telephone building in Los Angeles.

Stretching southward the repeater stations shown in Fig. 1, are located on Mount Diablo, Mt. Oso, Panoche Hill, Joaquin Ridge, Pyramid Hills, Temblor Range, Mt. Tehacapi and Oat Mountain. The system consists of two channels, one permanently orientated south to north. The other is reversible. It will be used initially for television and later for both television and long distance messages. While several hundred telephone calls can take place over the facilities simultaneously, only one television program can be transmitted on a channel at one time.

The California system, known as the TD2 system, operates in the super high frequency band between 3700 MC and 4200 MC, and without the use of high power can be made sufficiently directive to operate on a point-to-point, radio relay basis. Six channels in each direction of transmission are provided. The 500 MC bandwidth is divided into 12 channels; each 20 MC wide with a separation of 20 MC from adjacent channels. Alternate channels are used for transmission in each direction. Channels transmitting in the same direction are therefore spaced 80 MC apart.

In the TD2 system, frequency modulation at the radio terminals is used to convert signals at video frequency to an i-f of 70 MC. Fig. 2 shows the general arrangement of terminals, repeaters, and frequency utilization.

Power Supplies

Three power supplies are required, delivering 12 v., 130 v. and 250 v. The 24-v. power supply for the alarm circuits, VF amplifiers for the order circuit, talking battery, rectifier control circuit, etc., is in addition to the above supplies. These voltages are obtained from batteries floated on the line by means of rectifiers operating from commercial 60-cycle power. A gas-engine generator furnishes emergency power in case of a commercial power failure.

The repeater bays in each relay station, are nine feet tall and de-

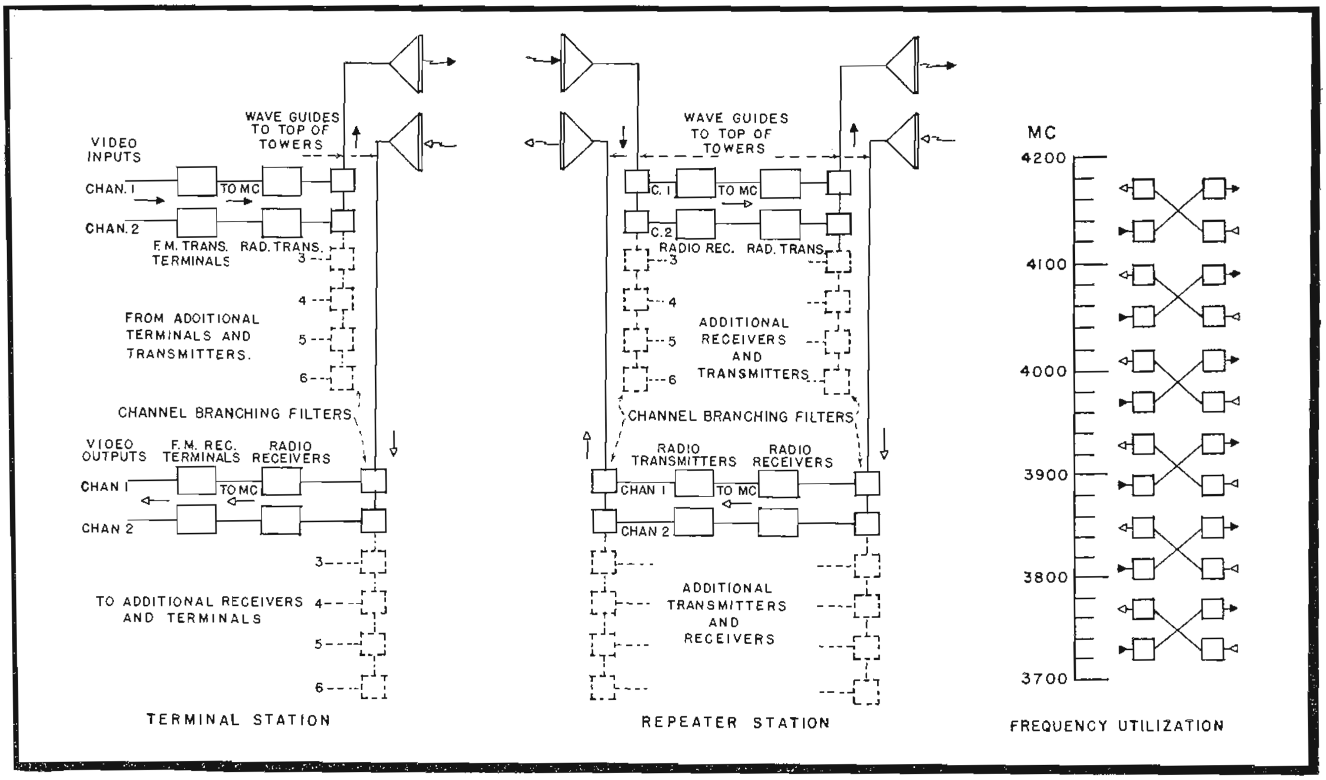


Fig. 2: General arrangement of terminals, repeaters, and the frequency allocation and bandwidths used for each operation

Francisco Microwave Relay

and telephone signals over 350 miles of mountainous operating conditions and warn of imminent trouble

signed for back-to-back mounting for conserving floor space. These bays provide for the receiving and transmitting equipment for one channel.

A unique alarm and express order system, see figure 3, has been provided. The alarm system connects from unattended and partially attended stations to fully attended stations. Each alarm center can take care of as many as six stations, and is capable of receiving 42 alarm indications from each unattended station, and sending 10 remote control orders to each of these stations. The alarm circuit employs a distinctive continuous VF tone. When an alarm condition occurs at an unattended point, the tone is interrupted or pulsed, depending upon whether the alarm is major or minor. Suitable audible and visual signals then register at the alarm center. Detailed information is obtained from the station by the reports from all individual alarm indications which have operated (this information is transmitted by pulsed voice-frequency tones causing appropriate lamps in the indicator bank to light). All alarm and indication tones are passed to the alarm center over a two-wire, one-way, circuit. The remote control system provides alarm centers with the means of controlling as many as 10 circuits at each of 12 unattended stations. Thus, one of the 10 order circuits directs a station to report the condition of all individual alarms; another starts the gas-engine generator for a routine maintenance check; another serves as a calling-in signal for local order circuits, etc.

Local Order Circuits

All unattended stations are bridge connected on 4-wire local order circuits terminating at adjacent main repeater stations. Main stations have access to two local order circuits, one to the east and one to the west. The express order circuit is used for isolating troubles to particular main repeater sections, coordination of patches, consultation between alarm centers and radio control offices, etc.

The TD2 system is designed to operate over distances as great as 4000 miles. Its first application will be for inter-city television networks, and is based on main routes which are bridged at high frequency in the order of 70 MC to supply branch routes. For purposes of feeding a program to a local station or spur route it is not necessary to demodulate the "through" channels. The video programs to be relayed are fed by coaxial facilities to a common switching point, known as the *television operating center*. The sound portion of the television program is not transmitted by the high-frequency relay system, but is relayed by regular broadcast sound facilities. It is understood that subsequently the

(*Continued on page* 83)

Resistance and Capacitance

New design approach permits better understanding of operation. source and load impedance. Use of filters in feedback circuits

By *LOUIS G. GITZENDANNER*
General Engineering and Consulting Lab., General Electric Co., Schenectady, N. Y.

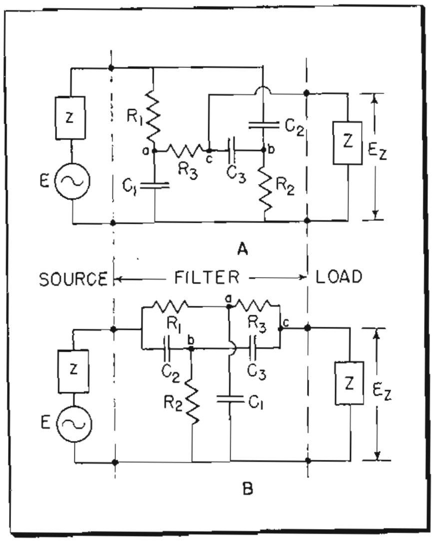
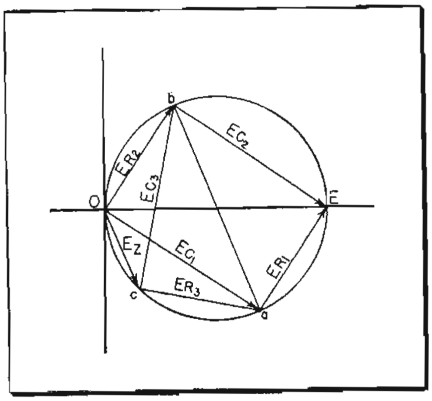


Fig. 1: Circuit diagram of twin T filter

Fig. 2: Vector diagram for ideal case



GENERALLY one thinks of inductances and capacitances when filters are mentioned, but the twin T filter utilizes only three resistances and three capacitances and provides the communication engineer with a very useful and versatile tool. It has been used in one equipment both as an infinite rejection filter and also as a phase correction network. Articles describing its use in band pass circuits have been published[1]. The relative merits of R-C versus L-C filters may be debated, but especially at low frequency the absence of inductances may be an important factor. The analysis or design of the R-C twin T filter is generally based on a purely mathematical solution of conditions for infinite rejection, or on an impedance concept such as is used for L-C filter design. A somewhat different approach to analysis and design has proved valuable in that it gives a much better physical concept of the operation of the circuit useful in applying, designing or adjusting filters in test.

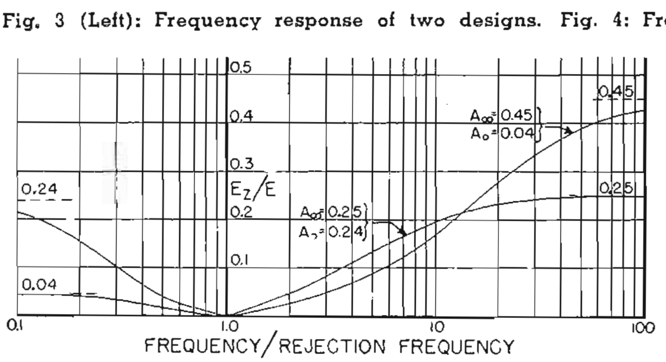
The conventional double T circuit diagram is shown in Fig. 1B. The same circuit redrawn with an H configuration is shown in Fig. 1A and will be preferred for obtaining a physical picture of the circuit's behavior.

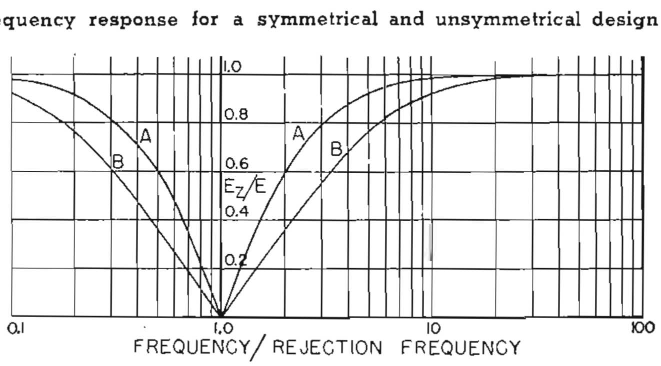
To simplify the explanation, let us make use of some simplifying approximations whose effects will be discussed later. Specifically, let us assume the source impedance, z, is zero and momentarily remove components R_3 and C_3. All that is left are two simple circuits each having a resistor and capacitor in series. With the input voltage constant and the frequency variable, the vectors representing the voltages across C_1 and R_2 move in semicircles as shown in Fig. 2. If the time constants of these two circuits are made the same then the ends, a and b, of the voltage vectors mentioned will be diametrically opposed. Now, if the impedance of R_3 and C_3 are very high compared to the other circuit components and if the load impedance, Z, is considered infinite or is disconnected, then R_3 and C_3 may be reconnected without upsetting the voltage at points a and b. It may be seen then that the voltage applied across R_3 and C_3 is of constant magnitude but rotates clockwise in phase through 180° as frequency varies from zero to infinite. Point c moves in a semicircle relative to a-b as a diameter. As a consequence it moves 360° clockwise around the circle as frequency increases from zero to infinite. The voltage between point c and ground is the circuit's output voltage.

At some intermediate frequency point c will pass through the origin and the circuit will have infinite rejection, i.e., zero output regardless of input.

If we deviate from the assumptions made, the locus of points a, b, and c in particular, will not in general follow the circle of Fig. 2 and point c may pass to the left or right of the origin instead of through it. If it passes to the right of the origin, for a frequency band near the supposed rejection frequency, phase will shift in a leading direction as frequency is increased which effect

Fig. 3 (Left): Frequency response of two designs. Fig. 4: Frequency response for a symmetrical and unsymmetrical design





Twin-T Filter Analysis

Specific formula developed for conditions of equal and unequal to sharpen rejection or to form band-pass discussed

may be utilized to compensate for lagging phase shift in other circuits.

Regardless of how the circuit is set up and regardless of its intended use, the H configuration associated with the diagram in Fig. 2 will prove valuable in clearly understanding the circuit's operation.

General Theory

It should be apparent that aside from the numerous designs of non-rejection filters, there are also numerous designs of rejection filters possible. The latter may be studied by writing the general loop equations and solving for conditions for rejection. The results are

$$R_1R_3 = \frac{1}{\omega_0 C_1}\left(\frac{1}{\omega_0 C_2} + \frac{1}{\omega_0 C_3}\right) \qquad (1)$$

and $$R_2(R_1 + R_3) = \frac{1}{\omega_0 C_2} \cdot \frac{1}{\omega_0 C_3} \qquad (2)$$

It should be noted that the conditions for infinite rejection do not involve either source or load impedance, though obviously both must be considered in the filter design.

It is convenient to substitute T, a time constant, for RC. Then for equations (1) and (2) it may be shown that if a null is reached

$$T_1 > \frac{1}{\omega_0^2 T_3} > T_2 \qquad (3)$$

Appreciation of the inequalities expressed in equation (3) may aid in design

A condition often imposed is that the filter be symmetrical in which case

$$T_1 = \frac{2}{\omega_0^2 T_3} = 4T_2 \qquad (4)$$

and the six filter components are given by:

$$R_1 = R_3 = 2\ (\omega_0 C_2)^2/R_2 \ldots \qquad (5)$$

and

$$C_2 = C_3 = 2/(\omega_0 R_1)^2 C_1 \ldots \qquad (6)$$

In fact, many authors place the additional restriction that $R_2 = 1/2\ R_1$ in which case

$$R_1 = R_3 = 2R_2 = \frac{1}{\omega_0 C_3} = \frac{1}{\omega_0 C_2} = \frac{2}{\omega_0 C_1} \qquad (7)$$

While equations (5) and (6), or equation (7) yield infinite rejection filters, there is little reason to believe that they are the best for all cases. In all, eight impedances are involved so eight assumptions or equations will be needed to uniquely define them all and the proper choice of conditions to fix the parameters depends on the application.

One application of rejection filter is insertion between matched impedances, which we shall assume to be resistive and specified. It is reasonable to make the filter symmetrical, thus two more parameters are fixed. The equations for a null fix two more leaving only two arbitrary conditions or parameters. The ratio of output to input for above or below rejection frequency are indicative of the outputs possible and are useful quantities. Hence, let us specify by A_o the ratio of output to input voltage at zero frequency and by A_{oo} the same ratio at infinite frequency.

Items that may be arbitrarily specified are then Z, A_o, and A_{oo} as well as the rejection frequency ω_o. In terms of these four quantities it may be shown that the filter components should be

$$R_1 = R_3 = Z\left(\frac{1}{2A_o} - 1\right) \qquad (8)$$

$$R_2 = 2R_1 \frac{A_o A_{oo}}{1 - 2(A_o + A_{oo})} \qquad (9)$$

$$C_2 = C_3 = \frac{A_o}{\omega_o Z(1 - 2A_o)}\left[\frac{A_o A_{oo}}{1 - 2(A_o + A_{oo})}\right]^{-1/2} \qquad (10)$$

$$C_1 = 8C_2 \frac{A_o A_{oo}}{1 - 2(A_o + A_{oo})}$$

Since negative resistances are not permissible, we can see from equation (9) that $(A_o + A_{oo}) = 1/2$

The point of significance is that the sum of the outputs well above and well below rejection frequency cannot exceed half the input voltage. Thus, for example, while A_{oo} is arbitrary and in a given instance we may wish it to be as high as possible it cannot possibly exceed 0.5 and if set at 0.45, A_o cannot exceed 0.05.

The ratio of output to input has been plotted on Fig. 3 versus the ratio frequency to rejection frequency for the nearly balanced condition $A_o = 0.24$ and $A_{oo} = 0.25$, and for the unbalanced condition where $A_o = 0.04$ and $A_{oo} = 0.45$.

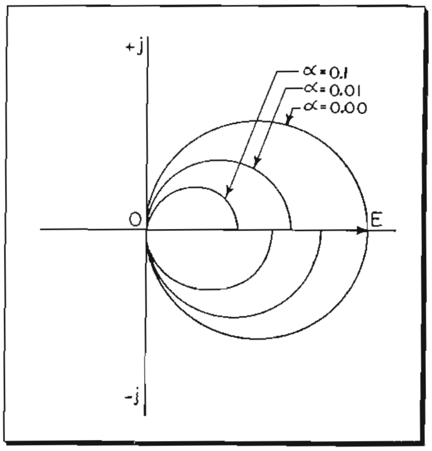


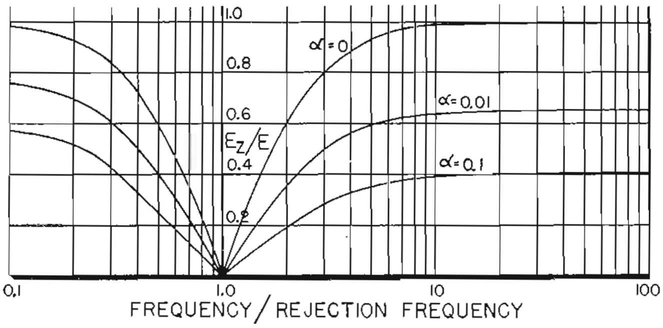
Fig. 5: Diagram showing the locii of output vector for several values of α

The filter components for these conditions, rejection at 60 cycles, and 10,000 ohm source impedance are:

Component	$A_o = .04$, $A_{oo} = .45$	$A_o = .24$, $A_{oo} = .25$
R_1	115,000 ohms	10,800 ohms
R_2	207,000 "	64,800 "
R_3	115,000 "	10,800 "
C_1	.0875 μf	1.7 μf
C_2	.0122 "	.072 "
C_3	.0122 "	1.7 "
z	10,000 ohms	10,000 ohms
Z	10,000 "	10,000 "

The unbalanced filter, it may be noted on Fig. 3, has the higher output at $\omega > 14\,\omega_o$ and also has a slower rate of rise near rejection making adjustment somewhat less critical. For some cases both features may be desirable.

A condition commonly encountered in electronic circuits is that in which a filter is driven by the plate circuit of one stage of an amplifier and drives the grid of the next stage, a considerably higher impedance. Equations such as equations (5) and (6), or (7), are commonly used and yield a workable filter. But, by taking advantage of the impedance conditions prevailing a filter just twice as sharp may be obtained using different equations to design the filter. These equations are based on an assumed resistive source im-



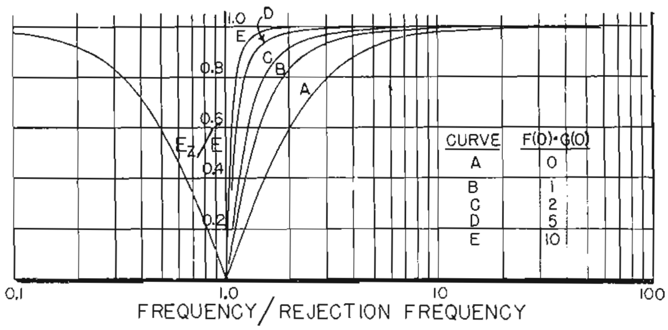


Fig. 6: (Left) Effect of α on output. Fig. 7: (Right) Curves showing the effect of loop gain on frequency response

pedance z, an assumed resistive load impedance Z, the conditions for rejection, and conditions which will distribute the mismatch between source and load throughout the circuit. By distributing the mismatch, each section of the circuit is best able to stand the loading effect of the next section and the ideal condition, as given in Fig. 2, is most nearly approached.

For convenience let the ratio of source impedance to output impedance, z/Z, be represented by α. In accordance with the assumptions stated above, the circuit parameters may be found to be given by:

$$z = Z\alpha \quad (12)$$
$$R_1 = Z\alpha^{2/3} \quad (13)$$
$$R_3 = Z\alpha^{1/3} \quad (14)$$
$$R_2 = (R_1 R_3)/(R_1 + R_3) \quad (15)$$
$$C_3 = 1/\omega_o R_3 \quad (16)$$
$$C_2 = 1/\omega_o R_1 \quad (17)$$
$$C_1 = 1/\omega_o R_2 = C_2 + C_3 \quad (18)$$

It is of interest to note that if one writes the general expression for ratio of output/input voltage and substitutes the value $\alpha = 0$, the formula reduces to the equation of the circle shown in Fig. 2 as the locus of the output vector. Thus, for $\alpha = 0$, the design yields the filter described previously and shown in Fig. 2.

A plot of output voltage versus frequency is shown on Fig. 4, Curve A for a filter designed for and applied to a condition of zero source impedance and infinite load impedance. Curve B shows the voltage plot for a filter designed to be used with matched source and load, but applied to the same terminal condition. It can be seen that near rejection Curve A is just twice as sharp as Curve B. The need for using proper design formulas is apparent if sharp rejection is wanted.

While much of the above discussion has been relative to the condition α equal zero, the results for other values of α are somewhat similar as shown by Fig. 5 and 6.

For the condition α equal one the circuit values as given by equations (12) through (18) yield the often used symmetrical filter in which the impedances to ground are made half the impedance of the elements in the cross bar of the two T's. Indeed, since α equal one infers a symmetrical condition this result is somewhat to be expected.

The ratios A_o and A_{oo} of output to input voltage at zero and infinite frequency respectively may be of interest. For designs based on equations (12) through (18) they are given by:

$$A_o = 1/(\alpha + \alpha^{2/3} + \alpha^{1/3} + 1) \quad (19)$$
$$A_{oo} = 1/(\alpha + 2\,\alpha^{2/3} + 2\alpha^{1/3} + 1) \quad (20)$$

While R-C filters are of considerable importance by themselves, their use is greatly enhanced when they are used in amplifiers employing feedback. By putting a filter in the output circuit of an amplifier and feeding part of the output back to the input, a very sharp rejection filter may be obtained. This circuit cannot, in general, give perfect rejection since the feedback path permits input signal to be fed to the output through R_4. If a cathode follower is used in the feedback loop, as shown in Fig. 8, this may be avoided. Numerous other circuit arrangements are possible too.

Fig. 9 shows an arrangement which can be used as a band pass filter.

By using a rejection filter and adding shunt capacitance to the output to cut off high frequencies an excellent low pass filter may be obtained. Similarly, by using a series capacitance in conjunction with a rejection filter to cut off low frequencies a high pass filter may be obtained. By combining the two a flat topped band pass filter may be obtained[1].

The theory of operation of such circuits and hence of design too can best be understood by going back to basic feedback theory.

(Continued on page 64)

Fig. 8: Rejection filter with feedback

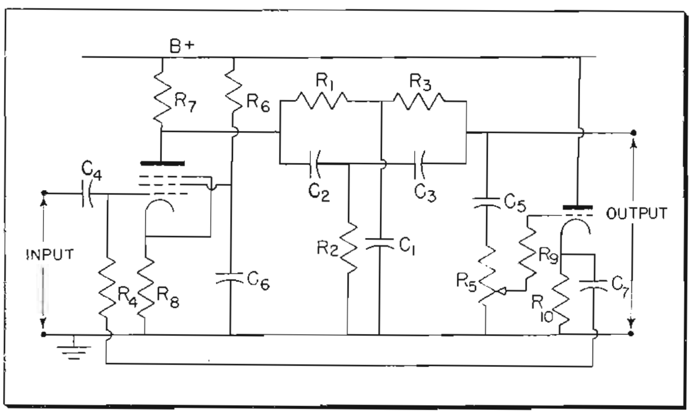
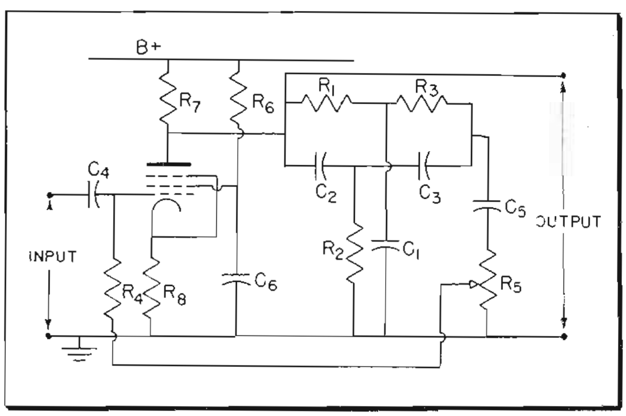


Fig. 9: Band pass filter



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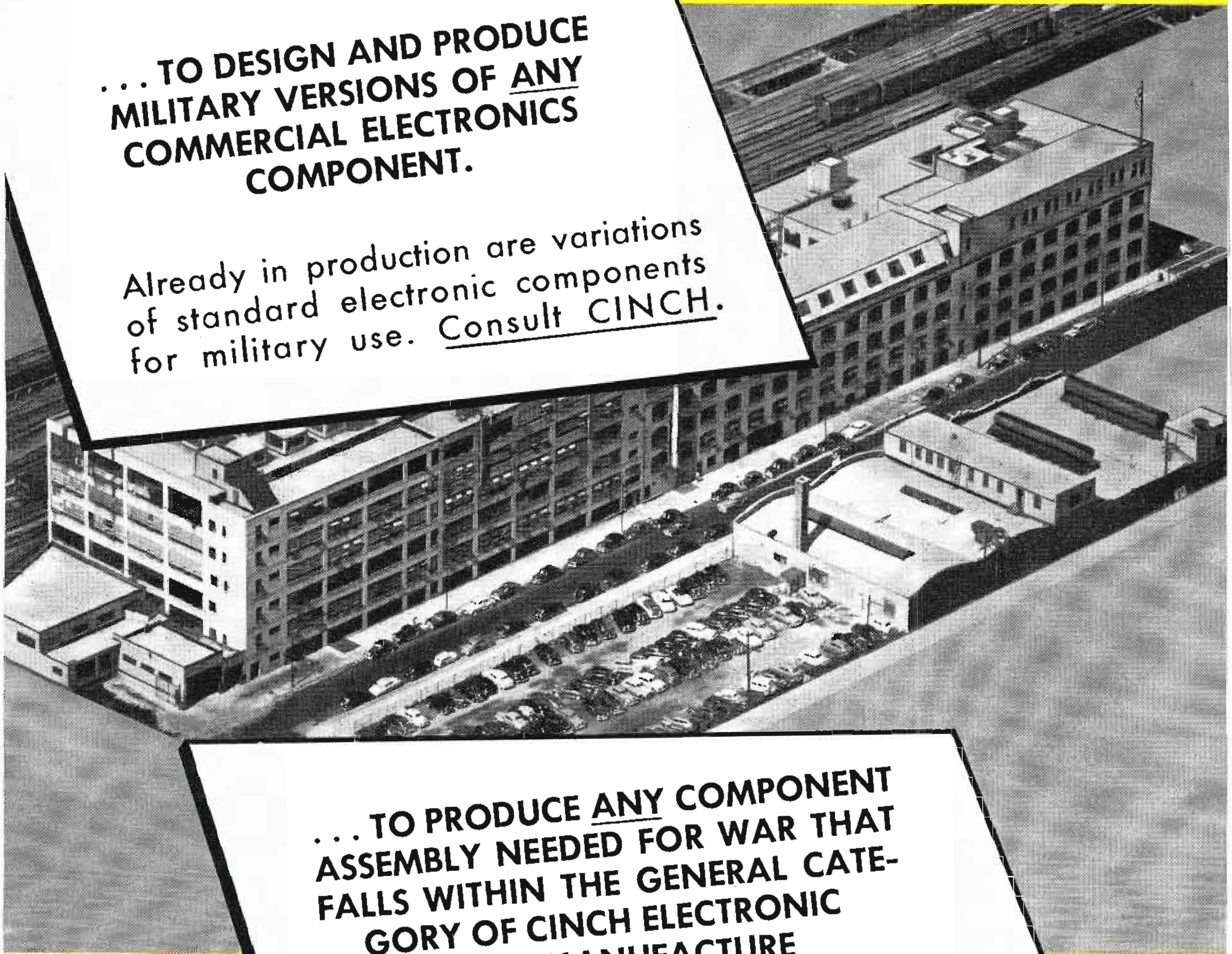

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WASHINGTON

News Letter

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

COLOR TV ON "SHELF"—Just as TELE-TECH has stressed right from the start of the FCC color-television decision (see our Washington News Letter, Oct., 1950) that the military electronics-radio procurement requirements and the shortages of vital materials and metals made the launching of CBS's color-TV plan impossible and literally in contravention to the nation's mobilization, the recent limitation orders of the National Production Authority on cobalt, copper, nickel and other short-supply critical metals have made this forecast entirely accurate. In fact, one NPA official cited at the time of the issuance of the complete control order over cobalt that it put color television "on the shelf." The continued urging by CBS that the National Production Authority give color television the opportunity to share with black-and-white television manufacturers in the extremely small supply of cobalt for civilian uses appeared to many National Capital observers as a rather complete disregard of the present defense preparedness situation.

PRESIDENTIAL BOARD'S REPORT—After a year of intensive study by its five outstanding members and a highly qualified small staff of experts, the President's Communications Policy Board will submit its long-awaited report and recommendations during mid-February to President Truman and a major proposal is slated definitely to be the creation of a permanent agency to formulate the Government's policies and programs in the field of communications and radio. Most important of the recommended spheres of authority for the projected permanent Communications Policy agency will be an assignment for it to become the coordinator on the division of the spectrum between government departments and agencies and civilian radio uses.

COORDINATOR OF IRAC, FCC—Frequently urged by TELE-TECH, the proposed new agency would act as the coordinator between the Interdepartment Radio Advisory Committee, the body which decides on the allocations of frequency channels to government departments and agencies but which has no policy-making powers, and the Federal Communications Commission, which makes the frequency assignments to civilian services such as television, broadcasting, communications and mobile radio. This would mean that since IRAC's creation a quarter-century ago there would be a government body which could review and reverse when necessary the IRAC decisions on frequency assignments. The temporary President's Communications Policy Board is headed by Dr. Irvin Stewart, President of West Virginia University, and its members are: President James T. Killian, Jr., of Massachusetts Institute of Technology; President Lee DuBridge of California Institute of Technology; Dean of Engineering William L. Everett of the University of Illinois; and David O'Brien, retired Graybar Electric vice-president and former War Assets Administrator.

COMPONENTS PLANTS EXPANDED—Expansion of production facilities in component part manufacturing companies' plants is major goal of the Munitions Board and government defense mobilization leadership since the bottlenecks for military equipment output have already appeared or are looming in the case of several key components. End-equipment manufacturers generally are geared for production needs for military, Munitions Board officials believe. In both component and end-equipment manufacturing fields, serious problem is shortage of skilled specialists and trained manpower. Munitions Board has no idea of commandeering present radio-television manufacturing plants and will not take any standby World War II plants out of "mothballs" until full use of present component and end-equipment manufacturing facilities is made.

MOBILE RADIO URGED—Portable mobile radio-communications, particularly walkie-talkies and police radio systems, were advocated as most valuable medium of communications for Civil Defense monitoring teams in measuring radiation hazards following atomic bomb attacks. Communications links to hospitals and headquarters of local civil defense radiological defense organizations must be planned in advance and must be adequate, Federal Civil Defense Administration advocated in a recent lengthy report on plans for communities in establishing organizations and health services to guard against atomic devastations.

National Press Building
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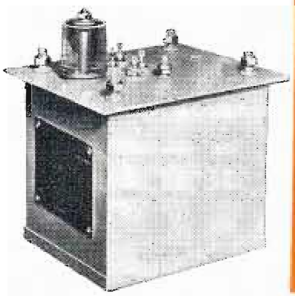
ROLAND C. DAVIES
Washington, Editor

a complete line of

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.



hermetically sealed oil-filled

HIGH-VOLTAGE COMPONENTS

Pulse Transformers

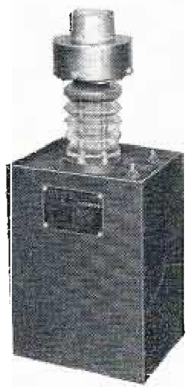
Pulse transformers for use with either hard-tube or line-type modulators. Available in voltage ratings of 10 kv or above. These units are ideal for radar applications, stepping up or down, impedance matching, phase reversing and plate-current measurements. Also suitable for nuclear physics research work, 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 can be 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. Apparatus Dept., General Electric Company, Schenectady, N. Y.

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. *Write to Apparatus Dept., 42-328A, General Electric Co., Pittsfield, Mass.*

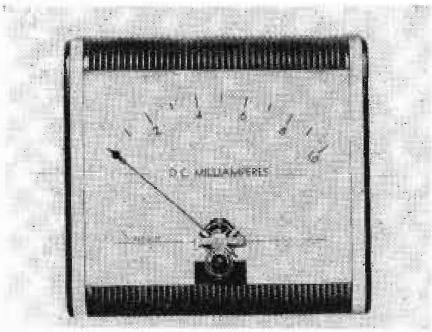
GENERAL ELECTRIC

401-63

NEW EQUIPMENT for Designers and Engineers

Panel Instruments

Etched faces extend across the entire fronts of three new panel meters which have been designed in 4½, 3½ and 2½



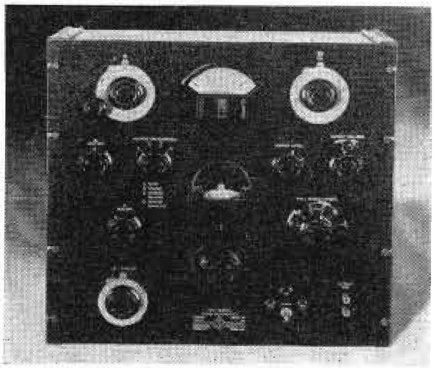
in. sizes. Vertical chrome-plated strips are recessed into the plastic, fluted covers of these new meters (models 1029, 1027 and 1127). The open scale layouts provide space for the customer's name, trademark, or effective color combinations.—**Simpson Electric Co., 5200 West Kinzie St., Chicago, Ill.**—TELE-TECH

Audio Oscillator

Model 410-A audio oscillator has a frequency range of 18 cps to 210 KC in four decades. This compact unit (4 x 5½ x 4 in.) will deliver 10 v. into 10000 ohms, with output constant within 0.5 db over the entire frequency range. Distortion at this amplitude is less than 0.3% from 100 cps to 15 KC, and rises to no more than 0.5% at 30 cps. Source impedance of the cathode-follower output is 560 ohms. Matching transformer will be made available to feed low-impedance balance lines. The total frequency error due to drift and dial calibration is less than ± 2%. Output control is logarithmic and is calibrated approximately in output voltage.—**The Electronic Workshop, 351 Bleecker St., New York 14, N. Y.**—TELE-TECH

Audio Generator

The model 1303-A two-signal audio generator is designed for supplying the test signals necessary in the various methods of measuring intermodulation distortion in audio systems. It can also be



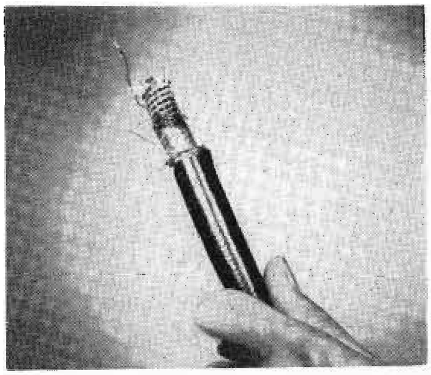
used as a general-purpose laboratory beat-frequency oscillator. The oscillator will supply any of the following signals: a single low-distortion sinusoidal voltage adjustable in frequency from 20 cps to 40 KC; two low-distortion sinusoidal voltages, each separately adjustable, one to 20 KC and the other to 10 KC; two low-distortion sinusoidal voltages, with a fixed difference in frequency maintained between the two as the frequency of one voltage is varied.—**General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.**—TELE-TECH

Oscilloscope

The WO-56A 7-in. oscilloscope has a wide frequency response, a high deflection sensitivity, and an excellent square wave response. It is portable, weighing only 31 lbs. The 11 mv/in. sensitivity is sufficient to provide large pictures of small waveforms such as those produced by microphones, tape-recorder heads, phototubes, phono pickups, and single stages in TV sets. Hum pickup is reduced to a minimum by the use of a shielded input cable and terminal amplifiers which have very low internal hum and are extremely stable at maximum gain. The WO-56A will display square waves over the frequency range of low "motor-boating" rates up to 100 KC. High frequency response is obtained by the use of frequency-compensated direct-coupled amplifiers without peaking coils.—**RCA Victor Div., Radio Corporation of America, Camden, N. J.**—TELE TECH

Flexible Conduit

An improved flexible electrical conduit has been developed which consists of an inner woven tubing made of longitudinal



Fiberglas yarns, and a spiral wrapping of metal foil, with an outer braided jacket of aluminum wire. Conventional construction makes use of a spiral armor of interlocked aluminum strip over a braided aluminum wire jacket. Using less metal than the conventional type, the new conduit is lighter, has greater flexibility, affords more uniform shielding and provides better resistance to damage from moisture, flame, oil spray and fungus.—**National Electric Products Corp., Fulton Blvd., Pittsburgh, Pa.**—TELE-TECH

Comparator Bridge Kit

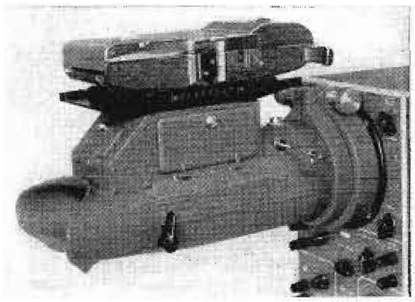
Model 950K R-C-L comparator bridge kit permits instant, easy and accurate comparison of any resistance, capacitance or inductance with any complementary component as a given standard. It tests every type of resistor over the .5 to 500 megohm range and every type of capacitor over the 10 $\mu\mu$f to 5000 μf range. For leakage test and polarization, a source of variable voltage is incorporated with the complete range of 0 to 500 v. This also provides for the precise measurement of the power factor of electrolytics from 0 to 80%.—**Electronic Instrument Co., Inc., 276 Newport St., Brooklyn 12, N. Y.**—TELE-TECH

Tube Base & Sockets

An extremely flexible 20-pin tube base with matching socket has been designed for plug-in unit construction. There is no molded center boss to break and pins are strong and stubby and do not bend or break out. By selecting variations of pin layout of less than 20 pins, critical voltages and frequencies can be isolated and the base can be made non-interchangeable so that it will mate only with the correct socket.—**Alden Products Co., 117 North Main St., Brockton, Mass.**—TELE-TECH

Oscillograph Camera

An oscillograph-record camera has been developed which provides a complete record of an oscillograph image in



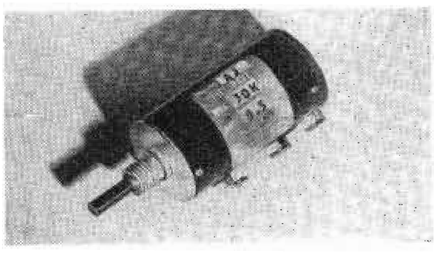
one minute. No darkroom facilities are required because the camera operates on the Polaroid-Land process. A sliding mount makes it possible for the camera to be positioned so that several traces can be recorded on a single print, for side-by-side comparisons. There is also a built-in detent which divides a single print into one, two, or three separate exposure areas. An illuminated data card provides an easy, positive method of photographically recording information on each print.—**Allen B. Du Mont Laboratories, Inc., 1000 Main Ave., Clifton, N. J.**—TELE-TECH.

Network Case

Any three-or four-terminal network can be made into a convenient plug-in unit through the use of a Berkshire Labcase. Originally designed for housing the Berkshire Labmarker, these cases are now available for housing wave filters, wave shaping circuits and other special or standard circuits. Input terminals of one unit may be plugged into the output terminals of another. The housing, which is 4-in. long and 1½-in. in diameter, is made of aluminum tubing with serviceable gray hammered-type paint finish. Overall length is approximately 5½ in. Output binding posts may be used with leads having single or double banana plugs, spade tips, or plain wire ends. Input terminals are banana type with standard ¾-in. spacing. — **Berkshire Laboratories, 518 Lexington Road, Concord, Mass.**—TELE-TECH

Potentiometer

A 10-turn potentiometer has been developed (model AJ) with a wire-wound resistance element 18 in. long, contained



in a case, the diameter of which is only ¾ in. The whole unit occupies no more panel space than an ordinary copper penny. The turns of the shaft provide a resolution more than 12 times that of a conventional potentiometer of equivalent diameter. Welded tap connections at almost any point on the coils and double shaft extensions can be provided. Model AJ is available from stock and also in special resistance values from 100 to 50,000 ohms with accuracies of ± .5% and ± .1%. Power rating is 2 watts and net weight is less than an ounce.—**Helipot Corp., 1820 Missou St., South Pasadena, Calif.**—TELE-TECH

ALL-PURPOSE RECORDING IS A *Sound* INVESTMENT

with General Industries' Model 250

TAPE-DISC RECORDER ASSEMBLY

There's literally no end to the merchandising possibilities of all-purpose recorders in which this GI Tape-Disc Assembly is used. In home entertainment units . . . in straight recorders for professional men . . . as an aid to overall business efficiency . . . it has excellent profit potential.

Designed and built to General Industries' customary high quality standards, the Model 250 incorporates many novel, fool-proof operating features. Its cost is amazingly low.

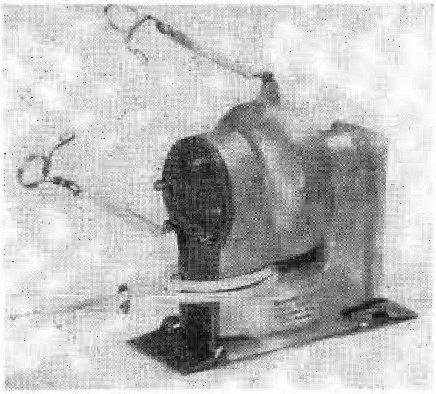
Write *today* for a catalog sheet containing a full description of *all* the recording and play-back features of this popular new tape-disc recorder assembly.

• When connected with suitable amplifier, the Model 250 records on discs . . . records on tape . . . records from tape to disc or disc to tape . . . plays back both tape and discs . . . plays 78 R.P.M. records. A complete service manual, included with each unit, contains a suggested amplifier circuit and complete amplifier parts list.

The GENERAL INDUSTRIES Co. GI® **Department L • Elyria, Ohio**

Horizontal Output and High Voltage Transformer

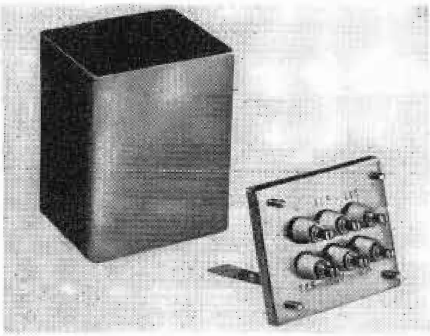
Transformer, coil and core of the Corona-sealed horizontal output and high voltage transformer are entirely sealed



in a molded plastic form. The high dielectric strength of the plastic provides greater protection against corona discharge, and the resultant fire hazards. Acoustical radiation is completely reduced. When nsed in a 66-70° circuit, it will provide full deflection and up to 14 kv anode potential.—**Square Root Manufacturing Corp., 901 Nepperhan Ave., Yonkers 3, N. Y.**—TELE-TECH

Transformer Cans

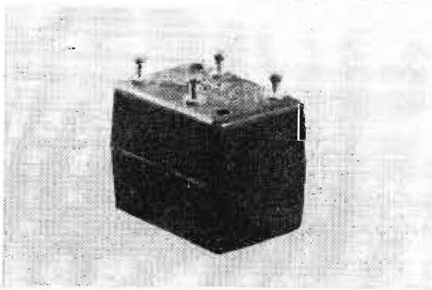
Tooling on all standard sizes of MIL-T-27 transformer cans has been completed and many sizes are already in



stock. These cans can be supplied with or without brackets, weld studs, blind inserts, compression-type hermetic seal bushings and stamped ratings.—**Heldor Metal Products Corp., 85 Academy St., Belleville, N. J.**—TELE-TECH

Pulse Transformers

ERA pulse transformers (100A2, 101A2, 102A2) have been designed for circuits requiring low power. General



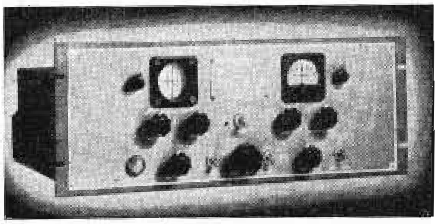
applications include triggering and counting circuits and blocking oscillators. More specfic uses are for dc isolation, inversion, pulse shaping and pulse transmission circuits. Type 100A2 can be used as an interstage coupling of pulse amplifiers where no impedance change is desired. The use of a transformer eliminates the need for an inverting amplifier stage. Type 101A2 will serve as an output transformer for pulse amplifier to match impedance into co-axial transmission line. The 102A2 will match magnetic reading head to input of reading amplifier; for stepping up voltage from reading head.—**Engineering Research Associates, Inc., 1902 West Minnehaha Ave., St. Paul W4, Minn.**—TELE-TECH

Recording Tape

Magneribbon premium sound recording tape has been added to the line of high fidelity magnetic tape recorders and accessories produced and distributed by the Amplifier Corporation of America. Four types of tape are available: red oxide (medium coercive) paper and plastic base; and black oxide (high coercive) paper and plastic base. All types are standard ¼ in. wide 1200-ft. lengths, wound on non-warping tempered aluminum 7-in. diameter metal reels that fit all standard recorders. Finest dimensionally-stable durable kraft paper and pre-stretched cellulose acetate plastic bases are used in their manufacture. A special coating process provides smoother, more even oxide dispersion, which assures lower background noise with smooth and quiet movement past magnetic heads, tape guides, rollers and tensioning devices. The tapes are precision-slit to close tolerances that are well within RMA standards.—**Amplifier Corporation of America, 298-26 Broadway, New York 13, N. Y.**—TELE-TECH

R-F Shift Converter

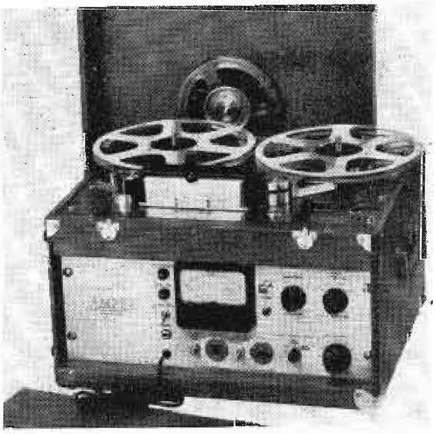
Simplicity of operation, precision tuning, highest quality performance, and small size are distinguishing character-



istics of the type 207 (model 2) r-f shift converter. It is a dual channel unit which converts mark and space tones into dc pulses and drives teleprinters, tape and other recorders directly. Its unique integral 2-in. oscilloscope provides an accurate tuning pattern for precise receiver adjustment during initial setup and while keying. It is capable of keying speeds up to 600 w.p.m.—**Northern Radio Co., Inc., 143 West 22nd St., New York 11, N. Y.**—TELE-TECH

Tape Recorder

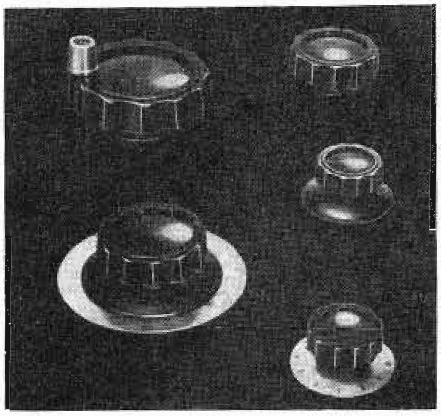
A tape recorder has been developed with a range of 15 KC on half-track tape at 7½-in./sec tape speed. Its per-



formance is said to equal or exceed the operational quality of most other recorders operating at 15-in./sec. on single-track quarter-in. tape. Known as the model 400, it includes simultaneous erase, record and playback and over 132 minutes of program material can be recorded on a single 10-in. standard reel. A built-in VU meter, three magnetic heads shielded in a single housing and a single control switch for fast forward, fast rewind, and record are also featured. At 7½ i.p.s., flutter and wow are less than one quarter of 1%. At 15 i.p.s., flutter and wow are less than one-fifth of 1%. Frequency response is ± 2 db, 50 cps to 15 KC.—**Ampex Electric Corp., San Carlos, Calif.**—TELE-TECH

Dial Knobs

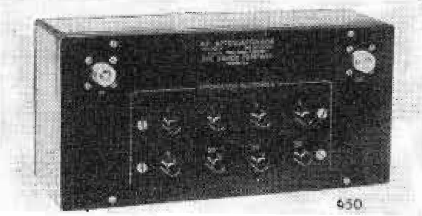
A new series of knobs and dials in many sizes and calibration markings has been developed. Available with or with-



out black phenolic skirts or satin chrome dials they have heavy brass inserts and thick walls for additional strength. The nickel silver dials with stain etched chromium are said to provide much better visibility than conventional spun finish.—**E. F. Johnson Co., Waseca, Minn.**—TELE-TECH

Attenuator

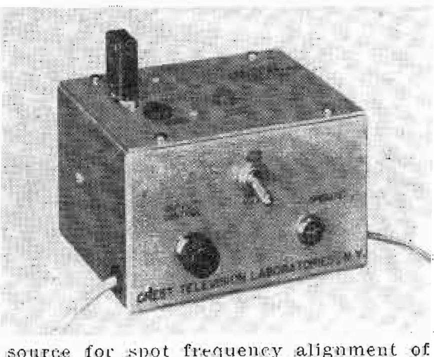
The r-f attenuation network, model 650, is a moderately-priced attenuator, incorporated in an r-f attenuation box.



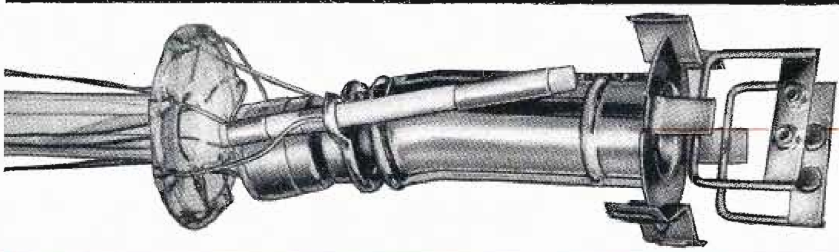
It has numerous applications where attenuation of UHF is desired, since it can be used as an all-purpose laboratory and test instrument. This unit has a flat frequency response from dc to 225 MC. Insertion loss is zero over the entire frenquency range. Resistors are calibrated to an accuracy of ±2%. Impedances of 50 or 73 ohms are standard, and units are available with type N or BNC connectors. Attenuation is inserted in the circuit by means of special push-button type switches, which are mechanically independent of each other. The electrical network is purely resistive, and no compensation is required.—**Daven Co., 191 Central Ave., Newark 4, N. J.**—TELE-TECH

Crystal Oscillator

Model 25 crystal oscillator is a high-output crystal-controlled signal generator suitable as a centralized signal

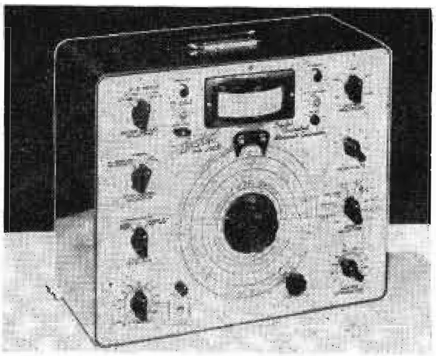


source for spot frequency alignment of television receivers. Compact in size, it provides a convenient and inexpensive means of obtaining multiple frequencies for master distribution of signals. It is available in the new 40 to 50 MC i-f range as well as the 4.5 and 20 to 30 MC range.—**Crest Television Laboratories, 34-11 Far Rockaway Blvd., Far Rockaway, N. Y.**—TELE-TECH



Signal Generator

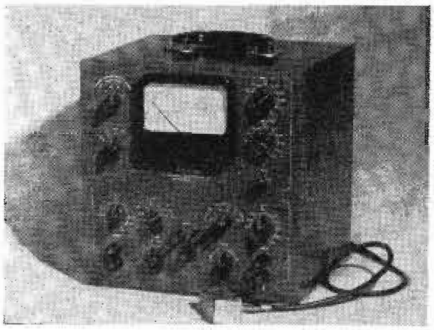
A new microvolt signal generator has been developed which covers all AM, FM, TV and mobile frequencies in 7



ranges. Known as model 292X, it has a double range of 125 KC to 110 MC and 150 to 220 MC, all on fundamentals. Crystal accuracy is available to .0025% for mobile bands of 30-50 MC and 152-162 MC. Temperature compensation, negligible change in frequency due to output, and absolute minimum leakage are featured. The 292X provides accurately-controlled and unmoldulatd output from .2 to 100,000 µv. through a 10 to 1 cast aluminum attenuator. It can also be externally modulated from 15 cps to 10 KC.—**Hickok Electrical Instrument Co., 10606 Dupont Ave., Cleveland 8, Ohio.**—TELE-TECH

Vectorlyzer

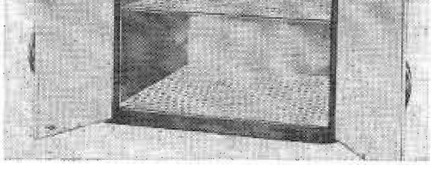
Model 201 Vectorlyzer is based on a new fundamental circuit which permits unusual speed and accuracy for measur-



ing vector relations of alternating voltages. It has a frequency range of 8 cps to 10 MC through panel binding posts and 20 KC to 500 KC through probe. Input impedance of probe is 2.5 µµf shunted by ¼ megohm and dielectric losses. Coaxial arrangements for matching low impedance cables are available. Input impedance of binding posts is 14 µµ f shunted by 100 megohms and dielectric losses. Accuracy is ± 3% through panel binding posts ± 1 db through probe for phase angle measurements.—**Advance Electronics Co., 244 Franklin St., Paterson, N. J.**—TELE-TECH

Portable Oven

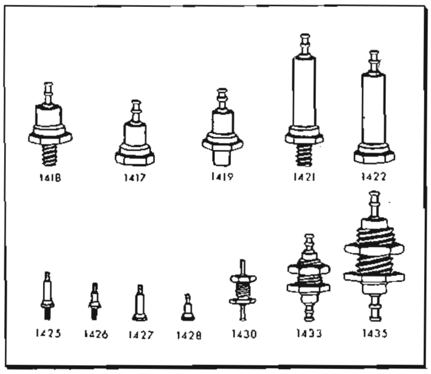
Thoroughly field tested, a new portable electric oven has been found practicable for baking enamels, lacquer, wrinkles and other finishes; for dehydrating bobbins, coil forms, paper tubing; and for preheating molds. Fresh air is drawn in and stale air driven out through vents by means of a fan driven by a motor mounted outside the unit. It is said that no stratification is possible,



and the change of air and forced circulation is advantageous for any dehydration and baking process. Adjustable damper gives wide range of constant temperature. Model CR-1 has single phase 110 v. motor and can be operated from any 110 v. outlet. Dimensions are, 29 in. wide, 24 in. deep, and 20½ in. high. Removable shelf and drip pan are standard equipment.—**Grieve-Henry Co., 1101 North Paulina St., Chicago 22, Ill.**—TELE-TECH

Molded Insulators

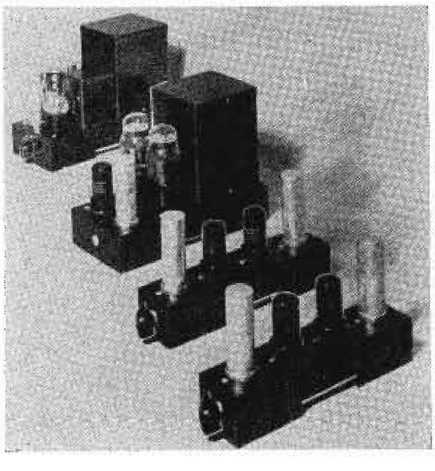
Improved performance at all temperatures and positive holding are features of the new 1400 series of molded insulation miniature terminal lugs, stand-offs



and feed-throughs. Use of the molded construction instead of preformed tubular plastic eliminates internal air gaps which act as moisture traps. In addition, the method provides solid mounting which is maintained under all normal heat and vibration conditions. Stand-off types are available with either molded LTSMG31 melamine or molded type MTS-El phenolic to JAN P14 specifications.—**U. S. Engineering Co., 521 Commercial St., Glendale 3, Calif.**—TELE-TECH

Amplifiers

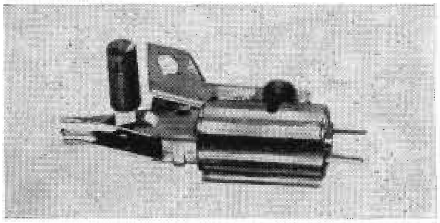
A new line of unitized amplifiers has been designed in the form of block units (modular units) that can be assembled



quickly and simply to form a single, rigid piece of equipment. As a result of the unitized construction, a large variety of assemblies can be constructed with the separate units available. For example, a phono amplifier might consist of a unit equalized preamplifier, a unit power supply and a unit power amplifier. Addition of a unit tone-control chassis providing up to 24 db of bass and treble boost and cut is readily accomplished. For use with a radio or TV tuner, a unit switching chassis can be interposed between the preamplifier and the main amplifier to provide selection of the desired input. All chassis are a standard length and width dimensions are integral multiples of 2⅛ in. Small tie plates lock units together to form a single structure for cabinet or rack mounting. —**ModulaR Audio Corp., 1546 Second Ave., New York 28 N. Y.**—TELE-TECH

Phono Pickup

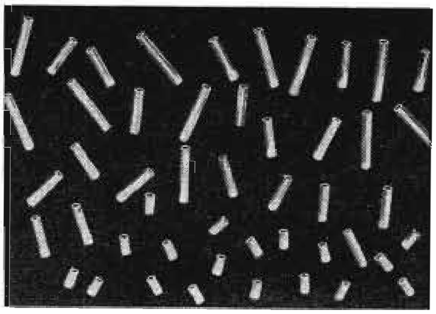
Two additions to the Sonotone line of Titone phonograph pickups have been made recently. The "Playal" can be used



with three types of needles. With a 3-mil sapphire needle, it plays 78 rpm recordings and a 1-mil sapphire needle is used with a 33 1/3 and 45 rpm discs. All three speeds can be played with a 2.3-mil truncated osmium needle. Either a diamond or sapphire needle can be used with the "Turnover" model (illustrated) which plays all three speeds. The "Turnover" design provides two needle points; a 1-mil for 33 1/3 and 45 rpm recordings and a 3-mil for 78 rpm. The point desired can be placed in position by a lever control.—**Sonotone Corp., Elmsford, N. Y.** —TELE-TECH

Insulator Bushings

Molded Nylon and Styron insulator bushings are now available for use by radio and television manufacturers.



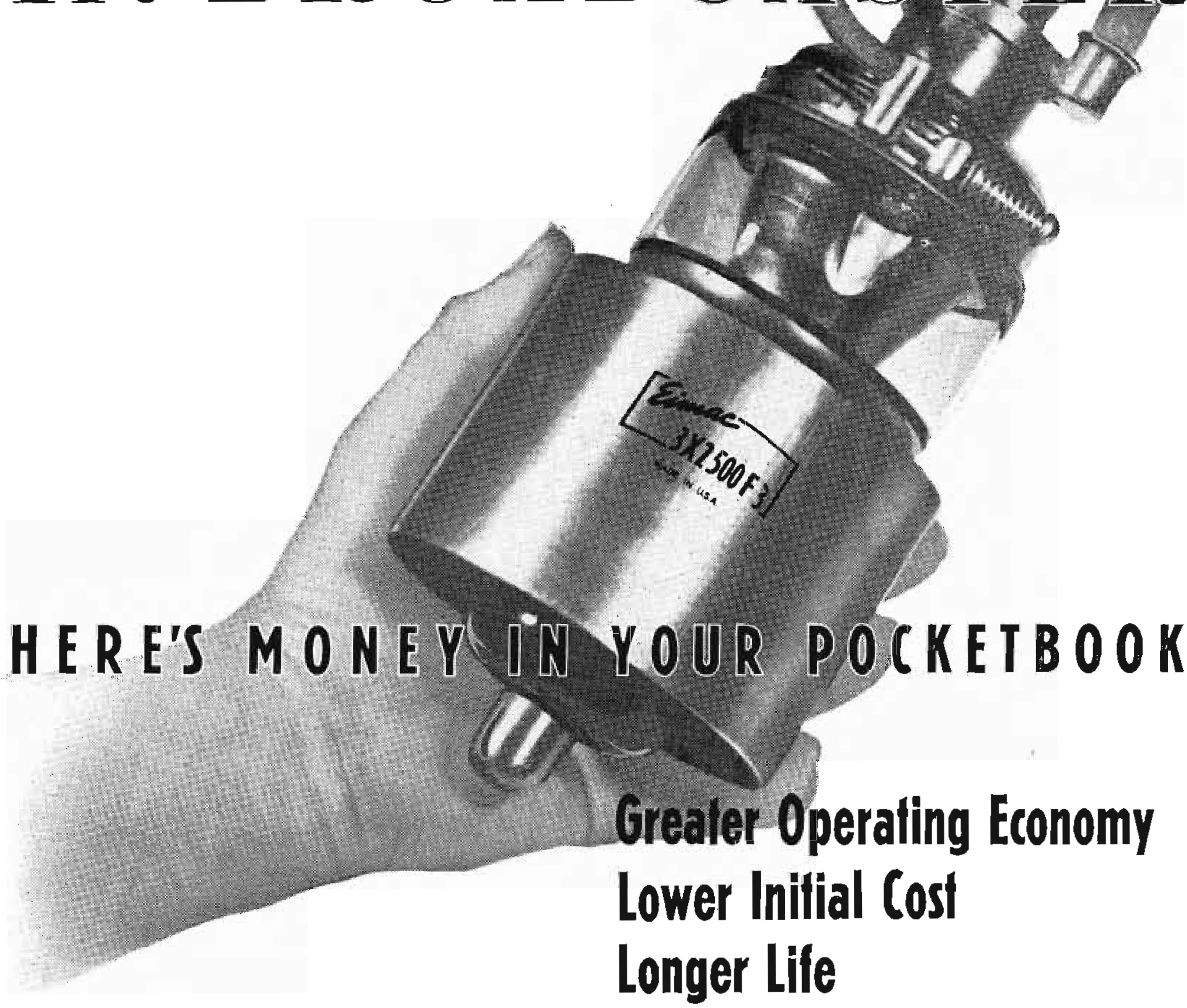
These new bushings are said to offer better insulation, and low moisture absorption. They are easily assembled and will retain their shape. All sizes are accurate and wall thickness is constant. They are available in lengths from ⅛ to 1 3/16 in. by 1/32 in. The overall diameter is .187 to .188 in. and the interior diameter is .126 to .128 in. Other sizes are made to order. Write for samples.—**American Products Co., 1652 North Honore St., Chicago 22, Ill.**—TELE-TECH

Playback Unit

The Audio-Master '51, a portable lightweight and flexible playback unit, plays all three phono speeds and all sizes of

records from 7 to 17½ in. Important component features are the 4-tube high-gain amplifier, the detachable 8-in. loudspeaker with a 10-ft. cord and the Twist crystal cartridge fitted with two permanent needles. Recently a special jack has been implemented into the set for the use of a microphone so that the unit is now equipped with a P.A. system, whose audience capacity is approximately 500 persons. Earphones can be used if desired.—**Audio Master Co., 341 Madison Ave., New York 17, N. Y.**—TELE-TECH

Mr. BROADCASTER



HERE'S MONEY IN YOUR POCKETBOOK

Greater Operating Economy
Lower Initial Cost
Longer Life

You save from every angle when you buy and use transmitters employing Eimac tubes. Saving starts with the initial tube cost . . . you save again every hour you're on the air because of higher tube operating efficiency . . . and you save still further by staying on the air more hours without service shutdown.

Take as an example of Eimac tube economy the rugged 3X2500F3 triode pictured above. Initial cost is $198.00 each, yet as power amplifiers they will provide 5 kw output per tube . . . that's lots of watts per dollar cost. The dependability of this tube and its high frequency version (type 3X2500A3) has been proven over many years by thousands of hours of life in AM, FM, and TV service.

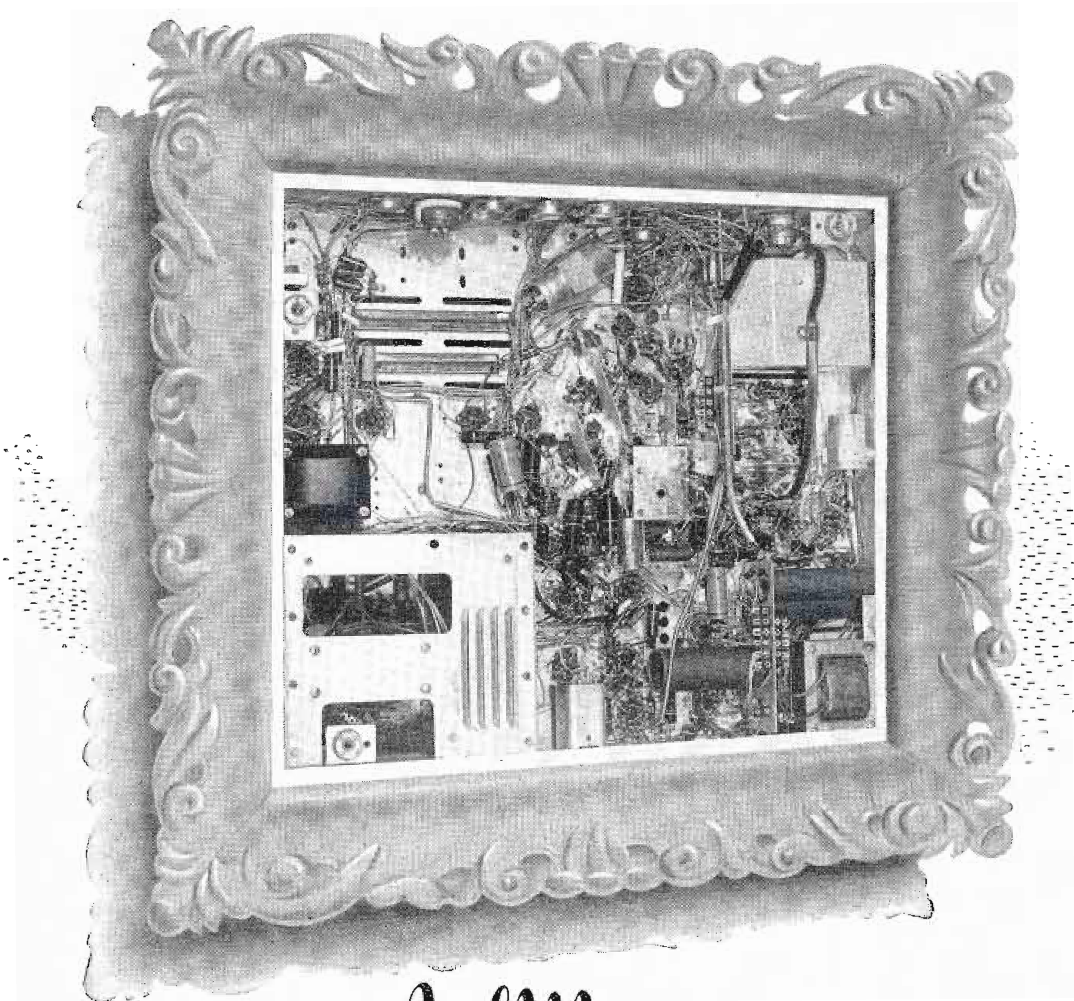
These tubes are the nuclei around which modern transmitter circuits have been developed and built.

Let us send your engineering staff complete data on the 3X2500F3 and other Eimac tubes for broadcast service. A letter to us will bring the material by return mail.

249

EITEL-McCULLOUGH, INC.
San Bruno, California
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

Follow the Leaders to
Eimac
TUBES
The Power for R-F



A Masterpiece

COMPLEX, EFFICIENT . . . KESTER SOLDER MAKES IT POSSIBLE

Good fast work can only be done with the best materials. Kester Plastic Rosin-Core Solder and the more active Kester "Resin-Five" Core Solder, made only from newly mined grade A Tin and Virgin Lead, are formulated especially for TV, radio, and electrical work. Kester Solders flow better . . . handle easier . . . faster to use. These two Solders, which are available in the usual single-core type, can now also be had in a 3-core form.

KESTER SOLDER COMPANY
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Newark, N. J. • Brantford, Canada

KESTER SOLDER

TELE-TECH's NEWSCAST

New FCC-CAA Antenna Rules

The FCC has announced the adoption of a new part 17 of the rules and regulations which deals with, and sets forth the method of selecting, antenna sites. In brief any tower of over 500 ft. in height above the ground, irrespective of where cited, requires special FCC and CAA study before a CP will be issued. If the tower is to be more than 170 ft. above the ground and raises the minimum flying height for any civil airways, a special study will also be required. In general the new rule eases the load on many applicants since it defines conditions in which automatic approval of towers may be obtained without the long and irritating delays so often encountered in the past by applicants trying to get action from both the FCC and the CAA.

CBS Revolving-Drum Color TV Receiver

The Columbia Broadcasting System has demonstrated a new 17-in. color television receiver which produces a picture on a standard rectangular tube. The external dimensions of the receiver are small—about the same size as a console model. The familiar disc has been replaced by a drum which is slightly greater than the length of the rectangular tube in diameter. Thus, set a little distance back from the mask opening of the receiver the color pictures are reproduced as the *nine* color segments of the drum pass successively in front of the tube. By the use of nine color segments instead of six the rotational speed has been reduced to 960 RPM which effects a considerable improvement from the point of view, of noise and mechanical vibration.

By enclosing the kinescope inside a color drum, many of the previous objections to the field sequential color TV system has been overcome since it points the way to enlarging color TV pictures by using larger tubes without increasing the size of the rotating element beyond reasonable limits.

In addition to the presentation of color TV in Philadelphia and New York, CBS has extended its color transmissions by means of the coaxial cable to include Chicago, thus initiating the first network color TV operation in daily use.

Magnetic Core Expands

John C. Webb, president of Magnetic Core Corp., 142 South Highland Ave., Ossining, New York, has announced the completion of the first wing of a new modern iron powder metallurgy plant in New Windsor, N. Y. This corporation has been specializing in magnetic cores for television, radio and communications since taking over the majority of the personnel and most of the equipment of the Ferro-Cart Corp. of America.

The New Windsor plant will specialize in government contracts and sub-contracts. Offices and laboratory are still located in Ossining, N. Y.

Meloy on Electronic Mobilization Committee

Thomas Meloy, president of Melpar, Inc., Alexandria, Va., has been appointed a member of the Munitions Board Electronic Equipment Industries Advisory Committee which represents the radio industry in negotiations on industry output for the military services. Melpar, Inc., has its research laboratories and plant at 452 Swann Ave., Alexandria, Va., where it employs 275 people, of whom 100 are engineers, and also maintains offices at New York and Dayton. The company specializes in research and development work for the Air Force and Navy, and as holder of a large number of prime contracts is now expanding its operations.

TELEVISION ENGINEERS DISCUSS ANTENNA PROBLEMS

Among the prominent television engineers and consultants attending an RCA symposium dealing with antenna problems in Camden, N. J., recently were: Ralph N. Harmon, WRS, Washington; George E. Hagerty, Westinghouse, Washington; Oscar Reed, Jr., of Jansky & Bailey, Washington; E. C. Tracy, RCA manager of broadcast field sales, Camden; Louis H. Stantz, WNBF, Binghamton; George C. Davis, of George C. Davis Consultants, and M. M. Garrison, Chambers & Garrison, both of Washington

Coming Events

March 5-9—American Society for Testing Materials, Spring Meeting and Committee Week, Cincinnati, Ohio.

March 19-22 — IRE Annual Convention, Hotel Waldorf-Astoria and Grand Central Palace, New York City.

April 15-19 — NAB Convention, Hotel Stevens, Chicago.

April 16-18—Joint Meeting of IRE and URSI, IRE Professional Group on Antennas and Wave Propagation, Spring Meeting, National Bureau of Standards, Connecticut and Van Ness Streets, N.W., Washington, D. C.

April 19-20—Armed Forces Communications Association, Fifth Annual Meeting, Drake Hotel, Chicago, Ill.

April 20-21 — Southwestern IRE Conference, Dallas-Fort Worth Section and Student Branch, Southern Methodist Univ., Dallas, Texas.

April 30-May 4 — Society of Motion Picture and Television Engineers, 69th Semi-Annual Convention, Hotel Statler, N. Y.

June 18-20 — American Society for Testing Materials, Annual Meeting, Atlantic City, N. J.

June 25-29 — AIEE Summer General Meeting, Royal York Hotel, Toronto, Canada.

August 29-31 — 7th Annual Pacific Electronic Exhibit, IRE and West Coast Electronic Manufacturers' Assn., Civic Auditorium, San Francisco, Calif.

THESE LIFE LINES OF AMERICA...

use long life dependable Sylvania Tubes

Progressive railroads everywhere are now using Sylvania radio tubes for multiple communications systems.

In engine-caboose-signal-tower networks, where clear tone and unfailing dependability are of utmost importance, Sylvania tubes are winning increased acceptance. These tubes are designed, built and tested to take more than their share of vibration and rough treatment.

Also, their clarity and freedom from internal noises make them ideal for critical transportation applications . . . in trains, buses, police cars, taxi cabs.

The Sylvania quality tube line is a complete line. Made in miniature and standard sizes. Also low-drain battery tubes for efficient, compact portable sets.

Get new listings

Call your distributor for new listings and full information. If he cannot serve all your needs immediately, please be patient. Remember, the tube situation is still tight and your distributor is doing his best to deal fairly with all his customers. For further information address: Sylvania Electric Products Inc., Dept. R-1402, Emporium, Pa. *Sylvania representatives are located in all foreign countries. Names on request.*

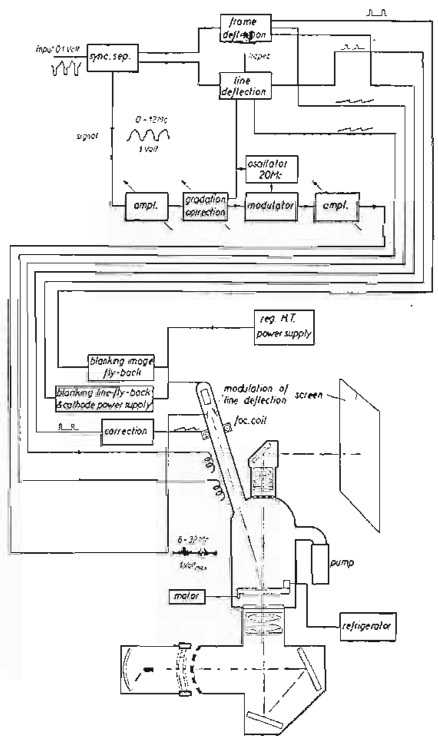
SYLVANIA ELECTRIC

RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS

Swiss System of Large Screen TV

Great interest has recently been shown in the *Eidophor* Theatre Television System which was developed by the late Professor Fischer at the Zurich Polytechnical Institute. Twentieth Century Fox personnel are reported to have visited Zurich to inspect it.

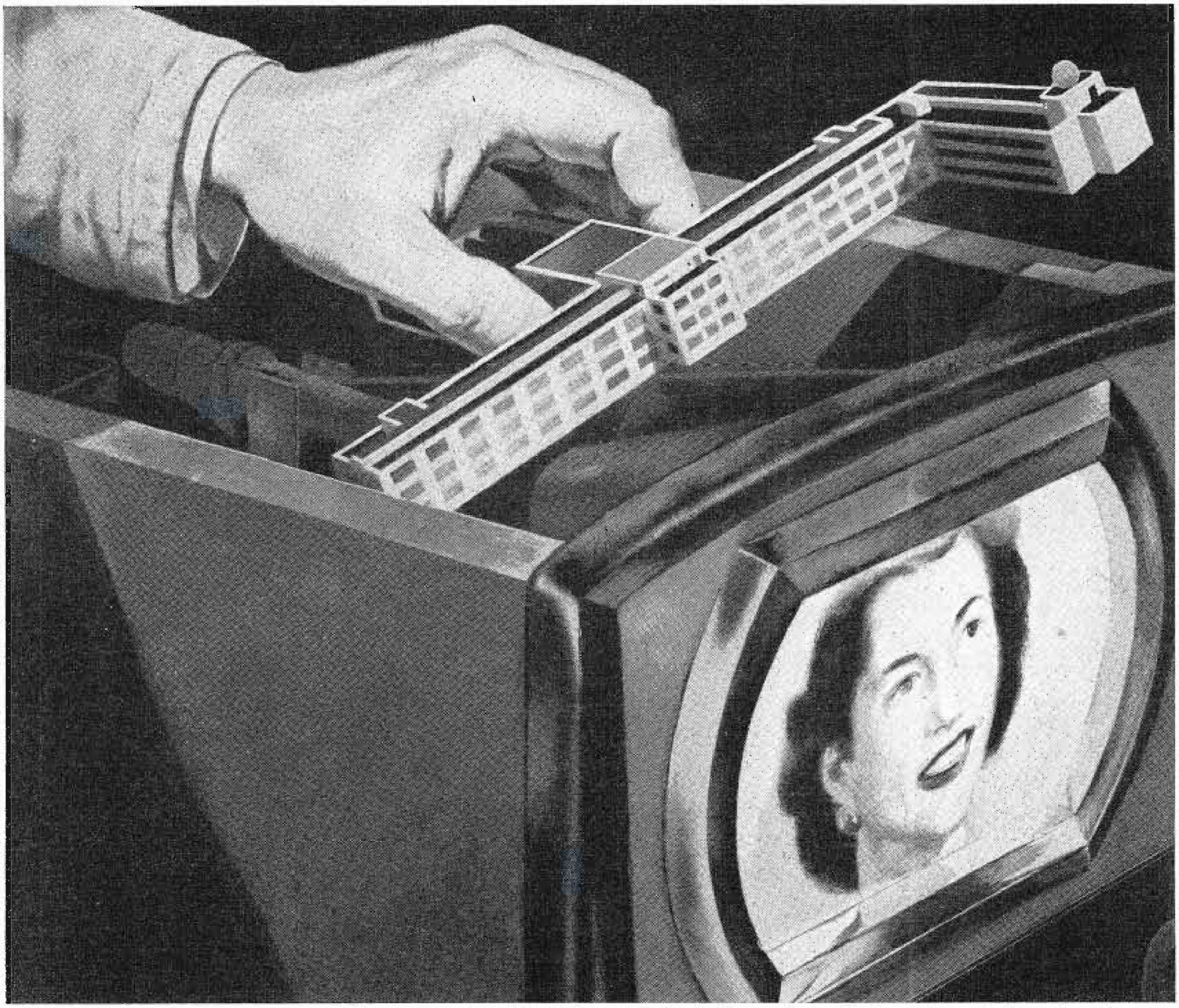
Briefly the system consists of a continuously evacuated cathode ray tube, with an *Eidophor* in place of the normal fluorescent screen. This forms the control element, and consists of a very thin layer of viscous liquid with an oil base deposited on a thin metallic element which is transparent to light. The *Eidophor* surface is deformed by



Simplified diagram showing connections and layout. Reprinted from SMPTE Jour.

the electrostatic charges produced by the action of the scanning beam on it. Since the light travels via a slit system, or *Schlieren Optics* this deformation of the *Eidophor* controls the light flux reaching the screen. Projection light is produced by a standard arc.

It is necessary to cool and renew the *Eidophor* surface periodically to prevent accumulation of electrostatic charges. This necessitates use of a refrigeration unit. Equipment for the original model filled two rooms; however it is understood that later equipment is smaller. This would appear to be a variant of the Supersonic Theater Television System without the revolving prisms which provide the horizontal and vertical scanning, but with added requirements in the form of exhaust pump and refrigerator, etc. Other methods of producing big screen pictures are the Paramount Intermediate Film System and the Skiatron System.



Basic research at RCA Laboratories has led to most of today's all-electronic television advances.

At the heart of every television set!

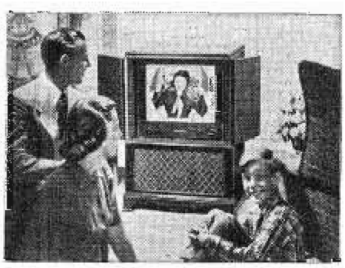
Why show RCA Laboratories *inside* your television receiver? Because almost every advance leading to all-electronic TV was pioneered by the scientists and research men of this institution.

The supersensitive image orthicon television camera was brought to its present perfection at RCA Laboratories. The kinescope, in these laboratories, became the mass-produced electron tube on the face of which you see television pictures. New sound systems, better microphones—even the phosphors which light your TV screen—first reached practical perfection here.

Most important of all, the great bulk of these advances have been made available to the television industry. If you've ever seen a television picture, you've seen RCA Laboratories at work.

* * *

See the latest wonders of radio, television, and electronics at RCA Exhibition Hall, 36 West 49th St., N. Y. Admission is free. Radio Corporation of America, RCA Building, Radio City, New York 20, New York.



Through research from RCA Laboratories, today's RCA Victor television receivers are the finest example of electronic engineering.

RCA

RADIO CORPORATION of AMERICA

World Leader in Radio — First in Television

PERSONNEL

Warren Oestricher, formerly of Western Electric, has been appointed chief engineer of Tele-King Corp. **Jerry Bresson,** formerly of Emerson Radio & Phonograph Corp., has been named assistant chief engineer.

Dr. Harry Stockman has been appointed director of research of the Tobe Deutschmann Corp. in Norwood, Mass. Prior to his present position, he served as consulting engineer to several industrial firms in the Boston area, contributing to the development of new devices and weapons on Government contracts.

Thomas G. Banks, Jr., has been chosen for the newly-created post of director of research and development at Gates Radio Co., Quincy, Ill. He was formerly sales engineering representative for the company's Oklahoma-Kansas territories

Austin Ellmore, formerly director of sales and engineering with Crescent Industries, Inc., Chicago, has just been appointed vice president in charge of sales and engineering for the big speaker, record player, wire recorder and dictation equipment manufactuer.

Robert B. Barnhill has been named manager of mobile radio sales of the Bendix Radio Communications Div. of Bendix Aviation Corp., Baltimore, Md. He has been transferred from the corporation's Chicago offices where he served as district sales manager.

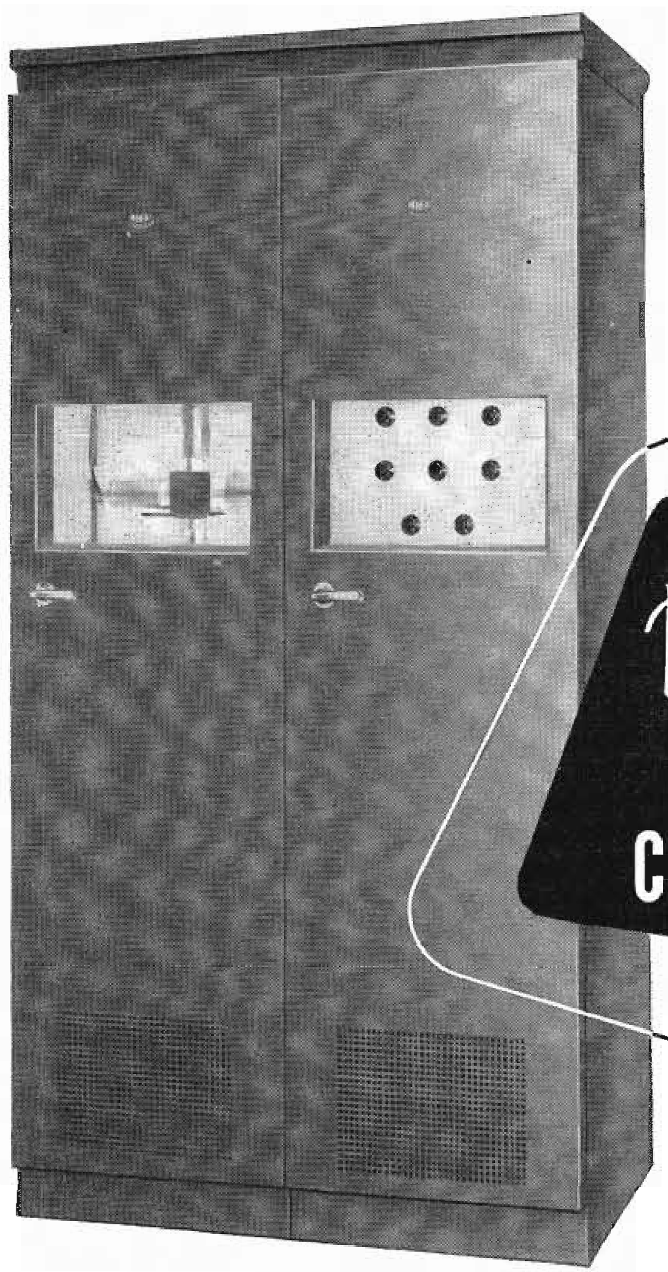
Howard Riordon, formerly vice president and controller of Colonial Radio Corp. has been appointed general manufacturing manager of the Radio and Television Division of Sylvania Electric Products, Inc.

F. C. Cahill, supervisor of the receiver section at Airborne Instruments Laboratory, Mineola, N. Y., has been named supervising engineer of a combined engineering group to be known as the Radar Section. The new group, a combination of the former Receiver and Radar Sections, now comprises about 40 engineers.

James D. Oglesby has been appointed chief engineer and production manager of Tel-O-Mount Electronics, Inc., 236-248 Marshal St., Paterson, N.J., manufacturer of electron-gun mounts for television-tube makers.

Carl Wasmansdorff has been named engineering director of the special apparatus div., Hoffman Radio Corp. Los Angeles. **H. R. Shaw** has assumed the newly-created post of director of television and radio engineering.

Walter Sterling has been appointed development engineer at Cinema Engineering Co., Burbank, Cal.



what about color TV?
what are you doing about it?

Du Mont Announces the UNIVERSAL COLOR SCANNER

A SIGNAL SOURCE FOR ALL TV COLOR SYSTEMS

Operating on the principle of the flying spot scanner, the Du Mont Universal Color Scanner provides for the Broadcaster, Receiver Manufacturer, Development Laboratory – tri-color signals from any 35 mm. 2 x 2" color transparency. Available as outputs are an FCC approved field sequential video color signal and three simultaneous video color signals which may be fed to any external sampling equipment for experimental work with line or dot sequential systems. Horizontal line frequencies may be set at 15.75 or 29.16 kc and vertical field rates at 60 or 144 fields per second (intermediate values may be specified as desired). This assures a flexible equipment embracing both present black and white standards as well as FCC approved color standards and adaptable for use with any of the other presently proposed color systems.

SEND FOR DETAILED TECHNICAL LITERATURE

DUMONT First with the Finest in Television

ALLEN B. DU MONT LABORATORIES, INC. • TELEVISION TRANSMITTER DIVISION, CLIFTON, N. J.

Twin-T Filters

(Continued from page 48)

Referring to Fig. 10, the quantity G (f) is a quantity which is a function of frequency and relates the output voltage to the net applied voltage, E. The net applied voltage, E, is the sum of the applied voltage E_1 and the feedback voltage. The quantity F (f) is a function of frequency and expresses the relation between the feedback voltage and the output voltage from which it originates.

The relationship between E_o and E_1 is given by

$$E_o = E_1 \frac{G(f)}{1 - F(f)\,G(f)} \quad \ldots\ldots\ldots\ldots (21)$$

For the case where the magnitude of F (f) G (f) is considerably greater than 1, the output is approximately

$$E_o = E_1(1/F(f)) \quad \ldots\ldots\ldots\ldots (22)$$

while for the case where its magnitude is small compared to 1, the output is approximately

$$E_o = E_1\,G(f) \quad \ldots\ldots\ldots\ldots (23)$$

In Fig. 8 G (f) is the product of the gain of the first stage and the filter characteristic. A negative sign is added to account for phase reversal between the plate and grid. The gain of the second stage and the setting of R_5 enter into the value of F (f). For simplicity it will be assumed that the amplifiers are flat over the frequency range of interest. The equation for output can be rewritten as

$$E_o = \frac{E_1}{F(f)}\left(\frac{1}{1 + 1/F(f)\,G(f)}\right) \quad \ldots\ldots\ldots\ldots (24)$$

from which it can be seen that if F (f) is constant, as inferred by assumptions made, the frequency response is a function of the loop gain F (f) G (f). See Fig. 7.

In Fig. 9, the forward transfer function, G (f), is a constant equal to minus the gain of the tube if we assume the amplifier to be flat over the range of interest. The feedback transfer function is the product of the filter characteristic and attenuation due to R_5. As for the rejection filter discussed above the frequency characteristic is a function of loop gain F (f) G (f).

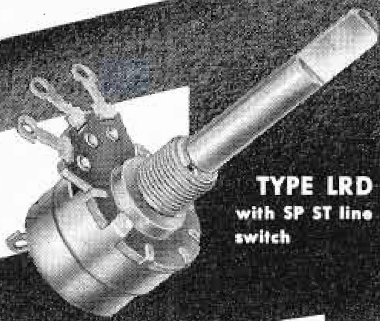
It is important to note in connection with any of the feedback circuits discussed that if the filter is detuned slightly in such a manner that the locus of the vector plot of E_o/E_1 for the filter includes the origin, an oscillation at "near rejection frequency" may be set up since posi-

(Continued on page 71)

Space and Cost Savers...

TYPE LR
without line switch

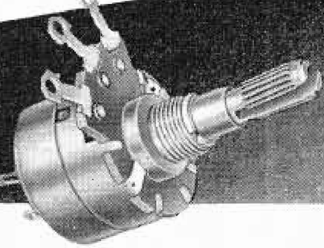
Only 57/64" in diameter...



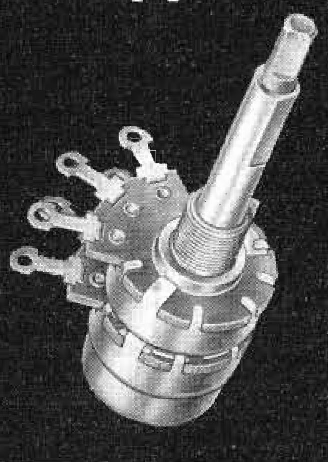
TYPE LRD
with SP ST line switch

CONSERVATIVELY RATED .5 WATT

TYPE LRA-10
with DP ST line switch



DUAL CONCENTRICS FOR TV



These sturdy little Stackpole LR type controls handle higher wattages more dependably than most controls that are a good bit larger in size. Less than an inch in diameter, they're conservatively rated at .5 watt for use where voltage across the units does not exceed 350 volts for linear tapers, or for non-linear ones having a taper of no less than 10% of the total resistance at 50% rotation, provided that 225 volts is not exceeded. Thus there is plenty of wattage capacity for a wide variety of present day uses including many television applications. Stackpole LP type controls, slightly larger, are rated .6 watt at linear taper if 500 volts is not exceeded and also at .6 watt if the resistance is not less than 10% at 50% rotation, provided that 250 volts is not exceeded.

LR controls are available as concentric shaft duals.

Electronic Components Division

STACKPOLE CARBON COMPANY
ST. MARYS, PA.

STACKPOLE

Mobile Communications

(*Continued from page* 39)

termodulation within control so long as attention is also paid to the geographical separation of the stations working in the same area.

Fig. 10 shows the Sensicon receiver intermodulation characteristics. Using a reference level of 0.5 of a microvolt, and a permissible interference beat of 10 microvolts on the desired frequency, as shown by Curve 1, we see that the adjacent channel signal must be at least 80 db above the reference level, before the 10 microvolt interference signal is produced. Note also that, for a 120 db adjacent channel signal an alternate channel signal of 20 db above reference will give the 10 microvolts of interference. On the other hand, a 20 db adjacent channel signal would produce no intermodulation interference because it would not be in the region of non-linear mixing to produce a second harmonic which would beat with the alternate channel station. So long as the adjacent channel signal is held substantially below the 80 db level, the only interference produced by an adjacent channel signal would be that introduced by direct desensitizing, rather than by intermodulation. These curves emphasize the necessity for geographical separation of the opposing station. While the adjacent and alternate channels have been used as illustrations, it is true that any pair of stations spaced in equal frequency steps from the desired station may produce this form of intermodulation. For example, a station 120 Kc removed may intermodulate with a 240 Kc carrier to produce the interfering beat.

Fig. 11 illustrates the approach to sectionalizing in the Sensicon receiver structure. Both servicing and manufacturing problems are simplified by this design. Two r-f decks are shown to the left, and by substituting the proper deck and changing certain coils in the amplifier structure, it is possible to provide with a single set of mechanical parts, a receiver for 25-50 Mc, 72-76 Mc, or 152-160 Mc reception. Two Permakay filters are shown in the background. It is suggested that, while 40 Kc is now bandwidth for the 25-50 Mc band, the time is not far away when 20 Kc bandwidth will be required, and this sectionalizing permits the removal of the 40 Kc filter and the substitution of the 20 Kc filter for operation on the split channel without obsolescense of the equipment. In the 160 Mc band, it is probable that 20 Kc channels will also be used and the substitution of the filter permits the change to the new standards without substantial obsolescence of equipment.

So far, the subject of spurious responses in the receiver have not been mentioned. The Sensicon receiver attenuates all responses, spurious responses and image alike, to 100 db or better.

I wish to acknowledge the work of Henry Magnuski, who directed the Sensicon receiver research program, of James Clark, who constructed several of the experimental prototypes, of Ben Niederman, who developed the specialized Permakay Filter, and of the staff of capable engineers working under Marion Bond, who translated a research prototype into a practical commercial receiver design.

This paper was presented before the West Coast IRE Convention in Long Beach, Calif., Sept. 1950.

Electrical Reactance Growth

Three and five-year service pins were awarded to employees of the Franklinville and Olean plants of the Electrical Reactance Corporation at a banquet held in Olean recently.

In the absence of Charles E. Krampf, president of the corporation, General Manager Tom Conway made the presentations. In his address Mr. Conway pointed out the tremendous growth of the corporation in the last twelve months. He reported that while peak employment at the Franklinville plant never quite reached a total of 750 people, yet in the new Olean plant, after having been in the new building only three months, employment in this plant alone has reached a total of 842, alone has reached 842, with 556 still employed at Franklinville.

NEW TV CAMERA

Designed as part of a new camera chain featuring four basic elements instead of usual six, this new image orthicon camera has its electrical controls on rear panel with turret and focus control on the right side. Awkward reaches to front of camera for aperture changes are eliminated by motor driven iris, remotely controllable. Unit made by General Precision Labs., Pleansantville, N. Y.

THERMIONIC EMISSION CALCULATIONS

(*Continued from page 43*)

This transcendental equation can be interpreted as representing the point of intersection of the two curves

$$y = (2T \log T)/5037 = F(T) \qquad (9)$$

and

$$y = \phi + [1.985 \times 10^{-4} \log (J/A)]T \qquad (10)$$

The first of these equations is a universal function of the temperature. Values of this function have been plotted in Fig 2. The second equation represents a straight line whose intercept at T = 0 is Ø and whose slope is (log J/A)/5037. All that is necessary, therefore, to find the required solution is to construct this straight line and read the value of T at which it intersects the F(T) plot. The necessary straight line is best constructed by calculating one point from equation (10), using an arbitrarily assumed value of T and the known quantities, and connecting this point with the point (T = 0, y = Ø). An example of this construction (for example 1 of Table I) is shown in Fig. 2.

Fig. 3 presents a nomographic solution of Richardson's equation. This nomograph actually consists of two separate alignment charts (one involving A and J and the other Ø and T) so related to each other that the solution of a problem on one chart can be used as an entering point on the other. The connection between the two charts is provided by the "transfer" line at the right of the figure. The use of this nomograph is easily understood from the illustrative problem shown. The transfer line can be extended if necessary.

The nomograph (Fig. 3) permits the easiest and most rapid solution of Richardson's equation for any one of the four variables involved. The accuracy obtained is limited by the size of the scales employed in the figure, and the straight-edge used.

TABLE I
Examples Showing the Insensitivity of the Algebraic Method to the Choice of T_o

Example 1 ϕ = 4.52 volts A = 60 amp/cm²deg² J = 6.0 ma/cm²		Example 2 ϕ = 1.10 volts A = 1 x 10^{-3} amp/cm² deg² J = 1.0 ma/cm²	
T_o	T_1	T_o	T_1
1800	2138		
1900	2137	700	938
2000	2137	800	934
2100	2136	900	933
2200	2136	1000	933
2300	2137	1100	935
2400	2137	1200	937
2500	2138		

The graphical method of Fig. 1 gives more accurate results, but because of the necessity of interpolation for values of Ø and the fact that the ratio (J/A) must be calculated separately, it is not as convenient as the nomograph. Fig. 2 is rather limited in use as it is intended primarily for calculating the temperature when the other variables are given. For this purpose, however, it is more accurate than Fig. 1.

For the highest accuracy, calculations should be made directly from Richardson's equation. If it is desired to calculate the temperature, the simplified algebraic method presented here will result in a saving of time.

Beam Instruments Reorganized

Beam Instruments Corp., located in the Empire State Building, New York City, has reorganized and elected T. Robinson-Cox first vice-president and a director. The company will sell Sterling Cables products and radio apparatus made by the Cossor Co., of England and Canada.

Miniature Pentode

(Continued from page 33)

center tap should be returned to some point in the power supply which is 20 to 50 volts positive with respect to the cathode.

The beneficial effect of this connection is based on the fact that the leakage current through the heater-cathode insulation increases only slightly after a certain value of applied voltage is exceeded (Fig. 9). If no bias is provided, ac heater voltage impressed across the insulation causes a relatively large ac current. If the ac heater voltage is superimposed on a dc bias, it causes only relatively small variations in the total current; i.e., the ac (hum) component will be small. The use of a center-tapped heater transformer with heater bias will reduce the hum on most tubes to a value of 20 microvolts or less referred to the grid of the tube.

Minimum Hum

For amplifier designs in which hum must be kept to an absolute minimum, the cathode resistor should be bypassed in order to minimize hum due to heater-cathode leakage. In addition, the heater supply should be provided with an adjustable ac ground by means of a low-resistance potentiometer across the heater winding. The arm of the potentiometer should be returned to a dc heater bias source. This variable heater ground will permit the capacitive coupling between the heater and the grid to be balanced out. In addition, when the potentiometer is adjusted for minimum hum output, a small hum-bucking signal, either positive or negative, is fed into the grid to oppose any other minor sources of hum in the amplifier. Fig. 10 indicates that when these steps have been taken the median value of hum is less than 4 microvolts.

Whitehead Metal Warehouse

T. M. Bohen, president of Whitehead Metal Products Co., Inc., has announced the removal of the Baltimore metal warehouse to enlarged quarters at 4300 E. Monument St., Baltimore, Maryland.

Ozaroff Heads Fidelity Tube

Benjamin Ozaroff has been named president of the Fidelity Tube Corp., of East Newark, N. J. Mr. Ozaroff, an industrial engineer, was formerly vice-president and general manager of the Benrus Watch Co., which he left, after 20 years, to become division manager of the Elgin American Co., in 1948. He is a 1922 graduate of Cornell.

Tallest TV Antennas

(*Continued from page* 35)

to be used here since the physical size of the elements of a channel 4 Super Gain Antenna would be entirely too heavy for the tower to support at this height.

FM Operations

In addition to the television stations there will also be three FM transmitters located on the top floors of the building. WCBS-FM, WNBC-FM, and WJZ-FM will all mount their FM antennas on the tower which supports the TV antennas. NBC will use a triplexer operation taking advantage of the closeness of the TV ferquency to the FM channel, and the board band width of the superturnstile antenna. WCBS-FM and WJZ-FM may use modifications of super gain antennas, but it is understood that final decisions have not yet been made and the matter is undergoing further study. At press time negotiations were in progress with WATV, Newark, N. J. concerning the possibility of that station becoming a sixth TV tenant.

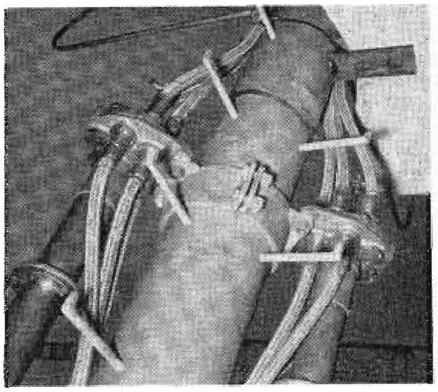


Fig. 7: Junction boxes on channel 4 center pole. Later, outer braid was stripped from the RG/U coaxial cable transmission line

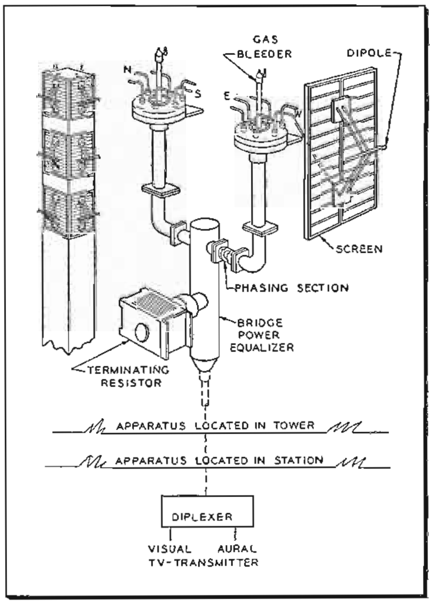


Fig. 8: Diagram of connections and arrangements of parts for phasing and exciting super gain antennas on low band channels.

NEW U-T EXEC

Hank Russell, formerly assistant to Ben Miller, general sales manager of United Transformer Company, 150 Varick St., New York 15, N.Y., has succeeded Mr. Miller as general sales manager of the company upon Mr. Miller's resignation.

Twin-T Filters

(Contnued from page 64)

tive feedback will result[2, 3]. It is also important not to tune the filter so the origin is excluded by too great an amount since if it is the quantity F (f) G (f) can never become small compared to 1 and the circuits will not operate as intended. Both conditions of imperfect tuning become increasingly important as high gain amplifiers and larger amounts of feedback are employed. A small amount of detuning may be advan-

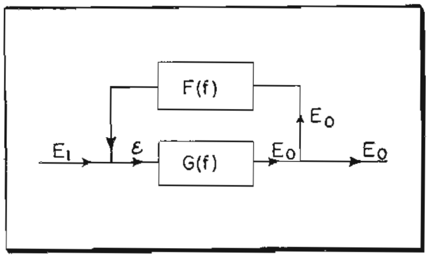


Fig. 10: Basic feedback diagram

tageously used to prevent too sharp a peak in a band pass type filter circuit and the results can be made very similar to those obtained with a tuned L-C circuit[4].

Design Equation

Design equations have been developed and are given in equations (5) and (6), (7), (8) through (11), and (12) through (18) for different conditions which are met in practice.

It should be realized that certain cases of rejection filters may be better met by other formulas, and that formulas for non-rejection filter design have not been given because of their specialized nature. However, the physical picture of the circuits operation as shown in Fig. 2 and discussed in the beginning of this article should aid considerably in reaching an intelligent design regardless of the requirements once they have been set down.

The merits of using appropriate design when the load presents a considerably higher impedance than the source have been shown in Fig. 4 and the possibilities of purposely designing for unsymmetrical frequency characteristics are shown in Fig. 3.

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ALUMINUM-CLAD IRON

(*Continued from page 30*)

and cathode because aluminum may distill over to the oxide cathode surface. For the latter application, a so-called "PN-Iron" was used, which is described below.

The PN-Iron has been used mainly for radiation-cooled anodes in small oxide cathode tubes. It consists of an iron core with aluminum covering on the side facing the outside and nickel cladding on the side facing the cathode, (Table III).

PN-Iron is manufactured as follows: Iron ribbon 20 mm thick, 250 mm wide and one (1) meter long of the same composition as specified for P2-Iron (Table II) and Mn-free nickel ribbon are laid on top of each other (well cleaned surfaces). This assembly is encased in a thin iron foil to prevent oxidation followed by heating to 1000°C in an electric oven. Then the assembly is hot rolled to 2.5 mm thickness using 7 to 9 passes. As a next step, the iron foil is removed by pickling. Thereafter aluminum is rolled on the remaining iron surface in the manner described in Table II. During the war, the Middle-European production of PN-material amounted to about 3 to 5 tons per month compared with 10 to 20 tons per month for P2-sheet.

For the sake of completeness, it may be mentioned that the Ni-shortage in Europe shortly after World War II caused a replacement of the Ni-cladding in PN-Iron by still other metals. The new material was named Pl-Iron and appeared in two forms, see Table III.

It may be interesting to note that the blackening effect of Fe and Al may be also produced by vacuum evaporation of Al on Iron. Other metal combinations give a similar effect; e.g.: Ni and Al, Mo and Al, etc., notwithstanding the fact that the combination of Fe and Al is very favorable, not only technically, but also economically.

It has been estimated that the Middle-European Electron Tube industry, during the years 1936 to 1944, saved about 500 tons of nickel by the use of P2-Iron. This quantity corresponds to about 250 million radio receiving tubes. In many cases it was possible to manufacture the vacuum tube at a considerable saving because of cheaper raw material costs, less expensive "Carbonizing" process, and shorter degassing and processing time. In other tubes a size reduction was possible due to the 85% radiation coefficient (black body 100%) compared with an optimum radiation coefficient of 75% for well-carbonized nickel.

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7. W. Espe & M. Knoll, Werkstoffkunde der Hochvakuumtechnik (book), Springer Berlin (1936), reprinted by Edwards Bros. Ann Arbor, Mich. (1944).
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9. Aluminum was used as reducing agent for iron (original C-content in iron less than 0.09%). The end product showed about 0.05% Al. This iron material substantially gas free was sold under the name of "E-Iron" and "EA-Iron" respectively, when specially selected for anodes (C-content 0.05% in form of spheriodized cementite). This iron became obsolete with the advent of P2-iron.

New Westinghouse Plants

The new electronic-tube division of the Westinghouse Co. is planning three new plants. Entering primarily into defense manufacturing, they will later produce transmitting, receiving, TV picture, and X-ray tubes. Sites are now being studied. The new division will be headed by E. W. Ritter with headquarters at Bloomfield, N. J.

LETTERS . . .

Jamming Foreign Broadcasts

Editors, TELE-TECH:

I have read with interest your suggestion of using both AM & FM channels for binaural transmission, published in TELE-TECH of Sept. 1950. I think this is a good idea worth trying.

Another suggestion, however, does not appeal to me at all—using very powerful UHF transmitters to cross-modulate broadcast receivers in Russia. This idea is not practical, to say the least, because of following reasons:

1. Very limited range of UHF transmitters, regardless of power, and enormous distances of Russia, hundreds of miles between major cities.
2. An enormous field strength will be necessary. There are several high power VHF (television) transmitters in New York proper, and they do not cross-modulate broadcast receivers in New York.

An effective answer to Russian jamming of the Voice of America could be the old and reliable method, used years and years ago, and proven excellent during the World War II by the anti-Nazi underground in European countries. That is the transmission of modulation sidebands with suppressed carrier, using the wavelength of a local station, to which most people listen. The restoration of the missing carrier occurs in the receiver itself. The interfering station does not radiate energy while not modulating, therefore its location cannot be easily discovered. Next, only very limited power is needed for quite strong interference, that can drown out the station modulation. The underground used to comment on Hitler's speeches during the speeches, using the wavelengths of German transmitters. There are many very powerful broadcast and long wave stations in Europe that do not have 24-hour service. They could be used, with consent of the respective governments, of course, for that kind of interference. And if new stations were necessary, their cost and performance will surely out-class any UHF cross-modulation.

A. APLECAIS,
Elizabeth, N. J.

Binaural Broadcasting

Editors, TELE-TECH:

In the September issue of TELE-TECH, a suggestion was made for binaural broadcasting using combined AM and FM standard facilities.

Washington's Good Music Stations WQQW and WQQW-FM in cooperation with the U. S. Recording Company, made an experimental binaural broadcast of the Washington National Symphony Orchestra conducted by Howard Mitchell on March 30, 1950. The program material was symphonic-classical and ideally suited to listening tests.

The methods used for the broadcast were as follows: Two identical Western Electric microphones were adjusted for cardioid pattern and were placed about 20 feet apart 15 feet in front of the first rows of the concert orchestra. It was felt that a binaural demonstration involving loudspeakers would be more an amplitude than a phase phenomenon, hence the wide microphone separation. The microphones were fed through identical (Western Electric) line amplifiers and identical equalized 15 Kc to a large studio set up for the demonstration and to the WQQW control. In the studio, two sound channels were provided consisting of McIntosh amplifiers and Pickering Speakers. A switching system was devised so that: (1) Either or both speakers would be fed from an AM tuner, (2) Either or both speakers could be fed from an FM tuner, (3) The speakers could be fed binaurally from the outputs of the FM and AM runners (4) The Speakers could be fed binaurally from direct line bridging, and (5) Headsets could be fed in the above combinations.

From the control room to the transmitters the channels were made alike, necessarily with frequency responses of 30 to 8.5 KC. The lines between studios and transmitters did not follow the same route, were provided with telephone company amplifiers which were not alike. It was believed that some linear phase problems would result from these facts. Apparently the 10% difference in line length of 10 miles was not enough to introduce noticeable phase problems.

The audience consisted of about a dozen members of the Washington Audio Society, each one an experienced electronics engineer, and each one actively concerned with various phases of high fidelity. The unanimous opinion of the witnesses was that the binaural reproduction on both speakers and headsets was vastly superior to either monaural channel, that the binaural advantages were not lost in being broadcast, and that 8.5 KC binaural air reception was superior to 15 KC monaural direct line feed.

When the speakers were placed about 10 feet apart the spatial distribution of the orchestra sections was immediately apparent. A sense of depth was noticed, especially during a tap dance with castanets where the dancers moved freely about the stage.

While considerable planning and thought went into the experiment it was not handled in as detailed a manner as the problem warrants. The aims of the broadcast were to demonstrate that the binaural effect transmitted over 8.5 KC channels is superior to 15 KC monaural reception.

It is expected that another binaural broadcast will be made in a more careful manner, where more useful audience response data will be collected and evaluated. A 21/2 channel system (with a center microphone—and speaker—common to both channels) will probably be used to provide better monaural listening than is otherwise possible and to reinforce the center response of the binaural system. Two Klipsch corner speakers will be used, and more accurate system response data will be taken.

ROBERT B. MARTIN, *Chief Engineer, WQQW, Washington, D. C.*
H. P. MEISINGER, *Chief Engineer, U. S. Recording Co.*

Du Mont Defense Facilities

The Allen B. Du Mont Laboratories Inc., 750 Bloomfield Ave., Clifton, N. J., announces availability of a new booklet describing its research, engineering and production facilities for national defense. The 28-page booklet may be obtained free of charge by addressing the Industrial Preparedness Representative who is located at the Allwood Plant in Clifton, N. J.

NYU Offers Color-TV Course

A college course in color-television will be offered by New York University's adult section, with classes beginning Feb. 6.

A non-technical course, "Color Television" will be directed by John H. Battison, associate editor of TELE-TECH magazine with sessions on Tuesday evenings from 6:15 to 8 at the University's Washington Square Center.

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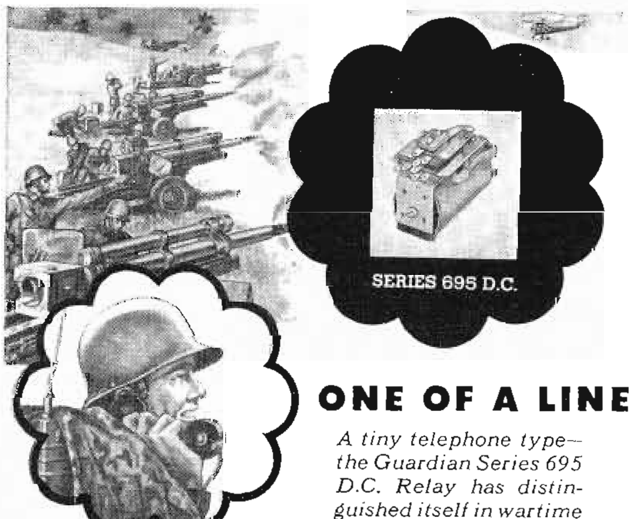

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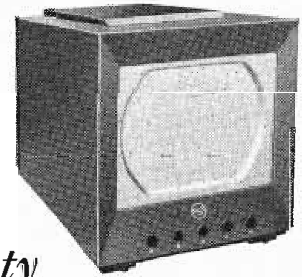

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In Canada: RCA VICTOR Company Limited, Montreal

BOOKS

"Father of Radio"

Autobiography of Lee de Forest, Published by Wilcox & Follett Co., 1255 S. Wabash Ave., Chicago 5, Ill. 502 pages. Price $5.

Writing with remarkable literary skill, Dr. de Forest tells interestingly of his boyhood and origins, his inventions, his patent struggles, and his romances and marriages. His life has so touched every phase of radio and television development, beginning with the very foundation of the three-element tube itself, that this book is not only a fascinating human biography but a reference volume of dates and eras in the development of today's multi-billion-dollar electronic industries.

Dr. de Forest's many historic "firsts" commend the admiration of those who have come after him:

1. First wireless transmission overland—1904.
2. First wireless telegraph between moving trains and fixed stations—1905.
3. First three-electrode vacuum tube—1906.
4. First broadcast—1907.
5. First transmission of voices without wires—1907.
6. First use of radio knife in surgery—1907.
7. First broadcast of Grand Opera—1910.
8. First successful telephone amplifier—1912.
9. First feed-back, or oscillator, circuit—1912.
10. First use of oscillating tube in broadcasting—1915.
11. First electronic musical instrument—1915.
12. First electromagnetic phonograph pickup—1916.
13. First transmission of voice by radiotelephone from airplane in flight—1916.
14. First theatrical presentation of sound-on-film talking motion pictures—1923.

Movies for TV

By John H. Battison. Published 1950 by Macmillan Co., 60 Fifth Ave., New York City. Price, $4.25; 376 pages.

Long needed in the television field, this book explains in terms which are equally valuable to the engineer and producer the functioning of various equipments used in making and telecasting motion pictures. The first part deals with the operation of most types of movie cameras and television projectors; sound recording; film recording; color films and color television, and the construction and execution of many special effects. Among the latter are examples of wipes, fades, moving, still and background titles. A discussion of film characteristics advisable for telecasting completes the first section.

Part two covers the filming of newsreels, productions for television, and the use of scale models to provide authentic scenic effects. Notes are included on location shooting and legal and copyright points to watch when handling films for television.

This is the first book to be written dealing specifically with the application of motion pictures to television, and for this reason is strongly recommended reading for all personnel employed in any branch of television or radio. It should appeal to non-technical as well as technical readers since production and programming aspects are covered. It is eminently suitable for use as a text-book or reference volume in every branch of television from agency to engineer.

Dunlap's Radio and Television Almanac

By Orrin E. Dunlap, Jr. Published by Harper & Brothers, 49 E. 33rd Street, New York. 1951. Price $4. 209 pages.

Since 1920 the author has been compiling facts, dates and biographical notes in connection with the development of radio and TV. Now presented in book form, this Almanac covers not only technical developments but the history-making events in such fields as international affairs, national politics, sports, aviation, the arts, for which radio and television have served as prime channels of public information. The almanac includes also a record of the officials, past and present, of the various radio and television trade associations, institutes and commissions. A detailed index of names and subjects provides complete cross reference to the chronological history.

Illustrations include over sixty "then and now" photographs dramatizing the progress of radio and television.

The author, for many years radio editor of *The New York Times*, is a Senior Member IRE and is vice president of the Radio Corporation of America.

BOOKS RECEIVED

Television (Vol. V, VI)

Edited by Alfred N. Goldsmith, et al. Published 1950 by Radio Corporation of America, Technical Book Series, Price $2.50 each. Over 400 pages each. Volume 5 covers the years 1947-48 and includes reviews of television equipment and circuits written up in various issues of the RCA Review. Volume 6 covers the years 1949-50 and includes additional information of color TV and UHF propagation.

Travelling Wave Tubes

By J. R. Pierce. Published 1950 by D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N. Y. Price $4.50, 260 pages. This is a practical account of the most important functions and operations of travelling wave tubes. Good balance is maintained between principles and practical details. All aspects of circuitry and theory are covered.

Antennas

By John D. Kraus. Published 1950 by McGraw-Hill Book Co., 330 West 42 St., New York 18, N. Y. 553 pages. Price $8.00. This long overdue book deals clearly with all aspects of antenna fundamentals and advnced operation and technics.

Survey of Modern Electronics

By Paul G. Andres. Published 1950 by John Wiley & Sons, Inc., 440 Fourth Ave., New York City. 522 pages. Price, $5.75. Fundamentals of electronics and a summary of applications are presented. Electrical engineering concepts are reviewed in many cases before the presentation of electronic devices and circuits on which they are based.

The Parry Cathamplifier

By C. A. Parry. Published 1950 by Mingay Publishing Co., 146 Foveaux Street, Sydney, New South Wales. Price, two shillings; 24 pages. This is the book of a new type of amplifier. It describes a number of low and high power amplifiers which operate with amazing low distortion and uses, cathode forms of coupling. Should be of interest to audio engineers.

MILITARY CONTRACT AWARDS

Manufacturers who have received contract awards for producing of radio - radar - electronic equipment for the Armed Services are listed below by name, city, equipment and amount of contract. Subcontractors interested in bidding on performance of any part of each contract should sell their services to these prime contractors. This list, which is current up to our press time, covers the period from November 29 to December 28.

Tubes, Electron

Amperex Electronic Corp., 79 Washington St., Brooklyn, N. Y., $412,500; Bomac Laboratories, Inc., 96 Park St., $356,500; Chatham Electronic Corp., 475 Washington St., Newark, N. J., $251,400; Continental Electric Co., 334 Ferry St., Newark 5, N. J., $147,000; Allen B. DuMont Laboratories, Inc., Clifton, N. J., $36,800; Robert Dollar Co., 947 Broadway, Redwood City, Calif., $29,250.

Electronic Products Co., 111 East 3rd St., Mount Vernon, N. Y., $45,000; General Electric Co., Schenectady, N. Y., $580,300; Kuthe Laboratories, Inc., 150 Summit St., Newark 4, N. J., $291,800; Radio Corporation of America, Harrison, N. J., $94,275; Raytheon Manufacturing Co., 138 River St., Boston 10, Mass., $1,329,119; Sperry Gyroscope Div., Great Neck, N. Y., $193,800; Sylvania Electric Products Inc., $650,700; Tung-Sol Lamp Works, Inc., 95 Eighth Ave., Newark 4, N. J., $27,000; Westinghouse Electric Corp., MacArthur Ave., Bloomfield, N. J., $32,700.

Other Equipment and Components

Altec Lansing Corp., 9356 Santa Monica Blvd., Beverly Hills, Calif.; Power Transformers, $33,600; Collins Radio Co., 855 35th St., NE, Cedar Rapids, Iowa, Radio Receiver, Transmitter, $102,622; Connecticut Telephone & Electric Corp., Meriden, Conn., Telephone, Central Centers, $1,200,000; Cincinnati Electronics Co., Cincinnati, Ohio, Radio receiver, & mounting, $39,403.

Allen B. Du Mont Labs., Clifton, N. J., CR Oscillographs, $47,328; Eclipse Pioneer Division, Bendix Aviation Corp., Teterboro, N. J., Transmitter, for aircraft F9F-2/3, $38,840; Hugh H. Eby, Inc., 18 West Chelton Ave., Sockets, $43,430; Federal Telephone & Radio Corp., Clifton, N. J., Transformer Rectifiers, cl-03c, $48,894; General Electric Co., Schenectady, N. Y., Electric tachometer, indicator, $63,141, Capacitors, $46,616.

Harvey - Wells Electronics, Inc., Southbridge, Mass., Signal generators, $209,450; Hammerlund, Mfg. Co., Inc., 460 W. 34th St., New York 1, N. Y., Radio Receivers, $150,000; The Hallicrafters Co., 5th & Kostner Ave., Chicago 24, Ill., Radio Set, $3,491,530; Leach Relay Co., Los Angeles, Calif., Relays, $39,612,

BULLETINS

Relays

Important new information on Potter & Brumfield relays, shaded pole motors, and timers is now availaole in new 24-page catalog No. 109. Write to Potter & Brumfield, 221 North Main St., Princeton, Ind.

Oscilloscope Camera

Fairchild Camera and Instrument Corp., has published a booklet containing a transcript of an address on the use and operation of the Polaroid-land camera for oscilloscope recording. Coples may be obtained by writing to W. J. Schubert, Fairchild Camera and Instrument Corp., 88-06 Van Wyck Blvd., Jamaica 1, N. Y.

Flexible Shafts

A new 12 page booklet, Bulletin 5008, outlining the basic principles of flexible shaft selection and application, has been issued by the S. S. White Co., 10 East 40th St., New York 16, N. Y. It includes the latest developments in flexible shafting and is illustrated with drawings, photographs and tables showing construction details and performance data of both power drive and remote control types.

Connectors

Buchanan Electrical Products Corp., 1290 Central Ave., Hillside, N. J. has published a bulletin on the company's improved "pres-SURE-connectors" for electrical wiring.

NEW RAYTHEON EXEC

Captain David R. Hull, USN (Ret), who joined the Raytheon Manufacturing Co., Waltham, Mass., in May 1949, has been elected vice president and manager of the Equipment Divisions. During World War II Captain Hull served as Asst. Director, Naval Research Labs. and in the Bureau of Ships as Chief, Electronics Design Branch; Deputy for Electronics; Asst. Chief of the Bureau for Electronics. For his services he was awarded the Legion of Merit and the Navy Commendation Ribbon. Prior to World War II he was well known for his work in underwater sound, VHF radio-telephone and radar development.

RADIO-TV STOCK

Price Ranges of 115 Radio-TV & Communications

Statistical Information Compiled by

Stock Exchange	Company	1945-1949 Price Range High	1945-1949 Price Range Low	1950 Price Range High	1950 Price Range Low	Current Price 1/3/51	Dividends Paid 1950 $ per share	Yield %
U	Acme Electric Corp.	—	—	5½	3	4¾	0.32½	6.8
NYCE	Acme Wire Co.	36	19½	31	21	29½	3.50	11.9
U	Adams & Westlake Co.	—	—	14	11	14	*	—
NYSE	Admiral Corp.	19¼a	3a	39¼	17¼	24	1.00	4.2
U	Aerovox Corp.	7⅞a	3¾a	12¼a	4 3/16a	8⅜	0.40a	4.8
U	Aircraft Radio Corp.	—	—	6⅜	3⅝	6⅜	0.60	9.4
NYSE	Allegheny Ludlum Steel	61⅛	17⅛	47¼	21⅛	45¾	2.50	5.5
U	Alliance Mfg. Co.	—	—	16½	9	16	*	—
U	Allied Electric Products, Inc.	—	—	5¾	3	5	0.20	4.0
NYSE	American Broadcasting Co.	10½	5½	14¼	7⅞	10⅞	*	—
U	American Lava Corp.	—	—	78	70	75	*	—
U	American Phenolic Corp.	12⅝	2⅞	10⅜	6⅛	9¼	0.70	7.6
NYSE	American Tel. & Tel. Co.	200¼	138	161¾	146¼	151⅞	9.00	5.9
U	American Transformer Co.	9½	2	3	2	3	*	—
NYSE	Anaconda Wire & Cable Co.	45¼	19⅛	38¾	27¾	37½	3.50	9.3
NYSE	Arvin Industries Inc.	18¼a	10⅜a	30⅝a	17⅛a	24¼	1.66⅔a	6.9
U	Automatic Radio Mfg. Co., Inc.	—	—	1½	⅝	1¾	*	—
NYSE	Avco Mfg. Corp.	14⅜	4½	9⅛	5¾	7¾	0.50	6.5
MWSE	Belden Mfg. Co.	27	11	22¼	11¾	18	1.80	10.0
NYSE	Bendix Aviation Corp.	63	26	53½	34½	53⅝	5.00	9.3
NYSE	Blaw-Knox Co.	30⅞	10⅞	19⅜	13⅝	19	1.25	6.6
NYCE	Breeze Corp.	31½	3¾	11⅞	5	11½	1.00	8.7
U	Capitol Records Inc.	29⅜	3⅛	7⅝	3	6⅜	0.12½	2.0
U	Chicago Molded Products Corp.	12½	5	9	5	13	1.05	8.1
NYCE	Clarostat Mfg. Co.	6	1¾	6⅛	2¼	5⅜	0.16	3.0
NYCE	Claude-Neon, Inc.	9	1⅛	7⅛	1⅞	4⅞	*	—
U	Collins Radio Co.	20⅛	4	16	4½	15⅞	0.50	3.1
NYSE	Columbia Broadcast. System "B"	50	16⅝	40	25	28½	1.60	5.6
NYSE	Cornell-Dubilier Electric Co.	27⅞	7	17¼	10⅝	15¾	0.95	6.0
NYSE	Corning Glass Works	39⅞	18	45¼	28⅞	40½	2.00	4.9
NYSE	Davega Stores Corp. (NY)	34	11¼	19½	13⅛	14¾	2.10	14.2
NYSE	Decca Records, Inc.	37⅝	4⅝	10	6⅛	8⅛	0.50	6.2
NYCE	Driver Harris Co.	66	23	36¼	24½	36⅛	2.25	6.2
U	Dumont Electric Corp.	—	—	3½	1⅛	2¼	*	—
NYCE	Allen B. DuMont, Labs.	16¼	4½	21⅝	13⅛	15½	1.00	6.5
U	Durez Plastic & Chemicals, Inc.	22	8⅜	16⅝	13	15⅝	1.00	6.4
NYSE	Emerson Radio & Phonograph Co.	10⅞a	6⅛a	20¼a	12⅛a	13¼	0.73a	5.5
U	Espey Mfg. Inc.	—	—	2	1½	2	*	—
NYCE	Fairchild Camera & Inst. Co.	29	7⅛	30½	20	24	0.75	3.1
NYCE	Fairchild Eng. & Airplane Co.	8⅜	2	9	4⅞	8¾	0.60	6.9
U	Gabriel Co.	15⅝a	4⅛a	9⅛a	5¼a	8⅜	0.55	6.6
U	General Aniline & Film Corp.	148	57½	86	63	77¾	1.00	1.3
NYSE	General Bronze Corp.	23⅜a	7⅞a	20⅜a	11¼a	17	1.50	8.8
NYSE	General Electric Co.	52	31¾	50½	41⅛	49⅝	3.80	7.7
U	General Industries Co.	18¼	5	14	6¼	11⅛	1.60	14.4
NYSE	General Instrument Corp.	19	4⅝	13½	8¼	10	0.40	4.0
NYSE	General Precision Equip. Corp.	40½	11⅞	21⅜	12⅛	20	1.00	5.0
NYCE	Globe-Union, Inc.	13¼a	6¼a	25⅜	11	24¾	1.90	7.7
MWSE	Hallicrafters	9¼	2⅜	13¼	5¼	7⅝	0.15	2.0
NYCE	Hazeltine Corp.	26½	10	24½	16	25¼	1.75	6.9
U	Hoffman Radio Corp.	13¾a	1¼a	17¼a	7⅛a	10⅞	0.79⅙a	7.3
U	Hytron Radio & Elec. Corp.	5¾a	⅝a	7½	3¼	6½	0.50	7.7
U	International Resistance Co.	3⅛	½	6	2⅛	5⅛	0.30	5.8
NYSE	International Tel. & Tel. Corp.	33	7½	16	9¼	14⅛	—	—
U	Jefferson Electric Co.	53½	10¼	23¾	16½	22½	2.00	8.9
MWSE	Kellogg Switchb'd & Supply Co.	15½	6½	19	11¼	15½	0.90	5.8
U	Lear Inc.	8½	1⅛	4⅝	1 13/16	5	*	—
NYSE	Libbey-Owens Ford Glass Co.	74½	43	39⅛	30⅝	31½	3.50	11.1
NYSE	Magnavox Co.	21	5	24¼	10⅞	12⅝	1.00	7.9
U	Maguire Industries Inc.	8	9/16	1¾	⅜	1.65	*	—

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PRICE ANALYSIS

Stocks 1945-1951, with Dividends Paid and % Yield

Merrill Lynch, Pierce, Fenner & Beone

Stock Exchange	Company	1945-1949 Price Range High	1945-1949 Price Range Low	1950 Price Range High	1950 Price Range Low	Current Price 1/3/51	Dividends Paid 1950 $ per share	Yield %
U	P. R. Mallory Co., Inc.	38½	14½	26	16⅛	27⅛	1.17½	4.3
U	John Meck Industries	—	—	4½	2½	3½	*	—
NYSE	Minnesota Mining & Mfg. Co.	101	30	151	94	151	3.20	2.1
NYSE	Motorola, Inc.	26¾a	8¾a	57	23½	41½	4.50	10.8
U	Muntz TV Inc.	—	—	4⅜	2⅛	2⅜	0.15	6.6
NYCE	Muter Co.	12¼	7	11½	6⅝	8	0.45	5.6
U	National Co. Inc.	7¾	1⅜	6	2	4	0.05	1.3
NYCE	National Union Radio	14	2	5¾	2½	4⅝	*	—
MWSE	Oak Manufacturing Co.	14	6¾	18⅜	10½	13⅞	1.50	10.8
NYCE	Olympic Radio & Tel. Co.	—	—	12½	6⅝	8⅞	0.74	8.3
U	Packard-Bell Co.	4½a	1a	9a	6¼a	7¼	0.87½a	12.1
NYSE	Philco Corp.	47	20⅛	23¼	20	22	1.67½	7.6
NYSE	Pittsburgh Plate Glass Co.	48¾a	28¾a	40⅞	30½	38⅝	2.50	6.5
NYSE	Radio Corp. of America	19⅜	7½	23¼	12¼	16⅝	1.50	9.0
U	Ray-O-Vac	17¾a	6¼a	16⅛a	9a	16a	1.31¼a	8.2
NYCE	Raytheon Mfg. Co.	29⅛	4⅛	13½	6⅛	11⅝	—	—
U	Reeves-Ely Labs., Inc.	—	—	4⅜	3⅛	4⅛	—	—
U	Reeves Soundcraft Corp.	—	—	2	⅛	1½	—	—
NYSE	Revere Copper & Brass	31¾	10⅝	32⅜	14¾	28¾	2.50	8.7
MWSE	Sangamon Electric	37	22¼	37	26¼	37	3.50	9.5
U	Scophony-Baird Ltd.	—	—	0.35	0.10	0.18	*	—
U	Scott Radio Labs., Inc.	2⅝	⅝	5⅛	1	2⅝	*	—
NYCE	Sentinel Radio	10¼	1¾	9½	3½	6	*	—
U	Sight Mirror Television Corp.	—	—	0.05	0.05	0.05	*	—
U	Sight Master Corp.	—	—	0.45	0.05	0.13	*	—
NYCE	Sonotone Corp.	7¼	2½	5¾	2⅞	4⅜	0.32	7.3
NYSE	Sparks-Withington Co.	13⅞	3½	10¼	4½	6½	0.10	1.5
U	Speer Carbon Co.	—	—	30¾	13	30½	1.20	3.9
NYSE	Sperry Corp.	40½	16¾	33½	25⅞	34	2.00	5.9
U	Sprague Electric Co.	—	—	34	15⅛	31⅛	1.35	4.3
U	Standard Coil Products Co.	—	—	12	9	10⅛	0.25	2.5
NYSE	Stewart-Warner Corp.	26⅜	9½	21⅜	12	16¾	1.50	9.0
U	Stromberg-Carlson Co.	29	8¾	19⅜	11¼	13⅝	—	—
NYSE	Sylvania Elec. Products Inc.	43½	17⅛	26⅝	18¼	24	2.00	8.3
U	Tele-Tone Radio Corp.	—	—	6⅛	3	4	0.12½	3.1
U	Television and Radar Corp.	—	—	0.52	0.25	0.55	*	—
U	Tele-Video Corp.	—	—	0.28	0.02	0.24	*	—
U	Television Equipment Corp.	—	—	0.40	0.05	0.32	*	—
U	Television Electronics Fund	—	—	12.65	10.10	12.37½	1.00	8.1
U	Trad Television Corp.	—	—	0.59	0.15	0.50	*	—
U	Trav-ler Radio Corp.	—	—	5⅛	3¾	4¾	0.28⅓	6.0
NYCE	Tung-Sol Lamp	14⅛	3⅝	20½	8⅝	17¼	2.00	11.6
NYSE	United Carr Fastener Corp.	40	23¼	32	23	28⅛	2.50	8.9
U	U. S. Television Mfg. Corp.	—	—	1 11/16	0.15	0.25	*	—
U	Universal Winding Co.	11	7	13⅛	8¼	12⅞	1.00	7.8
U	Video Corp. of America	—	—	0.47	0.17	0.28	*	—
U	Webster-Chicago Corp.	11¾	7½	17½	8⅞	13⅞	1.25	9.0
U	Wells Gardner & Co.	9¾	2⅞	12¼	5½	6⅛	0.75	12.2
NYSE	Westinghouse Electric Corp.	39¾a	20⅝a	36	29⅛	34⅞	2.00	5.7
NYSE	Weston Elec. Instrument	63¼	21¾	34½	22⅜	33½	2.00	6.0
NYSE	SS White Dental Mfg.	44	21⅝	41	27⅜	31¼	1.60†	5.1
U	Wilcox-Gay Corp.	4⅜	⅜	3⅛	1¼	1⅞	*	—
NYCE	Woodall Industries Inc.	22½	8½	16⅞	13	14¼	1.15	8.1
U	R. Wurlitzer Co.	34	3	9¼	5⅜	7¼	0.45	6.2
NYSE	Zenith Radio Corp.	44½	14½	70¼	31½	50½	3.50	6.9

U—Unlisted—traded "over-the-counter". MWSE—Midwest Stock Exchange.
NYSE—New York Stock Exchange. a—Adjusted for stock dividends, splits, etc.
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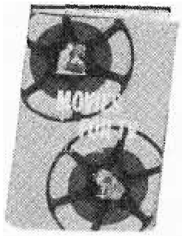

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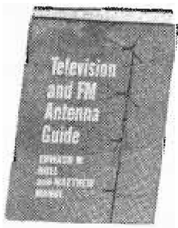

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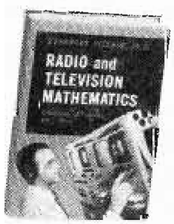

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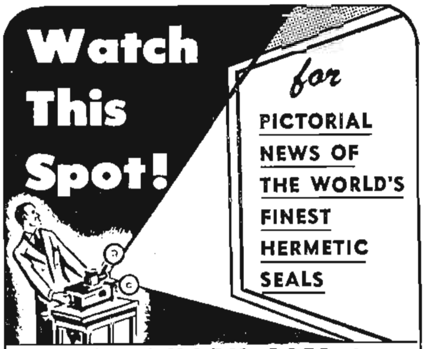

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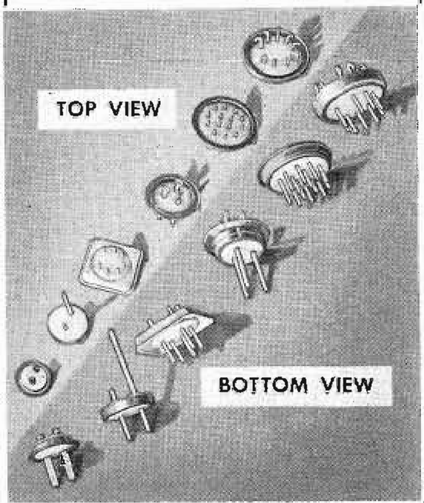

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LOS ANGELES-SAN FRANCISCO RELAY

(Continued from page 45)

TD2 system will be available for connection to multiplex telephone equipment, and FM terminal equipment will be required at intermediate offices whenever channels are dropped.

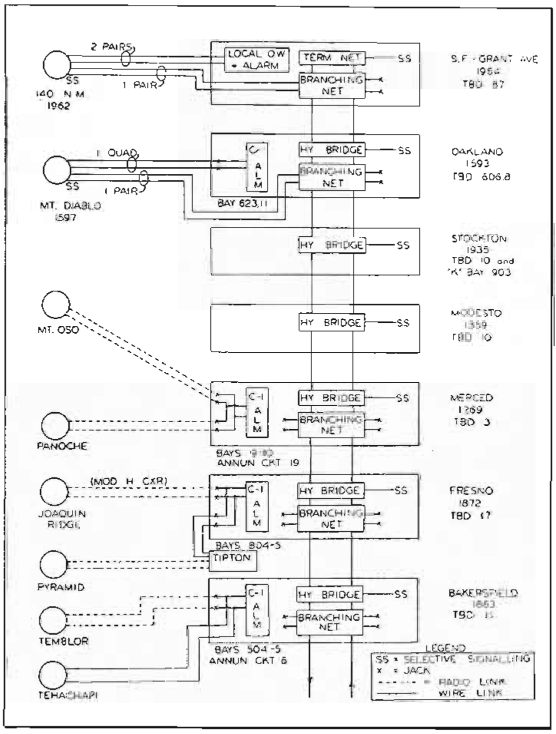
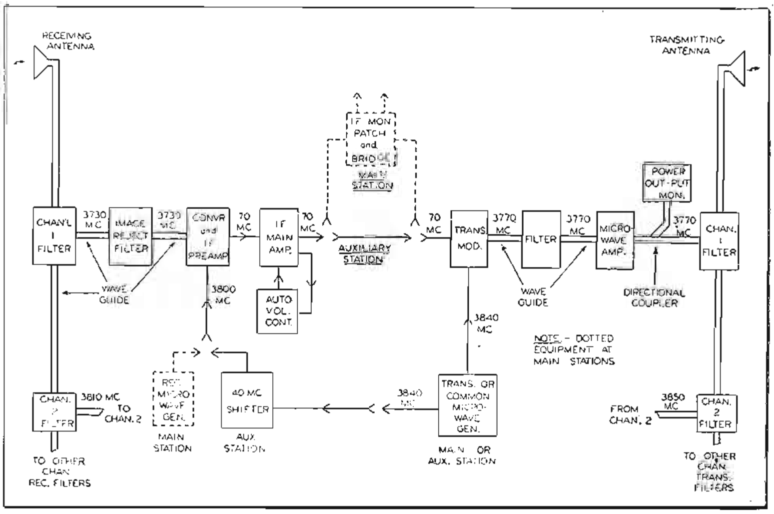


Fig. 3: Alarm and express order system for unattended stations. Each center can monitor 6 stations and receive up to 42 indications from each

Fig. 4: (below) A typical repeater station; equipment shown by broken lines is used only at main stations

The FM and microwave transmitting terminal will accept a 0.25 volt (peak-to-peak) video signal in the range between d-c and 5 megacycles. The signal before being fed to the frequency modulator is passed through a video amplifier and clamp circuit. The carrier frequency (difference frequency) of 70 MC is obtained from two microwave oscillators. The video signal modulates one of these oscillators, producing a peak frequency swing of 8 MC resulting in difference frequencies which vary



TV Relay

(Continued from preceding page)

between 66 and 74 MC. The average difference frequency of 70 MC is stabilized by means of an automatic frequency control.

An amplifier and limiter circuit follow the FM modulator and deliver a power of plus 13 dbm to the microwave transmitting circuit through a patching and monitoring bay. All channels connect through a common patching bay at the 70 MC i-f for monitoring, patching, switching, and bridging onto branch routes.

Referring to the transmitting microwave circuit; a 70 MC i-f signal and a microwave carrier frequency obtained from a crystal-controlled harmonic generator are fed to a vacuum tube modulator. The output of this modulator is passed through a side-band filter which removes one of the sidebands and then through 3 microwave amplifier stages which increase the signal amplitude by approximately 16 db. The signal output is connected through waveguides to the correct channel branching filter before being fed to the antenna. A directional coupler together with a crystal-detector type power monitor circuit are bridged on the waveguide between the amplifier and filter. This monitor circuit indicates not only the transmitter power, but also energizes an alarm if a drop of 10 db or more of power output occurs.

The microwave receiving terminals are located at both ends of the relay system. An image rejection filter connects each received channel to a crystal converter where it is converted to the i-f frequency of 70 MC. This is accomplished by beating a local microwave generator with the incoming signal. A preamplifier amplifies the signal before it is applied to the main i-f amplifier which has an automatic gain control circuit to maintain the signal at a constant level. The latter maintains the output of the main amplifier at plus 13 dbm by automatically adjusting the grid bias on five of the eight amplifier tubes. The i-f output is cabled through the i-f patching and monitoring bay to the FM receiving terminus.

The first circuit of the FM receiving terminal limits the i-f signal magnitude, and amplitude variations removed. The discriminator combines two tuned circuits, one resonant above 70 MC and one below 70 MC, the instantaneous frequency governing the voltage developed across these two circuits. By bridging op-

(Continued on page 86)

Opportunities for Engineers

TV Relay

(*Continued from page* 84)

positely poled detector circuits across the tuned circuits the video frequency may be recovered. The detector circuit is connected to a feedback video amplifier, the output of which is in push-pull to supply the 1.5 (peak-to-peak) output voltage to a 110-ohm balanced line. Gated input circuits are employed in the i-f patching and monitoring bay to permit rapid switching between the two connected circuits. Three multiple output circuits are bridged across the line to permit routing to branch lines. The signal may be observed on either an oscilloscope or picture monitor by means of monitoring jacks and equipment.

In the repeater circuits, the signal is received and fed to the branching filter. Each channel passes through an image rejection filter and is converted to the 70 MC i-f by mixing it with the output of a microwave oscillator. With the exception of the local oscillator circuits in unattended stations, the repeater station consists essentially of a microwave to i-f receiver and an i-f to microwave transmitter. Figure 4 shows a repeater station. The dotted connections, however, are used only at main stations. The i-f signal after amplification and automatic gain regulation is passed through the patching bay to the modulator and retransmitted to the next relay station. The microwave generator frequency is 40 MC greater, or less, than the received frequency from the preceding frequency to prevent any leaking to the receiving antenna which would cause "singing." The microwave generators are crystal controlled to within 0.003 per cent. Auxiliary stations are supplied with a 40 MC oscillator and mixer circuit to accomplish the 40 MC frequency shift between the repeater input and output. This microwave generator has two outputs, one which supplies the transmitter modulator and the other which feeds a mixer circuit where it is shifted 40 MC by the 40 MC oscillator. This 40 MC shifted output is applied to the receiver converter where the incoming signal is demodulated to the i-f frequency of 70 MC.

Lansdale Tube Buys Site

A subsidiary of Philco Corp., the Lansdale Tube Co., with its main plant and laboratories in Lansdale, Pa., has purchased a site at Frederick, Md., for a new plant for the manufacture of critically short electronic tubes for the Armed Forces and essential civilian requirements.

TELE-TECH

Advertisers—February, 1951

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1G6GT	1.30
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1J6G	1.20
1LH4	1.25
1N21 (Xtal Diode)	1.20
1N21A " "	1.40
1N22 " "	1.40
1N23 " "	1.30
1N23A " "	2.25
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1N29 " "	3.25
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2X2/879	.65
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3FP7	1.95
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6A3	1.60
6A6	1.21
6AF6G	1.30
6B7	1.50
6B8	1.30
6B8G	1.20
6C8G	1.30
6G12 Ballast	.45
6H16 Ballast	.45
6J5	1.30
6J8G	1.45
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6K7G	1.20
6R7G	1.10
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7E6	.75
7F7	1.10
7H7	1.80
7L7	1.33
7N7	1.50
7Y4	.80
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23D4 Ballast	.45
HK24/3C34	
24G/3C24	.45
CE-25D/927	1.25
25T/3C34	
30	.40
30/VT-67	.58
CE-30-C/930	1.20
33	1.00
34	.90
RK-34/2C34	.40
35/51	.90
36	.90
37	.75
38	.75
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41	.75
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100R	.85
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287A/722A	9.50
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307A	6.85
CE-309	3.90
316A	.85
327A	2.50
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368AS/703A	3.75
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371B	.59
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706AY	17.50
706CY	16.90
707A	12.95
707B	14.45
708A	3.45
709A	3.95
710A	.80
713A	.75
714AY	3.25
715A	6.25
715B	6.55
715C	20.50
717A	.90
721A	2.20
722A	9.50
724A	3.85
724B	2.50
725A	6.45
726A	4.50
730A	8.50
801	.40
801A	.65
803	3.00
804	6.40
805	5.75
808	1.65
814	2.20
815	2.20

TYPE	PRICE EACH
826	$ .75
830B	3.00
832	6.50
834	5.75
835/3811A	1.00
836	1.45
837	1.35
838	2.30
841	.40
843	.35
849	29.45
851	39.00
860	6.90
864	.35
865	1.40
866A	1.30
869	19.75
869B	26.35
872A	2.45
876	.35
878	1.65
879/2X2	.65
884	1.50
918/CE-1C	1.45
920/CE21D	2.40
923/CE23D	1.10
927/CE25D	1.25
930/CE30C	1.20
931A	3.95
954	.30
955	.45
957	.35
958A	.50
991/NE-16	.24
1005	.30
CK1089	3.90
CK1090	2.15
1148	.55
1201	.45
1203A	.65
1291	.25
1294	.95
1299	.30
1299A	.60
1616	.70
1619	.35
1624	.95
1625	.35
1626	.35
1629	.35
1630	2.25
1638	.60
1641	.80
1642	.55
1960	.75
2051	.75
7193	.55
8011	1.95
8012	2.25
8013	1.25
8020	1.50
8025	3.65
9003	.95
9004	.50
9006	.50
3811A/835	1.00

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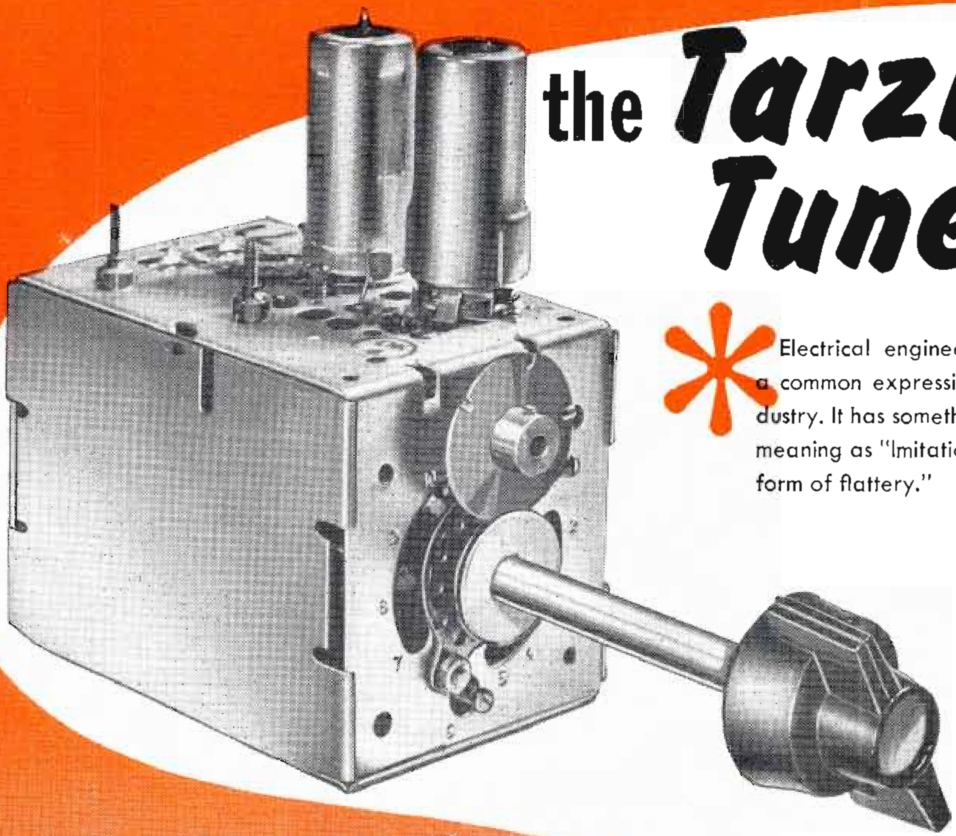

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- Insulated shaft design available at low cost
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- Each channel individually aligned for maximum performance
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- Extra terminals provided for tie-points

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