TELE-TECH

TELEVISION • TELECOMMUNICATIONS • RADIO

April • 1948

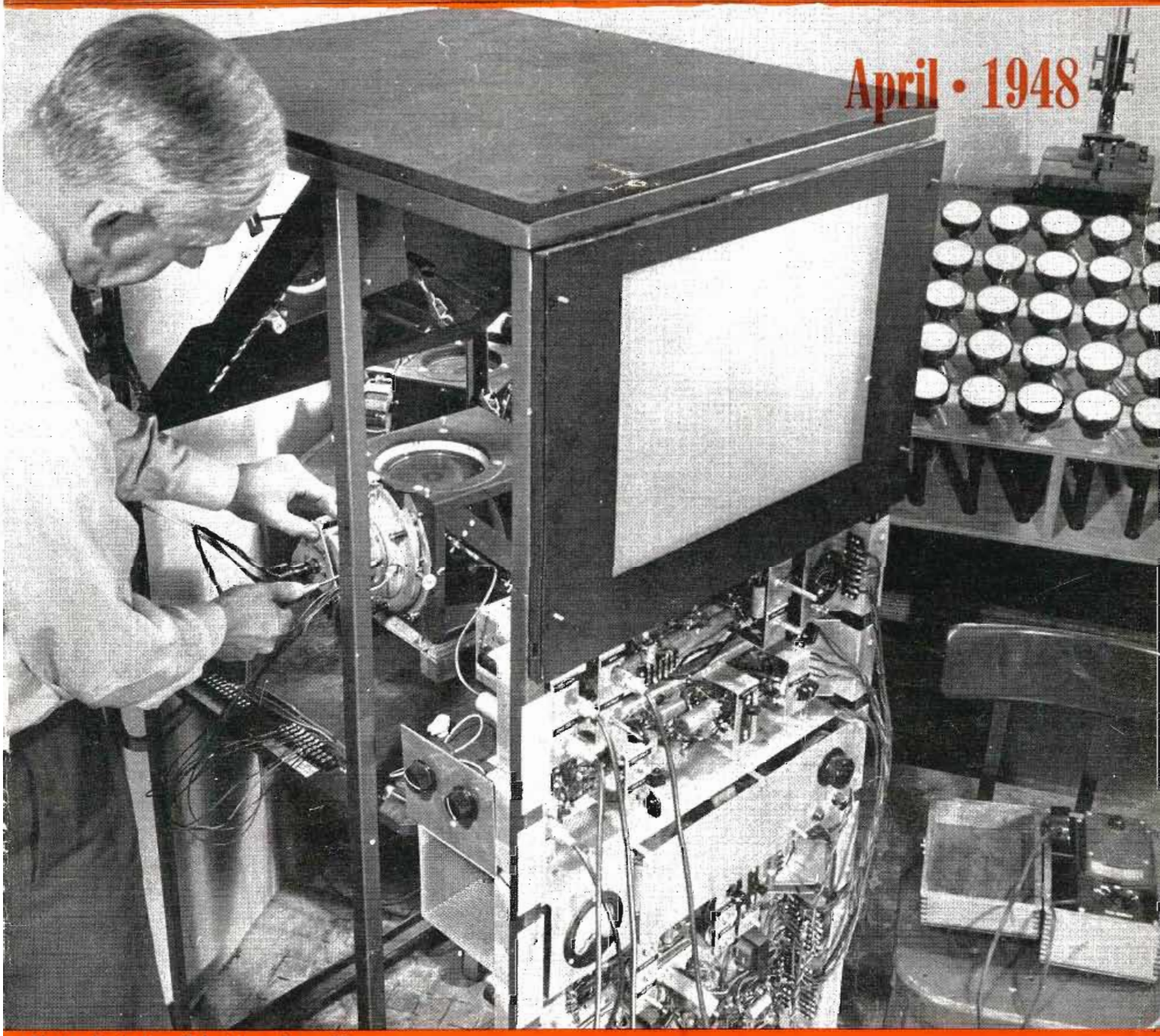
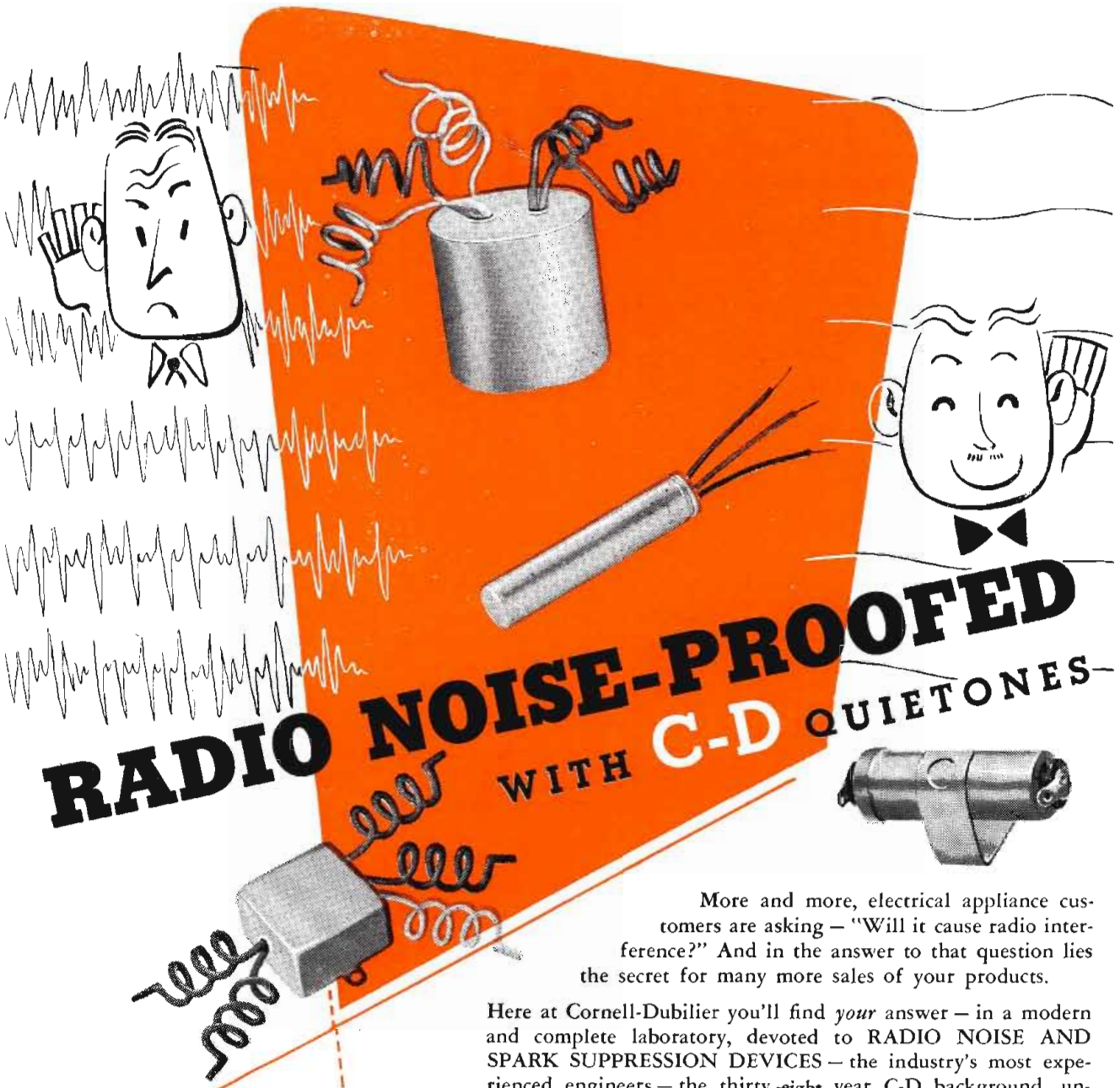


Photo: Projection Television—Page 30

How Much Pay is an Engineer Worth? Page 24

CALDWELL-CLEMENTS, INC.



RADIO NOISE-PROOFED WITH C-D QUIETONES

More and more, electrical appliance customers are asking — "Will it cause radio interference?" And in the answer to that question lies the secret for many more sales of your products.

Here at Cornell-Dubilier you'll find *your* answer — in a modern and complete laboratory, devoted to RADIO NOISE AND SPARK SUPPRESSION DEVICES — the industry's most experienced engineers — the thirty -eight- year C-D background, unequalled in the capacitor field. They're all at your disposal — NOW. Whether you want to Radio Noise-Proof equipment already in production — or if you're engineering a new product from the ground up — C-D Quietones will do the job efficiently and permanently. YOUR INQUIRIES ARE INVITED. Cornell-Dubilier Electric Corporation, Dept. J-4-8, South Plainfield, New Jersey. Other large plants in New Bedford, Worcester and Brookline, Mass., and Providence, R. I.

Make Your Products More Saleable with C-D Quietone Radio Noise Filters and Spark Suppressors

An Invitation from C-D
WORLD'S MOST ADVANCED RADIO "NOISE-PROOFING" LABORATORY IS AT YOUR SERVICE
without obligation

CORNELL-DUBILIER
WORLD'S LARGEST MANUFACTURER OF
CAPACITORS

1910 1948

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TELE-TECH

TELEVISION • TELECOMMUNICATIONS • RADIO

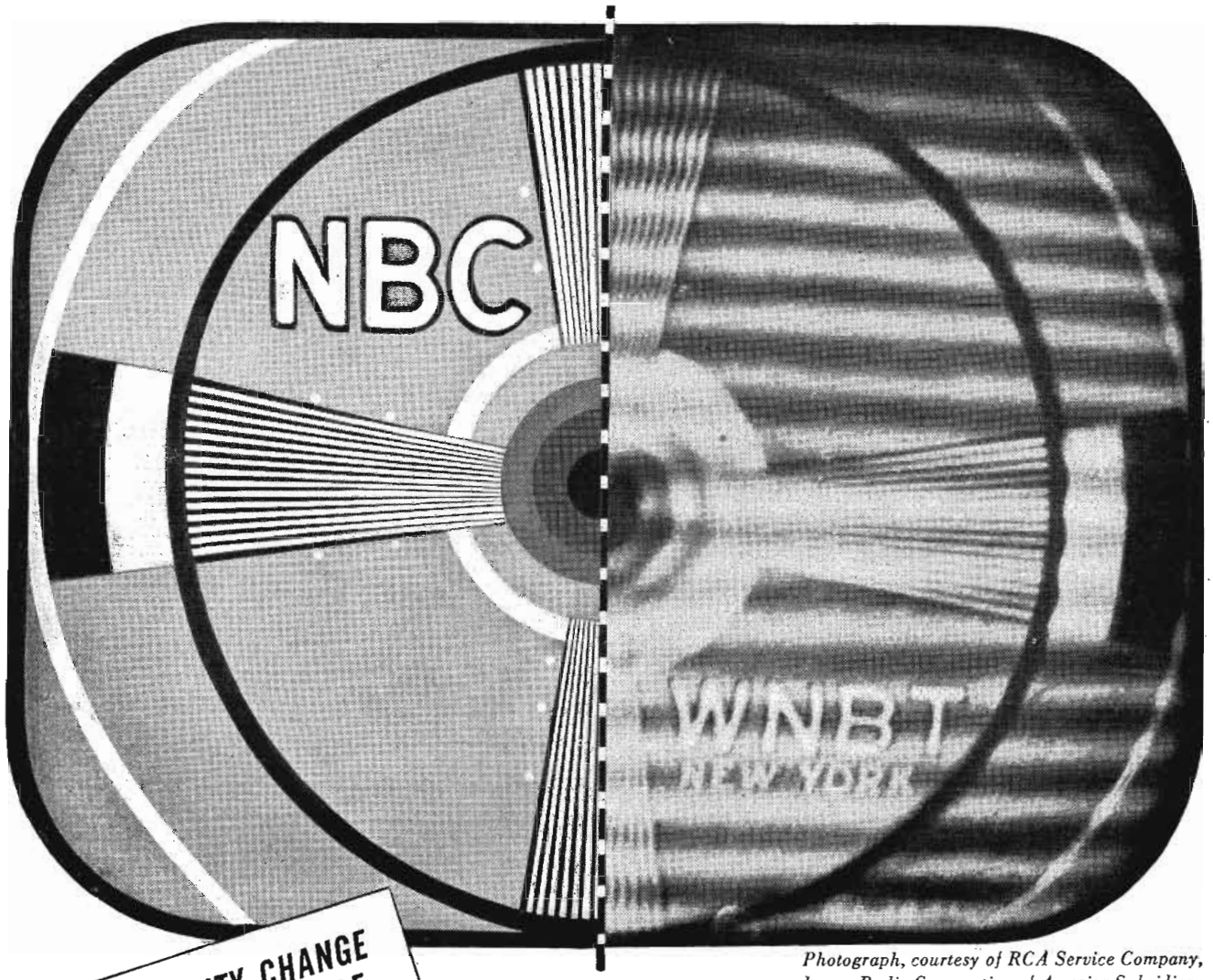
Formerly the TELE-communications TECH-nical Section of ELECTRONIC INDUSTRIES

APRIL, 1948

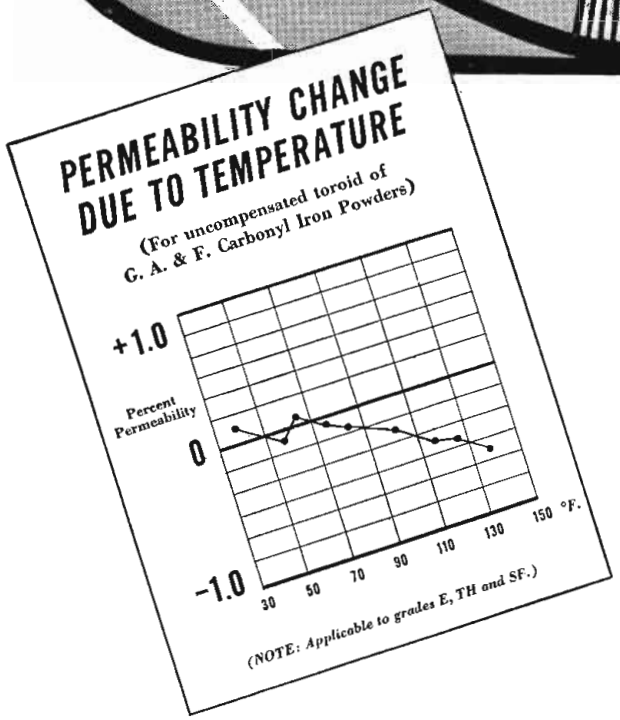
Editorial Contents

CALDWELL-CLEMENTS, INC., Publication Office, Orange, Conn., Editorial and Executive Offices 480 Lexington Avenue, New York 17, N. Y., Tel. Plaza 3-1340

Keep DISTORTION out of the picture



Photograph, courtesy of RCA Service Company, Inc., a Radio Corporation of America Subsidiary



Distortion of the television image can be reduced more effectively if your wave trap is cored with a G. A. & F. Carbonyl Iron Powder.

The inherent characteristics of G. A. & F. Carbonyl Iron Powders enable your core maker to produce cores with negligible temperature drift and excellent magnetic stability. Such cores in well designed coils give incomparable fidelity to your TV and RF circuits.

WHEN USED at radio frequency, G. A. & F. Carbonyl Iron Powders are superior in all important coefficients of stability (magnetic and temperature) and loss (eddy current and residual).

In comparison with air-cored coils, G. A. & F. Carbonyl Iron Powder-cored coils permit considerable savings in volume, weight and wire-length, along with great increases in inductance and Q value.

Ask your core manufacturer for information about G. A. & F. Carbonyl Iron Powders. Or write direct to: Antara Products, 444 Madison Avenue, New York 22, N. Y. Dept. 44

G. A. & F. CARBONYL IRON POWDERS

An Antara Product of General Aniline & Film Corporation*

*®

CURTISS WRIGHT AS "WATCH DOGS" USES CLARE SEALED RELAYS OF PROPELLER CONTROL SYSTEM

Curtiss-Wright's Propeller Division has produced many "famous firsts" in aircraft propulsion . . . one of the most important being the reversible propeller which provides positive, smooth braking action under all landing conditions.

Choice by Curtiss-Wright engineers of Clare "Custom-Built" Relays to perform important functions in the control of these propellers is a tribute to the ability of Clare engineers to "custom-build" a relay which meets the most exacting specifications.

Located in a relay panel in the rear of the pilot's compartment, four Clare Sealed Type "K" Relays function automatically to normalize the propeller reversing circuits, to reset the de-icing system, and to give warning if the propeller synchronizer motor is in an off-speed condition.

Clare Sealed Type Relays are used because of their immunity to changes in atmospheric pressure, humidity, dust or dirt . . . are sealed at the factory to operate exactly as required over a long period.

Clare Relays have long been first choice of manufacturers whose products must not fail. Selection of quality materials, precise manufacture, and ability to "custom-build" just the relay for the specific requirement have made Clare Relays a "must" with engineers who insist on . . . and get . . . the best.

Sales engineers are located in principal cities, ready to show you how the Clare "custom-building" principle can give you just the relay for your most difficult requirement. They are listed in your telephone directory. Look them up there, or write: C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. Cable Address: CLARELAY. In Canada: Canadian Line Materials, Ltd., Toronto 13.

Cutaway view of relay box of Curtiss-Wright Propellers shows (bottom) the four Clare Type "K" Relays which perform important operations. Two relays at right normalize the propeller reversing circuits; relay second from left is de-icing relay to reset the de-icing system; relay at left gives warning if propeller synchronizer motor is in an off-speed condition.

The Clare Type "K" d-c Relay is outstanding for speed of operation, resistance to vibration, and extremely small size. In the hermetically sealed cover, it is immune to the most extreme conditions of dust, moisture, air pressure and combustible gases.

CLARE RELAYS

"Custom-Built" Multiple Contact Relays for Electrical and Industrial Use

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For *greater* brilliance and *greater* DEFLECTION SENSITIVITY—

DUMONT TYPE 3JP *Cathode-ray* TUBE

Here's the logical successor to the war-time Types 3BP and 3FP, combining the high deflection sensitivity of the 3BP with the higher operating voltage and brightness of the 3FP. Thus, it is the ideal tube for test equipment which is operated under high ambient light.

The new DuMont Type 3JP is designed for oscillographic and other applications requiring a small, short tube with very high light output and high deflection sensitivity. The focusing electrode current under operating conditions is negligible, thereby simplifying bleeder design. The 2" dia. neck and diheptal base provide adequate insulation between electrode leads for high-altitude insulation.

For applications where deflecting voltages are under suitable control, the 3JP is directly interchangeable with the 3FP. Equipment using the 3BP may be readily adapted to use the 3JP by providing for connecting the intensifier electrode of the 3JP either to the second anode potential or to a higher potential than the second anode. Due to the higher deflection sensitivity, the 3JP can be utilized with intensifier potential equal to twice the second anode potential without reduction in sensitivity, as compared with the 3BP operating with the same second anode potential.

TECHNICAL DATA ON REQUEST.

CHARACTERISTICS . . .

Deflection and Focus	Electrostatic
Screen: Choice of P1, P2, P4, P7 and P11 Screens	

RATINGS:

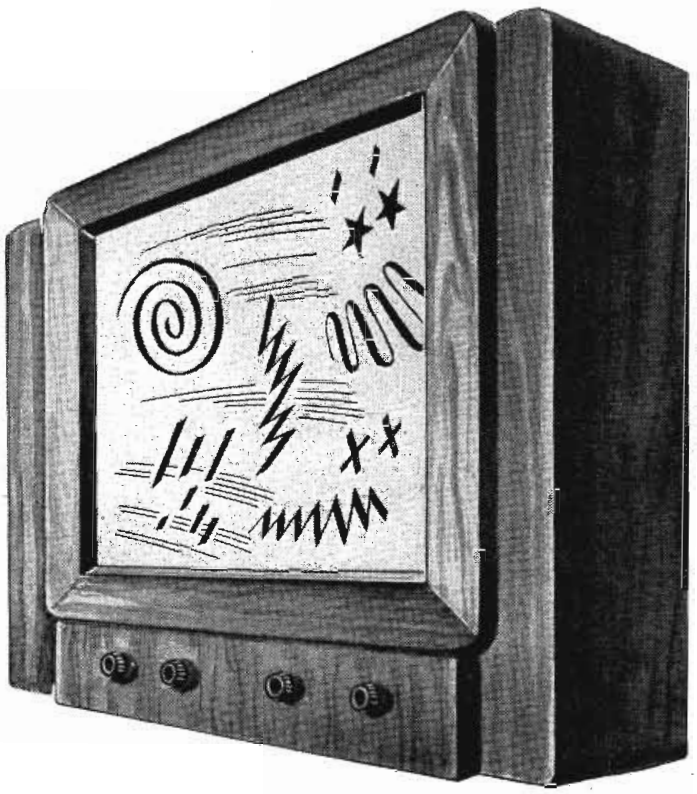
Heater Voltage	6.3 a.c. or d.c.
Current	0.6 ampere
Anode #3 (Intensifier)	4400 volts max.
Anode #2 (Accelerating)	2200 volts max.
Anode #1 (Focusing)	1100 volts max.
Grid (Control Voltage)	Never Positive
Peak Voltage between Accelerating Electrode and Any Deflecting Electrode	550 volts max.
Grid Circuit Resistance	1.5 meg. max.
Impedance of Any Deflecting Electrode Circuit at Heater Supply Frequency	1.0 meg. max.
E_{b3}/E_{b2} Ratio	2.3 max.

MECHANICAL CHARACTERISTICS:

Overall Length	10"
Maximum Diameter	3"
Base	Med. 12-pin diheptal

DUMONT *Precision Electronics & Television*

ALLEN B. DUMONT LABORATORIES, INC., PASSAIC, NEW JERSEY • CABLE ADDRESS: ALBEEDU, PASSAIC, N. J., U. S. A.



How to Smooth ROUGH RECEPTION

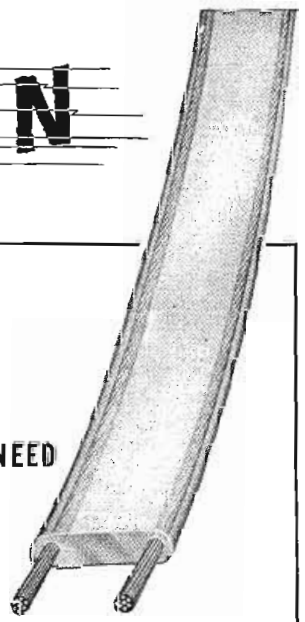
ANACONDA Type ATV* Lead-In Lines go a long way towards bringing perfect reception to television and FM sets.

The effects of attenuation and impedance mismatch on reception are minimized by ATV lines. The satin-smooth polyethylene insulation of this line sheds water readily—thus avoiding subsequent impedance discontinuities. This insulating material also has high resistance to deterioration.

Count on Anaconda to solve your high-frequency transmission problems—with anything from a new type lead-in line to the latest development in coaxial cables.

48457

*Reg. U.S. Pat. Off.



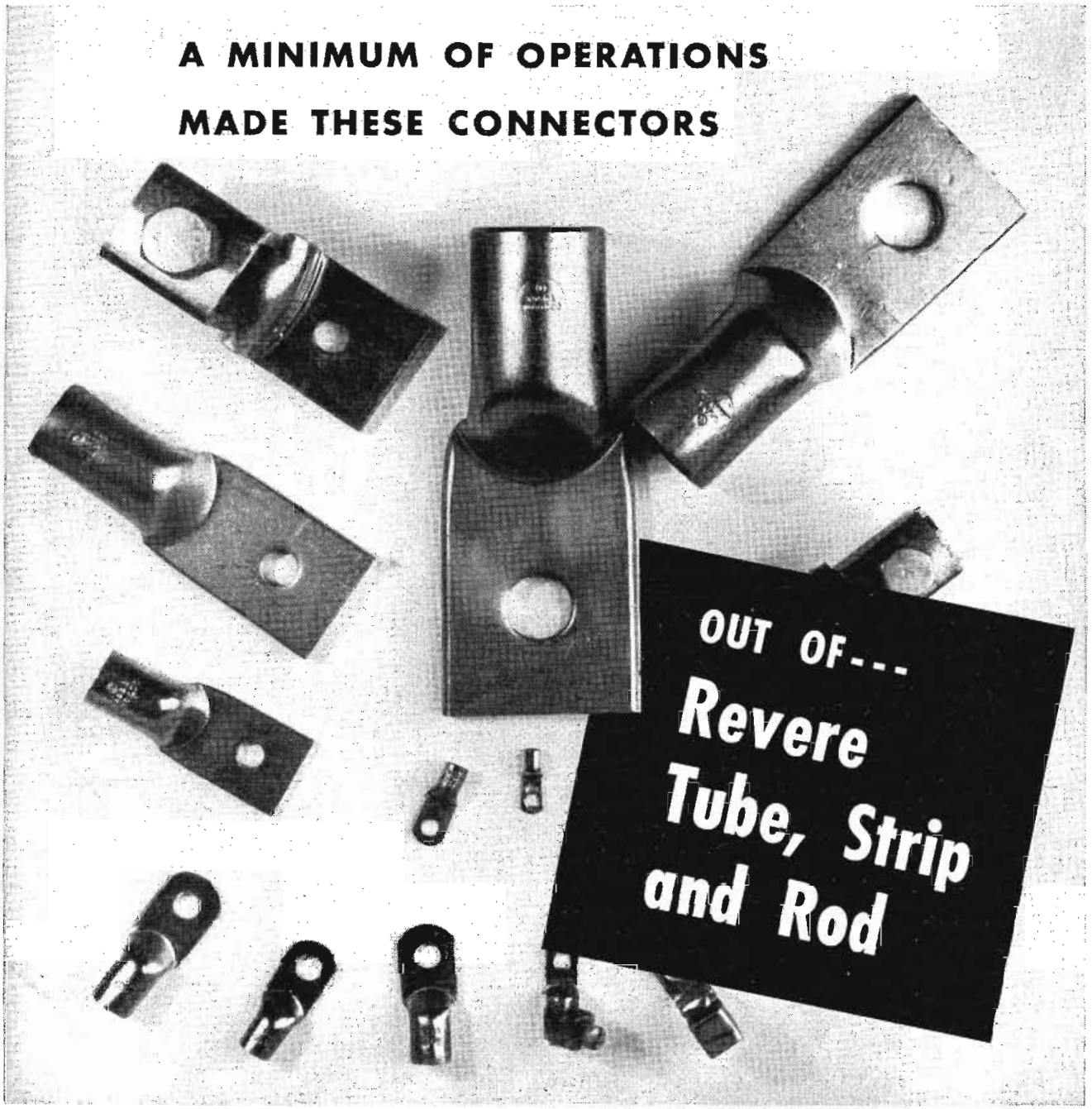
A TYPE ATV LEAD-IN FOR EVERY NEED

Anaconda offers a complete selection of Type ATV lead-in lines for 75, 150 and 300 ohms impedance, unshielded and shielded lines of high impedance. For an electrical and physical characteristics bulletin, write to Anaconda Wire and Cable Company.

ANACONDA

Anaconda Wire and Cable Company

25 BROADWAY, NEW YORK 4, N. Y.



THESE electrical connectors are but a few out of the hundreds of types being made today out of Revere copper and copper alloy tube, strip and rod.

Soldering lugs are made of Revere seamless tube, and are finished by simple stamping and punching. Solderless connectors are manufactured of tube, strip, bar and rod. The easy workability of the metal, plus the fact that it is supplied in forms requiring a minimum of operations, make Revere a favorite source of supply.

Other Revere products for electrical purposes include: Electrolytic and silver bearing copper commutator bar and segments; O.F.H.C., silver bearing, and electrolytic copper for armatures and rotors of micromotors and fractional h-p motors; Specially Prepared Switch Copper for switches, bus bars and similar applications; Extruded copper shapes for contacts, contact arms, solderless connectors, etc., Free Cutting Rod for parts machined to close tolerances; Tubular rivet wire.

The Revere Technical Advisory Service will gladly work with you in studying your requirements and determining the Revere mill products that lend themselves to the most economical manufacture and best service.

• • •

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Founded by Paul Revere in 1801

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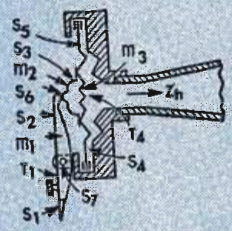
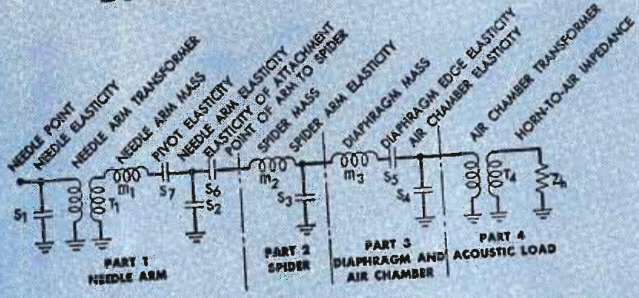
THIS IS THE REPRODUCER OF THE FIRST ORTHOPHONIC PHONOGRAPH



When the Orthophonic phonograph, developed in Bell Telephone Laboratories, was introduced in 1925, it represented an outstanding advance over previous acoustical types. Even more important to the progress in mechanical-acoustical and electro-acoustical systems, it represented the practical application of a basically new design tool—*the equivalent circuit.*

THIS IS THE SAME REPRODUCER WITH ITS MECHANICAL PARTS REPRESENTED BY ELECTRICAL COMPONENTS



Instead of time-consuming cut-and-try methods—involving experiments with mechanical parts of different sizes and shapes—Bell engineers tackled the design of the Orthophonic phonograph by representing each of its *mechanical* parts by an electrical *equivalent.* The effect of changing the mechanical specifications of any part of the phonograph could be predicted simply by changing the value of the corresponding electrical component, in accordance with the mathematics of electrical networks.

THIS IS THE CONCEPT OF THE "EQUIVALENT CIRCUIT"

An equivalent circuit is an electrical system in which each part is equivalent to a part in the corresponding mechanical system. The reaction of such an electrical system to electrical oscillations is identical to the reaction of the mechanical system to mechanical vibrations.

As a design tool, the equivalent circuit is particularly valuable in predicting performance of *transducers,* in which electrical energy is transformed into mechanical (and vice versa).

How the equivalent circuit came into being

The close analogy between elements in electrical and vibrating mechanical systems has long been recognized. Inductance corresponds to mass; capacitance to elasticity; electrical resistance to mechanical resistance, etc.

But it remained for the engineers of Bell Telephone Laboratories to integrate these facts into a practical design tool—to recognize and utilize the equivalence, not merely between *parts*, but between *systems.*

Once the fundamental idea of the "equivalent circuit" was applied, it quickly proved its merits as a practical, effective tool of transducer design. Employed in the design of the revolutionary Orthophonic phonograph, the equivalent circuit technique later became a standard procedure in transducer design.

The concept of the equivalent circuit is one of the many advances originating in Bell Telephone Laboratories that have contributed materially to progress in communications equipment.

Why it means better quality in Western Electric equipment

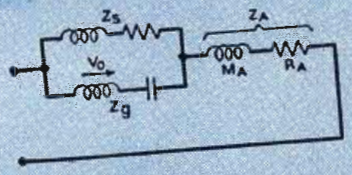
In designing Western Electric microphones, crystal filters and recording and reproducing equipment, Bell Laboratories applies its long experience and thorough knowledge in the use of equivalent circuits.

The results are twofold: *product designs* that mean greater dependability and improved performance, and *precise manufacturing information* that gives better control of quality during production.

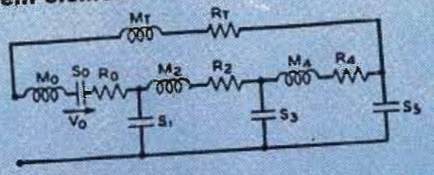
The use of equivalent circuits is another example of the thorough research and careful manufacture which typify all Western Electric products—for radio broadcasting, radio communications, sound distribution and industrial uses.

—QUALITY COUNTS—

THIS IS THE 639 MICROPHONE IN EQUIVALENT CIRCUIT FORM



Electrical equivalent of ribbon type pressure gradient element



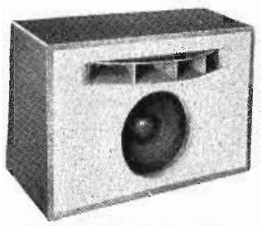
Electrical equivalent of diaphragm type pressure element

These circuits were the starting-point in the design of Western Electric's popular 639 Type Cardioid Microphone. By changing the values of the electrical components, they provided extensive information on expected performance before the first model was built.

THIS IS THE MICROPHONE ITSELF

When the 639 was built, its outstanding performance—in quality and adaptability to various pick-up problems—bore out the predictions of the equivalent circuit.

OTHER WESTERN ELECTRIC EQUIPMENT IN WHICH THE EQUIVALENT CIRCUIT IS A USEFUL DESIGN TOOL

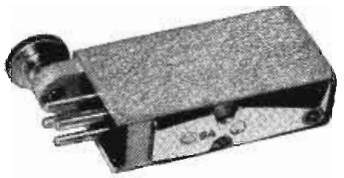


LOUDSPEAKERS

Finest in the Western Electric line is the dual-unit 757A—handling 30 watts, giving uniform response from 60 to 15,000 cycles, having a 90 degree coverage angle.

CRYSTALS

This new line of crystals for oscillator control ranges from 1.2 KC to 50 MC. All are engineered for improved accuracy and stability.



REPRODUCERS

The 9A, specially recommended for vertical cuts, and the 9B, used to best advantage on lateral cuts, have low distortion and provide maximum elimination of record noise.

Western Electric

Manufacturing unit of the Bell System and the nation's largest producer of communications equipment.

Distributed by GraybaR
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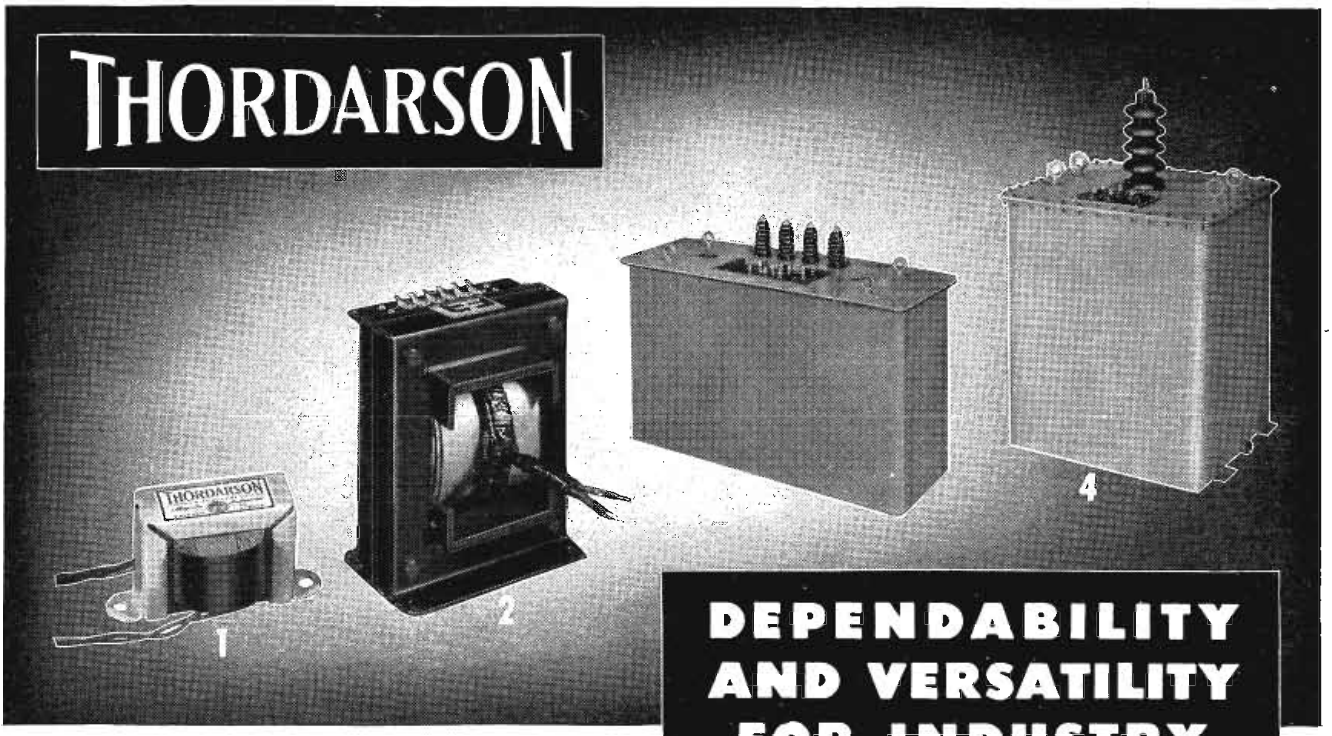
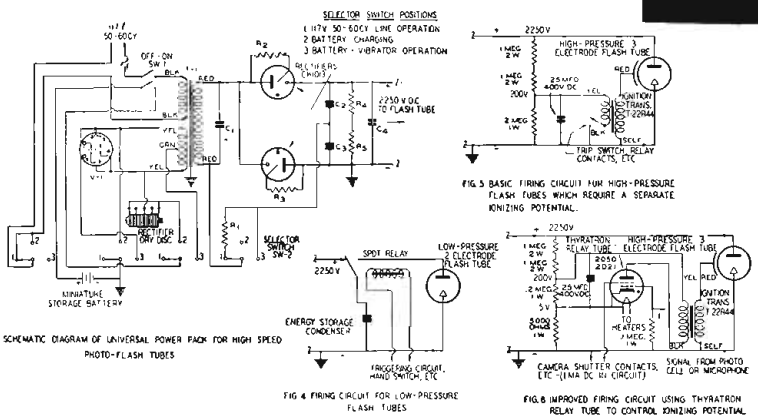
THORDARSON



DEPENDABILITY AND VERSATILITY FOR INDUSTRY



1. LOW VOLTAGE - LOW CURRENT
2. LOW VOLTAGE - HIGH CURRENT
3. HIGH VOLTAGE - HIGH CURRENT
4. HIGH VOLTAGE - LOW CURRENT

PHOTO FLASH POWER SUPPLY

Here is another Thordarson FIRST... a typical example of Thordarson engineering skill that has helped established leadership in the field. This circuit features:

- **A.C. Line or Portable Battery Operation**
- **Charging Time — 10 to 15 Seconds**
- **A.C. Line Battery Recharge Feature**
- **Light Compact Low Drain Power Transformer**
- **Power Supply Output — 2250 V.D.C.**
- **Storage Condenser Delivers 75 Watt-Sec. Energy Element**
- **Adaptable Trigger Circuits for 2 or 3 Tubes**
- **Cold Cathode Rectifiers Employed in a Voltage Doubling Circuit**

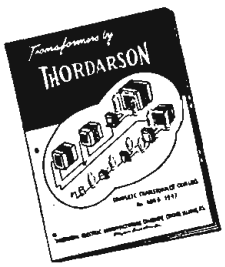
OUR ENGINEERING STAFF IS AVAILABLE TO SOLVE YOUR PROBLEMS FOR YOU UPON REQUEST

Whatever your position in the field of electronics Thordarson can serve you better. Our large variety of stock types fill almost every need. For extraordinary conditions, send us your problems and our engineering staff will come up with the right answers.

WHERE QUALITY IS A NECESSITY...

Thordarson has the answers to many electrical problems that daily confront industry. With a background of over 25,000 active specifications in their files, built up over 53 years of leadership in the field, Thordarson supplies the leaders with their large variety of stock types of transformers as well as the hundreds of special types built to customer specifications or resulting from recommendations of our own engineers upon studying the various requirements submitted to them by industry.

With this background, you know that your Thorardson equipment, purchased from stocks of a jobber or directly under special specifications, is of top-notch quality — sure to deliver unmatched performance. If you require the best, there is no unit either too large — or too small that Thordarson can't deliver.



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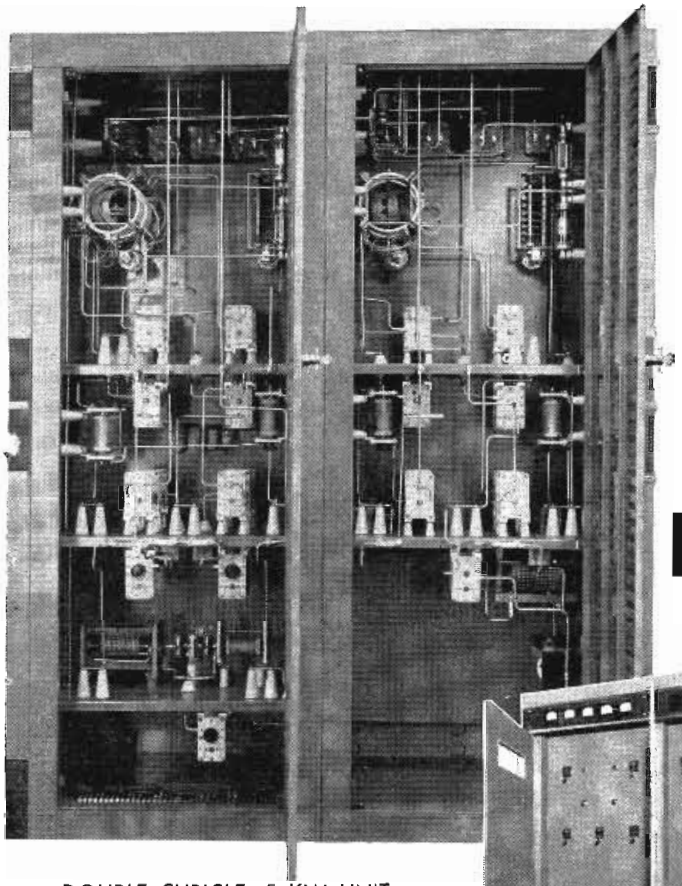
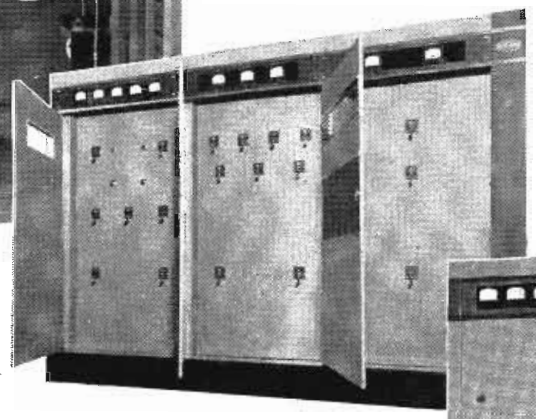
Excellence in Electronics

and in Directional Antenna

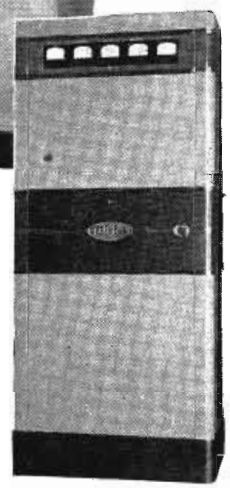
PHASING EQUIPMENT



DOUBLE CUBICLE, 5 KW UNIT, rear view, showing the compact but uncrowded arrangement of components. Large rear doors are interlocked for safety, provide easy access for maintenance or adjustment.



TRIPLE CUBICLE, 10 KW UNIT shows convenient arrangement of power and phasing controls, line current and input meters. Counters and panel lights indicate the setting and directional pattern in use. Safety doors exclude unauthorized personnel. NOTE: Cabinet design and number of cubicles is determined by equipment required — not necessarily by KW output.



SINGLE CUBICLE, 1 KW UNIT illustrates the handsome appearance of the heavy gauge steel and channel iron cabinet. Modern two-tone chrome-trimmed design adds smart style to any station.

Raytheon's specialists, cooperating with your consultant and station engineers, are prepared to custom-build directional antenna phasing and tuning equipment that will produce optimum results with your proposed or existing transmitting equipment. Engineered for maximum efficiency and stability . . . designed for utmost ease, economy and safety of operation . . . styled for ultimate appearance, convenience and accessibility — in the size to suit the power and special characteristics of your installation.

PROMPT DELIVERY . . . usually in 60 days or less. Call your Raytheon Broadcast Representative for complete information or — Write for Bulletin DL-R-444.

RAYTHEON MANUFACTURING COMPANY

COMMERCIAL PRODUCTS DIVISION · **WALTHAM 54, MASSACHUSETTS**

Industrial and Commercial Electronic Equipment, FM, AM and TV Broadcast Equipment, Tubes and Accessories

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Digest

TIMELY HIGHLIGHTS ON G-E COMPONENTS

tronic applications. It costs little and mounts in places where a rectifier tube and socket won't fit. Tests prove that this new selenium rectifier will outlast several 117-volt rectifier tubes. Installation is easier too—only two soldering operations and a minimum of mounting hardware are required.

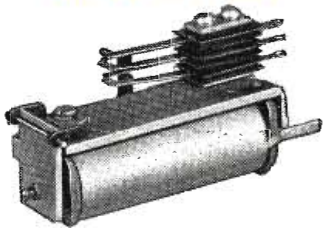
These rectifiers have an exceptionally high inverse-peak rating, and the inverse current is extremely low even with peak voltages up to 350 volts. At rated current output, the forward drop is five volts or less. Ratings are based on ambients of 50 to 60 C. Check Bulletin 21-127 for more information on this and other General Electric radio rectifiers.

NEW MACHINABLE PLASTIC FOR UHF INSULATION

A new arrival in the plastics insulator field is G-E No. 1422, which offers characteristics of advantage in the manufacture of ultra-high-frequency equipment, television, FM, radar, and radio sets, and many other electronic applications. Possessing a dielectric constant of 2.5 to 2.6 with a power factor of .0006 to .0009 at 3000 mc, G-E No. 1422 exhibits unusual heat resistance and excellent machinability.

Indicative of its machinability is the industrial production of r-f connector beads from G-E No. 1422 on automatic and semi-automatic screw machines. As a low-loss dielectric in the hands of the electric-equipment designer, it affords an excellent low-cost means of producing experimental models and small production quantities through the use of standard machine shop tools. Check coupon for technical report.

HANDLES 12 CIRCUITS SIMULTANEOUSLY



This new telephone-type relay is capable of handling as many as 12 circuits in a wide variety of contact combinations. Designed for multi-purpose use in industrial electronic apparatus, communications and signaling equipment, these devices have service lives measured in millions of operations. Working from five basic contact arrangements, combinations can be stacked to satisfy intricate circuit switching requirements. Silver, palladium, or tungsten contacts can be supplied; the choice depends on rating and life specifications.

More than 500 different coils are available, with ratings ranging from 1 to 250 volts, and 0.1 to 26,000 ohms. This varied selection of coil ratings makes it possible to match closely the coil voltage and resistance with the rating of the energizing circuits. Check Bulletin GEA-4859 for full details.

TO MEASURE TUBE LIFE

Now available for immediate delivery, General Electric Type KT time meters are ideal for inclusion in transmitters and other electronic equipment where knowledge of tube "on time" is important. They can record operating time in hours, tenths of hours, or minutes, and are built in four forms: round or square for panel mounting, portable with attached base, or for conduit mounting. Those designed for panel mounting are housed in small Textolite cases that harmonize with other panel devices.

Telechron motor drive assures an accurate record of tube operation over a long period of time. They can also be used on electronic production tools, such as resistance welders, to keep an accurate record of machine operating time. Researchers use them for measuring time intervals, verifying circuit operation, and life testing. Bulletins GEA-3299 and GEA-1574 have full details.

GENERAL ELECTRIC COMPANY, Section G-642-16
Apparatus Department, Schenectady 5, N. Y.

Please send me:

- ☐ GEA-2621 — 400-v D-c Capacitors
- ☐ GEA-3299, ☐ GEA-1574 — Type KT Time Meter
- ☐ 21-127 Selenium Rectifier
- ☐ GEA-4859 Telephone-type Relay
- ☐ Report on G-E No. 1422 Plastic

NOTE: More data available in Sweets' File for Product Designers.

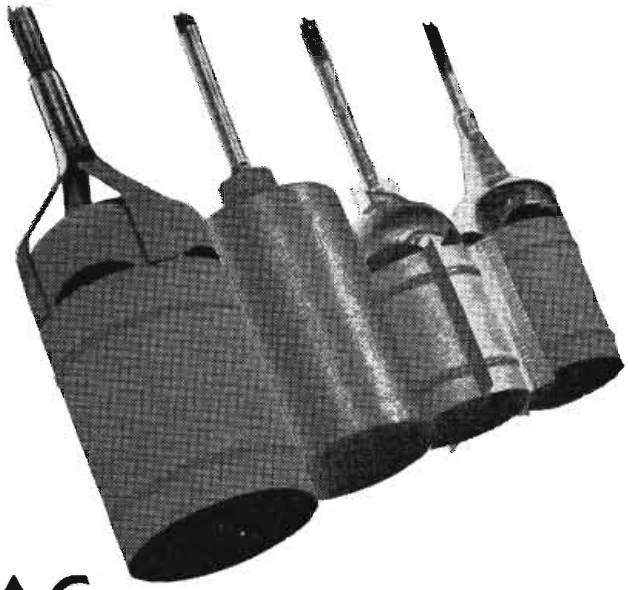
Name.....

Company.....

Address.....

City.....State.....

there IS a difference.



PYROVAC the new Eimac plate material makes a better vacuum tube anode . . . on all counts.

1 **LIFE . . .** Tubes with tantalum plates formerly giving 3000 hours of service, now, with Pyrovac plates operate in excess of 15,000 hours . . . a 400 percent increase.

2 **OVERLOADS . . .** With Pyrovac plate, 65 watt tubes have dissipated 900 watts—a 1280 percent momentary overload—without indication that the eventual life of the tubes or their characteristics were affected. In normal service these tubes are still going strong. Excessive plate dissipation due to tuning procedure and circuit failure normally won't mean the loss of your tube.

3 **MECHANICAL CHARACTERISTICS . . .** Pyrovac is easily welded, enabling rugged shock-resistant mounting. It is a "black body" radiator and possesses excellent characteristics as an electrical conductor.

4 **COSTS . . .** Pyrovac plates in Eimac tubes cost you no more, yet since they enable longer life you actually get more for your vacuum-tube-dollar.

5 **PROVEN IN SERVICE . . .** Pyrovac is the result of millions of hours of life tests. The universal acceptance of the 4-125A and the 4-250A in all fields of electronic endeavor can, in part, be attributed to Pyrovac for contributing overload resistance, life, and a general ability to "take it."

THESE ARE THE TUBES WITH PYROVAC PLATES

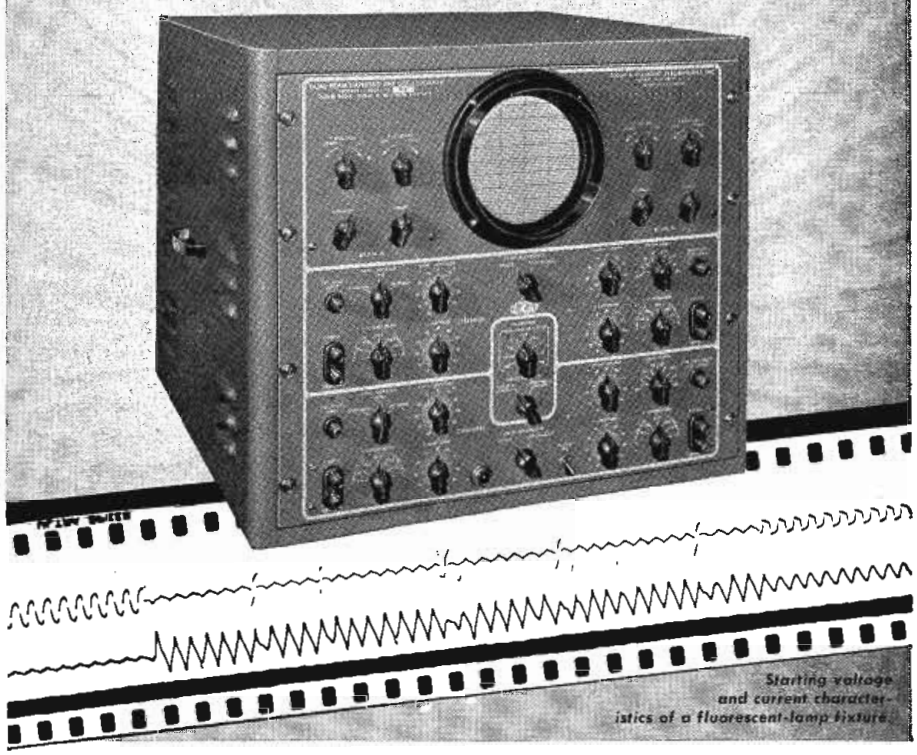
EIMAC TUBE TYPES	PLATE DISSIPATION watts
TETRODES	
4-65A	65
4-125A	125
4-250A	250
4-400A	400
4-1000A	1000
TRIODES	
25T	25
3C24	25
35T	50
35TG	50
75TH	75
75TL	75
100TH	100
100TL	100
152TH	150
152TL	150
250TH	250
250TL	250
304TH	300
304TL	300
450TH	450
450TL	450
750TL	750
1000T	1000
1500T	1500
2000T	2000

EITEL-McCULLOUGH, Inc.
193 San Mateo Ave., San Bruno, California

Export Agents: Frazar & Hansen 301 Clay St., San Francisco, Calif.

Two Completely Independent Oscillographs are combined in the *new* DUMONT Type 279

DUAL-BEAM CATHODE-RAY OSCILLOGRAPH



Starting voltage and current characteristics of a fluorescent-lamp fixture

WHAT IT IS...

- Two separate, completely independent, electron guns.
- Individual circuits for intensity, focus, and X-, Y- and Z-axis modulations.
- Independent, identical linear time bases for each beam. Choice of driven or continuous sweeps, or combinations thereof.
- Provision for applying common linear time base signal to the horizontal plates of both guns.
- Automatic beam control.
- Balanced output deflection amplifiers for each deflection system.
- Built-in voltage calibrator applicable to either Y-axis amplifier at any time.
- Position and sensitivity equalizing circuits for X-axis.
- Provision for use of an oscillograph-record camera such as Du Mont Types 271-A or 314.
- Operation at total acceleration potential of 4500 volts.
- Brilliant traces.

WHAT IT DOES...

Only the dual-beam oscillograph can simultaneously...

- ✓ Compare the complete signal and an expanded portion thereof.
- ✓ Enable observation of transient voltage and current (see accompanying oscillogram).
- ✓ Measure explosion time and rate of change of pressure.
- ✓ Show velocity and acceleration.
- ✓ Show velocity and pressure changes on engine valves.
- ✓ Compare speed and vibration.
- ✓ Compare voltages and currents in multiphase circuits.
- ✓ Compare adjustment of push-pull and other symmetrical circuits.
- ✓ Compare electrocardiograms picked up from two different points.
- ✓ Compare input and output signals of amplifiers.
- ✓ Offer two channel recordings, with Type 314 Oscillograph-record Camera.
- ✓ Compare related periodic phenomena on different sweep frequencies.

SPECIFICATIONS...

Type 5SP- Cathode-ray Tube.

Sweep-frequency range: 2 to 30,000 sawtooth cps.

Sweep recurrence: single or continuous.

Y-axis amplifier response: flat to dc., down 3db at 200 kc.

X-axis amplifier response: flat to dc., down 3db at 150 kc.

Deflection: for all amplifiers 1 v. dc. in. approx.

Power: 115/230 v., 50-60 cps., 300 watts, 3 amp. fuse.

Size: 17½" x 22⅝" x 22⅛"; wt. 125 lbs.

Housing: Cabinet or relay rack.

The introduction of the Type 279 Dual-beam Cathode-ray Oscillograph makes available for the first time a really dual instrument with *separate and wholly independent* electron guns. The circuits associated with each gun are also distinct and separate. For the first time, separate time bases are provided for each beam with provision for applying one time base to both guns, if so desired. For the first time, an oscillograph is offered which alone can perform the applications listed.

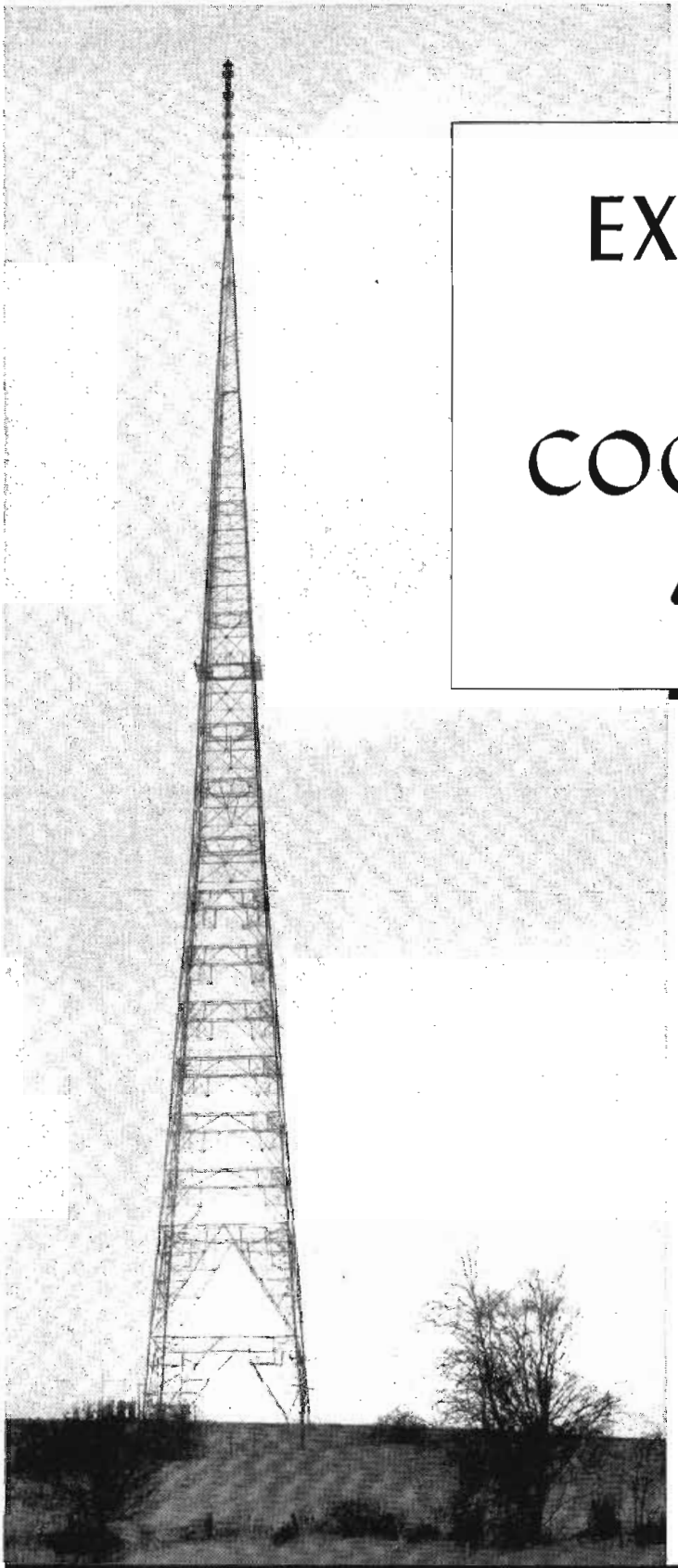
Now it is possible to superimpose two complete traces without a cumbersome and costly optical system or by the use of time-sharing devices. And with the P2 screen, the light output is more than sufficient for visual observation or for photographic recording of high-speed transients.

Other advanced features are the built-in calibrator and the ability to respond to direct-current signals.

Descriptive literature on request.

DUMONT *Precision Electronics & Television*

ALLEN B. DUMONT LABORATORIES, INC., PASSAIC, NEW JERSEY • *CABLE ADDRESS:* ALBEEDU, PASSAIC, N. J., U. S. A.



EXPERIENCE PLUS COOPERATION *DOES IT!*

There's a lot of satisfaction in working with radio engineers who know exactly what they need to get top efficiency from the transmitter. To their specifications Blaw-Knox applies an experience in antenna tower building that dates back to the days of "wireless" . . . Together we get results that reflect credit on our structural designers and the station's technical experts . . . If your plans call for more effective coverage or directional changes we would welcome an engineering interview at your convenience.

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OF BLAW-KNOX COMPANY
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◀ Blaw-Knox 550' Heavy Duty Type H40 Tower supporting a Federal 8 square loop FM antenna 74' high. Station WTMJ-FM, Richfield, Wisconsin.

BLAW-KNOX ANTENNA TOWERS

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Better Tubes—Longer Life—Increased Production through DPI HIGH-VACUUM ENGINEERING

YOUR present rotary exhaust machines can be completely automatic in operation, yielding increased production for any size tube.

Converted to DPI vacuum equipment, your machines will have a *fractionating* oil diffusion pump and a small mechanical pump *under each separate port*. Tubes are rough pumped through automatic solenoid valves.

Protective devices with automatic controls will seal off the pumps and isolate the trouble in case of faulty tubes. Seal-off pressure will reach 5 x 10^{-6} mm of mercury *before* getter is flashed.

DPI-engineered rotary exhaust machines produce *cleaner* tubes *faster*, by continuous pumping throughout the cycle—eliminate large backing pumps and rotary slide valve.

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SERVICE-PROVED COMPONENTS

Available Over Wide Range of Ratings

The extensive experience gained by General Electric in design and manufacture of electronic components for the Armed Forces is available to builders of commercial electronic equipments. In many cases the range of available ratings is wider than ever before.

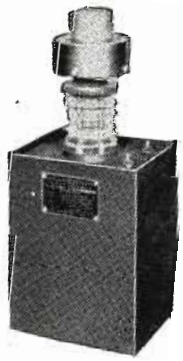
RESONANT REACTORS, OIL-FILLED, HERMETICALLY SEALED

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.

PULSE TRANSFORMERS, OIL-FILLED, HERMETICALLY SEALED

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 field.

FILAMENT TRANSFORMERS, OIL-FILLED, HERMETICALLY SEALED



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.

For price and delivery on components to meet your requirements, write your nearest General Electric District Office or direct to General Electric Company, Pittsfield, Massachusetts.

GENERAL ELECTRIC

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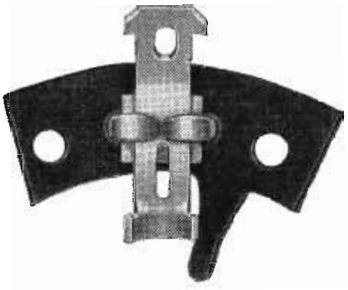
Compact Design... Unlimited Circuits...

...plus terminals that really stay put!

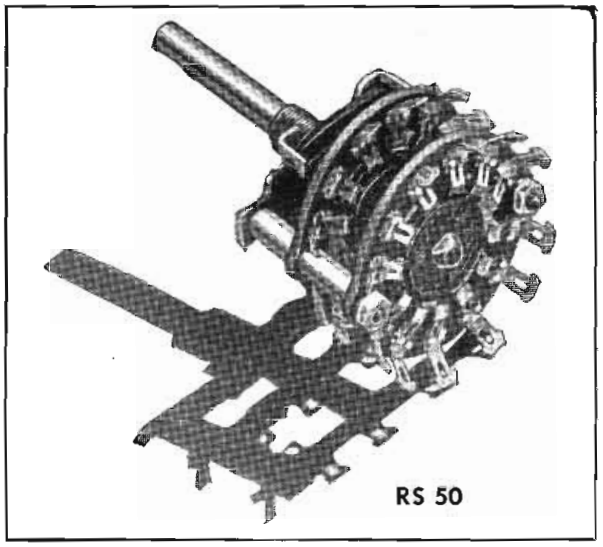


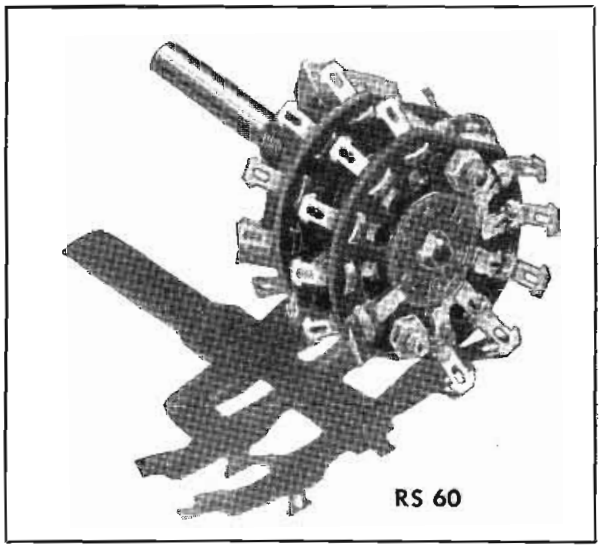
THEY'RE small, they're flexible, they're ruggedly designed. That's the story of the RS 50 and RS 60—two Mallory switches especially designed for radio receiver applications where low torque indexing is required.

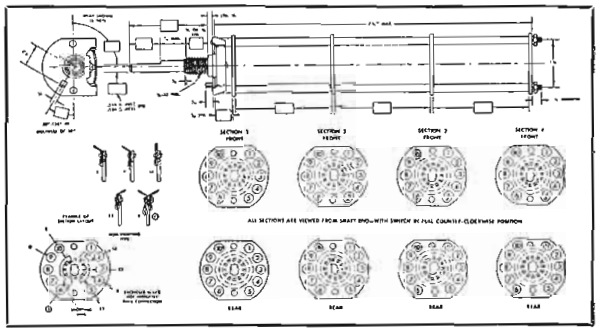
An outstanding feature of these switches is the two-point stapling which assures that terminals won't work loose. The terminals themselves are made of heavy spring brass for strength, silver plated, formed for flexibility, insuring low contact resistance.

Many other features are notable too: the improved low-loss phenolic in stator and rotor . . . the star wheel ball indexing with 30° between positions . . . silver-to-silver double wiping contacts . . . where desired the exclusive Mallory silver-indium treatment may be applied to rotor segments permitting higher contact pressure with lower, smooth operating torque and a minimum of contact resistance with extremely low noise level and long life.

The RS 50 is made with from 2 to 10 positions—the RS 60 with from 2 to 5. For more details, write for engineering data folder.







Ask for RS Specification Sheets

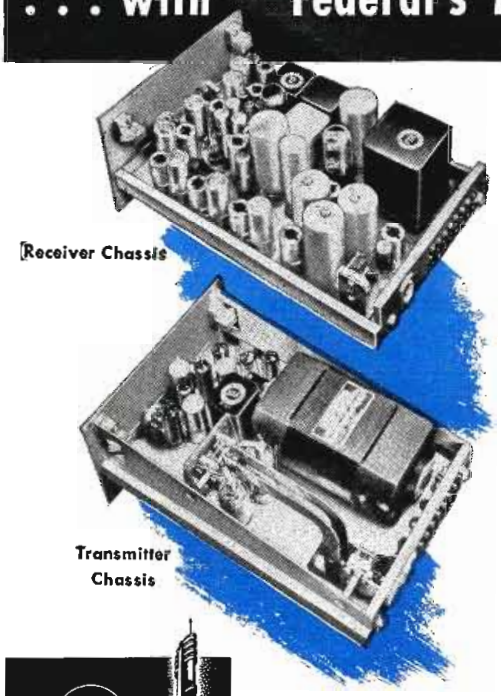
Printed on thin paper to permit blueprinting, these sectional drawings indicate standard and optional dimensions—make it easy for you to specify Mallory RS switches built to meet your circuit requirements. Ask your nearest Mallory Field Representative or write direct for a supply.

P. R. MALLORY & CO. Inc.

MALLORY SWITCHES

(ELECTRONIC, INDUSTRIAL and APPLIANCE)

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA



Transmitter and receiver units can be removed and replaced in a few seconds.

FEDERAL'S MOBILE RADIOTELEPHONE units are especially designed to save time and money on inspection and maintenance. Both the transmitter chassis and the receiver chassis slide out like a desk drawer—can be completely removed and replaced in a matter of seconds.

All connections are made or broken automatically, by perfectly-aligned plug-in connectors on the rear of the chassis and the inside of the housing. This not only saves valuable time, but avoids the possibility of making incorrect connections when a unit is replaced.

This "instant interchangeability" is just *one* of the many outstanding features of Federal's mobile FM radiotelephone equipment. Every component is designed for the convenience and economy of the men who use it—and its dependability and performance are backed by Federal's 37 years of research and experience in building better communications equipment. Write Federal today for complete information. Dept. I766.

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KEEPING FEDERAL YEARS AHEAD... is IT&T's world-wide research and engineering organization, of which the Federal Telecommunication Laboratories, Nutley, N. J., is a unit.

Federal Telephone and Radio Corporation

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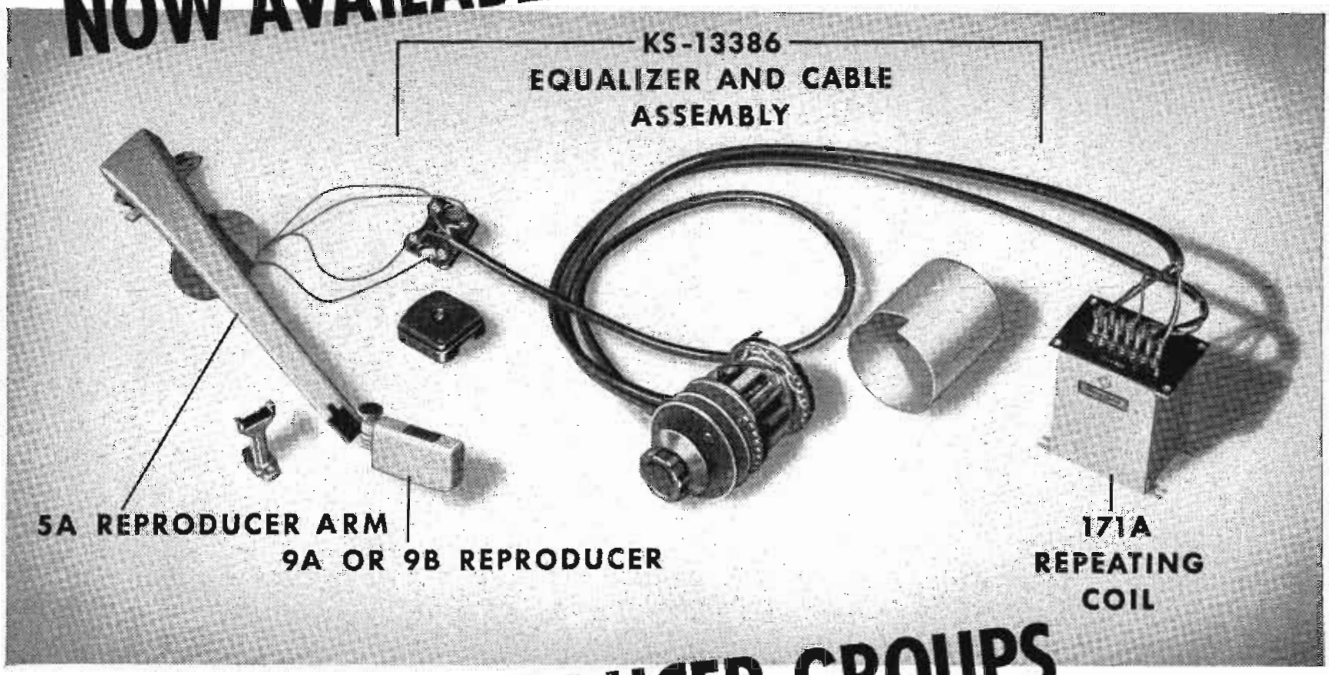

109 TYPE REPRODUCER GROUPS

The time-tested units developed by Bell Telephone Laboratories — manufactured by Western Electric

They're back in stock again! Western Electric's famous 109 Type Reproducer Groups are now available for immediate delivery.

These practical, efficient reproducer groups for use with any transcription turntable are *complete* "packages" incorporating reproducer, arm and rest, equalizer and cable assembly and repeating coil.

They're available in two types: the 109AA, with 9A Reproducer, and the 109B, with 9B Reproducer. Both types of reproducers give excellent results on either vertically or laterally cut discs. The 9A, with a 2 mil radius diamond stylus tip, is particularly outstanding on verticals; the 9B, with a 2½ mil sapphire stylus tip, is especially good for laterals.

The improved equalizer switch provides a choice of 7 positions, 2 for vertical recordings, 5 for lateral. Careful, thorough design and production control assure the closest possible matching of present day recording characteristics. Choice of scratch equalization is provided.

The low intermodulation distortion and wide response of the Western Electric 9A and 9B Reproducers retain for these popular units their leadership in the quality field. *Prove it to your own satisfaction on a well cut disc and wide range system.*

Get the full story on the 109 Groups and the 9 Type Reproducers . . . better still, place your order right now for immediate shipment. Call your nearest Graybar Broadcast Representative, or write Graybar Electric Company, 420 Lexington Avenue, New York 17, N. Y.

Western Electric

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PROMPT, CONVENIENT REPLACEMENT SERVICE ON 9A and 9B REPRODUCERS

Western Electric factory-rebuilt 9 Type Reproducers are immediately available on a revolving stock basis at your Graybar district warehouse. You can also arrange with your Graybar representative to trade in a used 9A against a new 9B, or vice versa.

TELE-TECH

TELEVISION • TELECOMMUNICATIONS • RADIO

O. H. CALDWELL, EDITOR ★ M. CLEMENTS, PUBLISHER ★ 480 LEXINGTON AVE., NEW YORK (17), N. Y.

NON-COMMUNICABLE COMMUNICATION ENGINEERS—A modern inconsistency in this advanced era of communications is the neglect on the part of television and radio engineers to observe the first principles of good communication when addressing engineering audiences with or without aid of microphones and public address systems. It seems an odd fact to find that engineers, whose apparent aim in life is to design efficient sound and sight transmission and reception equipment, fail to observe the requirements of good communication—the ability to be heard clearly. Recent attendance at engineering meetings disclosed the spectacle of engineers speaking into microphones from ineffective distances or with their backs to both the audience and the PA system for no obviously good reason at all with the result that they cannot be heard by half the audience. We submit that communication engineers make a conscious effort to be more communicable by making more effective use of sound systems when addressing audiences. Otherwise they defeat the whole purpose for which they are delivering their talk.

NEW APPROACH TO ENGINEERING EDUCATION—Dean Thorndike Saville of New York University, New York, has a plan of engineering education designed to prepare engineers for managerial positions. By his proposed plan for 3 years of general courses followed by one or two years of specialization, Dean Saville believes 50% of present engineering students would be qualified through judicious choice of selective subjects, to follow an engineering career prepared for managerial posts in industry and government. Adoption of the plan is contingent upon its acceptance by the major engineering colleges.

CARBON-MIKE SUBSTITUTES—One of the first electrical devices to be developed and to become the father of the new industry of telephony—was the carbon microphone. That instrument to this day still fills an important role and, curiously enough, no great changes have taken place in its construction. However several new substitute principles are being actively developed which have created much interest. Some of these are:

- Ceramic film materials that exhibit piezo-electric properties, providing microphones of high quality. Watch for a story on this development in these columns.
- A gelatine-like material charged with metallic flakes (gold?) that have capabilities of a power converter—turning sound waves into a substitute amount of watts without amplification.
- Concentrated research on the electret principles—permanently charged capacitors show that microphones can be developed giving quality at low cost. This phenomena is interesting and as yet largely unexplored.
- New Brush crystals (having all of the sensitivity and activity of Rochelle salts but able to withstand high temperatures) have expanded the field of application for crystal mikes enormously. Someday we expect to see crystal mikes mounted on the bearings of locomotives and other machinery (where 100% reliability is needed) to show when lubrication is insufficient—a case where the squeaky wheel broadcasts its own appeal.

TELEVISION NOTES: HARMONICS, CIRCUITS, LOW-PRICED RECEIVERS, THE THREE Rs—Currently valiant efforts on the part of many amateurs in filtering out harmonic emissions that fall within the television bands must be commended. We remind readers that many useful ideas on this problem appeared in an article on "Eliminating Spurious Radiations" by Dr. V. J. Andrew in the February issue of Tele-Tech, page 22 . . . The more complicated circuits become in TV receivers, the more they multiply the chances for a cheap component to cause trouble and make detection and replacement costly so that any hope of a profit on that receiver is lost. . . Far-sighted management places low price last on his list of objectives. In any new development, not all desirable objectives can be obtained at once. Any short-sightedness on this score resulting in dumping sets that incorporate ill-advised designs does everybody harm—especially the bargain hunters who buy the sets. . . Now that there are so many new names on the panels of television receivers we would like to repeat an observation gained from following radio broadcasting and now television advancement: learn how to build TV receivers *right* before trying to build them *cheaply!* . . . The Third R in the schoolboy's curriculum is an important item in a television man's stock-in-trade just now. While there are many problems that are replete with integral signs and fancy calculus, most of the important problems in receiver design involve the summation and difference frequencies that show up when front-end selectivity is inadequate!

How Much Pay is an Engineer Worth?

Symposium Prepared by the Editors of TELE-TECH

Broadcast engineers voice their opinions regarding pay scales in the engineering profession. Here are some of their answers to this $64 question. What do you think?

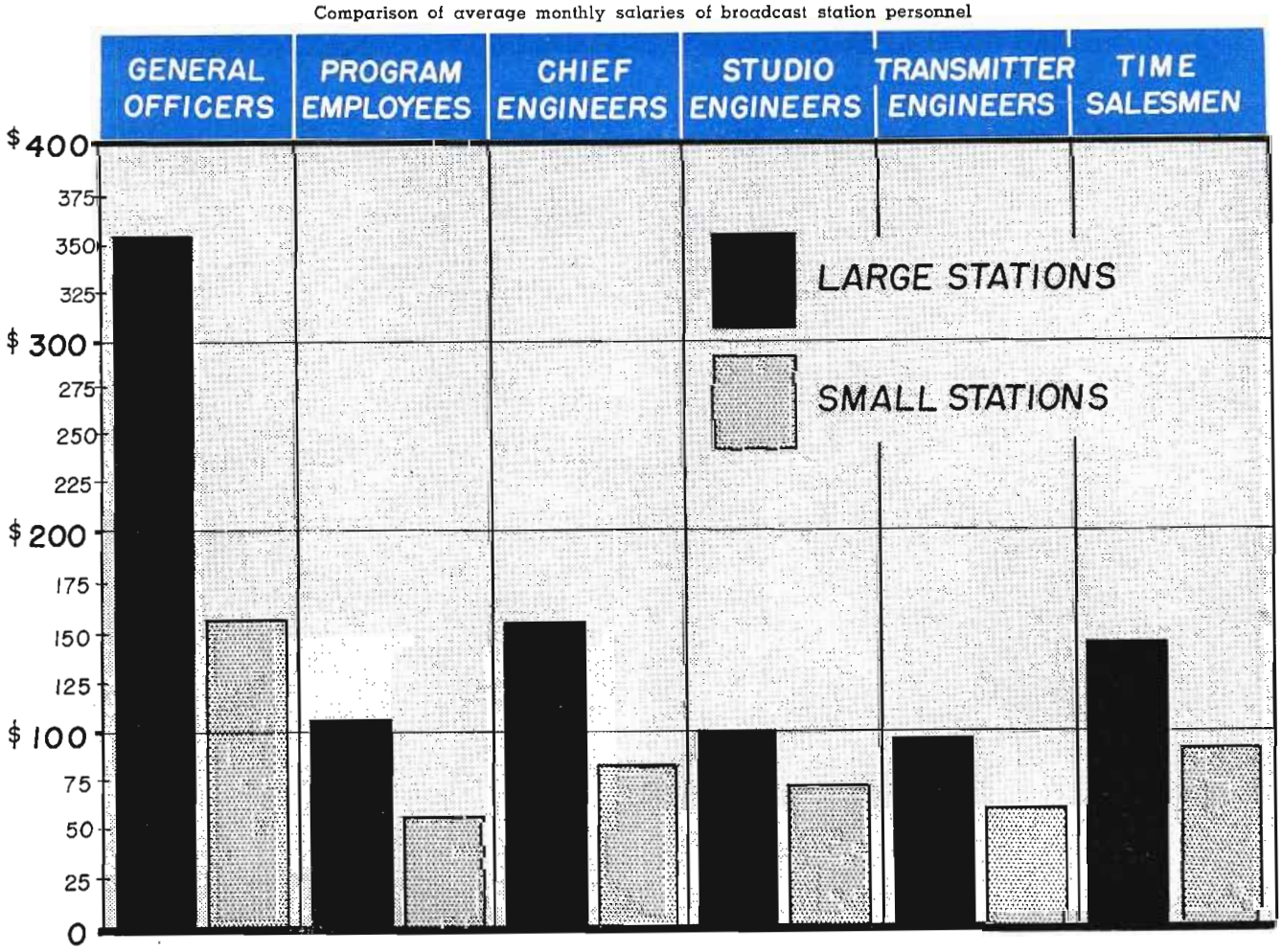
ARE broadcast station engineers adequately paid? In view of the time they must spend in acquiring a technical education to qualify for a job and the responsibility they must shoulder in keeping the station on the air, is pay in keeping with the position they occupy in an organization? Is it in keeping with the pay of engineers in other fields?

In short, is the engineer's pay envelope as fat as it should be?

The question is a moot one. Some believe that present pay scales are on a proper level with the importance of the engineer's job. Others are inclined to the belief that engineers are underpaid; that it is the engineer who keeps the station on the air, and operating in accordance with strict FCC requirements; that without him there just wouldn't be any station.

In any case the fact remains that except in the relatively few large stations, engineers who hold first-class tickets get an average of $64

Comparison of average monthly salaries of broadcast station personnel



a week. Actually, the figure varies from above this to well below it, depending upon station income, geographical location and other factors. You can find numbers of broadcast station operators advertising in the Help Wanted columns for chief engineers with first-class tickets to work for $40 or $50—and they must double as announcers.

According to a recent FCC survey* there are 35,000 persons now employed in radio broadcasting. Of these, 6,500 are technical employes, including qualified engineers, who work an average of 41 hours a week for an average of $72.80. Since this figure includes compensation for technical employes of the larger stations (which number only 1% of the total) this does not represent a true pay picture of the majority of engineers in the broadcast field.

Sixty-three percent of broadcast stations are 1 kw or less. In these small stations the engineer is considerably more of an all-around man than is the large station engineer who tends to specialize. Nevertheless, it does not necessarily follow that the engineer in charge of a small station is a beginner as compared with those who work in large stations.

Nor does it necessarily follow that the broadcast station operator always exercises full control over the pay of his help. In an important percentage of cases the unions have a big voice in the matter, though in the main it is only the broadcast stations in the larger metropolitan centers that are unionized.

What Broadcast Engineers Say

TELE-TECH has received several letters from engineers who have definite opinions on the question of whether or not qualified engineers and responsible technicians are getting paychecks commensurate with their importance in the industry and their responsibilities to their employers and to the public.

Our first opinion is from an engineer associated with a radio station in the South. He states that:

"According to the FCC's Statistics of the Communications Industry in the United States, the average pay for engineers under the grade of chief was $57.04 for the country as a whole. In the Southeast the rate was only $47.28. This is for operational personnel which comprise by far the largest percentage of technical employees. In view of these pay facts, I have formed a purely personal opinion to explain the present sorry plight of the engineer.

"Radio is by nature a subject, mastery of which calls for an enthusiastic approach and a peculiar imagination on the part of the student. This attitude on the part of early experimenters and amateurs caused them to rush in without proper consideration of the real value of their knowledge, when they were offered the opportunity by broadcasting to follow as a career their intriguing hobby. These men were susceptible to lower pay because of their enthusiasm for radio. Since men of this high level of interest are always attracted to the field, there has usually been a sufficient number of technicians available to keep wages down.

"For many years I have been aware of the technical knowledge and skill, the training as well as the inherent ability required of the broadcast engineer. During this

*FCC Public Notice 8304, June 23, 1947.

WHAT DO YOU THINK?

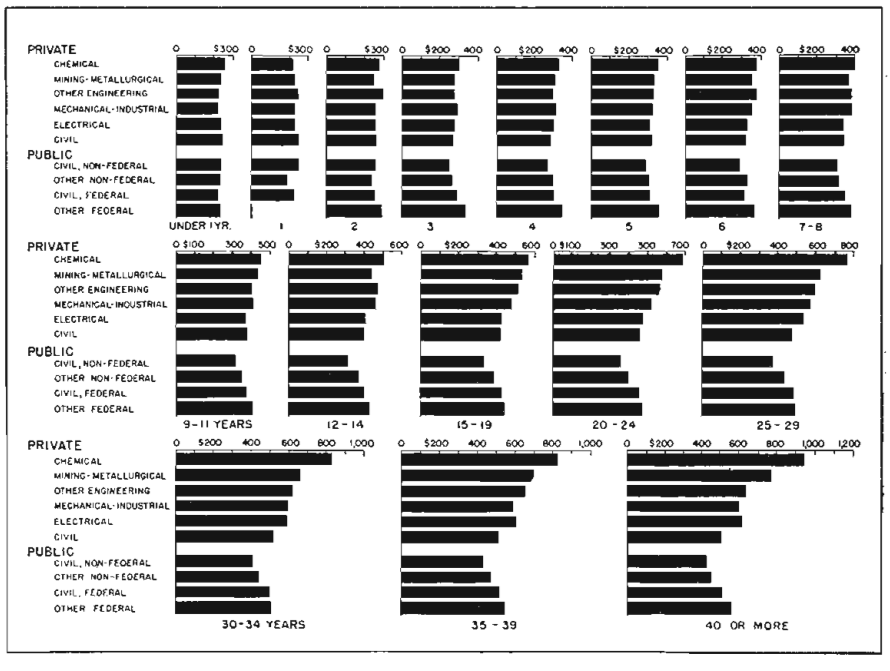
Does the pay of engineers in the communications industry keep pace with the rise in income in other industries and professions? Considering the elements of education, application of skill, engineering responsibilities and contribution to communications and our economic life, are engineers receiving adequate pay? Do engineers feel adequately paid? In short, how much is an engineer worth?

The editors of TELE-TECH went to the engineers themselves to get their opinions. This first article relates to the pay of broadcast engineers whose comments are published herewith. Comments of engineers in other categories of communications will be discussed subsequently.

TELE-TECH takes no sides in this issue, merely seeks to air opinions. Your letters will be welcome.

MONTHLY PAY SCALES IN OTHER ENGINEERING FIELDS

Compiled by Engineers Joint Council in its 1946 survey of engineering profession, table below shows by experience level in years what engineers in private and public industries receive as base pay. Report available from Council, 33 W. 39 St., N. Y. $1.



period I have consistently held that his pay should be a minimum of $300 a month, based on a cost of living index of 100. Of course, with the index recently reported to be at 166, this raises the minimum proportionately to nearly $500., an amount which will cause station managers and owners to shudder.

More Pay for Chief Engineers

"Chief engineers should receive from 10% to 15% more than technicians. In cases where the chief engineer is called upon to act as an executive, he should also be paid for those difficult-to-define qualities which make for managerial capabilities. Special compensation should be provided for any work by consulting engineering caliber done by the engineer whose duties do not normally include research and development.

"Naturally, such a pay scale presuppose certain qualifications on the part of the engineer. The exact requirements might be set up by a Committee of Standards as mentioned later. Certainly the FCC license alone is not enough. In my opinion, before a man begins broadcast operation, he should not only have a thorough background in theory but several years practical experience in such work as receiver repair, or as an *active* amateur or a radio technician in military service.

"Chief engineers, in addition, should have a certain minimum of broadcast experience, preferably in the station where they are to be employed as chief. The chief should be completely familiar with the theory and operation of all equipment under his responsibility at the transmitter and at the studio. He should have a good grounding in directional array theory, where arrays are used. He should be familiar with telephone company operations as it affects his work.

"Broadcast operations are so standardized that it would not be difficult to reduce practically all positions to a few classifications. The pay could then be set up according to these classifications and with consideration of the individual station's income. This classifying and the setting up of standards could be done by a Committee of Standards whose rulings would probably have to be morally binding rather than legally compelling. But who is to set up such a committee? Should it be a government function? The NAB is a suitable body but its members represent management and this committee should be representative. It is not likely that the NAB would favor such a plan.

Peg Salaries to Revenue

"In support of my arguments, let us consider salaries in relation to station revenue. These figures are from the FCC Statistics of the Communications Industry for 1939 and 1945.

"The corrected increase is qualified by the fact that in the 1939 listing, there are 705 stations, and the 1945 table account for 901. Making the very *generous* assumption that the 196 new stations got their full share of the total business, in competition with the older established stations, and that their pay scale was equal with that of older stations (which is not usually the case) the actual increase of business of the 705 previously existing stations is 705/901 or about 7/9 of the total percentage increase shown, with the same average pay increase.

"It can be argued that the 1939-1945 period includes the war years, when wages were frozen, and that therefore normal increases were not granted. I think it will be conceded, though, that normal increases would not likely have been over 100% in a six year period. Certainly since wage controls have been lifted I have not observed any movement to make such an adjustment.

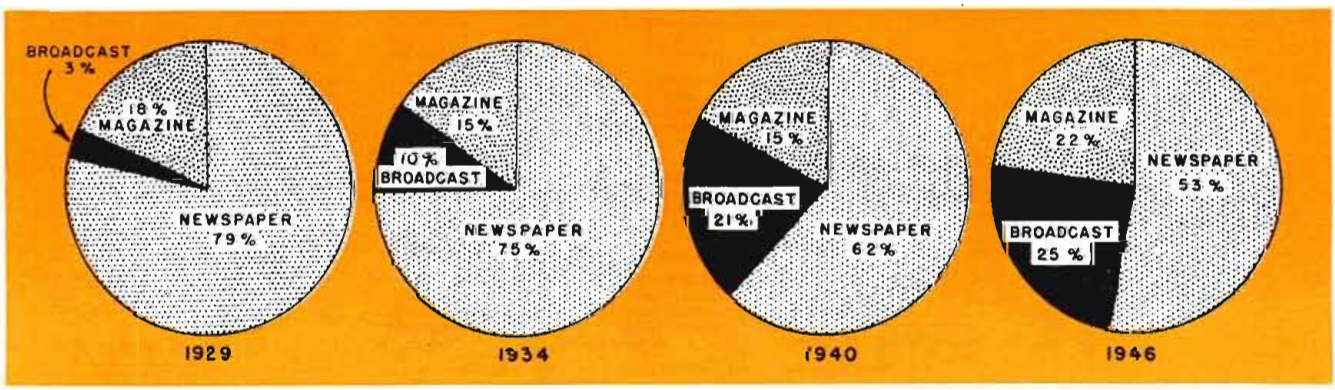
"We must raise our families and provide for future security on the radio engineer's salary. In some areas, in order to achieve this security, engineers formed a union. The union is certainly not an ideal solution. It is not a cure-all. In this region, I would estimate that the union engineer's pay averages about 40%above that of the unorganized engineer. This is still well under $70. per week, which at this time is still barely more than half the figure I place as minimum on the 166 index."

A second letter on engineers' salaries is from a man associated with "a typical 250-watter" whose name is omitted at his request. He says:

"I have held a first class radiotelephone operator's license for 15 years. It has been renewed on the

(*Continued on page* 60)

Has engineers pay increased in proportion to the increase in broadcast advertising? The pie tables below show the percentage of radio advertising to other media through 1946. Broadcast billings, program and talent business brought 1947's volume to $500 million



Ignitrons in Broadcast Service

Application of grid-controlled rectifiers for high-powered broadcast transmitters provides long life and reliability; can be used to regulate voltage output and as circuit breaker

By HOWARD E. ZUVERS, General Electric Company, Schenectady, New York

THE technics and inventions used in one series of applications often may be extended to other fields of usage. Typical of this is the metal-jacketed, sealed ignitron developed for low-voltage rectifiers which provide high-voltage direct-current for radio transmitters. This application provides long life, reliability, and virtually unlimited emission of the pool cathode. In addition, the combination of ignitor and grid control can be used to regulate the output voltage and provide "circuit-breaker" action in the tubes themselves in case of fault in the direct-current circuit. With grid control, the flow of power from the rectifier may be interrupted in approximately one cycle.

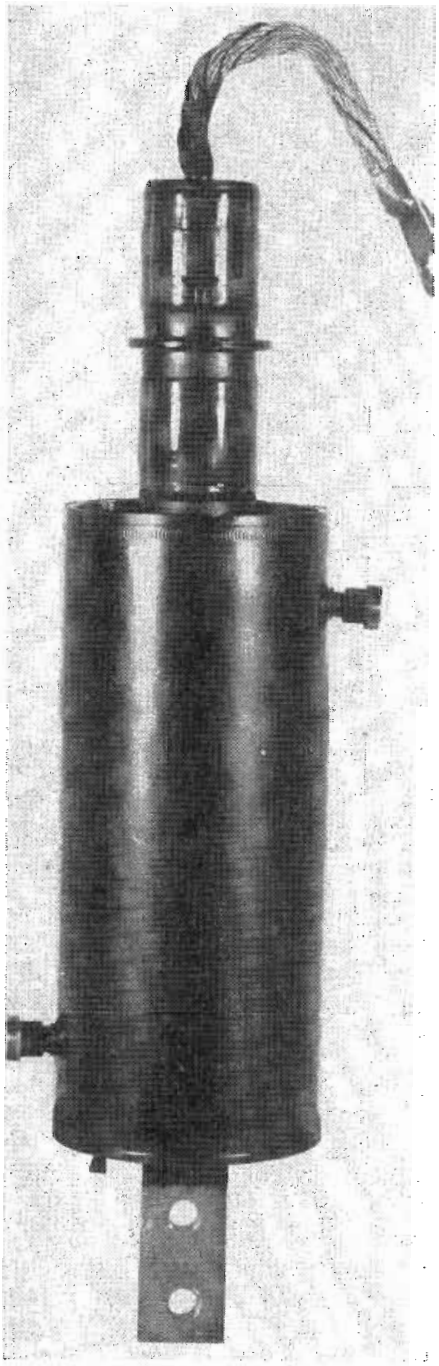
Electronic faults, momentary or transient failures (such as arc backs or gas flashes which do not result in permanent impairment of the tube performance) will probably always be present in high power electronic equipment. The fault current which flows through any short circuit is supplied by energy stored in filter capacitors and reactors, and by the main power supply. The latter will furnish 20 to 40 times normal current when short circuited because rectifier transformers used in radio-transmitter power supplies must be designed with a low impedance to minimize the carrier shift resulting from variations in plate voltage with changing loads. The duration of these fault currents must be limited to prevent damage to a transmitter tube or to a circuit component when a voltage breakdown occurs.

An electric contactor can be used to supplement the action of the mechanical circuit breaker for stopping the flow of energy from the rectifier. It can consist of either an ignitron contractor in the primary of the rectifier transformer or a grid-controlled rectifier. Both the ignitron contactor and the grid controlled rectifier operate very rapidly and will stop the flow on energy from the the ac side of the rectifier transformer to the dc side in one cycle. The mechanical circuit breaker need only be used as back-up protection in event of a failure in the electronic contactor.

An ignitron contactor, when used in conjunction with a phanotron rectifier, forms a composite system that will interrupt the primary currents of the rectifier transformer in less than one cycle. Fig. 1 shows an ignitron contactor used with a phanotron rectifier. Each element of the ignitron contactor consists of 2 tubes in a back-to-back connection. Three pairs of tubes control a three-phase power supply. The ignitor is used to initiate conduction at the beginning of each half-cycle. An auxiliary anode mounted a short distance from the mercury pool is used to maintain cathode excitation for the full 180° in event the main anode current falls below the normal arc-extinction value, and to provide for the no-load exciting current of the power transformer which lags the voltage by approximately 90°.

The ignitron contactor can also be used to reduce or to regulate the output voltage of the rectifier by phase control of the contactor tubes by delaying the firing of the ignitors.

The use of rectifier tubes in which the starting of conduction can be controlled by the grid and ignitor gives the best over-all performance. With this system the rate of decay of direct current can be increased. During normal operation the grids and ignitors are phased to start con-



GE Type 5630 high-voltage, sealed-ignitron. Tube is 34 in. long overall and weighs 23 lb.

duction when the anode-cathode voltage becomes positive. When interruption of the direct current is desired, as in event of over-current, the grids and ignitors are blocked, that is, prevented from firing; hence, no tube not then conducting will begin to conduct. In contrast to the ignitron contactor the rectifier transformer remains energized and the direct current continues to circulate through the dc windings.

The direct-current will decay exponentially as in the case of the ignitron contactor, but in addition there is now superimposed an ac component. The actual current is the sum of the exponentially decaying direct-current and the alternating-current. Current will cease when the sum of these currents equals zero. Since the initial direct-current is approximately twice the alternating-current component, the time required for cessation of current is slightly less than the time constant of the circuit. Use of grid and ignitor blocking on the rectifier tubes, therefore, provides the fastest method of interrupting a rectified direct-current, for only by blocking the rectifier tubes can the ac system voltages be used to commutate out the direct-current. Fig. 2 shows a sealed ignitron rectifier.

Grids are used in ignitrons to improve voltage-control characteristics. The use of grid and ignitor in combination provides characteristics similar to those of thyratron tubes. Even with a positive anode-cathode voltage, conduction will not start until the ignitor initiates a cathode spot and the grid is made positive to attract electrons. The critical grid voltage at which the main anode will conduct is influenced by geometry of the tube, grid spacing, grid thickness, grid hole diameter, operating temperature and residual ionization remaining from the previous conducting period.

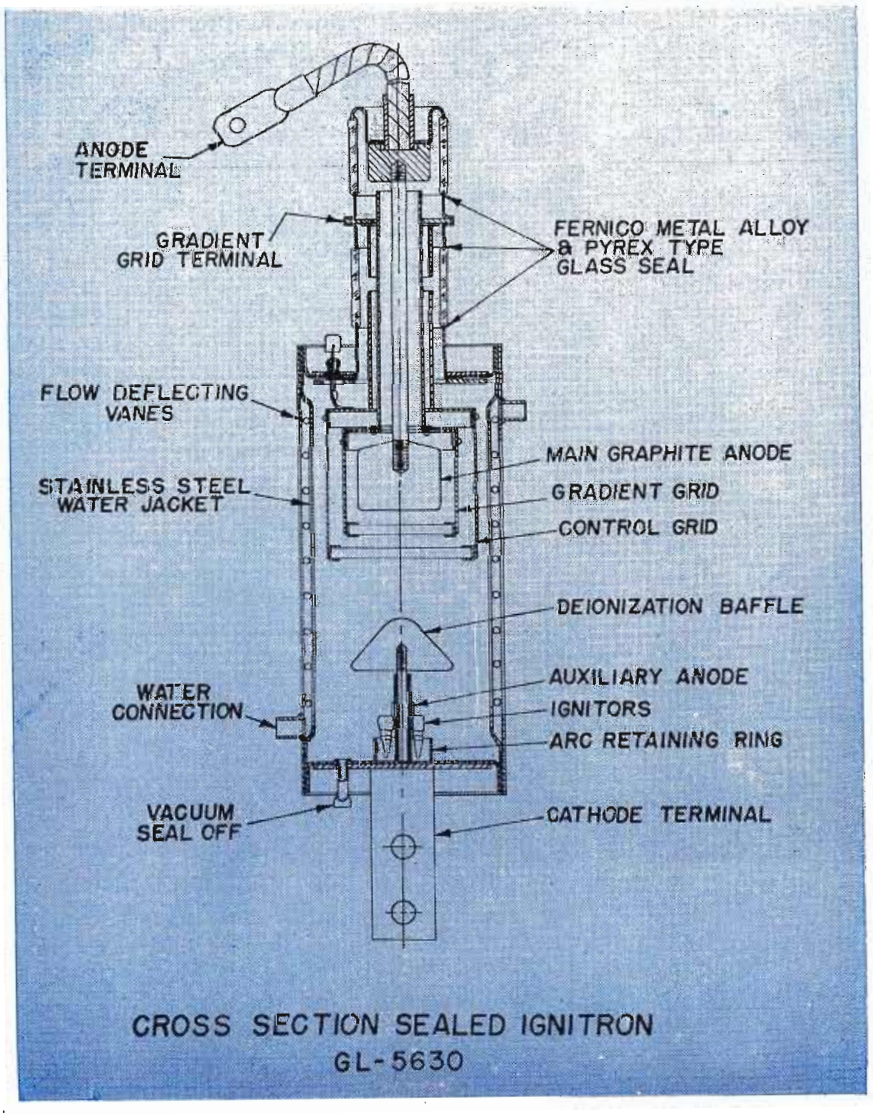
Variation of the grid and ignitor firing time by phase control of the grid and ignitor circuits makes possible regulation of the output voltage. The preciseness of regulation is limited only by the speed of response of the phase-shifting networks used to supply the grid and ignitor circuits. The most accurate firing is attained by pre-firing the ignitor to provide a cathode spot as a source of emission, and then driving the grid positive with a voltage having a steep wavefront. This accuracy of firing (of the order of one microsecond) is unnecessary when the tube is used in rectifier service, the ignitor is used to control the firing point.

There are two principal methods of interrupting the rectifier output current in case of fault. In one, both the grid and ignitor are retarded 90° to the point where the output voltage is zero. In the other the grids and ignitors are blocked so that conduction cannot start in any tube not already carrying current.

Retarding the ignitors more than 90° changes the mode of operation from rectification to inversion with the result that the energy stored in the filter reactor is transferred to the ac system. This method is effective but tends to be slower than grid-blocking because the speed of response is dependent on the rate at which phase shift can take place.

Grid blocking is the term applied to the processes by which the tube is prevented from firing. Once an ignitron starts to carry current, the current cannot be interrupted by any control function of the tube, and must either decay naturally or be commutated out by the ac system. Grid blocking by preventing ignitor firing and maintaining grid voltages at the bias level is com-

Fig. 4: Cross section of high-voltage, sealed ignitron showing general design



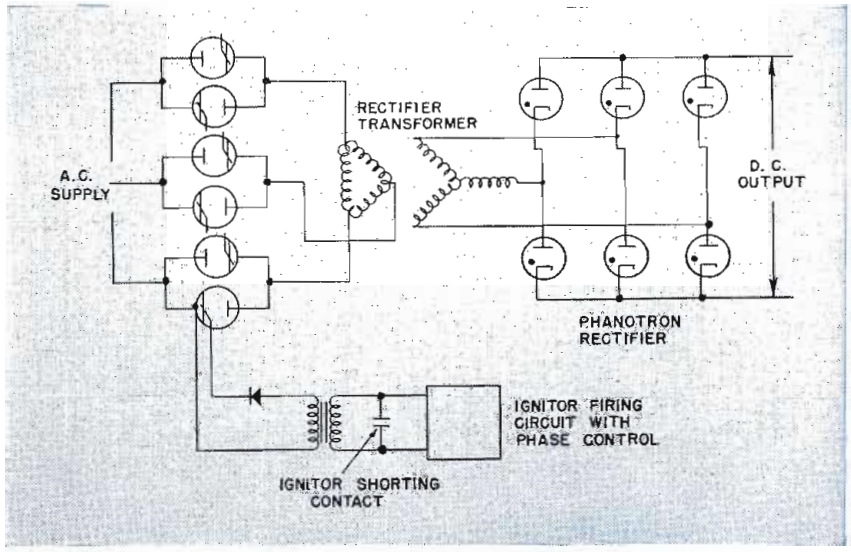


Fig. 1 (above): Phanotron rectifier controlled by an ignition contactor

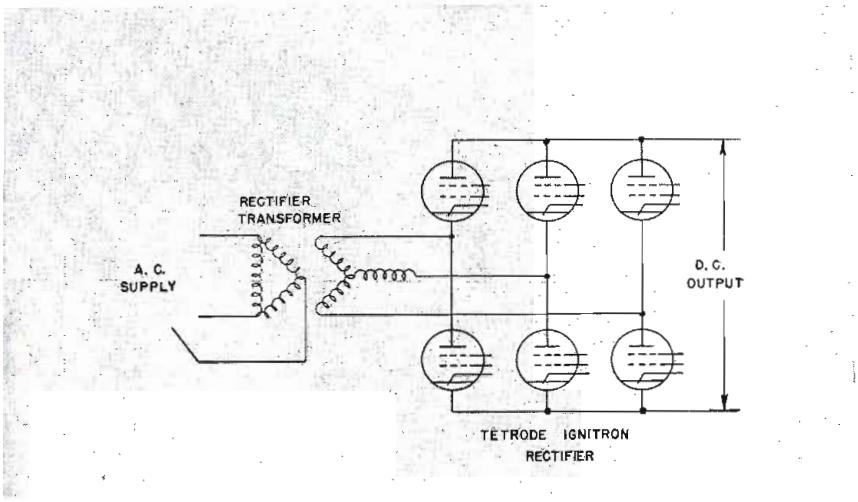


Fig. 2 (above): Ignitron in which rectification and control are in one group of tubes

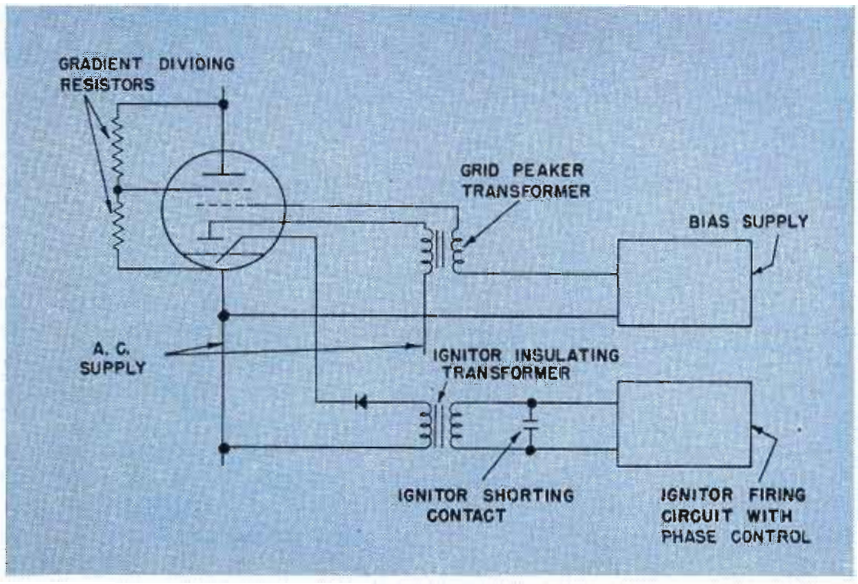


Fig. 3 (above): Grid circuit which interlocks grid pulse with firing of ignitor

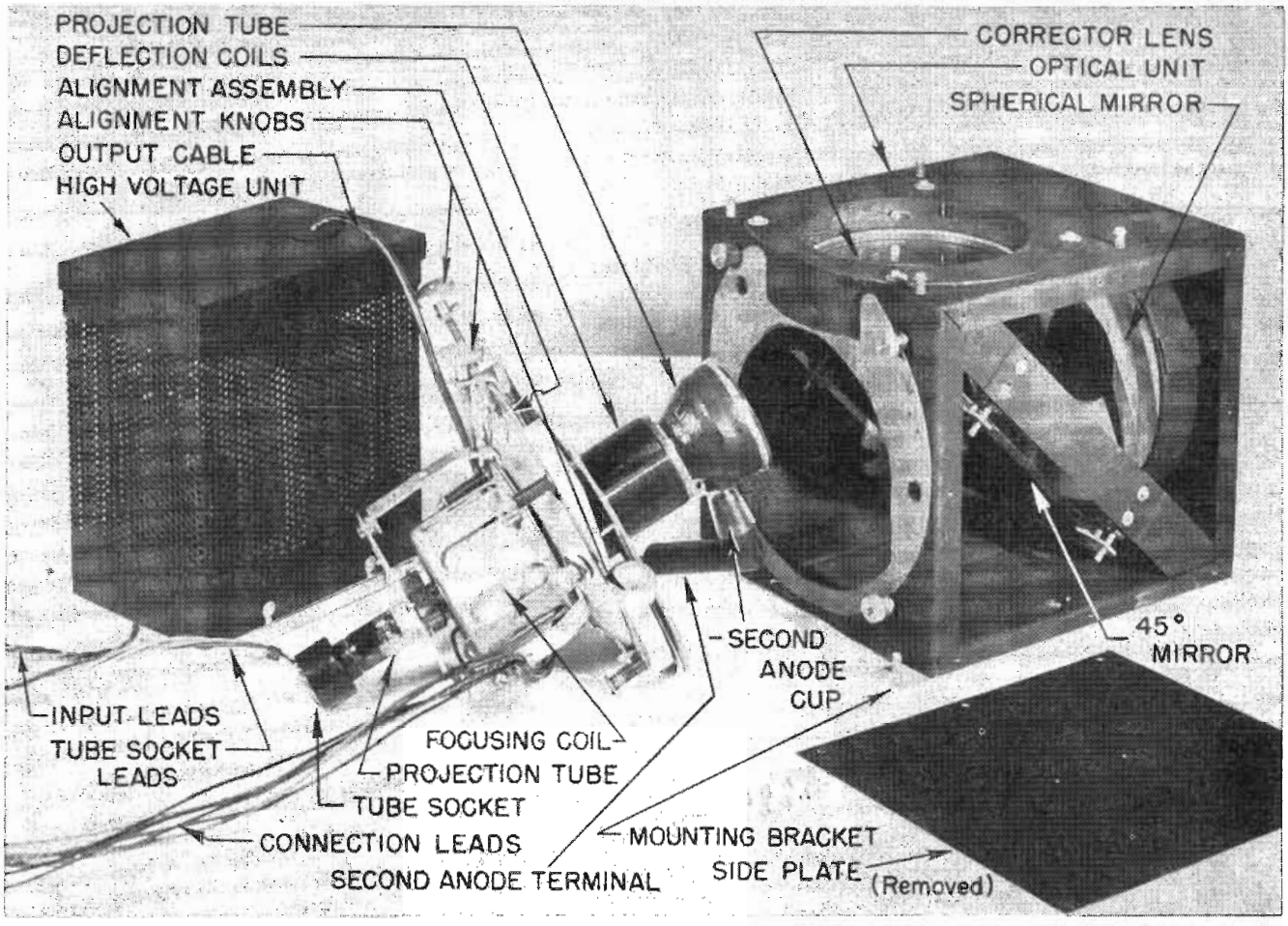
pletely effective in preventing the starting of conduction in the tube not already carrying current. In case of short-circuit of the dc circuit, only the 2 tubes previously carrying current will continue to conduct and the dc current will be commutated out by the ac system. Arc-back current resulting from an arc-back of a rectifier tube is commutated out in one cycle by the ac power system since tubes following in phase sequence are blocked and cannot supply current to the arc-back. Fig. 3 shows a control circuit for grid blocking in which the grid and ignitor are electrically interlocked. In this circuit the primary of the grid peaker transformer is in series with the auxiliary-anode circuit, so that this transformer cannot be energized until the auxiliary anode conducts current, since a conducting path does not exist until a cathode spot is started by the ignitor. The grid, therefore, is interlocked electrically with the ignitor and it is necessary only to block the ignitor impulse to prevent main-anode conduction.

Grid circuits are used accurately to time the beginning of conduction and as an aid in the deionization process when current ceases. The voltage appearing on the grid should consist of an ac positive pulse superimposed on a negative bias. The rate of rise of the grid pulse must be sufficient to insure the desired accuracy of firing. When positive control tubes are used, the grid must not only be driven positive, but the grid current should be sufficient to insure electron diffusion through the grid and rapid starting of main anode current.

A further requirement for a grid circuit is that it have the proper width of grid pulse. For example, when the grid circuit is to be used in a three-phase, full-wave rectifier circuit, the width of the grid pulse must be less than 120° (electrical) so that a negative voltage is available to accelerate deionization, but it must be greater than 60° so that a conducting path will be available through two tubes simultaneously.

The ignitor is an electrode composed of a resistance material which has the property of starting a cathode spot when it is immersed in a mercury pool and energized by a pulse of current. This excitation

(*Continued on page* 68)



North American Philips' television receiver projection package showing 2½-in. tube and mounting and arrangement of mirrors fixed in box

New Projection Package for

Norelco's "Protelgram" projection system for television is adaption of folded Schmidt optical principles; designed to fit various size table and console cabinets

By L. J. A. van LIESHOUT, Assist. Vice-President, North American Philips Co., Inc., New York

A COMPACT television projection package for use with home receivers in various cabinet sizes[1] has been developed by the North American Philips Co. It consists of a tube mounted in a projection box and a high-voltage unit, both of small dimensions. (See TELE-TECH, March 1948, p. 33.)

A 450-line resolution, a contrast ratio of 30:1 and a highlight brightness of 45 foot-lamberts, or more, on a directional viewing screen is obtained from a 1.4 x 1.86-in. picture on the face of a 2.5-in. projection tube (MW-6).[2] The focusing and deflection excitation needed is only that for a normal 10BP4-type 10-in. direct-viewing cathode-ray tube, operated at 9 kv. Therefore, the system is suited for extending 10-in. direct viewing sets into projection television by using the same chassis.

After extensive investigations into the preferences of television audiences it was decided that a 12 x 16-in. screen provides the optimum picture size, permitting good viewing at less than 5 ft. and suitable for more distant observation by large groups.

The system is an adaptation of the "folded Schmidt" optical principles. A new magnetic core material Ferroxcube and a special voltage tripling rectifier system have been used for a 25-kv second-anode

[1] Home Projection Television, Proc. I.R.E., Vol. 36, #3, March 1948.
[2] MW-6 is an experimental number. The tube is being registered with the RMA and will have an RMA number.
[3] Non-Metallic Magnetic Material for H.F.—Philips Technical Review, Vol. 8, #12, Dec. 1946.

supply of the MW-6 projection tube.[3]

The MW-6 is a triode having a five-prong base, with which a special socket is used. It is 10.5 in. with a ⅞-in. neck 7 in. long. The latter extends into a cone, having a flange at the wide end, to which the face plate is sealed. A glass cup surrounds the second-anode contact, which is placed near the face of the tube. A molded thermo-plastic cable terminal, which carries the 25-kv second-anode potential, fits closely into the cup.

Dimensional glass tolerances are held quite closely. Because it is an element in the Schmidt optical system, the face plate must be optically correct. The inside dimensions of the neck have been held to such accuracy that the electron gun is centered by it. Various glasses, developed for specific tasks, are used in the assembly. The face plate is not discolored — as ordinary glass is — by the low intensity, soft, X-radiation produced by the 25-kv electron bombardment. The neck withstands a 25-kv strain and does not accumulate disturbing static charges. The glass cup around the second-anode cable terminal provides added insurance for corona-free operation.

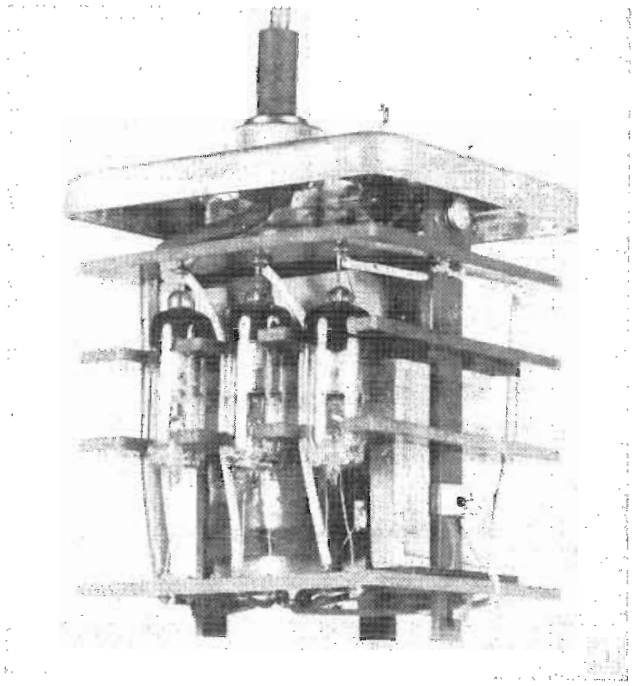


Photo shows inside of sealed transformer assembly and position of the three rectifier tubes as contained in the high voltage unit seen at left in the photo on the opposite page

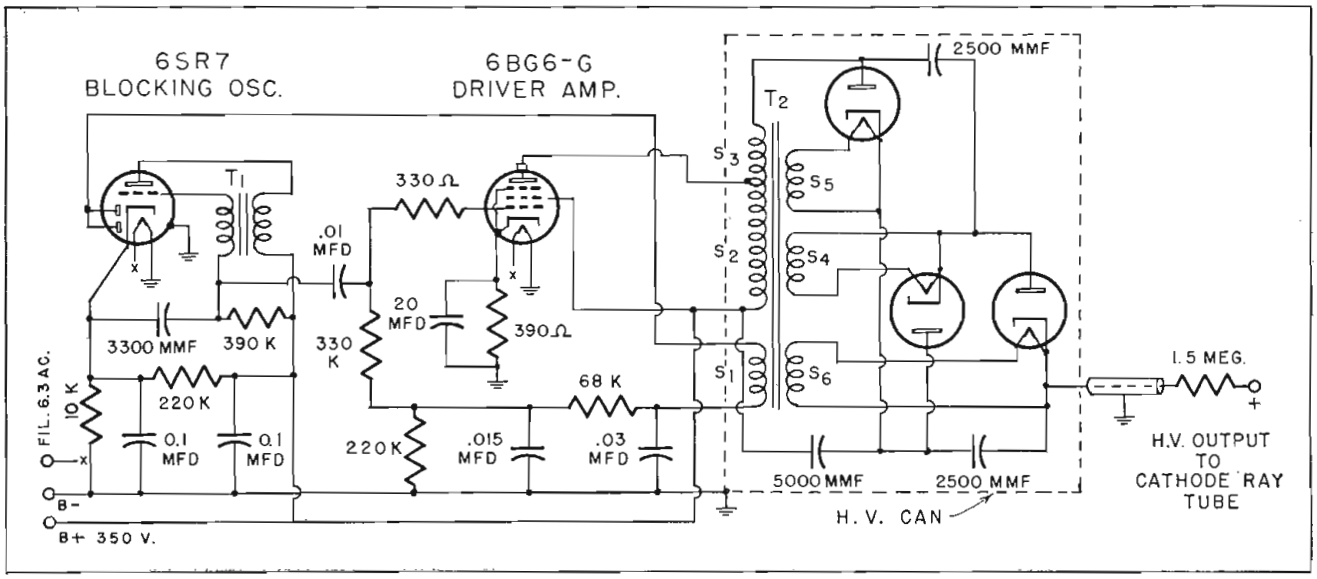
Television

The aluminized phosphor screen increases the light output and prevents ion spots so that no ion-trap is needed. This inside coating — the second anode — covers also the greater part of the cone. An outside coating, of "Aquadag," is grounded and used as a static shield. The capacitance between inside and outside coatings serves as the final filter capacitor for the 25-kv high-voltage unit.

A 1000 ampere-turn coil is used for focusing. While deflection coils meeting standard electrical specifications are used, their shape is necessarily different from conventional forms. The total deflection angle is 40 deg. Grid driving voltage required is about 50 volts peak-to-peak. The filament operates at 6.3 volts, 0.75 amp. Average beam current is approximately 90 μa, but highlight peaks reach 500 μa. Notwithstanding this, the spot remains substantially constant, approximately 0.003 in. The peak brightness on the tube face reaches 3000 foot-lamberts.

The color temperature of the

Circuit diagram of the driver amplifier and high voltage can with power values indicated. Arrangement of rectifier tubes is shown above

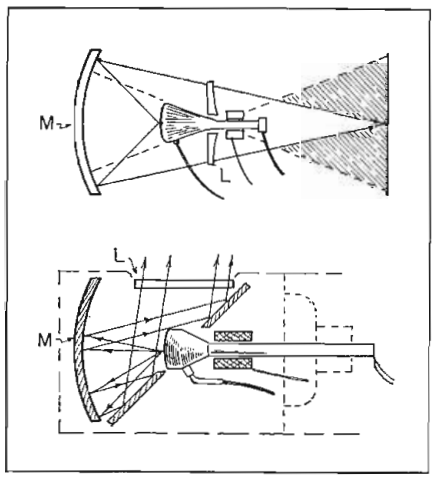


light emitted by the fine grain phosphor screen is approximately 6200° K. giving a pleasant, white color that is highly satisfactory under average ambient lighting conditions. Characteristic performance properties of the projected picture are: high resolution, no change in color with varying picture brightness, good picture fidelity, 30:1 contrast ratio, high brightness and absence of blooming.

The TV Projection Box

The two major parts to the metal TV projection box, the optical unit and an alignment assembly (see photo) are mounted together with 4 thumb screws, allowing rapid tube replacement and service inspection. The optical unit (8½ x 8½ x 9 in.) holds the usual Schmidt optical elements — a spherical mirror of 6-in. diameter, having a 200 mm radius of curvature and an aspherical corrector lens of 4.5-in. diameter — to which a special plane mirror is added. The function of this plane mirror, which is mounted at a 45° angle to the spherical mirror and corrector lens, is shown in the drawing illustrating the tube and mirror arrangement. It "folds" the light beam, hence the description "folded Schmidt" system. There are no obstructions in the light path (with the obvious exception of the tube face itself) that intercept useful light. Clearance for the tube face is obtained by an elliptical hole in the 45° plane mirror. The light emitted from the tube face is gathered by the spherical mirror, reflected to the plane mirror and from there projected upwards through the aspherical corrector lens.

Shaded areas in upper drawing below show the light lost by interception in the conventional Schmidt arrangement. Lower drawing —no light loss in folded Schmidt system



A throw distance of 31 in. from the corrector lens to the viewing screen is required. This light-throw forms an elongated projected beam with a circular base of 4.5-in. diameter at the corrector lens and a rectangular base of 12 x 16 in. at the viewing screen. It can be "folded" again with another (large) 45° plane mirror, near the top of the cabinet, for horizontal projection. The spherical mirror, the 45° plane mirror and the aspherical corrector lens form an optical triangle inside the optical unit. These three elements are adjusted in the factory and remain in adjustment under normal use.

The optical unit is dust-proof. Only the upper face of the corrector lens is exposed. This corrector lens is made from a special gelatin-in-water solution molded to a flat glass plate. This solution is shrunk, by controlled density and evaporation, to the correct shape. The lens is treated against fungus growth and atmospheric influences and then is chemically hardened. The corrector plate is covered with another glass plate so that it can be dusted with an ordinary cloth without being scratched. The linear magnification of the picture is 8.6. A numerical aperture of 0.62 is obtained with the "folded Schmidt" system.

The alignment assembly permits adjustment of the tube and carries the focusing coil and the horizontal and vertical deflection coils. It extends (including the tube and socket) 7½ in. beyond the 9-in. dimension of the optical unit. The optical adjustment is fixed by three locking screws to insure good mechanical stability. The tilting points of the optical adjustment motions must be centered in the middle of the tube face to avoid displacement of the picture with respect to its position on the viewing screen during focusing. A simple and effective alignment mechanism is used for this purpose.

The deflection coils are located inside, while the focusing coil is outside the optical unit. A molded phenolic form is used for the deflection coils, so shaped that the tube seats firmly in it. The deflection coils are so designed that linear current will produce linear deflection over the full picture area.

There are 7 leads to connect the focusing coil, ground, and deflection coils; 5 leads to the tube socket — with filament, cathode and grid connections — and a polyethylene high-voltage cable. All leads are connected either to the tube or to the alignment assembly in which the tube is mounted. This allows operation of the tube outside the optical unit, which aids servicing.

Some care is required to locate the projection box properly with respect to the cabinet mirror and viewing screen. The required accuracy is well within that obtainable in properly mass-produced cabinets. The box is provided with simple mounting brackets and its weight is 18½ lb. Additional means for adjustment suited to special types of cabinets can be readily devised. A black crackle enamel finish is provided for the optical unit. The alignment assembly is cadmium plated.

Two types of focusing coils can be used:

Series type:

r = 300 ohms, i = 120 ma ±10%

Shunt type:

r = 11,200 ohms, i = 20 ma ±10%

Deflection yoke specifications are:

Horizontal deflection coils:

L = 8.5 mh, r = 15 ohms

Vertical deflection coils:

L = 50 mh, r = 65 ohms

25-kv High-Voltage Unit

A 25-kv second-anode supply is needed for the MW-6 tube, with better than average stability to insure optimum picture quality. Small size and the ability to be supplied from a 10BP4-type TV chassis were other essentials. Because existing types of high-voltage sources do not meet these specifications, a new, compact unit was designed having low weight, small size, reliability, great stability and no rf radiation.

The new low-loss magnetic core material made it possible to apply a

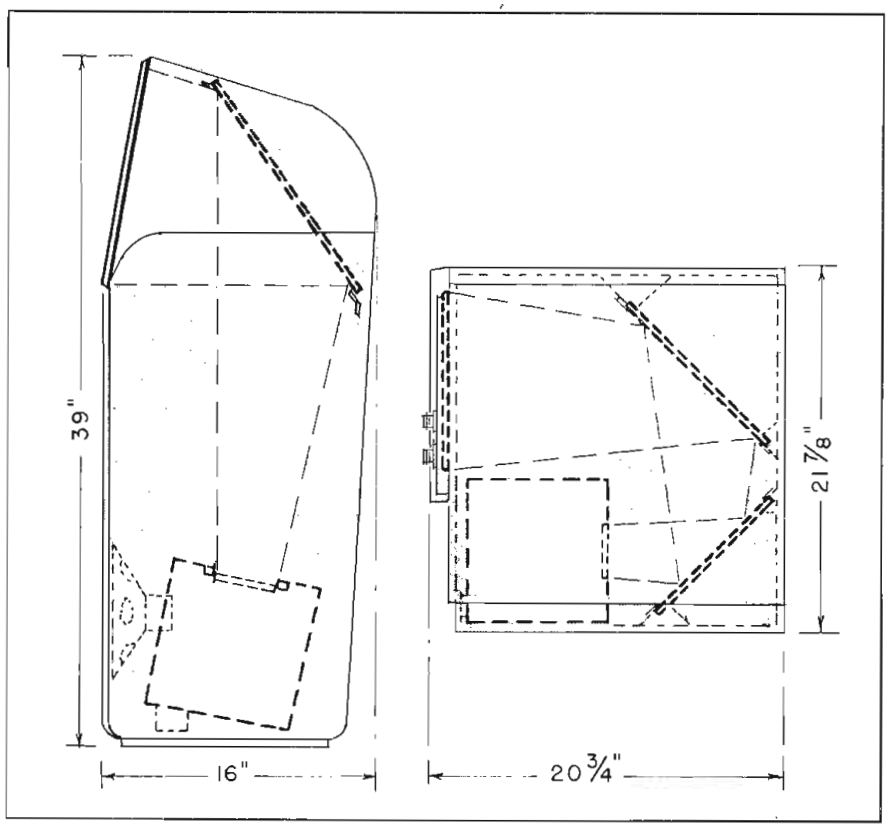
novel approach to voltage multiplication and rectification technics for the voltage and energy levels under discussion.

The high-voltage unit is 8½ in. high, 4½ in. wide and 7 in. long. It has a perforated black crackle enameled cover and a cadmium plated chassis. It can be mounted in various specific positions (according to manufacturer's mounting specifications for the 6BG6G), within a distance from the second-anode contact of the MW-6 that is limited by the length (15 in.) of its insulated second-anode connection cable. The high-voltage unit weighs 5 lb. There are only 3 input connection wires: ground, filament and 350 volts + B.

Input requirements are: filament supply—6.3 volts ac; 1.2 amp (one side grounded). The 350-volts power supply must furnish a 30 ma load without any high voltage drain, and 42 or 50 ma at 100 or 150 μa drain, respectively. Typical output performance figures, with constant input supply voltages are 25.5 kv ±2 kv against ground at no load. This voltage drops less than 600 volts at 60 μa drain and less than 1200 volts at 125 μa drain.

On the 7 x 4½-in chassis are mounted a 6SR7 (duplex-triode) and a 6BG6G (beam power amplifier) with other associated circuit components and the sealed transformer assembly. This transformer assembly measures exactly 4x3x3 in. and contains 3 special rectifier-diodes (described below), magnetic core pieces of Ferroxcube, transformer coil and high-voltage capacitors. It is impregnated under high vacuum and sealed.

The triode section of the 6SR7 (Fig. 4) is used as a 1000 c/s sawtooth oscillator and drives a 6BG6G biased near cut-off. It produces 1000 c/s peak voltages in its plate circuit, which is part of the high-voltage transformer primary. Due to the positive excitation, during part of the 1000 c/s sawtooth excursion, the 6BG6G will draw a plate current almost equal to its maximum emission. Because the transformer is tuned to approximately 25 kc/s, the 1000 c/s pulses will start a 25 kc/s train of damped oscillations. The first oscillation peaks — amounting to 8.5 kv — charge the filter capacitors of the tripler circuit. A 25.5 kv potential is thus obtained by connecting the 8.5 kv output of each rectifier stage in series. Subsequent oscillations are used for feeding the 0.5-watt filaments of the 3 rectifier tubes from 3 separate secondary windings.

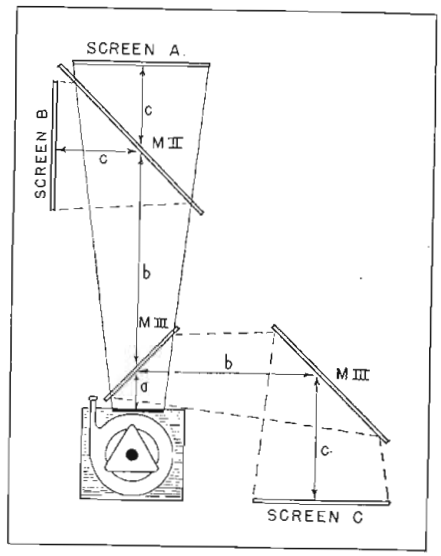


Above are shown two light throw arrangements possible with the "Protelgram" projection box as the system would appear installed in receiver cabinets. Below are three arrangements of the light throw. A is straight throw; B is once folded; C is twice folded. Throw is 31 in.

Improves Voltage Regulation

Part of the oscillations are used, after rectification, as a negative feedback voltage. They are rectified by the 2 diode sections in the 6SR7 and supplied to the control grid of the 6BG6G. The amount of current through the high-voltage transformer primary can, therefore, be controlled, which in turn improves the external voltage regulation characteristic.

The three rectifier-diodes (½ in. dia. and is 1½ in. long) are soldered in the circuit and form an integral part of the sealed transformer assembly. Upon failure, which will be infrequent because of the long useful life of the rectifier-diodes, it is necessary to replace the sealed transformer assembly. Replacement is a simple service operation, involving only 6 screws.

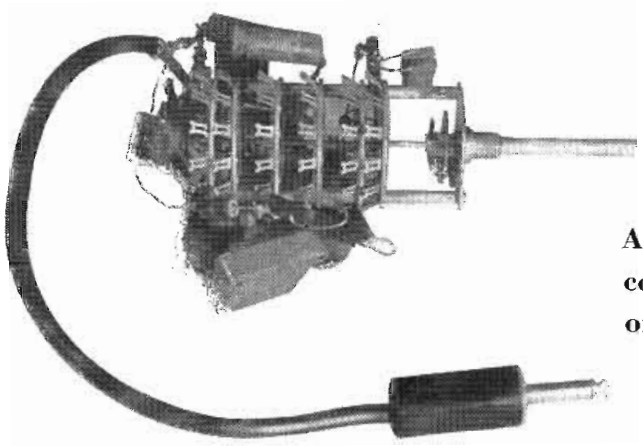


To appreciate the flexibility in cabinet design permitted by this compact television projection package, the following is suggested: cut from a piece of paper the 8½ x 8½-in. contour of the projection box and a trapezoid with bases of 4.5 in. and 12 in., having an altitude of 31

(*Continued on page 56*)

Design of Audio Compensation Networks

By WILLIAM A. SAVORY, Audio Engineer,
Englewood Cliffs, New Jersey



Application of correct equalization for various commercial phonograph recordings has an effect on character of reproduction. Part III of series

THIS is the third and last of a series of articles on phonograph reproduction. This part covers low and high frequency accentuation and attenuation network data, primarily in chart form, for easy interpretation. A circuit for a phono preamplifier incorporating a 6-position combined low frequency crossover and high frequency correction equalizer is included. See January and February 1948 issues of TELE-TECH for Parts I and II.

In the two previous sections of the article, it was assumed that the networks under discussion would be placed in the circuit directly after the reproducer. In the case of the preamplifier furnished with Reproducer A, the low frequency compensation network is actually between plate 1 and grid 2 of the amplifier tubes. An improved type of preamplifier, with a similar network location is shown in Fig. 1. The input transformer may be eliminated, but it was felt that the additional 15 db gain afforded, and the vastly improved signal-to-noise ratio obtained by virtue of the balanced-to-ground input line more than justified the additional cost. The 200-ohm wirewound potentiometer across the 6.3-volt filament winding provides a source of out-of-phase 60-cycle hum voltage to "buck" with and cancel 60-cycle hum encountered in later stages. A non-magnetic chassis and a separate power supply were also employed to reduce hum troubles.

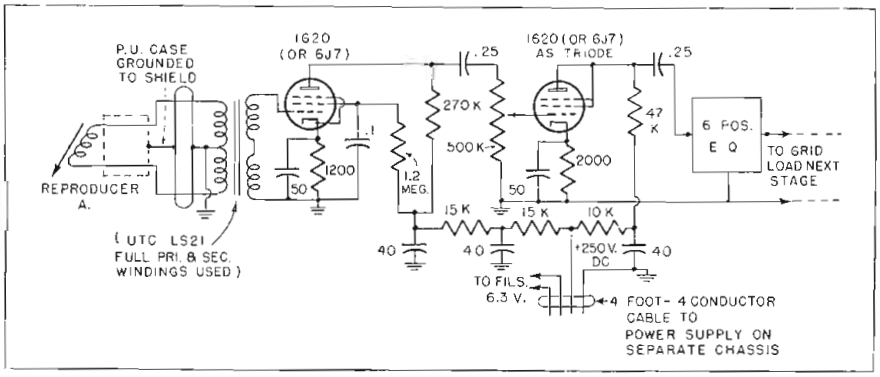
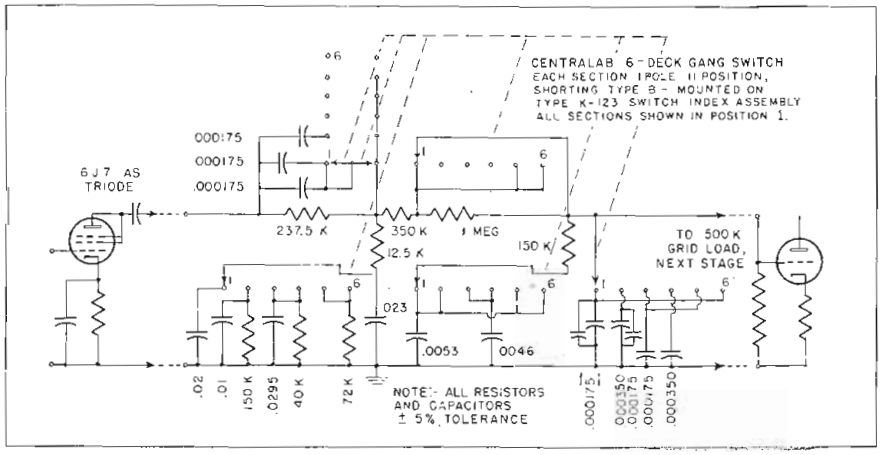


Fig. 1: Circuit used in 2-stage phonograph preamplifier system. 6J7-G has lowest noise level

Fig. 2: Six-position equalizer built up on a 6-deck gang switch designed for tests as described



The 6-position combined low frequency crossover and high frequency correction equalizer, designed for Reproducer A on the basis of information presented in these articles and charts, is shown in Fig. 2. The various network response curves obtainable are shown in Figs. 3 and 4. The top response curves shown were obtained by the following method: For the response in the 50 to 1000 cycles/second region "bare" (unequalized) reproducer runs using the various commercially available frequency records were made. Networks for

compensation of the indicated low frequency recording losses were then designed and inserted in the circuit. For the lower compensated curves, the 1 to 10 kc response was then plotted according to known or "derived" recording characteristics. Individual frequency runs of the reproducer in each equalizer position were then made to determine the extent of high-frequency correction needed. This was necessary because of the additional losses in the 1 to 10 kc region introduced by the low frequency crossover networks. When this information was known, the reproducer high frequency response in each equalizer position was individually corrected to give either "flat" (lower section Fig. 3) or complementary curves (lower section Fig. 4).

An 11-position switch was selected to allow for additional compensation networks to be incorporated, such as the NAB standard for vertical recording, NBC orthacoustic transcription standard, etc. However, the 6 positions provided will accommodate the majority of

(*Continued on page 64*)

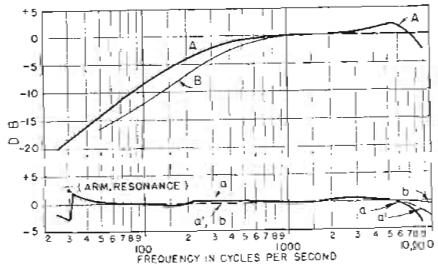


Fig. 3: Curve A shows 25-9500 cycle response; B shows 800-cycle crossover curve; a & b curves are complementary responses

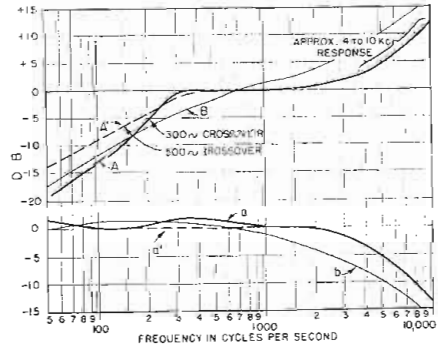


Fig. 4: A is 300-500 cycle response curve; B is lateral transcription response curve. See article for full explanation of curves

Right: Computations needed for setting up networks are shown in charts A, b, C, and D. These are fully described in the article

SLOPE CHARACTERISTIC	6 DB PER OCTAVE	3 DB PER OCTAVE
GENERAL CONFIGURATION	Z_{IN} — R_1 R_2 R_3 C	Z_{IN} — R_1 R_2 R_3 C
INSERTION LOSS:	AT $10 f_{dp} = 20 \log_{10} \left(\frac{R_2}{R_1+R_2}\right) = 20$ DB. FOR a CIRCUIT VALUES, AND 26 DB FOR b.	AT $10 f_{dp} = 20 \log_{10} \left(\frac{R_2}{R_1+R_2}\right) = 10$ DB
RESPONSE VS. FREQ. CHARACTERISTIC	DB, f_{dp} = 3 DB "GAIN" POINT, f	DB, f_{dp} = 3 DB "GAIN" POINT, f
CIRCUIT VALUES:	a: FOR 20 DB INSERTION LOSS * $Z_{IN} = R_1 + R_2$ $R_1 = .9(R_1+R_2)$ $R_2 = .1(R_1+R_2)$ $R_3 >> R_2$ (AS LARGE AS IS PRACTICABLE – SEE DESIGN NOTES IN PART 1 OF TEXT.) $C = \frac{10^6}{2\pi f_{dp} R_2}$ b: FOR 26 DB INSERTION LOSS * $Z_{IN} = R_1 + R_2$ $R_1 = .95(R_1+R_2)$ $R_2 = .05(R_1+R_2)$ $R_3 >> R_2$ (SEE NOTE UNDER a, ADJACENT) $C = \frac{10^6}{2\pi f_{dp} R_2}$	* $Z_{IN} = R_1 + R_2$ $R_1 = .7(R_1+R_2)$ $R_2 = .3(R_1+R_2)$ $R_3 >> R_2$ (SEE NOTE UNDER a, ADJACENT) $C = \frac{10^6}{2\pi f_{dp} 2R_2}$
(A)		

SLOPE CHARACTERISTIC	6 DB PER OCTAVE	3 DB PER OCTAVE
GENERAL CONFIGURATION	R_1 C R_2	R_1 C R_2
INSERTION LOSS	AT $f_{dp}/10 = 20 \log_{10} \left(\frac{R_2}{R_1+R_2}\right) = 20$ DB *	AT $f_{dp}/10 = 20 \log_{10} \left(\frac{R_2}{R_1+R_2}\right) = 10$ DB
RESPONSE VS. FREQ. CHARACTERISTIC	DB, f_{dp} = 3 DB "GAIN" POINT, f_{HL}, f_{OL}, f_{ML}, f	DB, f_{dp} = 3 DB "GAIN" POINT, f_{HL}, f_{OL}, f_{ML}, f
CIRCUIT VALUES	$R_1 = .9(R_1+R_2)$ $R_2 = .1(R_1+R_2)$ $C = \frac{10^6}{2\pi f_{dp} R_1}$ * MAX. INSERTION LOSS FREQ., $f_{ML} = f_{dp}/10$ (=20DB) HALF-LOSS FREQUENCY, $f_{HL} = 4 f_{dp}$ (=10 DB) MIN. LOSS FREQUENCY, $f_{OL} = 10 f_{dp}$ (= 4 DB)	$R_1 = .7(R_1+R_2)$ $R_2 = .3(R_1+R_2)$ $C = \frac{10^6}{.2\pi f_{dp} .615 R_1}$ * $f_{ML} = f_{dp}/10$ (= 10 DB) $f_{HL} = 1.7 f_{dp}$ (= 5 DB) $f_{OL} = 10 f_{dp}$ (= 1.2 DB)
(B)		

TYPE:	LOW FREQUENCY ATTENUATION	HIGH FREQUENCY ATTENUATION
GENERAL CONFIGURATION	R_1 R_2 R_3 R_C C_1	R_2, OR R_3 — C_R
INSERTION LOSS:	AT $f_{dp}/10$, WITH $R_C = X_{C_1}$ LOSS UNDER NORMAL 6 DB PER OCTAVE SLOPE = 2 DB	(AT FREQ. WHERE $X_{C_R} = R_2$ OR R_3) = 3 DB, AND FOLLOWS A 6 DB PER OCTAVE SLOPE AS f INCREASES
RESPONSE VS. FREQ. CHARACTERISTIC	DB, $f_{dp}/10$, f_{dp}, f	DB, f_{dp}, f
(C)		

GENERAL CONFIGURATION	RESPONSE VS. FREQUENCY CHARACTERISTIC
C_2 R_1 R_2 R_3 C_1	DB, $f_{dp(LF)}$ $f_{dp(HF)}$, f
(D)	

Lab Testing TV Receivers

Equipment for development of television receivers includes instruments not generally used in set design; basic equipment and their test characteristics are described in this article

By WILLIAM F. BAILEY, Engineer-in-Charge, Television Advanced Development Lab., Hazeltine Electronics Corp., Little Neck, L. I.

LABORATORY equipment which must be set up for development of television receivers includes many instruments not commonly used in the design of radio apparatus for sound transmission. Some of these devices are complex and expensive, and laboratories which have not been active in television work may experience difficulty in deciding which pieces of equipment to buy. Some of the instruments that would be very useful in television-receiver development work are not yet available commercially.

In making up the list of necessary items of equipment, several factors were considered: Scale of work contemplated; availability of television broadcast signals; amount of money to be invested in test equipment. Apparatus ordinarily regarded as standard laboratory equipment is not listed here.

In this list, the first 10 items are believed to be the minimum equipment with which any reasonably successful television receiver development can be done.

While these 10 items may be used to determine the essential operating characteristics of a television receiver, testing will be rather laborious and time-consuming. Response characteristics of the several amplifier sections of the receiver will have to be adjusted and measured by the point-by-point method. The specific items may require certain desirable specifications. For example, the television oscilloscope should have a vertical deflection amplifier with a bandwidth of at least 3 mc (preferably 4 mc). The cutoff characteristic at the high-frequency end should be sufficiently gradual, preferably not exceeding about 15 db per octave until the amplitude response is down about 30 db. At the LF end, this amplifier should transmit a 60 c/s square wave with a variation of amplitude during the flat portions of the wave of less than $\pm 2\frac{1}{2}\%$. The deflection sensitivity should be continuously adjustable over a range from about a tenth of a volt to 200 volts (peak-to-peak) per inch.

The horizontal deflection circuit should provide a normal sawtooth sweep over the frequency range from less than 30 c/s to more than 30 kc. Some form of mono-line sweep should also be available; in this type of deflection, the repetition rate is 60 sweeps per sec. The sweep duration should be continuously adjustable from a minimum of about 100 microsec to a maximum of at least 2 millisec so that a portion of the picture ranging from about 2 to 40 lines may be observed. If the start of the mono-line sweep is made continuously adjustable in phase over a 360° range from a reference 60-cycle signal, then any portion of the picture signal may be displayed.

A square-wave signal at 30 c/s or frame frequency may be introduced into the vertical deflection amplifier, to separate successive traces, with its phase fixed relative to the 60-cycle sweep signal. This arrangement displays 2 traces on the screen, one for each of the 2 fields making the complete frame (Fig. 1). A signal derived from the horizontal sweep wave may be used to turn the beam on during the useful trace times.

Video-frequency generators capable of producing a sine-wave output of at least a few volts over a frequency range extending from 20 c/s to 5 mc are currently available from several manufacturers.

In current television receiver de-

TEST EQUIPMENT FOR TV RECEIVER DEVELOPMENT

Minimum Equipment Required

- Television Oscilloscope
- Video-Frequency Signal Generator
- Intermediate-Frequency Range Signal Generator
- Radio-Frequency Range Signal Generator
- High Voltage Voltmeter
- Sensitive RF Voltmeter
- Television Monitor Receiver
- Set of Wavemeters
- Scanning-Slope Detectors
- *Communication-Type Receiver*

Supplementary Test Equipment

- RF Impedance-Measuring Equipment
- Random-Noise Generator
- Impulse-Noise Generator
- Squarewave Generator
- Camera for Film or Direct Pickup

Additional Useful Equipment

- IF Range Sweep Generator
- RF Range Sweep Generator
- Video-Frequency Range Sweep Generator
- Television Pulse Generator
- Monoscope Signal Generator
- Scanning Linearity Pattern Generator
- Stepwave Signal Generator
- Picture Monitor
- RF Signal Generator (Suitable for TV Picture Modulation)

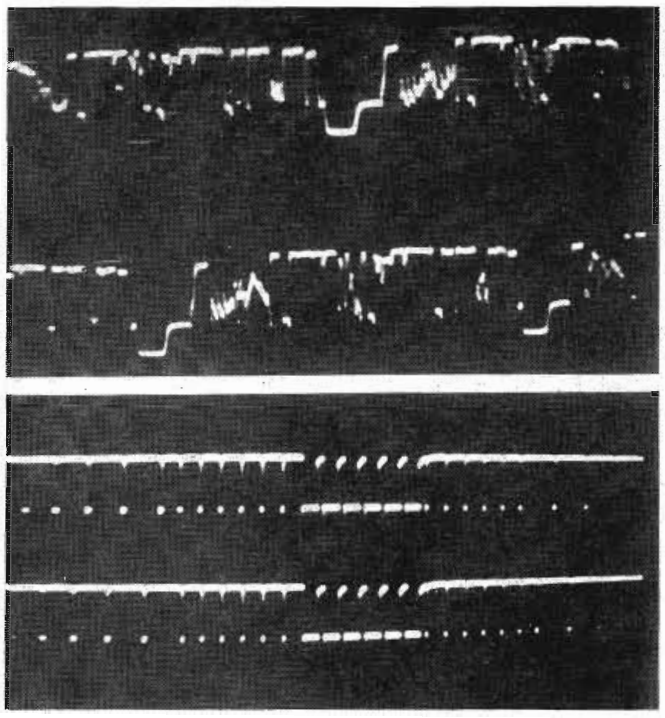


Fig. 1: Oscillograms made with Mono-Line Sweep. Upper view shows complete signal from successive fields. Lower view shows sync signals in vicinity of field retrace in interlaced relation

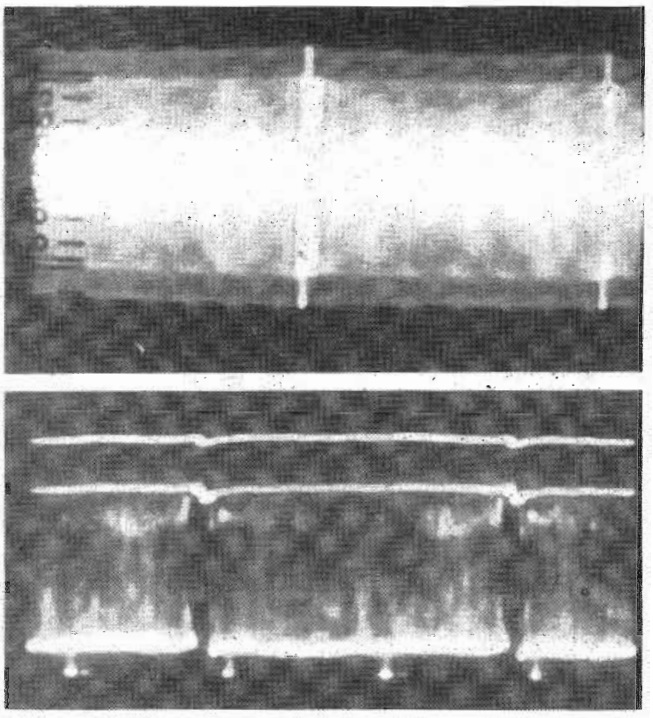
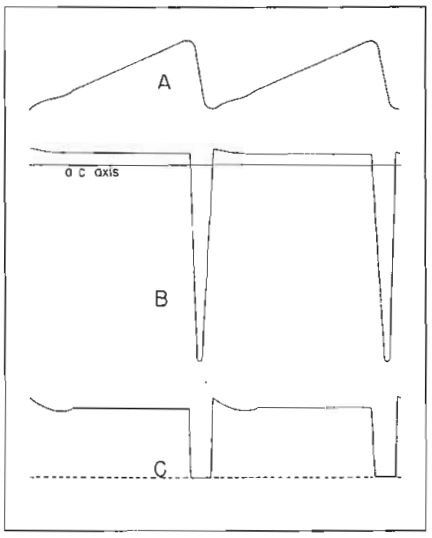


Fig. 2: Picture signal in carrier and video forms are shown. Upper view is modulated IF wave with sync peaks outermost. Lower view is of video only matching upper half of top view. See article

sign, the intermediate-frequency IF range is from about 21 to 27 mc, but for development work, a signal generator for testing IF amplifiers should probably cover the frequency range from 15 to 40 mc giving at least a tenth of a volt (preferably 1.0 volt) so that measurements may be made of high-level circuits. The output attenuator should be capable of reducing the level to at least 110 db below 1 volt, or to 3 microvolts.

Fig. 3: Graph of slope detector waveforms. A is sawtooth current flow in deflecting coils; B is induced voltage in pickup coil; C indicates the scanning velocity



Both sine-wave AM and FM should be provided. It is also very useful to be able simultaneously to amplitude-modulate and frequency-modulate the generator with different audio frequencies for the development of frequency-modulation detectors. It is possible to meet these requirements by employing several generators, but no single generator is available which meets all requirements.

The RF signal generator should be suitable for both RF circuit development and overall receiver testing. For RF circuit development a signal, having a maximum output level of at least a tenth (preferably 1.0) volt, should be available.

For overall testing of the receiver picture circuits, both cw and pulse-modulated signals are desirable over the television frequencies and extending about 50 mc wide above 88 and 216 mc so that image rejection and oscillator radiation may be measured.

It appears to be an advance in the art to use a pulse-modulated signal for measuring some of the overall characteristics of the picture portion of a television receiver. By using a pulse-repetition frequency close to 15,750 pulses per second, with an 8% to 10% duty cycle, the actual television signal is more nearly simulated than by sine-wave modulation. The action of dc restorers in the television receiver would be essentially normal with the pulse-modulated signal, and the output level may be easily measured with an oscilloscope.

For high-voltage measurements, a meter drawing 50 μA or less at full scale is desirable and, for work on most direct view tubes, a full-scale value of 10 kv is suitable. Instruments for this range are commercially available.

For work on either projection tubes or some of the larger direct view tubes, voltmeters should be capable of reading to 30 kv or perhaps 50 kv full-scale. Commercial instruments suitable for this range are procurable.

For RF circuit development, a sensitive tube voltmeter to about 250 mc is required. A very useful and highly sensitive RF voltmeter[1] uses a 1N28 crystal rectifier in a low-impedance circuit (without any associated vacuum tubes). The instrument, useful from about 10 to above 250 mc has an essentially square-law characteristic over a range of rectified dc output from 1 to 10 μa. As the sensitivity over this

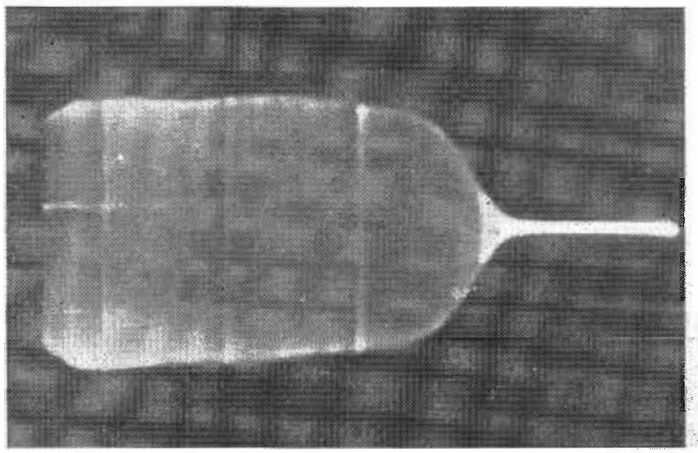


Fig. 4: Signal generator with swept video modulation shows IF receiver response on the left and HF at the right as recorded in the lab tests

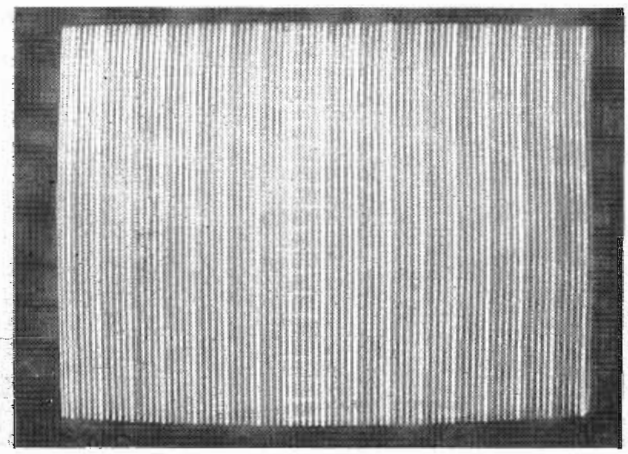


Fig. 5: This test shows the appearance of the linearity pattern on a receiver with good scanning performance. Details in text

range is high (about 1000 μa per volt-squared), RF voltages lying between about four-hundredths and a tenth of a volt rms can be handled. The instrument can also be employed for measuring the rms voltage of wide-band random noise.

A television monitor receiver should be at hand to show depth of modulation of the various parts of the picture signals. This instrument will show the measurement conveniently as an oscillogram. There is needed, however, a definite reference level for zero carrier amplitude, so that the black level, or the level of any of the picture signal components, may be evaluated in terms of peak carrier.

The upper oscillogram of Fig. 2 illustrates a display of the television signal as a modulated envelope before detection to video frequency with a superheterodyne receiver by amplifying the IF signal to a level of about 75 volts peak-to-peak applying directly on the cathode-ray tube. The synchronizing signals occupy the outer 25% zones of the envelope. The picture components occupy the inner regions from 75% amplitude to approximately zero. As the cathode-ray beam is moving vertically at the IF rate, the pattern is filled in and observation of fine detail in the signal is poor.

The lower oscillogram of Fig. 2 shows a different display technic[2] where the signal is converted to video frequency by the second detector, and the level corresponding to zero carrier is established in the diode circuit by short-circuiting the detector output load periodically at a point where the dc component of the signal has been retained. The times at which this short-circuit is applied are not critical. The synchronizing-signal peaks (representing 100% carrier amplitude) are shown as the separated horizontal line in the upper part of the oscillogram. The small intervals at the bottom represent zero carrier, as the diode load voltage is zero because of the short-circuit during these times.

Slope Detector Waveforms

After the input-output characteristic of the receiver have been determined, the degree of modulation of any signal component may be measured. The use of a crystal rectifier for the second detector helps to obtain a substantially linear relationship between signal amplitude and oscillogram amplitude, since the crystal exhibits no initial current.

A set of simple absorption-type wavemeters (10-500 mc) are useful in the approximate adjustment of the local-oscillator frequency, and for locating any HF parasitic oscillations.

A set of scanning-slope detectors should be available to show nonuniform scanning velocity. It is difficult to make quantitative investigations of the velocity variation and to evaluate the improvement caused by minor changes. The slope detector consists of a pickup coil,[3] which may be inserted into the deflection yoke in place of the picture tube, and an associated clipper circuit.

In Fig. 3, wave A indicates the sawtooth current flowing in the deflecting coils. Wave B, which is the derivative of A, is the induced voltage in the pickup coil. Here the narrow negative pulses indicate the retraces and the long positive intervals between pulses indicate the trace periods. The output voltage is amplified, if necessary, clipped on its ac axis (so that high-amplitude retrace pulses are suppressed), and remaining voltage amplified and displayed on an oscilloscope as wave C, in which the ordinate at any point indicates directly the rate of change of the magnetic flux, and thus the scanning velocity. Where the radius of curvature of the fluorescent screen is not the same as the distance from the effective center of the deflection yoke to the screen, a correcting factor, which is a function of the spot location on the fluorescent screen, must be used.

A characteristic of television receivers which is important at the present time is the signal radiated by the local oscillator. A communication-type receiver covering the local-oscillator frequency range of about 70 to 250 mc appears to be the best laboratory measuring instrument for determining the oscillator radiation level.

While development of IF ampli-

[1] Constructed by B. F. Tyson of the Hazeltine staff.
[2] Method proposed by T. J. Buzalski (NBC).
[3] U. S. Patent 2,347,064 issued to H. A. Wheeler contains circuits and a further discussion of the slope detector.

fiers can be conducted with point-by-point measurements of the frequency characteristic using a standard cw signal generator, measurements may be made much more rapidly with a sweep generator several types of which are available commercially. For eliminating regeneration, checking the effect of the IF gain control on the frequency characteristic, or the final touching up of an amplifier amplitude characteristic, such a sweep generator is very desirable.

The same comments apply to the RF sweep generator for the development of the RF tuning unit and checking overall regeneration. In conjunction with a long length of antenna cable, such as 100 ft. or more, it has been used to measure the change in the overall frequency characteristic of a receiver caused by the antenna mismatch. There are several instruments of this class on the market today using either a mechanical sweep or an electronic sweep.

A sweep generator covering the video-frequency range is also a time-saving device to check the video amplifier or to amplitude-modulate an RF carrier by the swept video-frequency signal for overall checking.

If the receiver video output signal is then displayed on an oscilloscope several items of information may be evaluated readily as in Fig. 4. Since the modulation will be double-sideband up to video frequencies of at least 1¼ mc, the designer may determine the correctness of the combined RF and IF frequency characteristic in the vicinity of the carrier frequency. It is necessary not only to provide 6 db attenuation at the carrier frequency, but also correct shaping of the characteristic for about 1 mc on either side of the carrier in order to obtain good vestigial-sideband operation. An imperfect match of the attenuation on each side of the carrier frequency will be indicated by a variation in the receiver video output over the range up to about 1 mc.

An additional measurement which may be made with the video sweep signal is the overall conversion at the second detector from a modulated IF signal to a video-frequency signal. A diode rectifier with a relatively low-impedance load is normally used to demodulate the IF signal. The driving impedance for the diode, that is, the output impedance of the final IF coupling network, affects the rectification efficiency and the damping on the detector video-frequency load. The driving impedance is not, in general, uniform over the IF pass band, and also may have variations over the video-frequency range, both of which influence the video-frequency output. While these factors may not be explicitly isolated by this method of testing, their effect on the overall conversion from a modulated IF signal to a video-frequency signal may be measured.

To avoid dependence upon broadcast signals for overall testing, the first element needed is a generator to supply the standard television synchronizing waveform and a set of blanking signals properly related to the synchronizing signals. Several designs of equipment of this sort are available.

Test For Contrast

An overall check of television picture resolution and of contrast range is most conveniently made by the use of a transmitted television picture having resolution wedges and such areas of known brightness as can be produced readily by a monoscope signal-generating tube such as the type 2F21 with its associated scanning, high-voltage and video-amplifier circuits. Apparatus of this sort is available.

For evaluating the overall scanning linearity and measuring the effective retrace duration of the scanning generators, a linearity pattern generator produces and mixes signals at harmonics of the horizontal and vertical scanning frequencies. See Fig. 5.

Next, a stepwave generator which produces a signal having, in this case, 7 equal steps over one field interval, is useful. Low-frequency transmission troubles and non-linearity in the amplitude characteristics of the electrical circuits of a receiver may be evaluated by means of this sort of signal, Fig. 6.

A picture monitor, which displays the signals generated by the monoscope camera, the scanning-linearity signal generator, or the stepwave generator before modulation on the

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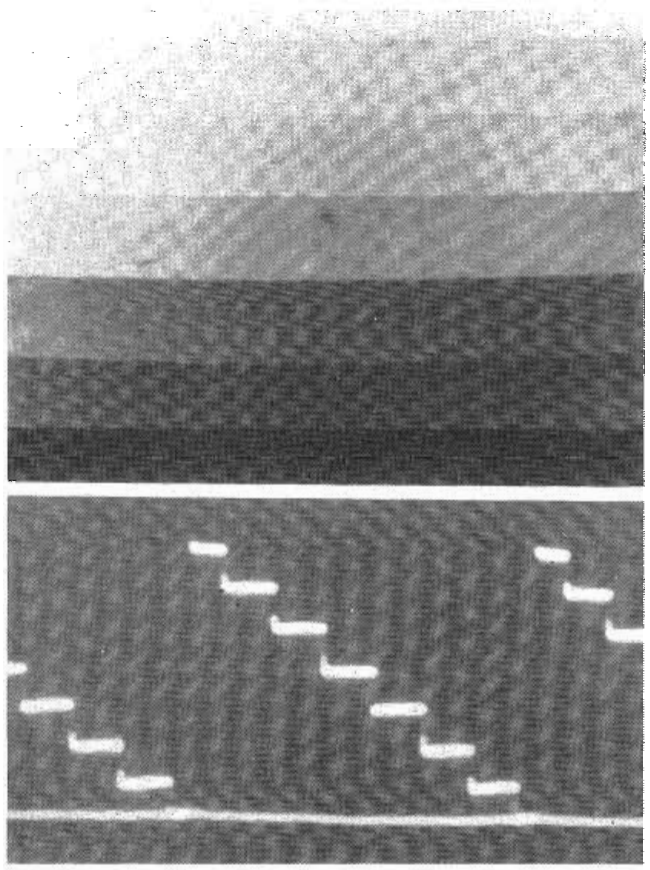
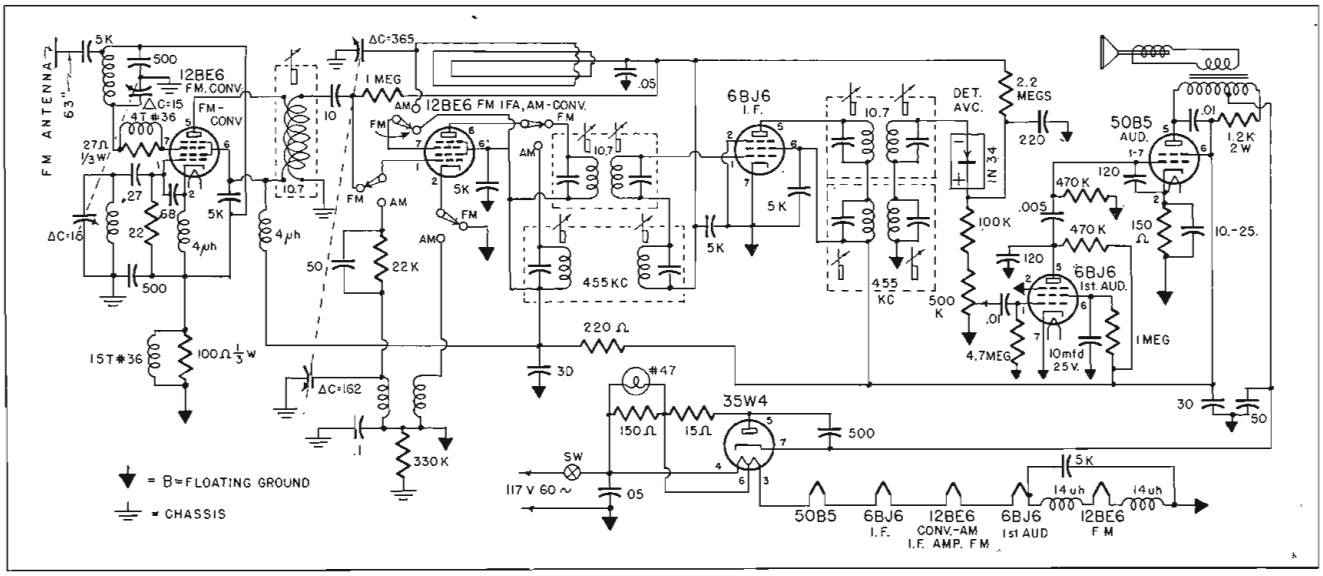


Fig. 6: Showing intensity gradation on receiver screen and stepwave signal used for testing. The stepwave generator produces the signal with equal steps over one field interval as indicated in charts



Circuit design and power specifications for FM-AM table model receiver

Low Cost FM-AM Receiver Design

Metropolitan FM-AM receiver circuit developed for table models in $35 to $39 price range; Design eliminates FM alignment gear, high-frequency switching; and offers 6-tube FM and 5-tube AM with 8-tube FM and 7-tube AM performance

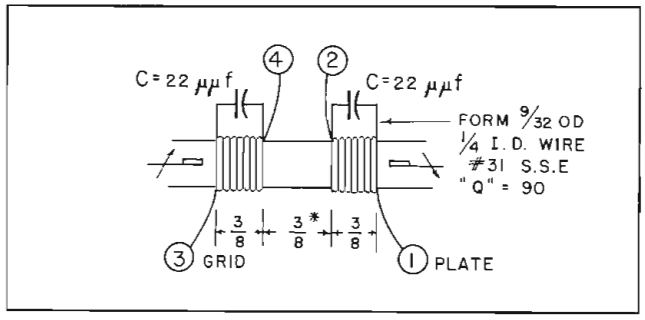
By WILLIAM F. FRANKHART, Radio Design Engineer, Fort Wayne, Indiana

THIS receiver was designed to fill the demand for a metropolitan FM-AM table model in the $35 to $39 bracket. Its cost in parts, when built several months ago, was $10.16. All alignment functions on this FM-AM receiver are AM; it requires no FM alignment gear.

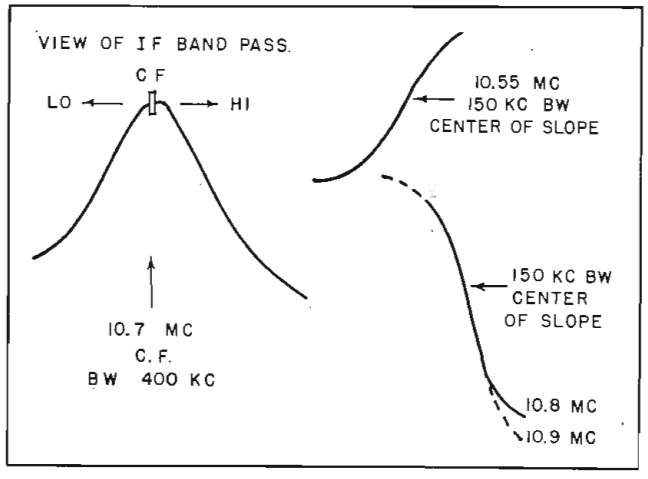
The sensitivity of this receiver is 200 μv for 50 mw output and is measured as a typical AM set, with 23 kc deviation, modulated with 400 cycles. In this circuit, there is no high frequency switching involved as the FM converter is used in that capacity only and is not used when the broadcast band is in operation.

The first FM-IF amplifier becomes the AM converter in the broadcast band position. The FM-IF frequency is 10.7 mc, the demodulator is a 1N34 germanium diode in a reverse polarity half-wave rectifier circuit, which operates on FM on the side slope. The demodulator recovers more audio than any FM

Details and specifications of IF transformer illustrated in photos on opposite page



Details of the IF pass band at very high signal input. Strong signal is necessary before two-spot tuning is noticeable after translation on a slide rule dial



demodulator tried up to November, 1947, when this receiver was designed. As all alignment functions are AM no special production equipment is involved and all operators are accustomed to this type of alignment procedure. The only FM gear necessary is the FM generator for establishing its sensitivity.

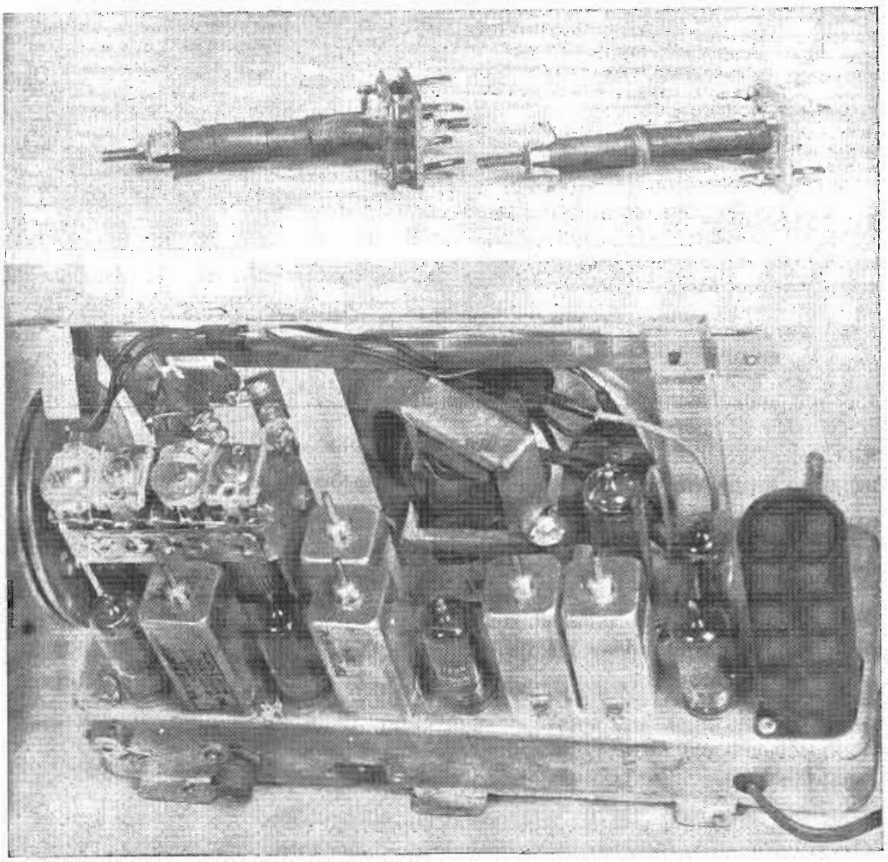
After the FM-AM demodulation ratio is established all operations can be performed with simple AM generators of the proper frequency. The first FM-IF transformer is a bifilar-wound self resonate type adjusted with a single slug. The bifilar-wound transformer does not contain capacitors and the single slug is a low cost, low "Q" stakpole type SK-13. The "Q" of the unit in the can is only 24; its 24-cent cost is small. The second FM-IF transformer and the third FM-IF transformer are double tuned. The second critically coupled and the third just under critical coupled.

Two Tube Lineup

Two tube line-ups are usable with nearly equal results. The tube line-up favored, for power output only, is with the 50B5 in the output. The line-up is 12BE6 FM converter, 12BE6 FM-IF amp, and AM converter, 6BJ6 FM-AM IF amp, 6BJ6 first audio amp, 50B5 output, 35W4 rectifier; 12BA6's can be used in place of the 6BJ6's when a 35B5 output tube is used.

The detector is a germanium crystal type 1N34. Audio recovery is obtained on each side slope with no more distortion than found in the typical ac-dc AM receiver. The entire receiver is side-tuned for FM operation and all alignment functions are on center frequency. Tremendous signal is necessary before two-spot tuning is noticeable after translation on the typical slide rule dial. It is perhaps an advantage to be able to demodulate on each side slope as this could, under certain conditions, eliminate adjacent channel interference.

With a tremendous signal input the space occupied on the dial, both side slopes included, is less than the typical ratio detector. With a 200,000 μv input, two-spot tuning, there is no interference with another μv signal 400 kc away. This circuit will demodulate a 200 μv signal with no apparent distortion and is still very easily tuned.



Top: Two transformers designed for this FM-AM receiver circuit. Both are 10.7 mc. The one on right is bifilar wound, showing extreme simplicity. Below: View of laboratory model

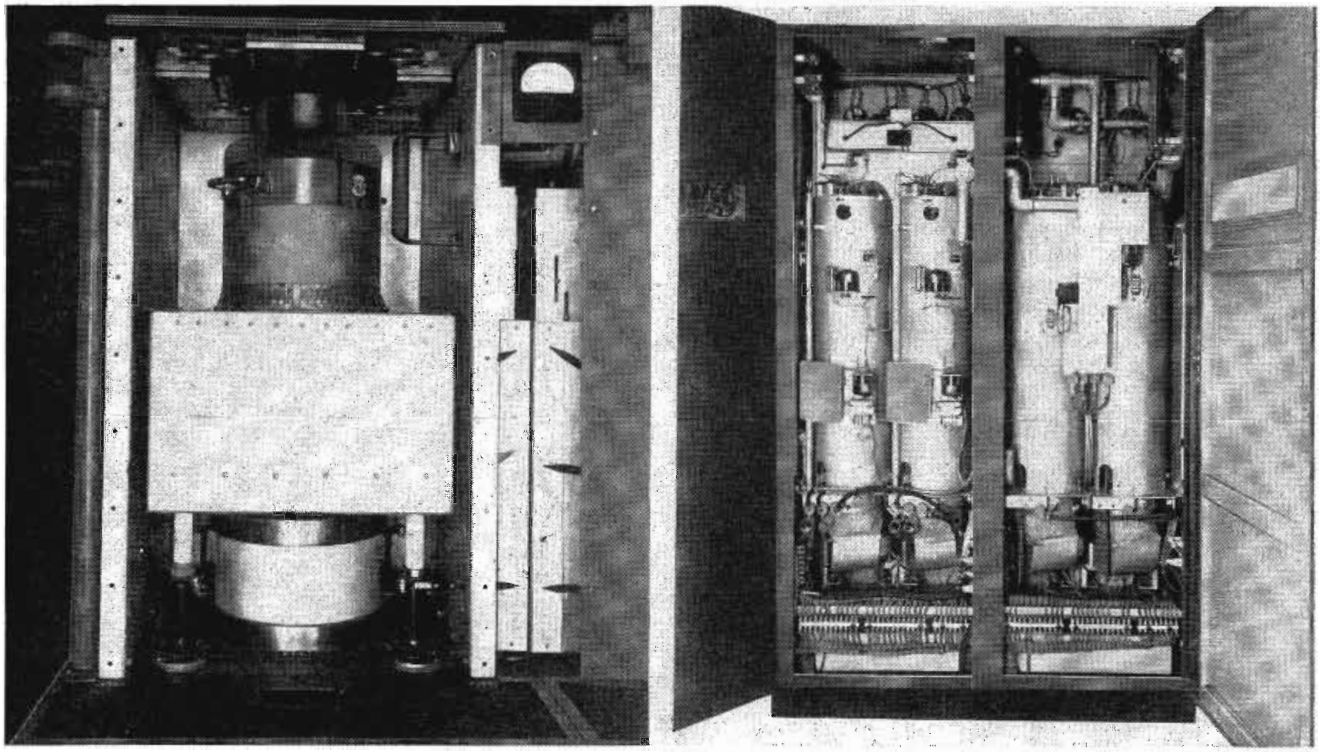
Certain design features which add much to the performance is the element switching in the 12BE6 FM-IF amp, AM conv. When the set is switched to FM the injector grid of this 12BE6 is switched to its screen grid, raising its Gm and increasing the input resistance of this stage, making it a very good amplifier at 10.7 mc.

High Signal Input

The antenna circuit produces more signal input than any yet found and at the same time effects an economy as it eliminates the need of a dual power line rf choke coil. It is to be noted that the 12BE6 FM converter stage has an isolated B- floating ground which adds much to eliminate unstability and frequency drift to the hf oscillator.

The only questionable disadvantage if this circuit is that it has no AM rejection when operating as a side slope FM detector. It is reasoned, however, that this lack of AM rejection is actually of very little disadvantage because of the frequency involved and the tremendous signal levels a set such as this would be subject to. Have you ever been unable to receive a satisfactory program on the broadcast band because of a storm, and then, turned your set on short wave only to receive the programs clearly. As the frequency goes up, less interference is had, and high signal inputs such as obtained on the 88-108 mc band further helps this noise-free reception. It is also to be noted that the reverse polarity diode provides very effective bypassing at 10.7 mc.

Through the use of the 1N34, hum is eliminated in this circuit. and wiring simplicity is effected. A vacuum tube diode will not work in this circut. The photograph shows the first onide laboratory model. It was built on a 10¼ X 3⅜ X 1½-in. chassis, which we determined to be the most economical size in which this receiver could be mass-produced. A larger chassis would be desirable and is recommended for maximum efficiency. With this circuit you have a 6-tube FM; 5-tube AM receiver with 8-tube performance on FM and 7-tube AM quality.



Engineering a 50 kw

Tube and circuit design, radiation, high conductivity seal, current distribution were some of the problems that required laboratory development before production

ENGINEERING a 50 kw FM transmitter in the frequency range from 88 to 108 mc presented a major problem to both the tube and the circuit designer. Many of the design details called for laboratory development in advance of actual commercial design. The following information describes development of a 50 kw amplifier for commercial production.

Circuit and tube development was conducted simultaneously since transmitter circuits suitable for FM frequencies are entirely dependent on tube design. In basic planning it was felt that a conventional type triode, in a grounded grid circuit, offered greatest possibilities and the use of air cooling provided simplicity of equipment and minimum maintenance. Accordingly, an air-cooled triode was developed with a low inductance grid header, and with inter-electrode spacing insuring adequate efficiency (minimized transit time effect).

When tested in an amplifier using special open-line tank circuits, these tubes were successful in producing stable power, but the tests brought to light several other problems in tube and circuit design, such as the necessity for a high conductivity seal between metal and glass and the need for careful attention to current distribution from circuit elements to tube connections. Radiation problems were also encountered.

Calculations indicated that this tube (developed for 50 mc) with minor modifications and slight derating could be used for the 88 to 108 mc range. The amplifier circuit, while satisfactory at 50 mc, was not satisfactory for use at 108 mc and was replaced by a circuit having a concentric line type of construction. Experience gained at 50 mc indicated advantages of parallel tube operation over push-pull operation, the former having much easier adjustment and simpler design as there was no problem in driving from a single-ended stage and in feeding an unbalanced load.

From the standpoint of harmonic radiation push-pull operation offers no real advantage since it is impossible to eliminate electrostatic coupling from the load. However, air-cooled tubes large enough to produce 20 kw at 108 mc are necessarily large (in terms of a quarter wavelength) and it seemed doubtful whether they could be coupled tightly enough to really operate in parallel without going into push-pull operation or producing parasitic frequencies. Three identical amplifiers were built, one being used to drive the other two operating in parallel and feeding a common load. Precautions to prevent

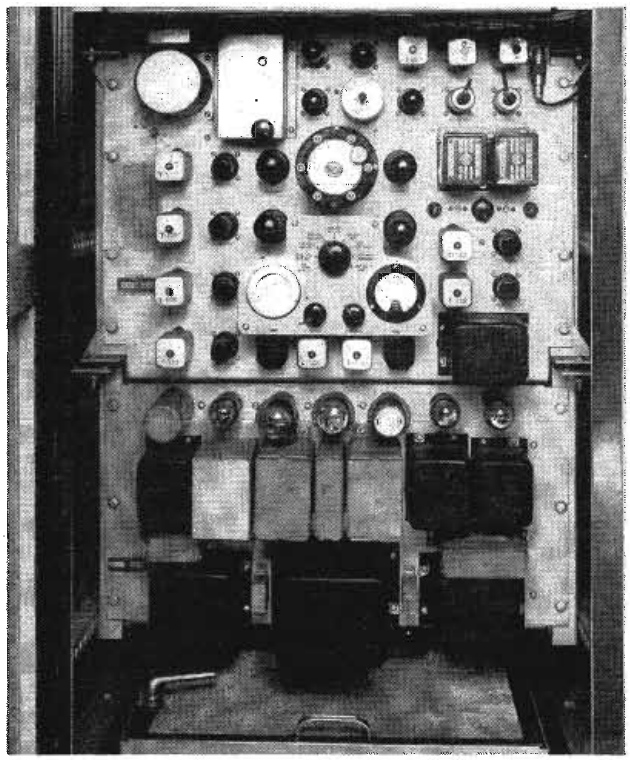


Fig. 2 (on opposite page at right): Rear view of low power amplifier. The intermediate PA is located in the right side of the cabinet

Fig. 3 (on opposite page at left): Front view of 50 kw amplifier showing plate line, and "shorting-bar," output coupling loop, balance meter and tuning indicators

Left: Front view of the exciter unit which incorporates all frequency generating and modulating circuits

FM Transmitter

By C. J. STARNER, Engineer, Broadcast and Industrial Engineering Section, RCA, Camden, New Jersey

radiation were taken to the extent that all control wiring was kept out of the rf fields, and radar-type plumbing was used in the rf circuits.

The amplifier was found to provide stable power with flexibility and ease of adjustment and practically no stray radiation. Refinements in the tube centered about improved methods to raise seal conductivity and to lower grid inductance between the active grid and the grid terminal. This also resulted in better shielding of the filament from the plate thus minimizing feedback capacitance. An overall plate efficiency of 65% was achieved, considering plate input as the input into the driver and both output stages. The frequency range of 88 to 108 mc was covered with no trick gadgets or suppressing circuits.

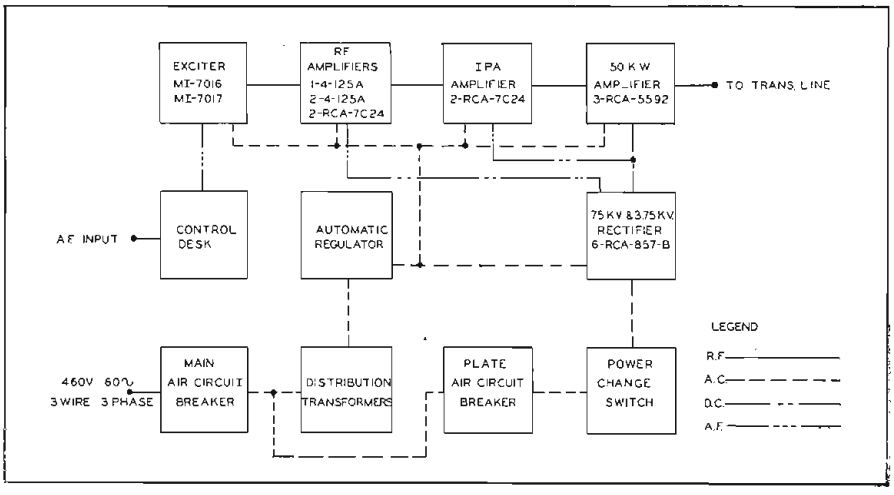
The commercial version (designated RCA type BTF-50 A) is entirely air cooled and uses only two types of high power rf tubes, 7C24 and 5592, both fin-cooled external anode triodes. As both tubes have low current density grid and plate glass-to-metal seals, they are well adapted for use in grounded grid circuits. Grid header construction provides good cathode - to - plate shielding and low grid inductance. The external anode tubes employ special low impedance concentric line circuits, with the cooling fins of the tube forming part of the line.

The exciter unit includes all the frequency generating, modulating, and frequency multiplying circuits of the transmitter, except the final doubler. The circuit provides all the advantages of direct FM plus the stability of crystal control. Center-frequency stability is maintained by electronically comparing a subharmonic of the modulated signal with a standard frequency developed by a temperature controlled crystal oscillator. Any difference in frequency actuates a two-phase induction motor which rotates a frequency compensating capacitor so that the transmitted frequency is held within the frequency limits determined by the crystal (deviation is less than 1000 cycles).

The exciter drives two conventional grounded-cathode 4D21 tube amplifiers. The first operates as a frequency doubler, the second as a conventional amplifier. These in turn drive 2 grounded grid 7C24 tube amplifiers in cascade providing driving power for the intermediate power amplifier, Fig. 1.

In the latter two, type 7C24 air-cooled tubes are paralleled in a grounded-grid circuit, the same as that used in the previous type 7C24 stages. These amplifiers all employ tuned transmission - line

Fig. 1: Simplified electrical schematic BTF-50A transmitter. Type 7C24 tubes are operated in cascade to approximately 7.0 kw level. Type 5592 tube converts from 7.0 to 50 kw level



type circuits, Fig. 2. A pi network is used, with 2 elements tuned to control the driving power. The output of the driving stage is coupled to this network by means of a small coupling loop fed from a concentric transmission line.

Each plate tank is concentric with the anode of the tube and its air cooler forming the upper end of the inner conductor of the transmission line. Tuning is accomplished by adjusting the position of capacitor-type shorting bars by means of motor-driven screws. Small loops properly oriented within the space between the inner and outer conductors of the plate lines, couple to the output. Power output tuning is controlled from the front panel through a tuning switch and motor.

The 50 kw amplifier, consisting of three identical amplifiers, is unusual in that the outer conductor of each concentric line plate tank is square and forms the skeleton of the unit, Figs. 3 & 5. Each unit is self-contained, housing all electrical components associated with its operation, Fig. 4. Its base forms a plenum chamber for cooling air and contains the control wiring and high voltage bus. The concentric line is formed by the frame of the unit and a center conductor mounted on a ceramic socket. The tube in turn is mounted on top of this center conductor and its cooling fins become a part of the conductor.

Tuning of the plate line, accomplished by moving a shorting bar vertically along the center conductor, by means of motor driven lead screws. The shorting bar is fabricated in the form of a box, 14 in. in length and an inch smaller in width than the space enclosed by the outer conductor of the plate line, with spring contacts engaging the center conductor. This arrangement forms an open line between the surface of the "shorting-bar" and the inner surface of the outer conductor.

Shorting Bar Contact Fingers

The capacitive reactance of this line is low enough so that the rf voltage developed across it is of moderate value, but large enough to materially lengthen the plate line electrically, allowing it to tune to a higher frequency than if direct contact to the outer shell were used. To keep the physical length of the plate line short at the lower frequency limit, the shorting bar is equipped with two sets of inner contact fingers of which the set at the top of the shorting bar is removable, while the set at the bottom of the bar is permanent.

Removal of the top set of contact fingers leaves a section of shorted line, next to the inner conductor, of the proper length and characteristic impedance to resonate at the 88 mc end, with the open section of line next to the outer conductor. The net result is the equivalent of a direct short at 88 mc. This method allows tuning of the plate line over the frequency range of 88 to 108 mc with a total shorting travel of about 7 in.

Complete shielding in a grounded-grid circuit, and the use of an air-cooled tube with a clear air passage around the grid header introduce conflicting requirements. The grid blocking capacitor is made in 4 sections which are symmetrically disposed around the grid connection of the tube, on the shelf which forms the ground plane between input and output circuit. A satisfactory compromise was obtained by breaking the area into small units, leaving no large unshielded area.

Since the physical size of the tube

Fig. 4: Mechanical diagram of amplifier unit shown in photo at right

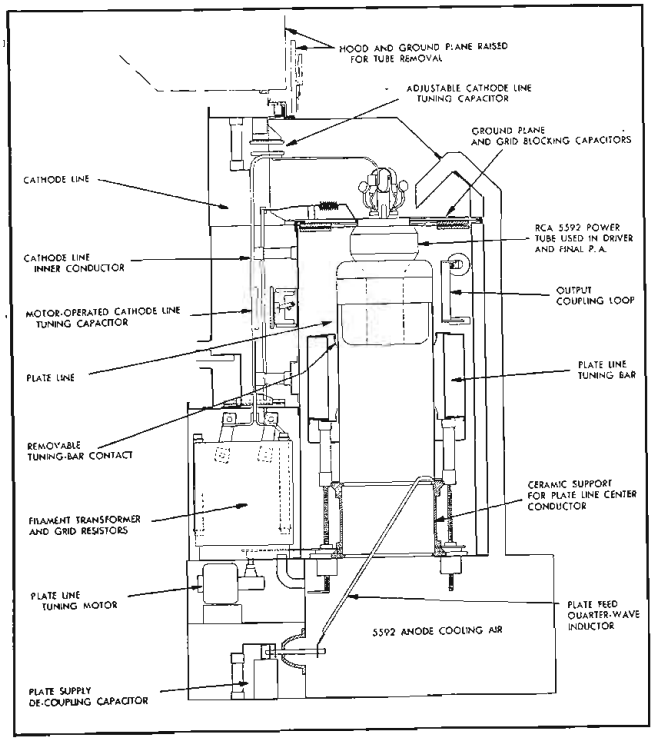
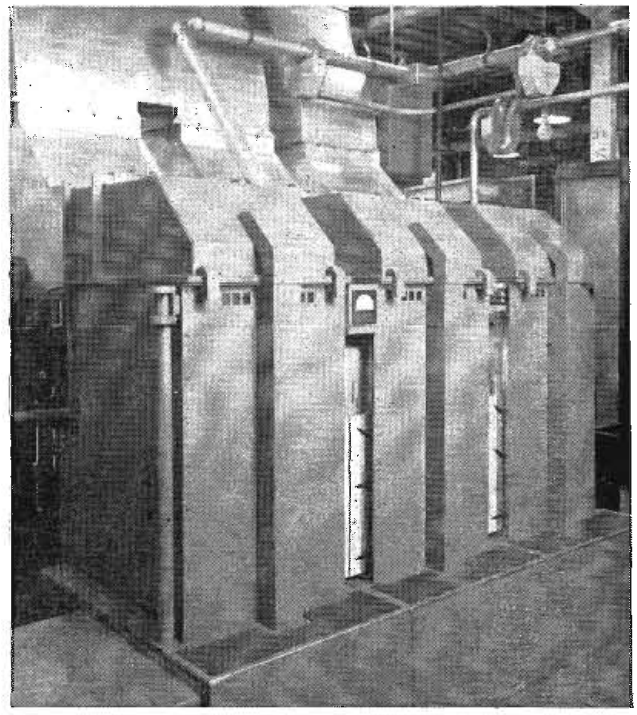


Fig. 5: Front view of amplifier showing feed lines, switching system



is such that at 108 mc the electrical length from active filament to filament terminals is nearly ¼λ, a capacity-loaded ¾λ, shorted at the input, is used for the filament circuit. This line is formed by the power-frequency filament buses which are folded over and pass down at the back of the plate line. Its input end is isolated from ground for direct current and for the filament current, but is shorted to ground through capacitors for rf. Tuning is accomplished by the use of 2 flat plate air-dielectric capacitors, located along the first electrical half-wave from the shorted end of the line, Fig. 4. Two capacitors are used in covering the entire frequency range in order to break up harmonic impedances and to enable the use of lower voltage ratings, one of which is motor-driven and the other manually adjusted.

Coupling rf energy to the filament line is accomplished through a loop located at the grounded end of the line. Provision is made for matching the impedance of the coupled circuits and in the case of the output stages, for balancing the driving circuit. Output coupling is motor-controlled and is accomplished through the use of a coupling loop with its reactance tuned out by a series capacitor located at the ground end. A coaxial capacitor is used whose value is unaffected by loop coupling. The loop moves through a 60° angle around a vertical axis, giving a wide variation of loading with smooth control.

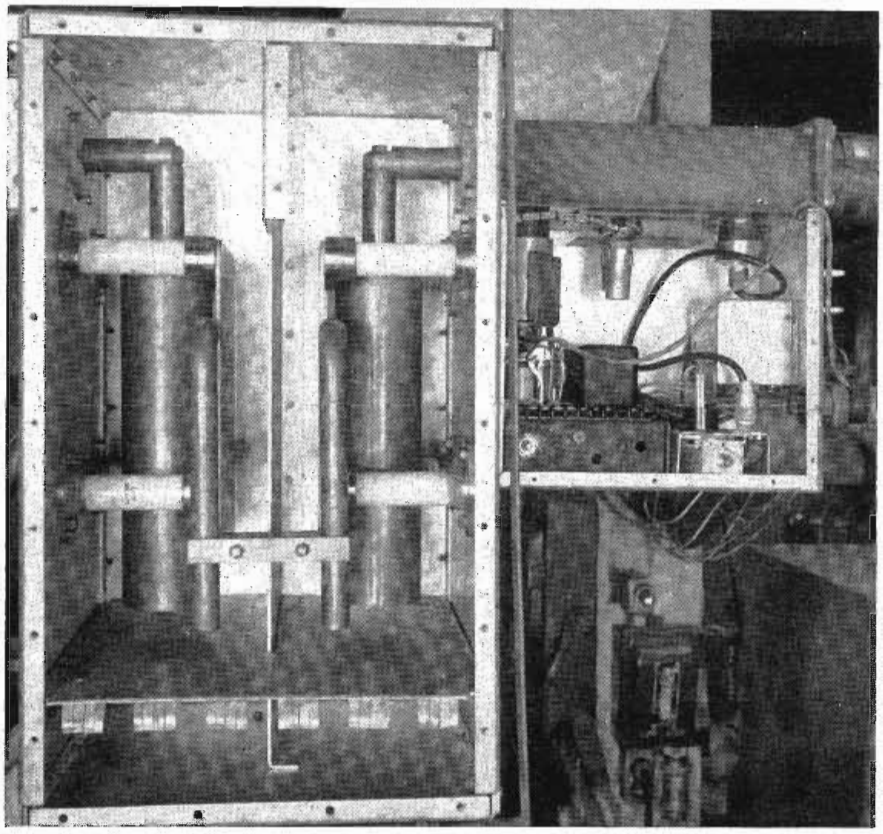
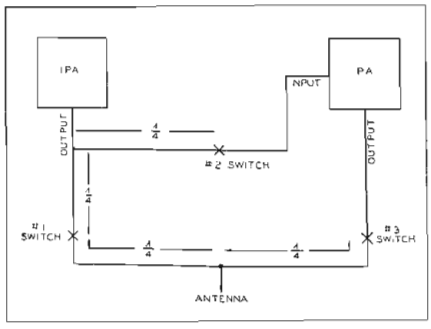
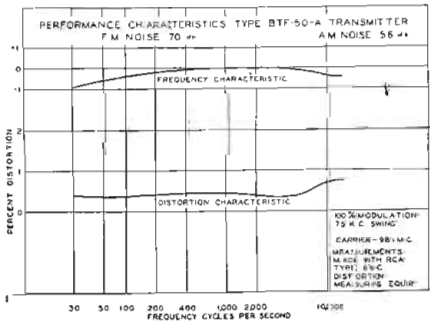


Fig. 7: Harmonic attenuator and transmission line monitor with covers removed

Fig. 6 (top): Emergency cut-back system

Fig. 8 (bot.) Transmitter performance curves





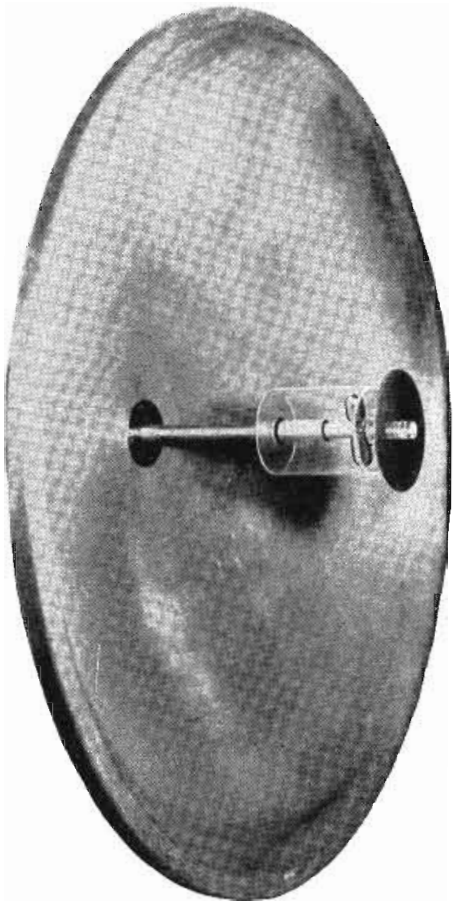
Motor-Driven Output Coupling

The power from the output stage is fed to a 24-ohm coaxial line transformer section so that each amplifier feeds a load impedance of approximately fifty ohms. Individual motor-driven output coupling provides easy load balancing between the two amplifiers as well as adjustment of power output. For an amplifier balance meter a crystal rectifier feeding a dc meter is connected across a slot located in the center of the outer conductor which interconnects the two output amplifiers. The meter registers the voltage across this slot caused by the current flowing from one amplifier to the other and is unaffected by the current flowing from each amplifier to the load.

The amplifier tuning controls are located on the front panel. One set of controls operates the driver tuning motors and another set of controls operates the tuning motors of both output amplifiers. A differential key switch, designated balance-tune switch, mounted adjacent to the output-stage tuning controls allows the tuning motors in the output amplifiers to operate simultaneously in either the same or in opposing directions. Operating both tuning motors in the same direction affords simultaneous tuning of both amplifiers. Operating them in opposing directions balances the amplifiers with practically no effect on the tuning or loading of the output stage.

While the 2 parallel amplifiers feeding the common load are called the output stage, the driving amplifier contributes materially to the output power. Power gain of the output stage is such that each output amplifier contributes approximately 19 kw to the load while the driver contributes 12 kw. Under these conditions we have a 3-tube 50 kw amplifier.

(*Continued on page 72*)



Four-foot diameter paraboloidal disc antenna, dipole feed. Power gain at 1350 mc is 900

Using only two channel assignments, Philco's New York-Philadelphia hook-up transmits simultaneous signals two ways; two chains may share channels without interference

by W. H. FORSTER, Projection Engineer, Research Division, Philco Corporation

Two-Way TV Relay

IN 1941 Philco began a radio relay (AM), on 210 mc which carried the video signal from WNBT in New York to WPTZ in Philadelphia. In 1944 this relay was extended to Mount Rose, N. J., picking up WNBT directly on channel 4, and Wyndmoor, Philadelphia, a distance of 32 miles.

A second link (236 mc) has been in service as a studio-transmitter link between the Philadelphia studio and Wyndmoor. Using similar equipments, a four-link system was installed and operated between Philadelphia and Washington during 1944 and 1945.

Today, a wide-band, frequency-modulated television relay system is in simultaneous two-way operation between Philadelphia and New York. It was inaugurated during the 1947 football season, relaying several of the games to WNBT in New York. These television relays require a 20 mc channel and operate in the band from 1295 to 1425 mc.

An entire relay chain may be operated with only two channel assignments, and relatively closely spaced stations in different chains may also share channels without interference. For a potentially crowded microwave spectrum, this is an important feature.

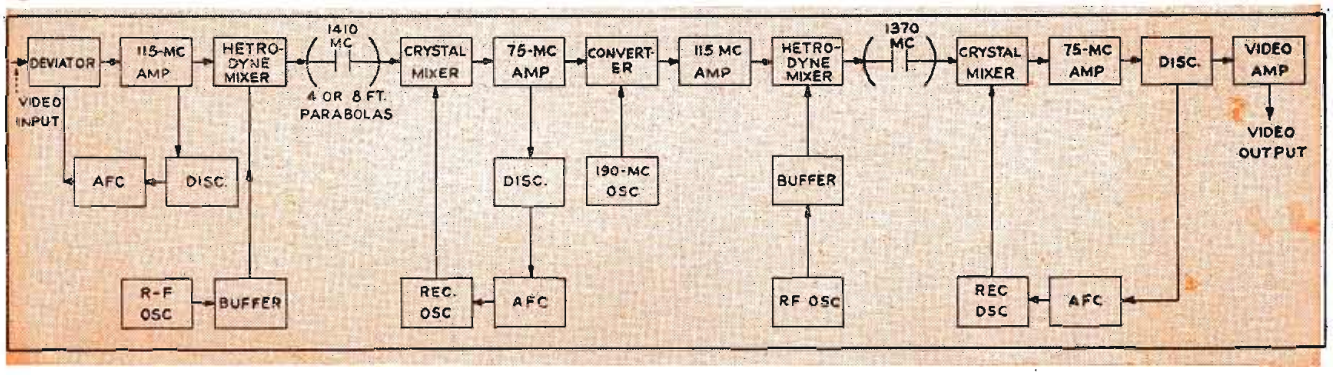
The complete Philadelphia-New York relay chain is designed to handle 4.5 megacycle television video without loss of picture quality. Programs may be transmitted simultaneously in both directions. The first hop, from the Philadelphia studio to Wyndmoor, serves as both a studio-transmitter link and as the first link in the Philadelphia-to-New York relay system.

Only two channels are necessary for simultaneous two-way operation of the system, because the directivity of the antennas is sufficiently great to keep signals of approximately equal strength, but coming from opposite directions, from interfering with each other. At Mount Rose, for instance, transmitters for both north and south-bound relays operate on channel 1. This means that the back lobes of the antennas must be at least 60 db below the main beam. When the power radiated from the north-bound antenna in the south-bound direction is 60 db less than the power radiated in the south-bound direction by the south-bound antenna, there will be no noticeable interference from the north-bound transmitter at the Wyndmoor terminal receiver.

Complete standby equipment is supplied at all locations and can be switched into the video and antenna circuits by coaxial switches. All component chassis are mounted in standard 19-in. relay racks. A relay transmitter or a repeater fits a 6-ft. rack, and a terminal receiver requires 2 ft. of rack space. The length of interconnecting cables is non-critical, making possible any reasonable redistribution of chassis for a specific installation.

Unitized construction is used throughout in order to facilitate servicing and maintenance. Subchassis can in general be prealigned, making possible replacement of units rather than the repair of them in the field. In this way test equipment for field use is reduced to a minimum: a 20,000 ohm-per-volt multimeter, a 5-in., 500 kc scope, plus a microwave wavemeter and a crystal detector; the latter two instruments are both supplied with each repeater station.

The equipment is designed to be adapted for unattended operation. The equipment includes no operating controls except power switches and a video gain control on the relay transmitter which requires no adjustment, providing the signal level is monitored at the station console. The block diagram shows a relay



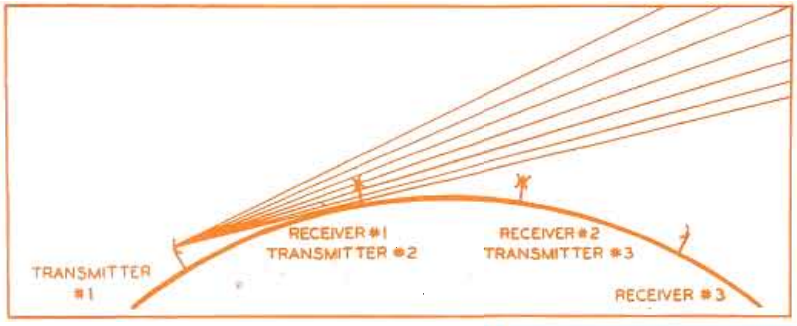
Block diagram of relay transmitter, relay receiver and repeater. Their operation is described in detail in the accompanying article

transmitter, a repeater, and a relay receiver. Blocks with a common name are identical as used in both the repeater and the terminal equipment.

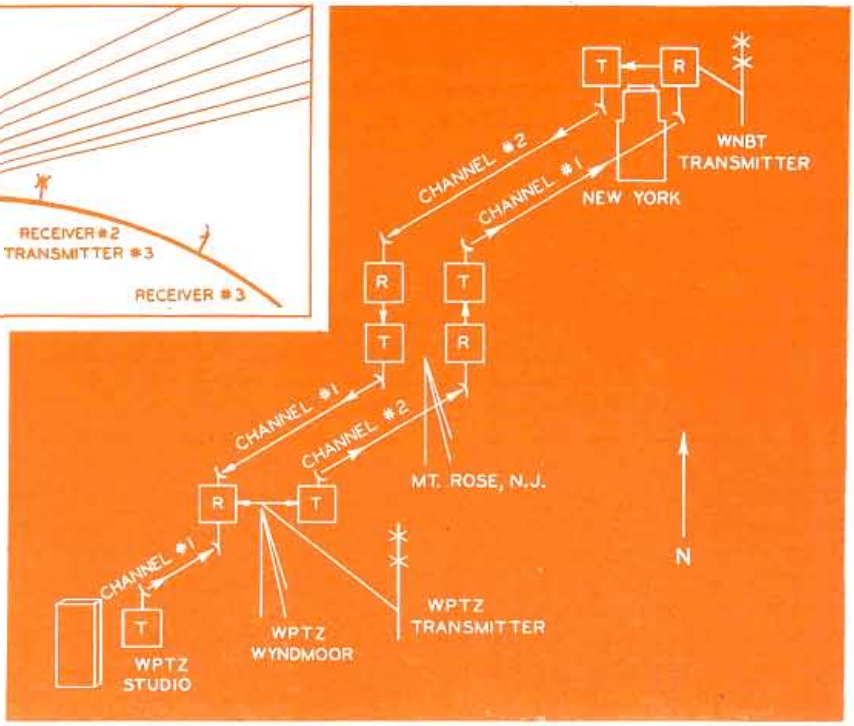
The transmitter deviator consists of a two-stage video amplifier and phase invertor which modulates the reflectors of a pair of 2K28 klystrons in push-pull. The oscillators operate at about 3300 mc and are tuned approximately 115 mc apart. Their difference frequency is obtained by beating the two microwave signals in a crystal mixer which has its output circuit tuned to 115 mc. In normal operation the reflectors are modulated with 12 volts peak-to-peak of video and a 12 mc IF frequency deviation is obtained.

The 115 mc IF amplifier has a bandwidth of 20 mc to the half power points and amplifies the frequency modulated signal to 25 volts peak. A 115 mc discriminator is provided for monitoring and for deriving a signal for automatic frequency control. This discriminator has a cross-over at 123 mc. The deviator oscillators are tuned so that in the absence of afc, the sync tip frequency in the 115 mc IF amplifier is at 125 mc. Under this condition, the sync tip produces a negative output from the discriminator which is passed by a pick-off crystal diode which follows the discriminator. This sync tip signal is amplified, detected, filtered and added to the leveler bias on one of the 2K28s in such a polarity that the carrier frequency corresponding to the sync tip is shifted back towards the cross-over of the discriminator. Because of the action of the pick-off diode, no afc signal is developed when the sync tip rides beyond the cross-over, so that the afc system tends to hold the sync tip on 123 mc. This afc combined with sync tip leveling in the klystron reflector circuits preserves the dc level throughout the relay system.

Frequency modulated microwave power is obtained from the heterodyne converter. The grids of the two 2C39 lighthouse triodes are driven in parallel by the frequency modulated IF signal; the cathodes are driven in push-pull by a 2C39 microwave oscillator and buffer chain with a signal of the same amplitude. The grid plane is grounded for rf by the open-circuited quarter wave lines, which act as grid plane supports, but is part of a resonant circuit at 115 mc. The cathode cavity is tuned to the frequency of the rf oscillator. The plate cavity is tuned



Above: Microwave relay. The first and third links may be operated on the same frequency



Right: Philco's New York-Philadelphia relay chain designed for 4.5 mc video. The hook-up will transmit simultaneous signals two ways

TWO-WAY TV RELAY

(Continued)

to the sum of the rf and IF frequencies.

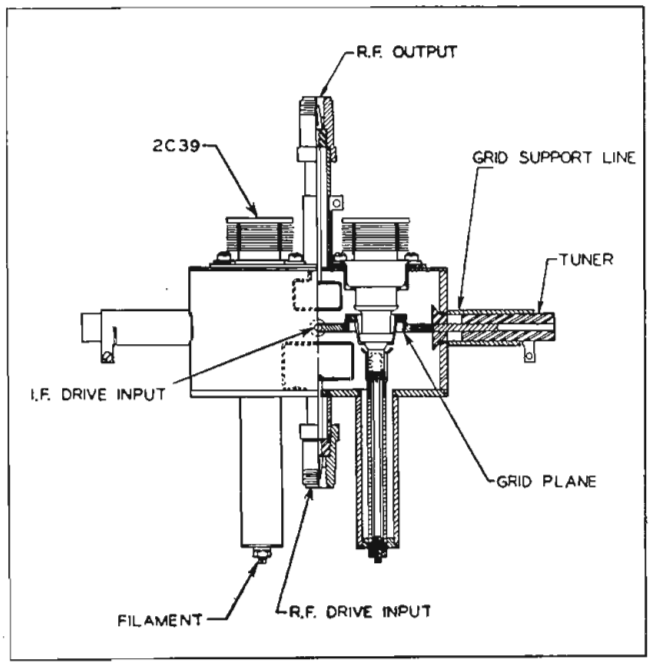
The heterodyne mixer is a cross between a low-level converter, as used in a superheterodyne receiver, and a radio frequency Class C amplifier. If both rf and IF drives are adjusted to produce individually a conduction angle of approximately 50 degrees, the plate circuit efficiency can be made equal to that of a conventional Class C amplifier. This high level converter can theoretically be adjusted to operate with the same efficiency as a Class C amplifier. But at 1400 mc, using type 2C39 lighthouse triodes, this efficiency is not as great as in the broadcast band. The plate circuit efficiency of this push-pull heterodyne mixer is about 20 percent, giving 15 watts of frequency modulated rf with a plate input of 40 watts per tube.

Heterodyne modulation has many advantages. It is a method for producing wide band, frequency modulated radio frequency power without using rf amplifiers.

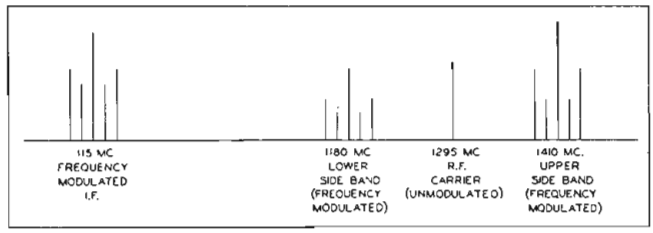
In some applications this simplifies the design and reduces the problem of frequency stability. In a relay chain, requiring many repeaters, heterodyne remodulation eliminates demodulation to video and remodulation to rf or IF in the repeaters. This removes a large percentage of the sources of distortion and of poor low and high frequency response. It makes possible the cascading of many repeater stations with a small distortion increase.

The receiver is a microwave superheterodyne employing a reflex klystron local oscillator, a crystal diode converter, and a 75 mc IF amplifier of 20 mc bandwidth. This is terminated by a limiter and a frequency modulation discriminator. Video from the discriminator drives a cathode follower which provides signal for the relay receiver station. IF output is derived from an amplifier in parallel with the discriminator. In the repeaters, this IF goes through a second converter which includes a crystal controlled oscillator. The repeater transmitter, from the converter on, is identical to the relay transmitter at the terminal.

Diagrammatic cutaway of heterodyne converter using a pair of 2C39 triodes with grids driven by IF signal, cathodes being fed by the local RF oscillator



Principal components in the spectrum of the 1300 mc heterodyne mixer



An afc, similar in principle to the afc system which controls the deviator oscillator, is used in the receivers for both the repeaters and the terminal equipments. Sync tip signal, which is derived from the discriminator, produces a frequency correcting bias on the reflector of the 2K28 local oscillator.

In a frequency modulation system, the linearity is principally a function of the phase response of the system rather than of the tube characteristics. Tube characteristics affect the linearity of the deviator in the relay transmitter, by which the video signal is converted to a frequency modulated IF signal, and also the linearity of the frequency modulation detector at the end of the receiver. But a relay system of any number of links includes only one relay transmitter (and hence one deviator) and only one relay receiver detector. The linearity of the repeaters is almost entirely independent of tube characteristics.

The phase response of the system, which does determine the linearity, is controlled largely by the receiver and transmitter IF amplifiers which are designed with special attention to linearity of the phase vs. frequency characteristic. Both good linearity and high mean stage gain are achieved by using stagger tuned stages, both single and double tuned.

The 75 mc amplifier in the receiver consists of 14 single-tuned circuits which are distributed between 54 and 95 mc. This gives a resultant bandwidth to half power in excess of 20 mc with a mean stage gain of 2.7.

The 115 mc amplifier consists of 12 tuned circuits, 8 of which are grouped in double-tuned circuits. The single-tuned circuits are designed to be aligned with a CW signal generator; the grid current of the double-tuned circuits is monitored to facilitate alignment with a sweep generator.

For the three link system connecting Philadelphia and New York, the signal-to-noise ratio of the individual link varies between 48 and 50 db, depending on the distance, the antenna diameter, and the length of the antenna cables. For the entire 84-mile relay the signal-to-noise ratio is 45 db.

WASHINGTON

★ ★ ★ **Latest Electronic News Developments Summarized by Tele-Tech's Washington Bureau** ★ ★ ★

TV RELAYING NOW NEEDS IMPETUS—Television audiences in the two most heavily populated regions of the United States are coming into their own in a big way this year for network video programs, under the relaying plans now blueprinted. The Eastern seaboard will be able to view the next "blue ribbon" TV public service showings, the Republican and Democratic conventions in June and July, and the major Middle Western cities east of the Mississippi will have offered next fall the full complement of network television programs, including football games, probably the most popular "dish" of telecasting.

The flow of television station applications to the FCC has kept up at a high rate and there is every prospect of fulfillment of the prognostication of such an able and veteran television expert and observer as former FCC Commissioner E. K. Jett, now radio vice president of the Baltimore Sunpapers, that by the end of 1948 around 100 cities of the nation will have television stations. Radio manufacturers are well geared to supply the TV station transmitter equipment and have swung into mass production of television home receivers. As has been outlined in articles in TELE-TECH and in the press, the U. S. radio manufacturers are continually bettering the receiving sets so this nation's television industry certainly can claim achievement of a technical video system, both in telecasting and audience reception, that leads the world.

COMPETITION IN HANDLING PROGRAMS—The American Telephone and Telegraph Co. and Bell System have projected the most extensive facilities for handling network television programs, but some strenuous competition is looming for the telephone companies in this sphere of service. Western Union, which for years took radio lightly, has entered the television relaying field with plans to handle network programs over its microwave radio beam system, which it is building in the East and Middle West to carry telegrams with the goal of eventually replacing its wire system. To get the "show on the road" as speedily as possible, several large radio organizations are conducting their own television relaying systems—General Electric and Philco in the East, Balaban and Katz in the Middle West, and Westinghouse through its "stratovision" airplane method.

The FCC, although it sees eventual "frequency economy" through having communications carriers as the sole TV "highways," has given impetus to intercity video relayings by the large television concerns themselves by assigning the microwave TV pickup and studio transmitter bands in the upper spectrum ranges of the 2000, 6000 and 12000 megacycle bands for secondary use for TV network relaying. The A. T. & T., of course, is using both coaxial cable and microwave radio relay as the principal media for television relaying. Entrance of these several elements to handle TV network relaying promises the most equitable charges feasible for this service, so that the television broadcasting industry will not be overburdened with too heavy costs of relaying during the current period of expansion.

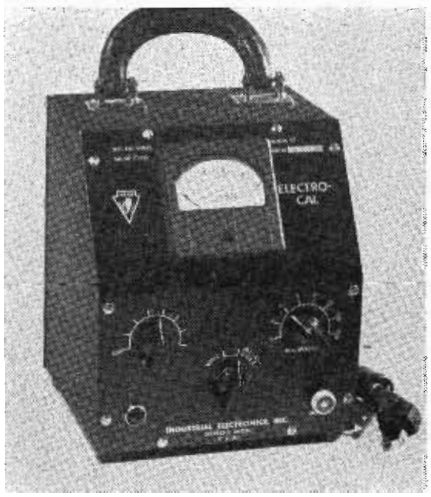
FEDERAL RADIO APPROPRIATIONS — Radio agencies and activities of the Federal Government have fared well in their appropriations for the next fiscal year (1948-49), starting this coming July 1, at the hands of economy-minded Congress. The FCC only received a slight cut of funds from the House, and the Senate Appropriations Committee appeared amenable to restoration of the House slash of $240,000 which the Commission planned to use primarily for enlargement of its engineering staff for the mobile-marine-industrial radio services. The "Voice of America" shortwave broadcasting operations of the State Department was given a substantial boost over the current funds allotment, which will mean enlarged uses of the short-wave outlets of NBC, CBS, and WRUL, etc., but some curtailment of building relay stations abroad.

The Civil Aeronautics Administration, in line with the increased Congressional support for expanded civil-military radio-electronic communications and navigation aids systems for aviation, came out with practically its full request of $22 million, which will mean continued purchases of DME, ILS, and beam and surveillance radar equipment for the nation's airways.

The Central Radio Propagation Laboratory, conducted by the Bureau of Standards under the capable direction of Dr. J. H. Dellinger, received a complete endorsement by the House for its extremely valuable research into radio propagation, ionosphere, and studies of standards for radio equipment and tubes. Because Dr. Dellinger is one of the most respected scientists in the radio world today, the stamp of approval on his agency's work by Congress was regarded as most fitting.

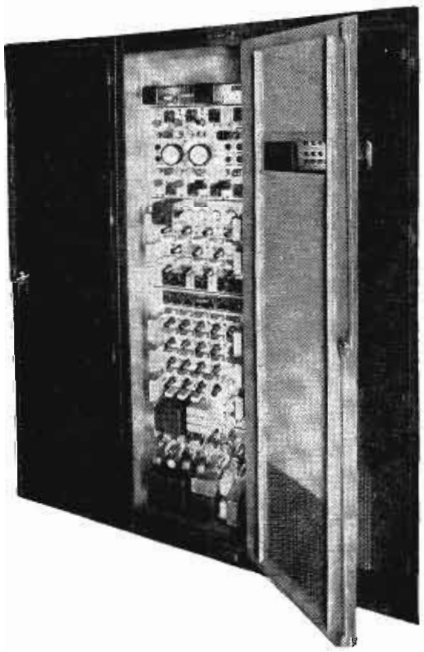
ROLAND C. DAVIES
Washington Editor

New Lab and Test Equipment



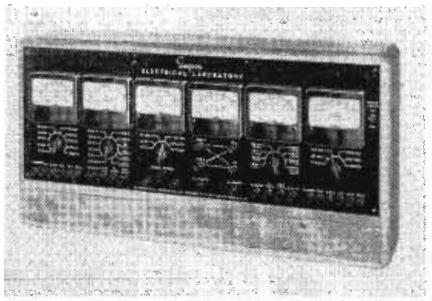
Signal Generator

Model 3433 FM-AM signal generator covers from 100 kc to 120 mc in 10 fundamental bands, plus an additional 50 mc from a fixed oscillator to extend the range to 170 mc on fundamentals. Constant deviation has been achieved by using a fixed frequency reactance-modulated oscillator. A meter is provided for measuring relative rf output. RF leakage is minimized by double copper-plated shielding. Other features include: ladder attenuator, coaxial cable output, air trimmer capacitor and permeability adjusted oscillator coils, heterodyne detector, and voltage regulated power supply. The instrument operates on 115 V, 50-60 cycle, ac.—**The Triplett Electrical Instrument Co., Bluffton, Ohio.**



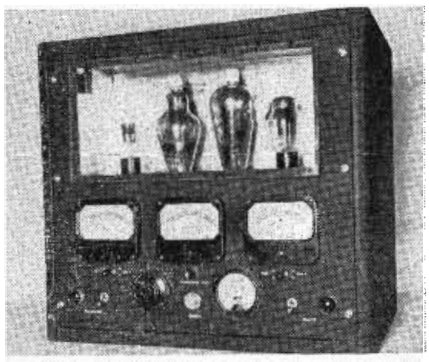
Sync Signal Generator

Model TA-107 A/B sync signal generator furnishes horizontal and vertical driving pulses, blanking signals and complete synchronizing signals required by studio and film cameras, camera control units, monitors and other telecasting station equipment. Two 3-in. cathode-ray tubes are used in simultaneous monitoring (without switching) of all frequencies. Linearity test signals at 900 cycles provide 15 horizontal bars, while 167.5 kc signals provide 10 vertical bars with blanking for checking scanning linearity of picture monitors and television receivers.—**Television Equipment Div., Allen B. DuMont Labs., Inc., 42 Harding Ave., Clifton, N. J.**



Multiple Purpose Test Instrument

Model 1005 electrical laboratory is a test unit for servicing and laboratory use, incorporating six individual 4½ in. rectangular meters, each with a complete set of ranges. A wide variety of ac and dc voltage and current ranges, a multi-range ohmmeter and a single-phase wattmeter are provided. One of the instruments has a sensitivity of 20,000 ohms per volt on dc voltage measurements; ac voltages are measured with a rectifier type instrument with a resistance of 1000 ohms per volt on all ranges. Volume indications are covered from minus 10 to plus 55 db. The cabinet has two compartments for accessories.—**Simpson Electric Co., 5216 West Kinzie St., Chicago, Ill.**



Thyratron Tester

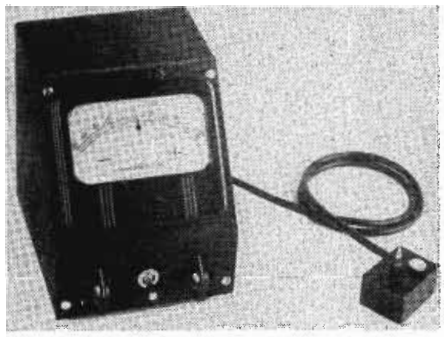
Designed primarily for thyratrons type FG 33, FG95, 632, and 82 and 83 rectifier tubes, model THO1 tester can be supplied for any type thyratron or rectifier. In testing, tubes are triggered the same way and under the same conditions of load as in service. The tester also ebecks open circuit in any of the tube elements, short circuit between elements, emission under rated peak load current, and emission characteristics under rated average load currents. Terminals for connecting a cathode ray oscilloscope to observe conduction characteristics are provided.—**Sierra Electronic Corp., San Carlos, Calif.**

Log Scale Ohmmeter

This direct-reading megohmmeter utilizes a logarithmic scale to provide a range of 1 to 100,000 megohms, covered in six decade steps. A safety switch applies voltage only during measurement. By use of an external voltage the range can be extended to 1,000,000 megohms. A charging position is included in the range switch to facilitate measurements on components having large capacitances.—**Macleod & Hanopol, Charlestown 29, Mass.**

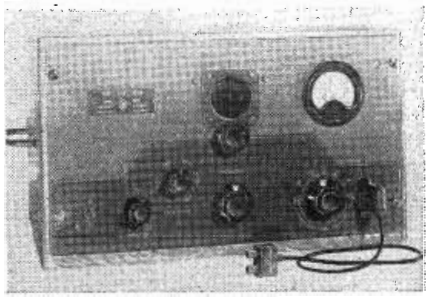
Sweep Calibrator

Model GL-22 is a pulse timing marker oscillator designed for use with oscilloscopes and synchroscopes in the measurement of time intervals and triggered or recurrent sweeps. A marker selector switch makes available 0.1, 0.5.1.0, 10, and 100 microsecond pulses. A positive or negative variable width gate pulse output is provided for test purposes. — **Browning Laboratories, Inc., Winchester, Mass.**



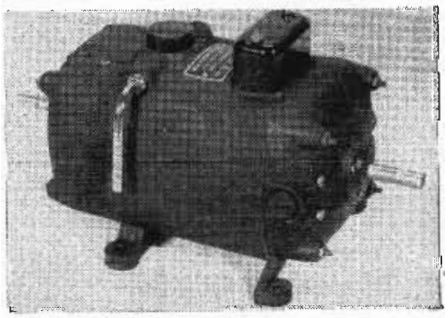
Electric Micrometer

Capable of the usual measuring and gauging operations, type 156 Electric Micrometer may also be used for telemetering for remote indications of small movements at distances up to 100 ft. The Micrometer is designed for battery operation and is composed of a transmitter, a control unit and connecting cable. There are no tubes or amplifiers. Dimensions are 1½ x 2 1/16 x ½ in.—**Stevens-Arnold Inc., 22 Elkins St., South Boston 27, Mass.**



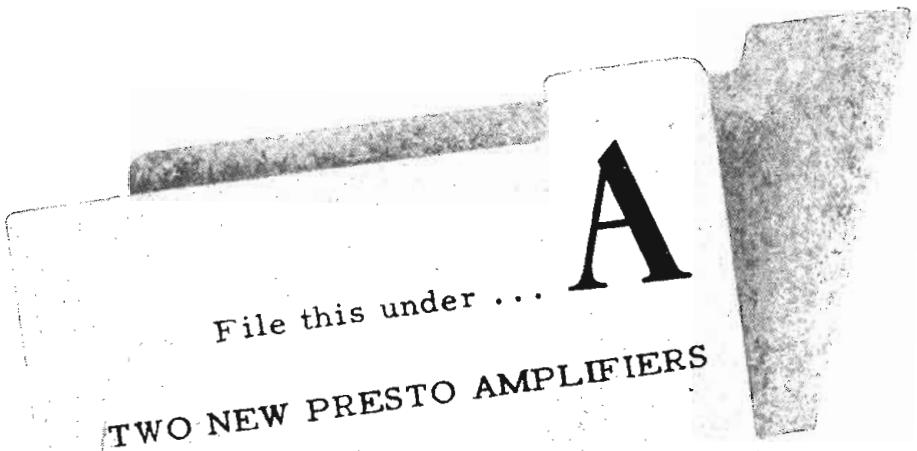
Resistance-Tuned Oscillator

Ease and accuracy for readings at rf, video and audio frequencies are provided in the model 650A resistance-tuned oscillator which covers a frequency range of 10 cycles to 10 mc in decade ranges. Output is flat within 1 db from 10 cycles to 10 mc and voltage range is .00003 to 3 volts. Output impedance is 600 ohms but a 6-ohm impedance is also available through an output voltage divider supplied with the instrument. Operating entirely from a 115-volt ac power supply, the 650A is provided in delay rack or cabinet mounting.—**Hewlett Packard Co., 395 Page Mill Rd., Palo Alto, Calif.**



Variable Speed Motor

Completely self-contained, the Guernet variable speed motor is particularly adapted to precision drilling, grinding, buffing, polishing, chemical mixing, wire or tape winding, utility and general laboratory work. It is variable from 1500 to 6000 rpm, giving adjustable stepless speed control. The motor is 1/5 hp, ball bearing, universal-wound, reversible, 115 volts, single phase, any frequency, and is approximately 9 x 7 x 5 in.—**Guernet Electrical Machinery Inc., Box 196, Meriden, Conn.**



Engineers will welcome these two new additions to the PRESTO line of superior equipment.

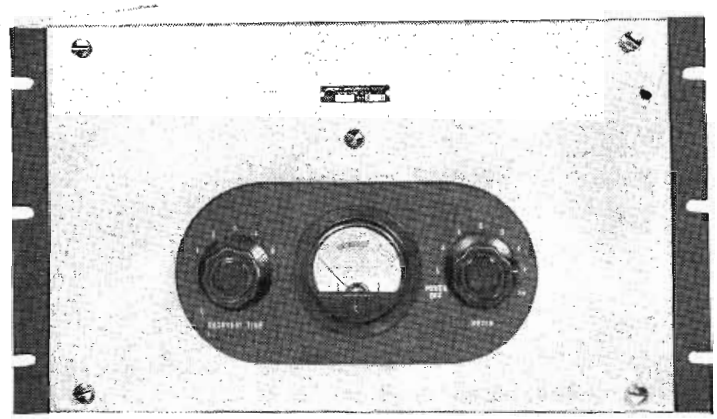
Presto Peak Limiting Amplifier (*Type 41A*)

DESIGNED to control program peaks, Type 41A removes the cause of overcutting and distortion in recording and over-modulation in broadcasting. Proper degree of peak limiting permits an appreciable increase of the average signal with consequent improvement of signal to noise ratio. Serves simultaneously as a line amplifier; its 60 db gain adequately compensates for line losses due to pads, equalizers, etc.

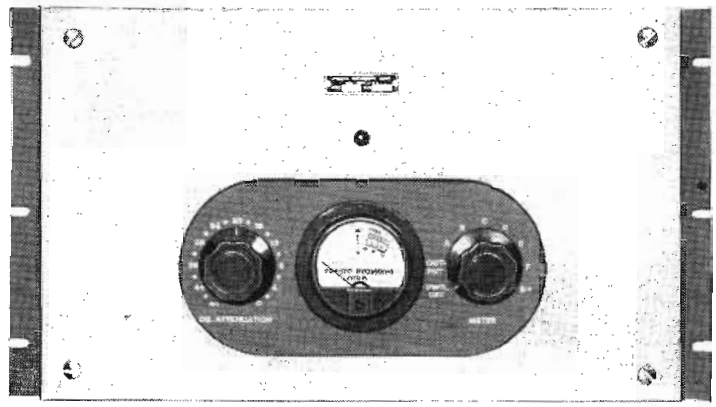
Presto Power Amplifier (*Type 89A*)

FOR recording, or monitoring use, 89A is the perfect high fidelity, medium power unit. 25-watt output, it fills the need for an amplifier between Presto 10-watt and 60-watt units. All stages are push-pull and sufficient feed back is provided to produce a low output impedance and general performance of the type 807 tubes which is superior to that of triodes.

FULL SPECIFICATIONS OF THESE TWO NEW AMPLIFIERS WILL BE SENT ON REQUEST.



Type 41A. Chassis construction is for vertical mounting in standard racks. Removable front panel gives access to all circuits. Meter and selector switch indicate amount of limiting taking place and current readings of all tubes.



Type 89A. Chassis construction is for vertical rack mounting. Removable front panel for easy access to all circuits. Meter and selector switch provide convenient indication of output level at 1000 cps and current readings of all tubes.

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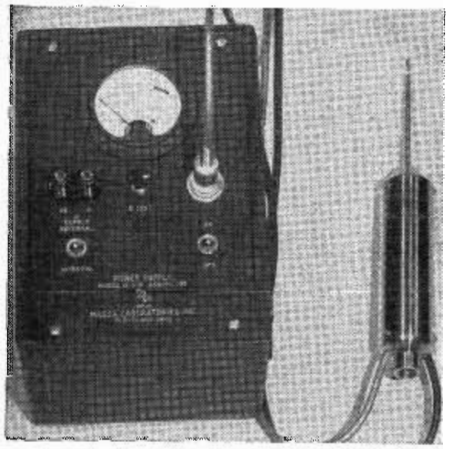
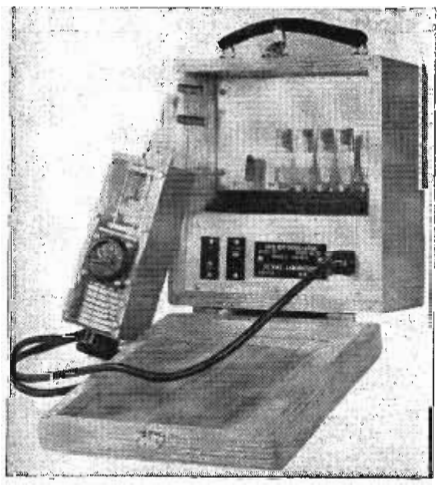


Sound Pressure Measurement System

Measurements of absolute sound pressure over the 50 cycle to 250 kc frequency range are facilitated by the Massa model GA-1005 sound pressure measurement system. Diffraction errors are eliminated for measurements throughout the audible range to beyond 20 kc. The microphone acts as a pure mechanical stiffness up to 250 kc, assuring constant phase shift between the generated voltage and the actuating sound pressure up to this high frequency; accurate reproduction of transient pressure waves result.—**Massa Laboratories, Inc., 3868 Carnegie Ave., Cleveland 15, Ohio.**



Grid Dip Meter

Many circuits and components in a television receiver can now be checked without its disassembly with the aid of this new model grid dip meter. The instrument is essentially an oscillating frequency meter particularly arranged for determining the resonant frequency of de-energized RF circuits. It contains a sharply tunable circuit in an extension probe, along with a 9002 triode oscillator tube and an indication instrument connected to read grid current. Operation details of this unit were fully described in the March issue of Tele-Tech, page 39.—**De Vine Laboratory, Madison, N. J.**

Television Antenna

Adjustable dipole elements, calibrated in megacycles, make possible pre-adjustment of the new Vertrod aerial to any frequency in the FM and TV bands before mounting the antenna assembly. The adjustable dipole elements are securely mounted in a 5-ft. tempered aluminum alloy mast and the aerial can be mounted at any angle.—**Vertrod Corp., 17 Williams Ave., Brooklyn 7, N. Y.**

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ELECTRONIC ENGINEERING HANDBOOK

By Ralph R. Batcher, E.E. and William E. Moulic

Written and published as o day-in day-out working tool far engineers interested in electronic applications in the industriol and communication fields. Edited by Rolph R. Batcher and William Moulic, this book contoins the writings af the foremost men in the particular phases af electronics covered by the book. Yet its messoges ore presented in a manner eosily understood by ony engineer with a bosic knowledge of electrical principles.

From fundamentals the book proceeds logically thraugh detailed discussions, covers every important circuit and essential application.

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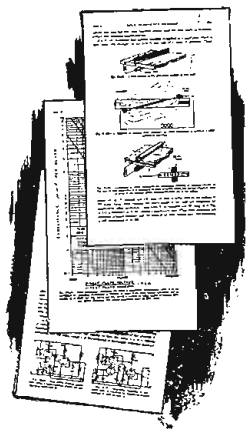

456 pages—Over 200 illustrations

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- *Electronic Principles*
- *Principles of Diodes*
- *Principles of Multi-Element Tubes*
- *Principles of Phota-electric Tubes*
- *Cathode Ray Tubes*
- *Special Purpose Tubes*
- *Materials in Tube Construction*
- *Vacuum Tubes as Circuit Elements*

Electronic Circuit Fundamentals
- *Principles of Rectification*
- *Principles of Amplification*
- *Low Frequency Amplifiers*
- *High Frequency Amplifiers*
- *Principles of Oscillators*
- *Principles of Modulation*
- *Principles of Detection*
- *Cathode Ray Oscillographs*
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- *Photo-electric Circuits*
- *Electron Tube Circuit Application*

Electronic Applications
- *High Frequency Heating*
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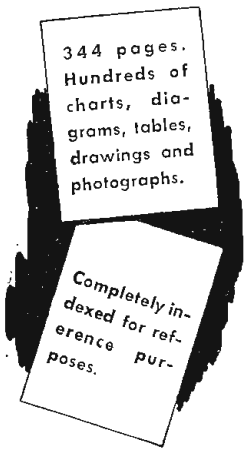
Here is o valuable storehouse of reference moteriol on the *fundomentols* of electronic control principles used in industry. Here is the first and only single source providing the essential doto you must hove to accurately oppraise the value ond specify on electronic control device. Electronic controls ore everywhere today cutting monufocturing costs, speeding production ond improving quality of products. This book gives you outhoritotive, foctual information from which you con sofely conclude when, how ond where they can improve efficiency in your plant.

The condensed contents listed below give a general idea of the material in this book, but nothing less than yaur personal inspection of the volume itself will enable yau ta appraise its constont volue. That is why we have arronged to send you a copy of the book at our risk, for your five day perusal.



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Section I—Basic Elements of Control
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Section II—Conversion Elements
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Section V—Control Applications
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- Chapter 2—*Motor Speed Control*
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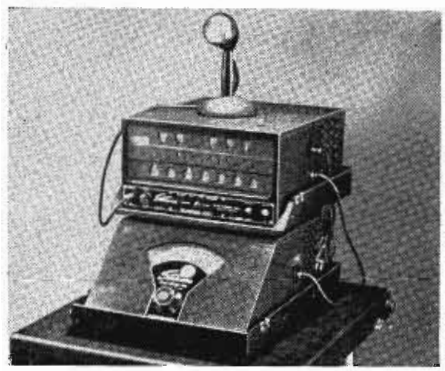
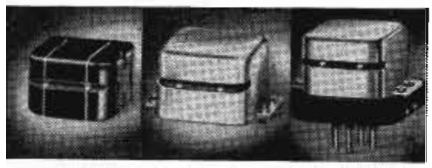


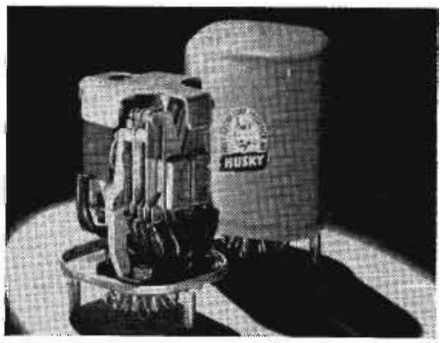
Sound Analyzer

An electronic device for rapid, accurate, visual measurement of sound frequencies to within 1/100th part of one semi-tone, the Stroboconn has 12 windows on its panel corresponding to the white and black keys of the piano in an octave from C to B. Sound picked up by the microphone causes whihling stroboscopic discs in these windows to become illuminated by a neon tube whose rate of flashing corresponds exactly to the frequency of the tone sounded. On each of the whirling discs there are 7 stroboscopic pattern bands, each representing a particular musical note as it occurs in 7 of 7 octaves.—**C. G. Conn Ltd., Elkhart, Ind.**



Wire Recording Heads

Each of these three wire recording heads, the WR 12, WR 14 and WR 16, has recording, playback, and erasing features combined in one compact unit. Air gaps are controlled, assuring uniform performance. The controlled froove contour provides the maximum effective position of the recording wire.—**Shure Bros., Inc., 225 W. Huron St., Chicago 10, Ill.**



Sealed Midget Relay

Hermetic sealing and the incorporation of an improved hinge are features of this "Sealed Midget" relay. Made with coil resistances up to 9500 ohms and contact combinations up to 5 PDT, this relay has mounting feet at the armature end and mounting holes can be supplied in the heel end. Palladium, silver and tungsten contacts are supplied to fit load requirements.—**Price Electric Corp., Frederick, Maryland.**

Television Filter

A Polaroid filter which is adaptable to any size video receiver is on the market. This filter produces a sharper, clearer image and reduces distracting glare from room lighting.—**Pioneer Scientific Corp., 350 Fifth Ave., N. Y.**

NEW BOOKS

Sunspots in Action

By Dr. Harlan True Stetson, Cosmic Terrestrial Research Laboratory, Needham, Mass. With foreword by Sir Edward V. Appleton, London. Published by the Ronald Press Co., 15 E. 26th St., New York 10, N. Y. 252 pages. Illustrated with 50 charts and plates. Reference tables and bibliography. $3.50

Radio engineers will find in this book the answers to many of the puzzling problems of radio transmission and propagation, as performance changes from time to time, with changes in solar conditions. Much new solar-radio data is presented, based upon Dr. Stetson's long-continued observations at his laboratory at Needham, Mass., operated in conjunction with the Massachusetts Institute of Technology.

Sunspots and associated solar radiations have become so important as factors controlling radio communication, that radio men will want to study carefully this most complete assembly of all relevant information bearing on the radio problem, now brought thoroughly up to date by Dr. Stetson.

Of special radio interest are the chapters on "Sunspots and Radio Communications", "Sunspots and Radio Prediction", "Sunspots, the Earth's Magnetism and the Northern Lights", "Radio Solar Eclipses and Cosmic Effects", "Radio and the Moon", "Predicting Sunspots", "Sunspots and the Economic Cycle", and "Sunspots the Radio Industry and the FCC."

Researches by such outstanding authorities as Dr. Stetson in America and Sir Edward V. Appleton in England, are now converting the former vagaries of radio transmission and reception into a definite science, of basic significance to the radio industry. This book is a "must" for the library of every radio engineer concerned in any way with the propagation of radio signals.

Ultra- and Extreme- Short Wave Reception

By M. J. O. Strutt, D. Techn. Sc., Electronics Consultant, N.V. Philips Co., Ltd., Eindhoven, Holland, published by D. Van Nostrand Co., Inc., New York, 1947, 387 pages, $7.50.

As indicated by the title, the book discusses principles, operation, and design of high frequency receiving apparatus.

A complete chapter is devoted to the study of spontaneous fluctuation noise, its origin, behavior, and reduction or elimination. Electromagnetic waves and antennas are also discussed. Laboratory apparatus and measuring methods for short waves are studied.

Patent Notes For Engineers

Published 1947 by RCA Review. RCA Laboratories Division, Princeton, New Jersey. 165 pages, $2.50.

Written by the Director of the Patent Department, this is the first volume of a new engineering book series to be published by RCA. Starting with an analysis of what constitutes an invention, theoretically and practically, it follows through the problems of records, prosecution of the patent applications, interferences and their handling, ownership, use and licenses.

NEW PROJECTION PACKAGE FOR TELEVISION

(*Continued from page 33*)

in., drawn to any convenient scale. See drawing of side view of the television projection box and the required light-throw clearance from the box to the viewing screen.

By folding the trapezoid so that, at the folding line, a 45° incidence and reflection angle is always maintained — to prevent keystoning — a variety of arrangements can be found. By using an 8½ x 16½-in. contour for the projection box and bases of 4.5 in. and 16 in., an illustration of the front view can be made. For either view the center of the small base of the trapezoid should lie in the center of the projection box. A double fold of the 31-in. light-throw made the table model design possible.

The consolette has an 8-deg. inclination of the viewing screen. This makes viewing at distances up to 20 ft. possible with this low cabinet. Both the table model and consolette are to be visualized with the usual single chassis replaced by two subchassis, one mounted on each side of the viewing screen. It is evident that the projection system is equally suitable for larger AM-FM-TV-phono combinations.

Any projection system requires, of course, a viewing screen. The light intensity of the system under discussion is such that moderately directive transmissive screens give good results. When desired, full advantage can be taken of the light gain available from the more directive screens. Transmissive viewing screens for projection television are flat and have square corners, both advantages over direct viewing tubes giving the same picture size. Various types of reflective screens have been tried and also give good results.

This television projection system provides a 12 x 16-in. picture from a compact, light-weight package. It is easy to install and fits small or large cabinets. Because it requires only the driving power of a 10BP4 chassis, it lends itself conveniently to an extension of 10-in. or larger direct-viewing sets, into various projection type models. It is not even necessary to make separate provision for feeding the high-voltage unit, since the input power requirements for the high-voltage unit can be obtained normally from such a chassis. Adjustment upon installation at the home of the customer, if required at all, is simple, and service inspection is easy.

This television projection system originated in the Research Laboratories of the N. V. Philips' Gloeilampenfabrieken at Eindhoven, Netherlands. Mr. J. R. Beers, Mr. H. G. Boyle, Dr. E. B. Doll and their associates of the Dobbs Ferry, N. Y., plant of North American Philips Company Inc. participated in the further development of the model described here, designated under the NORELCO trademark as PROTELGRAM Model 160.

Latest report from RCA is that the company is supplying 43 telecasters with television transmitter equipment.

NEWS OF THE INDUSTRY

Batcher Heads ISA Chapter

Ralph R. Batcher, engineering editor of TELE-TECH, has been elected president of the New York Section of the Instrument Society of America, and has also been appointed chairman of the publications committee of the national Society. A pioneer author in radio and electronics, Mr. Batcher's published books include "Cathode-Ray Oscillography", "Electronic Control Handbook" and "Electronic Engineering Handbook."

Ralph R. Batcher

Graduating from Iowa in 1920, he became a ship radio inspector for the Department of Commerce and later instructor in radio theory at the College of the City of New York and at the old Marconi Institute. From 1920 to 1924 he was design engineer for the Western Electric (now Bell) Laboratories, after becoming research engineer for A. H. Grebe & Co., and chief engineer for its pioneer broadcast station WABC. He later served as chief engineer for A. D. Cardwell Mfg. Co. He is a member of the board of editors of the Proceedings of the IRE, Fellow of the Radio Club of America, and a member of Tau Beta Pi.

CONVENTIONS AND MEETINGS AHEAD

April 7-9—Midwest Power Conference, Sheraton Hotel, Chicago.
April 8—West Coast Electronics Mfg. Assoc. Los Angeles Council, Hollywood Athletic Club.
April 14—IRE Conference, Chicago, Illinois Institute of Technology.
April 17—Chicago IRE Conference, Illinois Institute of Technology.
April 24—Regional Television Conference, IRE Cincinnati Section, Cincinnati, Ohio.
April 26-28—IRE Spring Meeting on Transmitters, Syracuse Hotel, Syracuse, N. Y.
May 3-5—American Section, International Scientific Radio Union, IRE, Washington, D. C.
May 10-15—Radio Parts and Electronic Equipment Shows Inc., Show, Hotel Stevens, Chicago.
May 17—National Association of Broadcasters, 26th Annual Convention and Engineering Conference, Los Angeles.
May 22—New England Radio Engineering Meeting, IRE, North Atlantic Section, Cambridge, Mass.
Sept. 30- Oct. 2—4th Annual Pacific Electronics Exhibit, West Coast Electronic Mfgs. Assoc., Biltmore Hotel, Los Angeles.

Mobile Communications Grows

Mobile Radio communications is continuing to grow by leaps and bounds, even though the FCC is still classifying all of the varied industrial and transportation radio systems, except for railroad radio, as *experimental* and has not yet finally determined the frequency space allocations. Each week brings to the FCC offices filings by taxicabs alone of applications which total more than $500,000 in equipment contracts.

The petroleum and natural gas industries have blueprinted elaborate radiotelephone facilities and are even turning to radar for operation of their tankers and pipeline dispatching. The logging and sawmill industry is planning over 500 mobile radio installations in the Pacific Northwest and is turning to use of walkie-talkies for cutting crews out in the timber areas. Power utilities have established comprehensive mobile radio systems for intra-system administrative communications and dispatching of "trouble" cars and crews. The coal and copper mining companies are now devising radio communications setups for the mines' operations underground. In the vehicular radio field the FCC has received applications for radio systems from every type of business from a diaper delivery service in Fort Worth, Texas, operators of undertaking establisments.

HEARD IN TELE CIRCLES

Feverish activity prevails in television circles marked by bigger and better plans and new names on the television bandwagon. Best known among the newcomers, perhaps, is Raytheon Mfg. Co., who has announced a "new and complete line of television station equipment with transmitters in two power sizes: 500-watt and 5-kw." Most persistent rumor, not included in the announcement, is that Raythcon's TV equipment manufacturing plans might be tied-in with those of DuMont's.

* *

Aerovox Corporation has a liquid plastic condenser project in laboratory development and under actual test. Now slightly higher in cost than paper condensers, it will be possible to produce the new type condenser at competitive prices, but with the added advantages of longer life and greater efficiency.

* *

Out of the Chicago area comes information that a radio manufacturer, who specializes in custom-built, high-quality receivers, is considering the possibility of using the television projection package described in this issue on page 30.

* *

Latest in low-priced TV is the 7-in. picture tube receiver announced for $99. Walter Spiegel of Regal Electronic Corp., N. Y., promised us details about April 15. Watch for our follow-up in the May issue of TELE-TECH.

* *

Kollmorgen Optical Corp., B'klyn, N. Y., optics manufacturer, is reported interested in the television lens field and is inquiring into the desirability of designing and producing projection lenses for TV use.

* *

A flat-faced, 15-in. CR tube for which greater picture area is claimed, is now in production at Zetka Laboratories, Inc., Clifton, N. J. James Zetka says the tube will permit a viewing area better than 143 sq. in. Company claims contingent orders in the neighborhood of $1 million from interested manufacturers.

* *

Make what you want of the information: Zenith is stocking thousands of name plates for television receivers (for the big push?). Plates are being stamped by the L. F. Grammes Company of Allentown, Pa.

Tele-Tech Ass't. Publisher

Stanley Gerstin, formerly editor and general manager of Telecasting Publications, Inc., has joined Caldwell-Clements, Inc., New York, as assistant publisher of TELE-TECH, the companys' television, telecommunications and radio engineering magazine. Mr. Gerstin was formerly an editor in the

Lt. Colonel Stanley Gerstin

automotive division of the Chilton Publishing Co. and with Fawcett Publications.

During the war he served as a Publications Chief for the Corps of Engineers and later as Chief Publishing Consultant to the Adjutant General with advisory responsibility over the publishing activities of technical services in Army Service Forces. He recently received the War Department merit award for his contribution to the development of technical publications for the Army.

RTCA Unfolds Huge Air Traffic Control Plan to Cost Billion

The integrated, all-weather, electronic air traffic control system, which is aimed to meet both military and civil aviation requirements, was disclosed in detail in mid-March by the Radio Technical Commission for Aeronautics' Special Committee SC31 and calls for a total estimated cost of $1,113,000,000 of which $989 million is required for modernization and new installations of ground aviation equipment and military airborne apparatus and $124 million for civilian airborne equipment. This entire program will require around 15 years for complete development, installation and training of operators.

Within the next 5 years, the RTCA recommended an interim program of $376,200,000 for the development and installation of the most modern air navigation and communications equipment in the nation's airports and relief of the present congested condition of the airways in the interest of national defense and civilian flying. The immediate interim program of RTCA calls for the following: a low-cost, lightweight VHF receiver to permit use of static-free voice channels and omni-directional range navigation on small aircraft; additional Instrument Landing Systems (ILS) and Ground Controlled Approach (GCA) installations; Distance Measuring equipments; a radar cover of the more crowded traffic routes; installation of airborne transponders in all aircraft; VHF automatic direction finder equipment at airports; and simple interlock mechanical boards to assist harassed traffic controllers and tower operators.

The only equipment which cannot be integrated into the final $1,113 million 15-year plan is the VHF automatic director finder, but the latter equipmay prove useful in the lower density areas on the edge of the radar network.

TELEVISION-RADIO PRODUCTION BOX SCORE

(RMA Members)

Receiver Production	Jan.	Feb.	Postwar Totals
Television	30,001	35,889	250,937
Consoles	13,261	10,295	87,609
Table M.	16,740	25,594	163,328
AM & FM	1,339,256	1,379,605	33,718,861
AM-FM	136,015	140,629	1,582,644

How Much Engineer Pay?

(*Continued from page 26*)

basis of a continuous service record. Originally, I received the ticket on the basis of 4 months of part-time study after a few years of ham tinkering. I've gone through the mill from part-time operation as a general staff man to 'technician' to operations manager. In the latter capacity I've had the responsibility of selecting technical personnel for this station since 1939. I've had my share of transmitter failures and "konk-outs" of other equipment and have managed, in most cases, to muddle through. But, to be honest about it, I don't consider myself a 'technician' in the sense that I use when interviewing an applicant. And I'm in no sense a graduate engineer, even though I've been in on the planning and construction of new installations from foundation to beacon. I'm just a guy with a ticket. And that's the heart of my argument.

"There are too many guys with tickets in broadcasting—and too few real technicians and engineers. Most of them did as I did—boned up with a Q & A book, got a little private coaching and passed the FCC examination. They happened to be available, especially during the war, and got a job. They're in the union, have seniority and they are technicians. If they're on a network affiliate they practically coast through their shifts and yell for the chief if trouble develops.

"If they are on an independent, the demands are greater because they have to be on their toes not to miss cues for the next platter—but you don't have to know anything about electronics to learn how to pick up cues. It may be worse in other areas, but round here, under the union deal, any operator with more than three months experience gets—in the lowest paid station—$72 a week, and $12 a week more if he does any announcing. And the scale goes on up to $92.50—and higher for supervisors. Is that 'underpaid?'

"Frankly, I'm all for supporting every legitimate claim that technical personnel can make for better wages—and I'm sympathetic with the fact that every man has to eat. But my point is that too few men

in the business really have the training, background, skill, know-how, and interest in the art to qualify as technicians. And, under present conditions, when a young and eager fellow does appear, he has practically no chance to practice the art he loves because the union will protect the man on the job, regardless of his qualifications.

"As I see it, the average technician on the job these days may not be overpaid (he says with tongue in cheek), but he certainly is not underpaid.

"With engineers, it's quite another thing. I firmly believe that a man who can qualify as an engineer, as I define it, deserves an executive's wages. But such engineers as there are in the run-of-the-dial stations don't get what they deserve because technicians are getting such a big slice of the budget available for technical people.

"As I see it, an engineer should have an academic background equivalent to an E. E. degree. He should be a good theoretician, but at the same time a thoroughly practical man. He should be deeply immersed in his subject and endowed with pride in the plant under his responsibility—primarily because its good operation is a reflection of his own interest and ability. Such men as these are rare indeed—and when found should be encouraged, first with the stuff that jingles, second with authority from the top management to keep his plant at peak efficiency.

"Frankly, I feel that every station, however small, should have at least one such man. But to achieve this end, management must be better sold on the idea that good engineering is good business, and unions must take a more vigorous attitude toward the qualifications of their membership. Men now working in broadcasting must somehow develop the attitude that it is not enough just to get by. Young men coming up should be encouraged to get the background to qualify as engineers, confident that they will find places to apply their knowledge."

Further comments were sent in by the engineer of a broadcast station in the Mid-West. He says:

"I don't think it can be disputed that the average broadcast engineer

(*Continued on next page*)

(*Continued from preceding page*)

is the lowest paid in the industry, even drawing less salary than the stenographer, in some instances. For his training and responsibility, an engineer should not be paid less than $250 a month, even on the 250-watt stations. In most cases a minimu mof $300 is indicated. I feel that engineers should also have taken into account their experience and longevity of service.

"I know of no formula that can be equitably in all cases since the geographical location of the station and the economic status of the area have much to do with the cost of living and salary scales. But certainly the engineer should be lifted from the present position in which he finds himself—almost as a glorified janitor! Too many station managers are prone to look upon the engineer as merely someone who throws a switch. I'd like to see management (other than those who came out of the engineering ranks) tune a high-efficiency transmitter or adjust a directional array.

"I think the application of progressive promotion, as practiced by the U.S. Civil Service, might be worth trying. The recent realignment of engineers as discussed by the NAB and as proposed by the FCC seems to me to be a poor start towards raising not only qualifications, but wages also."

PERSONNEL

Six General Electric men in the company's Electronic Dept. have received the Charles A. Coffin award for work of outstanding merit during 1946-47 on transmitter and broadcast development. They are **William F. Goetter, Ross A. Lash,** and **Henry P. Thomas** of the Transmitter Div. at Syracuse, N. Y.; **Robert P. Watson** and **Kenneth C. DeWalt** of the Tube Div., Schenectady, N. Y.; **Robert B. Dome** of the Receiver Div., Syracuse.

Dr. A. M. Skellett has been named vice president in charge of the Research Div. of National Union Radio Corp., Orange, N. J. He joined the Research Div. as chief engineer in 1944 after spending fifteen years as a member of the technical staff of Bell Telephone Laboratories.

Fred T. Caldwell, formerly vice-president and director of International Standard Electric Corp., has been appointed president of the Federal Telephone and Radio Corp. **Rear Admiral Ellery W. Stone,** formerly vice-president of ISEC is executive vice-president of Federal. The new appointments follow acquisition of ISEC manufacturing facilities by Federal.

William J. Morlock has been appointed division engineer of the Specialty Div., General Electric, Electronics Park, Syracuse and will be responsible for the division's engineering and drafting activities. Two appointments have been made in the Transmitter Div., also at Syracuse. **J. E. Keister** has been named section engineer of the television and broadcast engineering section and **H. B. Fancher** has been appointed assistant engineer.

Norman B. Krim has assumed the managership of the Receiving Tube Div. of Raytheon Mfg. Co. He succeeds **Carl H. Hollatz,** vice president of Raytheon's subsidiary, Belmont Radio Corp. of Chicago, who now becomes general manager of Belmont.

New Devices Revealed at IRE

A new type of tube which greatly simplifies FM circuits, a new system of broadcasting making possible two-channel transmission of sound, a reflected power system that operates without vacuum tubes, a radar system capable of detecting a single moving object—these are some of the new electronic developments unveiled at the IRE Convention in New York last month.

The FM circuit-simplifying radio tube described by Dr. Robert Adler, Zenith Radio Corp., known as the "gate-beam tube," operates as an FM "limiter," and makes a simplified circuit possible with greater ease of adjustment and tuning.

D. E. Norgaard, General Electric Co., described his "binural" reception resulting from a system of broadcasting employing single-sideband technics.

Dr. Harry Stockman described a reflected power system making possible communication between ship and shore or plane-to-plane. Using reflected beams, the signal must hit the target and reflect back to the sending point before the message is transmitted.

E. J. Barlow, Sperry Gyroscope Co., described a "selective" radar system that singles out a moving object from among many other objects.

A more comprehensive description of these and other developments disclosed at the IRE meeting will be described in the May issue of TELE-TECH.

Audio Compensation Networks

(*Continued from page* 35)

78 rpm foreign and domestic phonograph recordings manufactured during the past 20 years, in addition to 2 commonly encountered 33.3 rpm transcription characteristics.

Due to the amount of high frequency correction necessary to overcome the inherent losses of Reproducer A, this equalizer will not be suitable for types having a "flat" (on a velocity basis), or differing degrees of response in the 1 to 10 kc region. However, if the unequalized response of any reproducer is known, suitable modifications may be made to this equalizer by applying the information presented in these articles and charts. The 6-deck switch and all associated equalizer resistors and capacitors should be enclosed in a separate metal box to avoid unwanted signal pickup.

The ordinary computations needed in setting up networks for this service have been listed in the 4 charts herewith. Chart A refers to *low frequency compensation* and Chart B the *high frequency correction* equivalent. In either case where the correction network is to be inserted in the circuit directly after the phono reproducer Z_{in} should closely approximate the optimum load as recommended by the manufacturer, or as determined in the first article of this series. Where the network is to be inserted between two amplifier tubes, Z_{in} represents a minimum load that should approximately equal 5 times the plate resistance for a triode source, and 5 times the plate load resistor for a pentode source.

Charts C and D represent the low and high frequency *loss* networks and low and high frequency *accentuation* networks respectively. In the low frequency attenuation configuration, R_1 R_2 R_3 and C_1 comprise a normal low frequency crossover network. The addition of R_c limits the low frequency response, and the network then assumes a fixed insertion loss of 7 db in the normal usable range below $f_{dp}/10$. At $f_{dp}/100$ the insertion loss reduces to 4 db. In the high frequency group Chart C R might be any shunt resistance in a given network, as for example, R_3 of the low frequency

crossover network shown. At high frequencies, R_3 will actually have a value equal to (R_2R_3/R_2+R_3) in a network of this type. R_2 of a typical high frequency accentuation network may also be used as the shunt resistance, in which case the nominal resistance value of R is read directly when calculating X_{cr}. These matters were more explicitly explained in the previous articles.

The procedure for combining both low and high frequency accentuation networks (Chart D) is to decide first on the low frequency section. From Chart A, values for a low frequency network with the proper slope characteristic for the particular degree of correction desired are selected. (Similar type slope characteristics only may be combined: that is, 6 db per octave low frequency and 6 db per octave high frequency networks may be combined, or 3 db per octave low frequency and 3 db per octave high frequency networks, also. But not 6 db per octave low frequency with 3 db per octave high frequency networks, or vice versa.)

Once the low frequency network values have been decided upon, C_2 may then be calculated in the manner shown opposite Circuit Values on Chart B. The degree of correction obtainable from this combined type network depends primarily on the amount of separation between the two frequency design points, f_{dp}(HF) and f_{dp}(HF). With a 10 to 1 frequency range (say, 300 to 3000 cycles) between the two frequency design points, the maximum practical (as far as the audio spectrum is concerned) degrees of correction are obtained. The minimum is reached when f_{dp}(LF) and f_{dp}(HF) are the same frequency.

Audio Engr. Society Formed

Formation of the Audio Engineering Society has been announced by citing officers of the new society following a recent meeting of audio engineers in New York City. The first formal meeting last month heard Dr. H. F. Olsen, RCA, describe a tiny phonograph pickup with noise-suppressor tube. Those interested should write to Norman C. Pickering, Pickering & Co., Inc., Oceanside, New York.

Lynn Announces Projector

Lynn Television Co., Philadelphia, announces development of a television projector which will throw an image 9x12 ft. using equipment no more costly than the better home receivers.

Lab Testing TV Receivers

(*Continued from page 39*)

rf carrier helps to determine the correct adjustment of these generators. Manufacturers of television transmitting equipment supply this type of unit.

An RF signal generator must be capable of handling television picture modulation. To be of utility in receiver testing, the output signals of the television pulse generator, the monoscope, the linearity-pattern generator and the stepwave generator should be used to modulate an RF carrier on any of the commercially allocated television channels. This may be done by a beat-frequency generator, in which a signal conforming to the vestigial-sideband type of operation specified by the FCC is obtained at constant frequency, and heterodyned by a variable-frequency oscillator to any desired television channel.

For many purposes, however, a relatively simple modulated amplifier, producing essentially double-sideband modulation, is acceptable. This type of amplifier may be excited by a signal generator, or a fixed-frequency oscillator, and wideband modulation may be accomplished readily on any of the assigned channels by the use of a multigrid mixer or a pentode. In this case the modulation is applied to the suppressor which has a relatively sharp cut-off characteristic.

In the list of test equipment are show some items which are useful for receiver development, but which are not recommended for the average receiver laboratory because of non-availability, or excessive cost compared to the utility, or because their functions are fairly well taken care of by items previously discussed. For example, in the development of antennas, antenna input circuits, and RF matching networks, measurement of impedance is at the working frequency. The most suitable equipment for this purpose includes a slotted line provided with a traveling probe. The device whose impedance is being measured is supplied with power through the slotted line, and the standing-wave pattern appearing on the line is measured. From these measurements and certain readings the impedance of the device may be calculated.

Then again, a calibrated random-

noise source is a time-saving device. Such a generator should develop a noise signal whose components have uniform amplitude but random phase over the frequency range from about 40 to 220 mc. Used to furnish an input signal in conjunction with a square-law indicating instrument at the IF amplifier output, the noise factor may be evaluated conveniently without resorting to tedious measurement, and without calculation of the effective bandwidth of the receiver. Equipment of this type is not known to be commercially available.

Since receivers frequently fail in unfavorable locations because of the disturbances due to impulse noise, some sort of impulse-noise generator whose output is reproducible and preferably capable of being calibrated, is desirable. Such an instrument should have an extremely narrow pulse, of the order of 10^{-3} micro-sec. duration, so that its calibration, in volts per megacycle, would be approximately constant over the television channels from 40 to 220 mc. No equipment of this sort is known to be available.

Low-Frequency disturbances are also frequently encountered. These may be studied by measuring the frequency characteristic point by point, but the procedure is laborious. The application of a square-wave signal makes such disturbances immediately apparent on an oscilloscope and permits quick observation of the effect of adjustments, although it is frequently possible to use a signal from the television pulse generator or the stepwave for this purpose.

Finally, for some purposes in the testing of receivers, motion pictures rather than steady patterns are desirable. It is occasionally found that receivers exhibit defective operation only on pictures with peculiar distribution of the light and dark areas. Test for troubles of this nature are most readily run with a television camera which permits shots or patterns nf a special nature.

Consolidated Now TeleKing

The name of Consolidated Television Corp., New York, has been changed to TeleKing Corp., according to J. F. Crossin, newly appoint director of sales. Mr. Grossin was formerly vice-president and director of sales for Olympic radios.

Ignitrons in BC Service

(*Continued from page 29*)

current may be obtained through the load, as in the case of welding-control ignitrons, but in most rectifiers, and particularly high-voltage rectifiers, it is preferable to use separate excitation. Separate excitation circuits consist of pulse-forming networks. One circuit frequently used discharges a capacitor through an inductance and the ignitor.

Ignitor firing circuits are defined by the open-circuit voltage, short-circuit current, and pulse width, all interdependent factors as a consequence of the resistance-temperature characteristics of the ignitor and the wide range of temperature over which the ignitor must operate. Other factors influencing the characteristics of ignitors include the continual change in mercury level as the tube is operated. This variation in mercury level is caused by waves in the mercury set up by the movement of the cathode spots. Therefore, ignition takes place at a different point on the ignitor during each successive cycle. The net result is that ignitor volt-ampere requirements vary widely when the tube is operated. A circuit which will supply about 500 volts when open-circuited and 50 amperes when short-circuited with a pulse width of 500 microseconds is generally satisfactory. The ignitor power requirements are essentially constant regardless of the size of the ignitron.

The use of single-anode tubes makes possible a variety of circuits with wide variations in output, each using the tube to its maximum rating. The three-phase full-wave circuit is commonly used for high-voltage radio-transmitter power supplies. This circuit results in the most effective utilization of the transformer and least complication of transformer design. It provides a six-phase output voltage which has a relatively low ripple. The dc output voltage is nearly equal to the peak inverse voltage on the tubes, permitting maximum utilization of the tube design when high dc voltages are required.

The principal objective in tube design is to provide characteristics that would permit grid blocking at the moment when the tube is carry-

ing short-circuit currents, that is, when ion densities are high and ion decay slow. At this time the period of current conduction is lengthened because of circuit characteristics and this tends still further to increase the residual ionization. In tubes of small diameters ignitor blocking offers a considerable degree of control, but as the tube dimensions increase and for higher anode potentials, control grids become necessary.

From the technical standpoint, transmitters of much higher power than any now operating in the United States can be designed. Rectifiers providing 1500-3000 kw would supply 500-1000 kw transmitters. In the commonly used three-phase, full-wave circuit where 6 tubes are employed, a 20-kv, 50-amp tube is a practical size, since many of the components could be standardized with those of the lower-voltage ignitrons.

Ignitrons for use in low-voltage rectifier circuits do not require grids in order to achieve the desired performance. Grids, however, are a vital part of a high-voltage ignitron. They serve as a deionizing shield by completely surrounding the anode and providing optimum spacing for rapid deionization. Grids also act as baffles to protect the anode from mercury droplets sprayed from the cathode spots. Proper choice of grids and grid spacing makes possible a several fold increase in allowable forward and inverse voltage. Grids are usually made of graphite in mercury-arc tubes, but if there are space limitations, only the bottom of the grid need be made of graphite—the sidewalls being made of this metal such as perforated nichrome. As the ratio of thickness of the grid baffle to grid hole diameter is increased, the grid characteristic becomes more positive, and the ability of the tube to hold-off voltage is increased. The extension of this ratio to extremes can make it virtually impossible to start main-anode conduction.

An ignitron normally operating with full circuit voltage applied between anode and control grids is limited to inverse voltages below 20 kilovolts. Gradient grids which are mounted between anode and control grids and maintained at inter-

(*Continued on next page*)

(*Continued from preceding page*)

mediate potentials by means of potential dividers will reduce the voltage stress, and this reduction in voltage stress makes it possible to extend the voltage limit.

The basic elements of this new ignitron are an anode, a mercury pool cathode, and two grids. Fig. 4 shows a cross-sectional drawing of the photograph of such a tube. The graphite anode is surrounded by the two grids. The inner grid acts as a potential dividing or gradient grid to control potential gradients during non-conduction periods. The outer grid acts as a control grid to determine the time of starting, and as a baffle to shield the anode from the residual ionization at the end of conduction. A baffle below the grid structure serves the dual purpose of blocking the mercury spray during conduction and aiding the deionization of the space below the grids during the non-conducting period. The cathode has two ignitors, only one of which is used at a time. An auxiliary anode maintains cathode-spot excitation for low anode currents and is also used for control purposes.

The conventional method of testing low-voltage ignitrons is to operate them at normal voltage and temperature and increases the output current until the arc-back point is reached. This process is reversed in testing of high-voltage ignitrons since anode voltage has more influence on the arc-back point than has current. Increments in anode voltage are used to find the conditions of failure.

Maximum ratings of the GL-5630 ignitron are shown in the tube rating table below:

Maximum peak anode voltage: 20 kv inverse, and 20 kv forward.

Main anode current for zero phase control angle: Peak—200 amp, average—50 amp; surge—200° amp.

Water temperature: 45° C. maximum outlet; 35° C. minimum inlet.

Grid excitation requirements to establish conduction 0.200 amp positive current +100 volts minimum and a minimum of −50 volts to prevent conduction.

Cathode excitation requirements: 150 volts with a current of 40 amp.

TELE-TECH
Advertisers April 1948

ENGINEERING A 50 KW FM TRANSMITTER

(*Continued from page 45*)

If the 50 kw output stage fails, a control switch shuts off plate power, disconnects drivers and final amplifiers, grounds their dc feed, and transfers the antenna to the intermediate power amplifier.

Switching of the antenna from the 50 kw amplifier to the intermediate power amplifier is accomplished by means of new type triple-latch transmission-line switches. The antenna at all times remains mechanically connected to the 50 kw amplifier. Electrical switching is accomplished by using impedance characteristics of a shorted quarter-wave section of a transmission line, with the switches shorting these sections, Fig. 6.

Closing one switch located midway in the line between the output of the intermediate power amplifier stage and the antenna junction box (providing a quarter-wave section on either side) of the switch will create a high impedance on either the amplifier or the antenna side. A second switch is located a quarter wavelength from the intermediate power amplifier while a third switch is located a quarter wavelength from the antenna junction box in the output line.

All plate power to the transmitter is supplied by one rectifier unit using 6 RCA 857-B mercury-vapor tubes connected in a three phase full wave circuit, with a tap to supply the lower power stages. In case a tube fails, a pre-heated spare tube may be manually switched in place of any of the six operating tubes, at the same time removing the defective tube from the circuit.

The plate transformer is an air-cooled, natural-draft unit, totally enclosed and arranged for either throat or conduit connection. Primary taps are provided to accommodate line voltages from 440 to 480. An extended winding on the primary drops tuneup voltage to approximately 57% normal. Approximately 125 kw, 3/60 cycle input power is required for normal operation.

A harmonic filter and a protective device are provided as a part of the transmitter equipment. Both devices are important to continuous trouble-free operation of the station. The harmonic filter connected in the transmission line between the transmitter and the antenna, by attenuating all frequencies above the fundamental, insures other services operating on higher frequencies a total absence of interference even though located close to the transmitter. The protective standing wave detector, Fig. 7, monitors the antenna transmission line and will cut off the carrier if there is a sudden change in the standing wave ratio.

The performance characteristics for the BTF 50A transmitter are as follows (considering a ±75 kc swing): The audio frequency response is flat within ±1 decibel from 30 to 15,000 cycles at all percentages of modulation up to 100%, Fig. 8. Distortion is less than 1% rms, from 30 to 15,000 cycles, at 100% modulation. FM noise level measure −70 decibel below 100% modulation.

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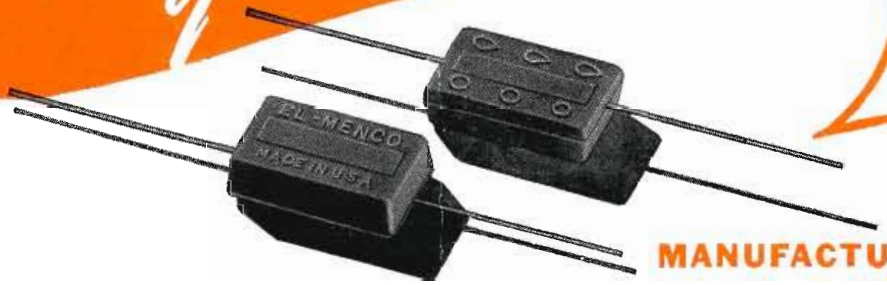

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	2P23	3KP1	
	5655	5UP1	
(Directly Viewed) 7DP4	1850-A		
7JP4			
10BP4			

PHOTOTUBES

Gas Types	1P41	921	927	930
Vacuum Types	922	929		
Multiplier	931-A			

GAS TUBES

Thyratrons	2D21	3D22	884	2050		
Ignitrons	5550	5551	5552	5553	5563	
Rectifiers	3B25	673	816	857-B	866-A	869-B
	8008					
Voltage Regulators	0A2	0C3/VR105	0D3/VR150			

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8000	889R-A	
8005	892-R	
8025-A	5588	
	5592	

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		807	
		813	
		815	
		B29-B	
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