TELE-TECH

Formerly ELECTRONIC INDUSTRIES

TELEVISION • TELECOMMUNICATIONS • RADIO

October • 1948

CALDWELL-CLEMENTS, INC.

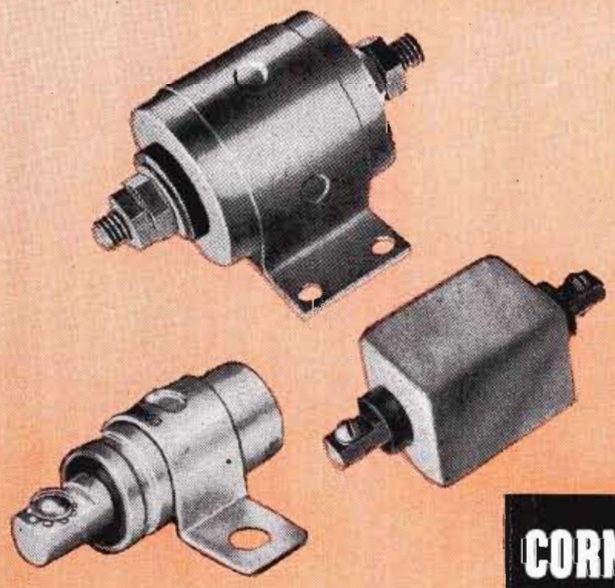
Photo: Central monitor control for Don Lee broadcast network designed by Western Electric — See Page 1

How to Sell to National Defense Agencies Page 24

ENGINEERING TECHNICS — DESIGN • MANUFACTURING • OPERATION

quiet as a goldfish

with C-D Quietones*



MICA • DYKANOL • PAPER • ELECTROLYTIC

A lot of ***electronic and electrical equipment is going to sea these days. But it won't stay there long—in fact, it won't even stay sold—unless it is Noise-Proofed against radio interference.***

To you—the manufacturer—this means that your product should include C-D Quietones in its basic design. With safety at sea—as well as listening pleasure—at stake, your marine customers demand the kind of interference-free equipment operation C-D Quietones are designed to give. Of the hundreds of Quietone types available, there may be one which will fit your needs to a "T"; if not, our sleeves are rolled up and we're ready in our modern and complete Radio Noise-Proofing Laboratory—to design the specific filter you need. C-D Quietones will solve your radio noise and spark suppression problems speedily, permanently and effectively. Your inquiry is invited. Cornell-Dubilier Electric Corporation, Dept. J10, South Plainfield, New Jersey. Other large plants in New Bedford, Worcester, and Brookline, Massachusetts, and Providence, R. I.

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

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WORLD'S LARGEST MANUFACTURER OF
CAPACITORS

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WORLD'S MOST ADVANCED RADIO "NOISE-PROOFING" LABORATORY IS AT YOUR SERVICE *without obligation*

*Reg. U.S. Pat. Off.

Formerly ELECTRONIC INDUSTRIES

TELE-TECH

TELEVISION • TELECOMMUNICATIONS • RADIO

OCTOBER, 1948

Editorial Contents

COVER: Bob Arne, engineering superintendent, is shown operating Mutual-Don Lee's master control panel designed for the network's Hollywood headquarters by Western Electric. Willett H. Brown, Don Lee's vice-president, looks on.

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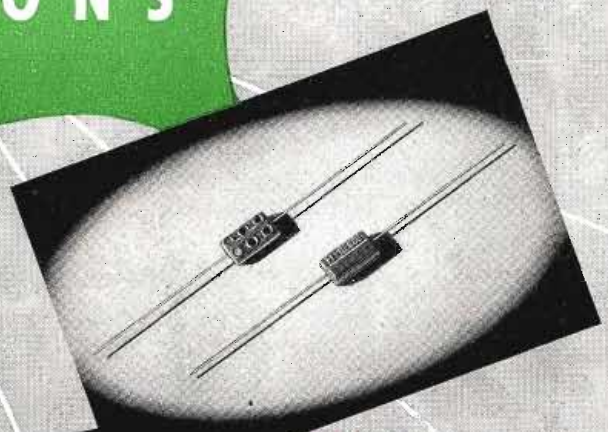
No product is better than its weakest component. This is why more and more manufacturers now use EL-MENCO mica capacitors. Rather than risk their reputations on inferior components they automatically specify El-Menco — the mica capacitor with the kind of performance that always gives customer satisfaction and builds better reputations.



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CM 15 MINIATURE CAPACITOR

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

For Radio, Television and Other Electronic Applications

2 to 420 mmf. capacity at 500 v DCA

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

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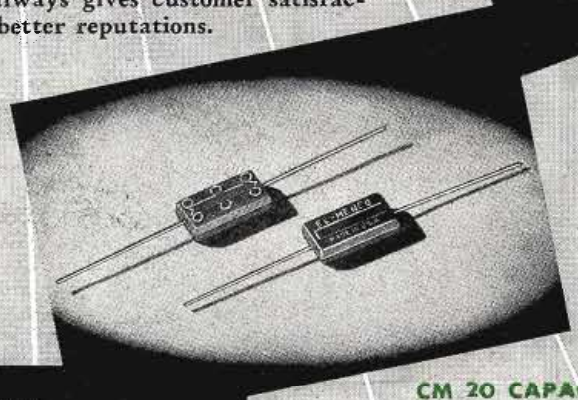

CM 20 CAPACITOR

Available in "A", "B", "C" and "D" characteristics

2 to 1500 mmf. in tolerances down to ± 1%* or .5 mmf. at 500 D.C. working voltage

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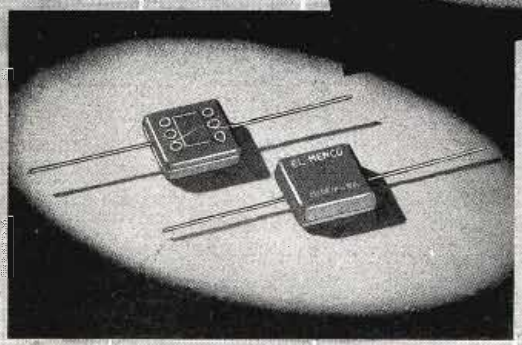
*Whichever is greater



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6-dot color coded

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Digest

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CAGED FOR PROTECTION

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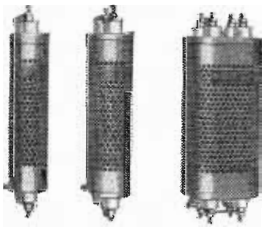


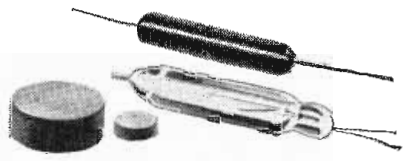
way being injured. The resistance wire has a low temperature coefficient so that the resistance remains nearly constant as the temperature increases. Ample protection to the units is provided by the perforated metal case. Each unit is rated at 85 watts and is available in resistance values from 0.5 to 100,000 ohms; one to four units in a cage. For more complete information please contact your G-E representative.

NEED A "LOW VA" VOLTAGE STABILIZER?

General Electric's latest additions to its line of automatic voltage stabilizers are three 115-volt, 60-cycle designs in 15-, 25-, and 50-va ratings. Check the low prices—you may now be able to utilize the advantages of an automatic voltage control for your application. The price consideration plus the low case height and small size will make these units especially applicable to radio chassis and other shallow-depth installations. Other features include totally insulated design, which is necessary where isolation is required between primary and secondary circuits, and universal lead construction which makes these units adaptable to various wiring and mounting arrangements. If you have an application problem, contact your G-E representative, or check bulletin GEA-3634B.

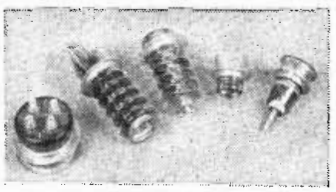
SOMETHING NEW IN CIRCUIT CONTROL DEVICES

Simplify your circuit designs by replacing complicated and costly components with simple, economical G-E Thermistors. These electronic semiconductors are unique in that the resistance changes rapidly with slight variations in temperature—electrical resistance decreases as temperature rises, and increases as temperature falls. G-E Thermistors give you these five advantages: flexible in application, small in size, available in various shapes, indefinitely stable, and they are economical. These new circuit devices are especially adaptable as sensitive elements in flow meters, liquid-level gages, time-delay relays, vacuum gages, switching devices, and modulating thermostatic circuits. Check coupon for technical report CDM-9.



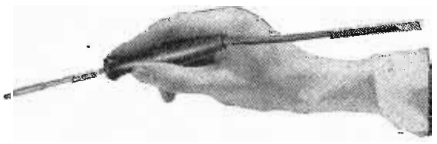
HERMETIC SEAL ELIMINATES MOISTURE PROBLEMS

The new cast-glass bushings with their sealed-in metal hardware can be readily welded, soldered, or brazed directly to the apparatus, thus eliminating gaskets and providing a better seal than ever before. The small, compact structure of the bushings often makes it possible to reduce the overall size and weight of the electric apparatus. Bushings are practically unaffected by weathering, microorganisms, and thermal shock. Their great mechanical strength makes them well suited for use in airplanes, etc., where they are subject to continual vibration. Available in ratings up to 8.6 kv and for currents to 1200 amperes. Check bulletin GEA-5093.



MORE SOLDERING WITH LESS POWER

G.E.'s midget soldering iron can do a big job for you with only one-fourth the wattage usually used. This handy 6-volt, 25-watt iron is only 8 inches long (with ⅛" or ¼" tips) and weighs but 1¾ ounces. It was especially designed for close-quarter, pin-point precision soldering. The "midget" offers you all these advantages: low-cost soldering; "fingertip" operation; quick, continuous heat; easy renewal; long life; low maintenance. The iron is a real aid in manufacturing radios, instruments, meters, electric appliances, and many other products requiring precision soldering. Irons and specially designed 115/6-volt transformers are available from stock. Check bulletin GES-3488.



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- ☐ GES-3488 Midget Soldering Iron
- ☐ GEA-3634B Voltage Stabilizer
- ☐ GEA-5093 Cast-Glass Bushings
- ☐ CDM-9 Thermistors

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No value equal to it...

Model 260 Volt-Ohm-Milliammeter

There's good reason why this is the world's most popular high sensitivity volt-ohm-milliammeter. In every part, from smallest componet to overall design, no competing instrument can show superiority. It outsells because it outranks every similar instrument. And in the Simpson patented Roll Top safety case, shown here, it brings you important and exclusive protection and convenience.

Sub-Panel Assembly—Strong, Simple, Accessible

with cover over resistor pockets removed to show design

The ruggedness, the simplicity of design, and the consequent accessibility of components are shown here. Molded of sturdiest bakelite, the sub-panel provides separate pockets for resistors. This separation makes for orderly assembly, highest possible accessibility, and added insulation for preventing shorts. All connections are short and direct. Cable wiring is eliminated. Each battery has its own compartment, again increasing accessibility.

The New Simpson Switch Mechanism. You will find no other switch mechanism on the market like this Simpson switch. It is built of molded bakelite discs. Unusually sturdy contacts, of heavy stamped brass, silver-plated for superior conductivity are molded permanently into each disc. They can never come loose, never get out of position. When the discs are assembled into the complete switch, these contacts are self-enclosed against dust. Danger of shorts is automatically eliminated. As the switch is rotated from range to range, the contact is always positive and unvarying.

A ball-and-spring mechanism positions the switch at the selected range by a 3-point pressure. Switch is thus held securely in place, yet smoothly re-positions to each new range. This mechanism is also self-enclosed against dust in a bakelite housing.

High voltage probe (25,000 volts) for TV, radar, x-ray and other high voltage tests, also available.

RANGES

20,000 Ohms per Volt D.C., 1,000 Ohms per Volt A.C.
Volts: A.C. and D.C.: 2.5, 10, 50, 250, 1000, 5000
Output: 2.5, 10, 50, 250, 1000
Milliomperes, D.C.: 10, 100, 500
Microomperes, D.C.: 100
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Decibels (5 ranges): —10 to +52 D.B.
Ohms: 0-2000 (12 ohms center), 0-200,000 (1200 ohms center), 0-20 megahms (120,000 ohms center).
Model 260, Size: 5¼" x 7" x 3⅛".....**$38.95**
Model 260 in Roll Top Safety Case, as shown. Size: 5⅜" x 7" x 4¾".....**$45.95**
Both complete with test leads and 32-page Operator's Manual

Ask your jobber or write for complete descriptive literature.

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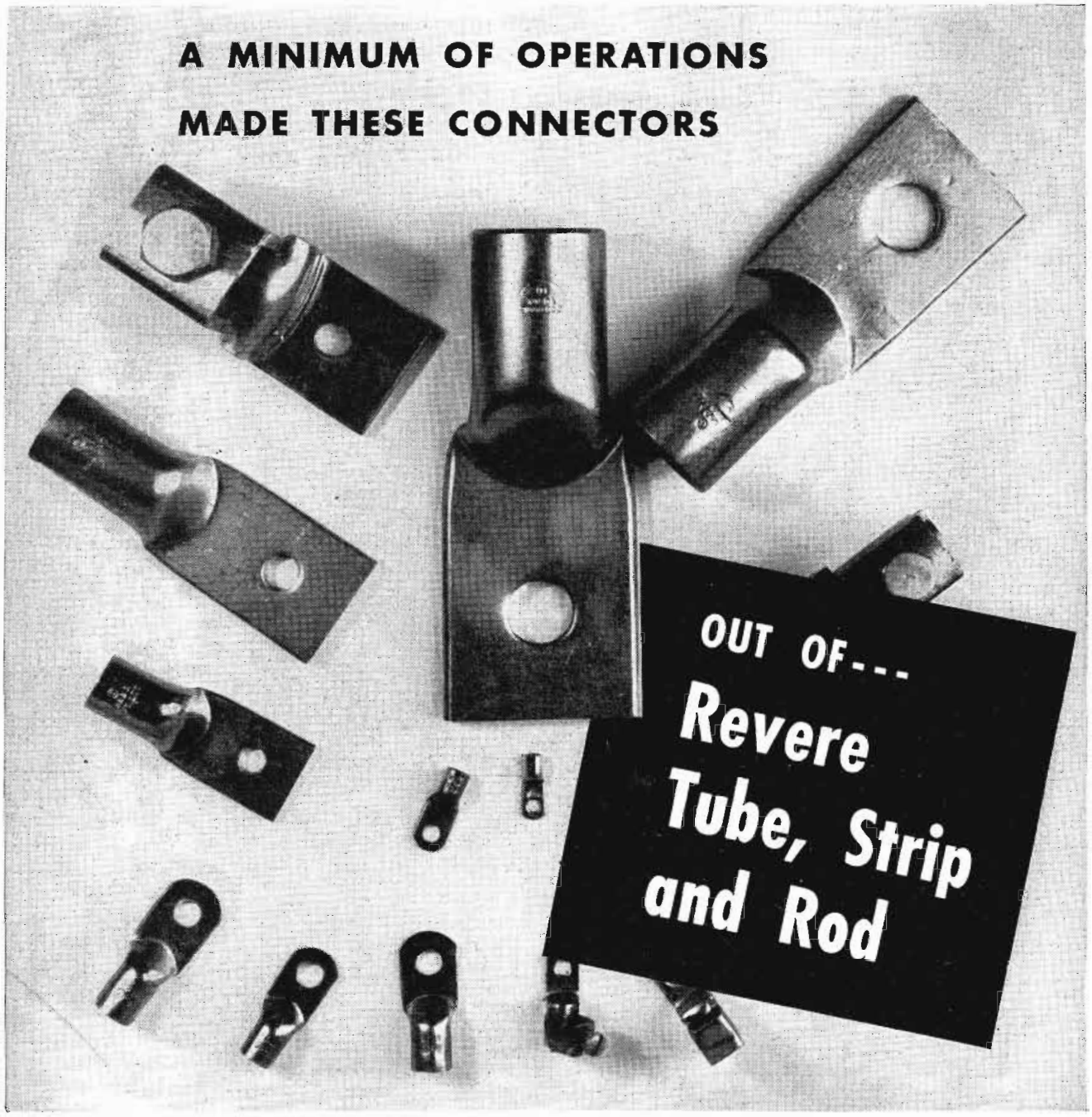

THESE electrical connectors are but a few out of the hundreds of types being made today out of Revere copper and copper alloy tube, strip and rod.

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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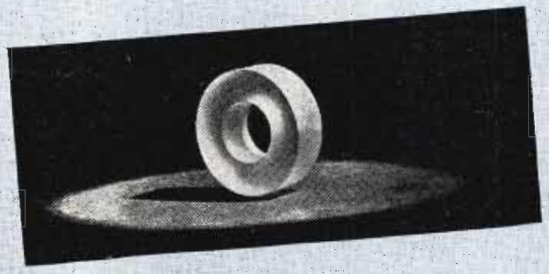
How a quartz ring drove the first crystal clock in 1928



Heart of the crystal clock built 20 years ago at Bell Laboratories was this quartz ring, adjusted to a frequency of 100 kc. With the crystal cut to correct proportions in this annular shape, positive and negative temperature coefficients of frequency effectively neutralized each other. Resultant temperature coefficient was less than 1 part in 10^6 per degree C.

In the complete oscillator, the crystal was mounted inside a chamber in which the temperature was kept constant within 0.01° C, and placed in a hermetically sealed bell jar to maintain uniform pressure. The frequency of the oscillator output was reduced to 1,000 cycles by means of sub-multiple generators.

In the clock mechanism, a 1,000-cycle synchronous motor, driven by the output of the sub-multiple generators, was geared to the clock hands. Accuracy of this clock in 1928 was within 1 part in 10^6. Accuracy of its present-day successor is of the order of 1 part in 10^8.—an advance made possible by continuing research.

Where a second is

. . . in the clock that varies less than 1/1000th of a second a day

There's a clock at Bell Telephone Laboratories —evolved by the scientists there—that keeps accurate time within 0.001 second a day. It is the latest step in a series of developments that began 20 years ago when Bell Laboratories built the first crystal clock.

Why are the men of Bell Laboratories, whose basic interest is *communications*, so concerned with *time?* Because the study of communications is largely the study of frequency — and frequency is the inverse of time. To deal with frequencies in megacycles requires accurate measurement of fractions of micro-seconds.

In their early studies of piezoelectric crystals for frequency control, Bell scientists saw the desirability of using them also as a source of accurate time.

Two obstacles stood in the way of devising a crystal clock: the relatively high temperature coefficient of crystals, and the fact that their frequencies were too high to drive a synchronous motor. Annular crystals, with extremely low temperature coefficients, solved the first problem. Sub-multiple generators solved the second, accurately dividing the crystal frequency. Thus the barrier between *frequency* standards and *time* standards was finally broken down.

BELL TELEPHONE LABORATORIES

World's largest organization devoted exclusively to research and development in all phases of electrical communications.

a long, long time . . .

...in a frequency standard that's accurate to 1 part in 10^8 a day

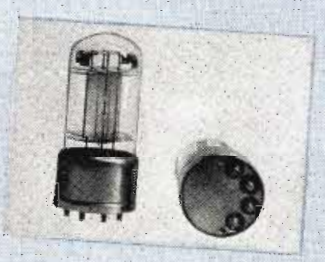
Continuing research on piezoelectric crystals at Bell Laboratories resulted in a development of far-reaching importance—the GT cut.

This opened the way to revolutionary advances in instruments for time-frequency measurements. The GT-cut crystals make possible entirely new standards of accuracy, because of their extremely low temperature coefficient—less than 19 parts in 10^8 per degree C, far lower than produced by any other method of cutting.

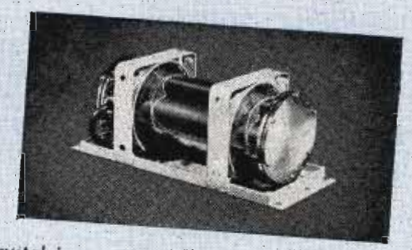
Moreover, GT-cut crystals are admirably adapted to wire-suspension mounting, which virtually nullifies the effect of shock on frequency. This greatly enlarges the range of conditions under which accurate measurements can be made.

The Western Electric Primary Frequency Standard is the embodiment of these new concepts in design. It is a 100-kc source that combines accuracy and ruggedness to a remarkable degree. Frequency variation is less than 1 part in 10^8 over a 24-hour period; yet the Standard, far from being confined to the laboratory, performs with equal accuracy on ships, planes and vehicles—even in earthquake areas! *Wherever* there is a need for time-frequency measurements, or the synchronous operation of two or more systems, the Frequency Standard is ready and able to take on the job.

How the Frequency Standard maintains its accuracy



Key to the accuracy of the Western Electric Primary Frequency Standard is a GT-cut crystal, surpassing even the annular cut in the degree to which it nullifies the effect of temperature on frequency. The crystal is suspended by wires inside an evacuated glass envelope. The wire mounting results in an exceptionally rugged crystal unit, practically immune to shock.



The GT crystal is mounted inside this oven in which temperature is controlled electronically with extreme accuracy. In conjunction with sponge rubber pads, the oven acts as a further safeguard against vibration and shock, contributing to the outstanding ruggedness of the instrument.

The complete Standard, compactly designed, ruggedly built, weighing only 90 pounds, brings the accuracy usually associated only with delicate laboratory apparatus into field service.

—QUALITY COUNTS—

Western Electric

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

Distributed by Graybar — Offices in 100 principal cities

DISTRIBUTORS: IN U. S. A.—Graybar Electric Company. IN CANADA AND NEWFOUNDLAND—Northern Electric Co., Ltd.

TELE-TIPS

RADIO EQUIPMENT 20%—that's a close rule-of-thumb basis for the estimating value of the radio-communications-radar equipment that goes into any modern military or naval structure. Strangely, it applies fairly accurately to latest air-corps and naval airplanes, battleships, airplane carriers, cruisers, tanks, etc. Just take 20% of the total cost of any military structure and you have estimated cost of equipment supplied by our own radio-radar industry.

EMERSON is bringing out an FM only table model receiver to sell at $29.95 which will have a circuit of their own development.

PHILCO television engineering study being prepared by TELE-TECH for the November issue will be the most comprehensive presentation of its kind ever attempted in the history of the industry. It will give the complete engineering, research, design and production story of the Philco TV plant. Watch for the November issue.

ZETKA LABS, Clifton, N. J., manufacturers of high-definition, flat-faced 15-in. television viewing tubes is experimenting with a flat-faced 12-in. model which may be available soon.

TELEVISION TIMETABLE of stations on the air, published with the May issue of TELE-TECH, will be revised and reissued with the December issue. The new survey will chart TV stations going on the air up to June, 1949.

CORONET RADIO of New York City plans to start producing 10 and 16-in. television receivers in January, 1949.

NEW TELEVISION RECEIVER plans have been announced by the following manufacturers: Audar, Inc. Argos, Ind., reports plans to produce table models this month; Coronet Radio & Television Corp., New York, N. Y., plans to produce table and console models with 10-in. to 16-in. picture tubes in January 1949; National Co., Inc., Malden, Mass., will start production of models with larger screens and projection images for winter delivery; Noblitt-Sparks Industries, Inc., Columbus, Ind., plans production of table models in 1949; Stewart-Warner Corp., Chicago, plans production of 10-in. table model and 12-in. console this month; Watterson Radio Mfg. Corp., Dallas, Texas, plans production of 10-in. table model in January 1949; Wells-Gardner & Co., Chicago, plans table and console models in November. Sets will include 18 tubes plus dual rectifiers; Certified Radio Laboratories, Brooklyn, N. Y., plans fall production of 10-in., 12-in., 15-in. complete table and console models.

DEFENCE CONTRACTS to radio-electronic manufacturers during 1948 are expected to total $150,000,000. For 1949, the figure will be upped to at least $300,000,000.

MOVIE EXHIBITORS or theatre owners will be completely out of business within six years when home television sets pass 20,000,000 mark, declares N. Y. TV research institute.

TRANSMITTER manufacturers are eyeing the export market for transmitter calls. GE and RCA have a few orders but shipments are snagged by monetary difficulties. RCA has a rep in Spain talking TV equipment at this moment.

MOTION-PICTURE ENGINEERS considering equipping theatres with separate recording tape for better sound—dropping sound-track from picture film, as in early Jolson days. Because of different expansion rates of film and tape with moisture and temperature, accurate synchronization will require either slotting the tape or recording a standard frequency along edge to regulate speed under all weather conditions.

S. G.

RCA Field-Intensity Meter
Type WX-1A
50 to 220 Mc

NEW *field-intensity meter*
—for the television and FM bands

SPECIFICATIONS

Freq. Range . . . . . 50 to 220 Mc

Sensitivity . . . . . 5 microvolts to 20 microvolts/meter, depending on frequency

I-F Bandwidth . . . . . 150 kc

FM Adjacent Channel Selectivity . . . . . 65 to 1

FM Band Image Ratio . . 130 to 1

Power Supply . . . . . Built-in 6-v, voltage-regulated (a-c power supply also available)

Weight
Meter . . . . . 43½ lbs.
Antenna (including tripod) . . . . . 15 lbs.

Size . . . . . 19"L x 14½"H x 13" D

THE WX-1A meets the strict requirements of FM and TV engineers for a field-intensity meter of laboratory accuracy covering television, FM, and AM services between 50 and 220 Mc. Its high sensitivity permits minimum readings ranging from as low as 5 microvolts per meter at 50 Mc, to 20 microvolts per meter at 200 Mc.

Completely self-contained, the WX-1A includes a very stable superheterodyne receiver. Selectivity characteristic is down 65 to 1 on adjacent FM channels. Image ratio is 130 to 1 at 100 Mc. A 2-stage audio amplifier drives a built-in loudspeaker for continuous audio monitoring of the signals being measured. Separate output terminals provide for convenient use with the standard Easterline-Angus recorder. The built-in vibrator power supply includes its own voltage regulator. The antenna . . . furnished with each WX-1A...is adjustable for horizontal or vertical polarization.

For accurate data on the service area of any TV, FM, or AM station in the uhf —and for authoritative coverage information for FCC proof-of-performance—the WX-1A is second to none. Complete details are available from your RCA Broadcast Sales Engineer. Or from Dept. 87J, RCA Engineering Products, Camden, N. J.

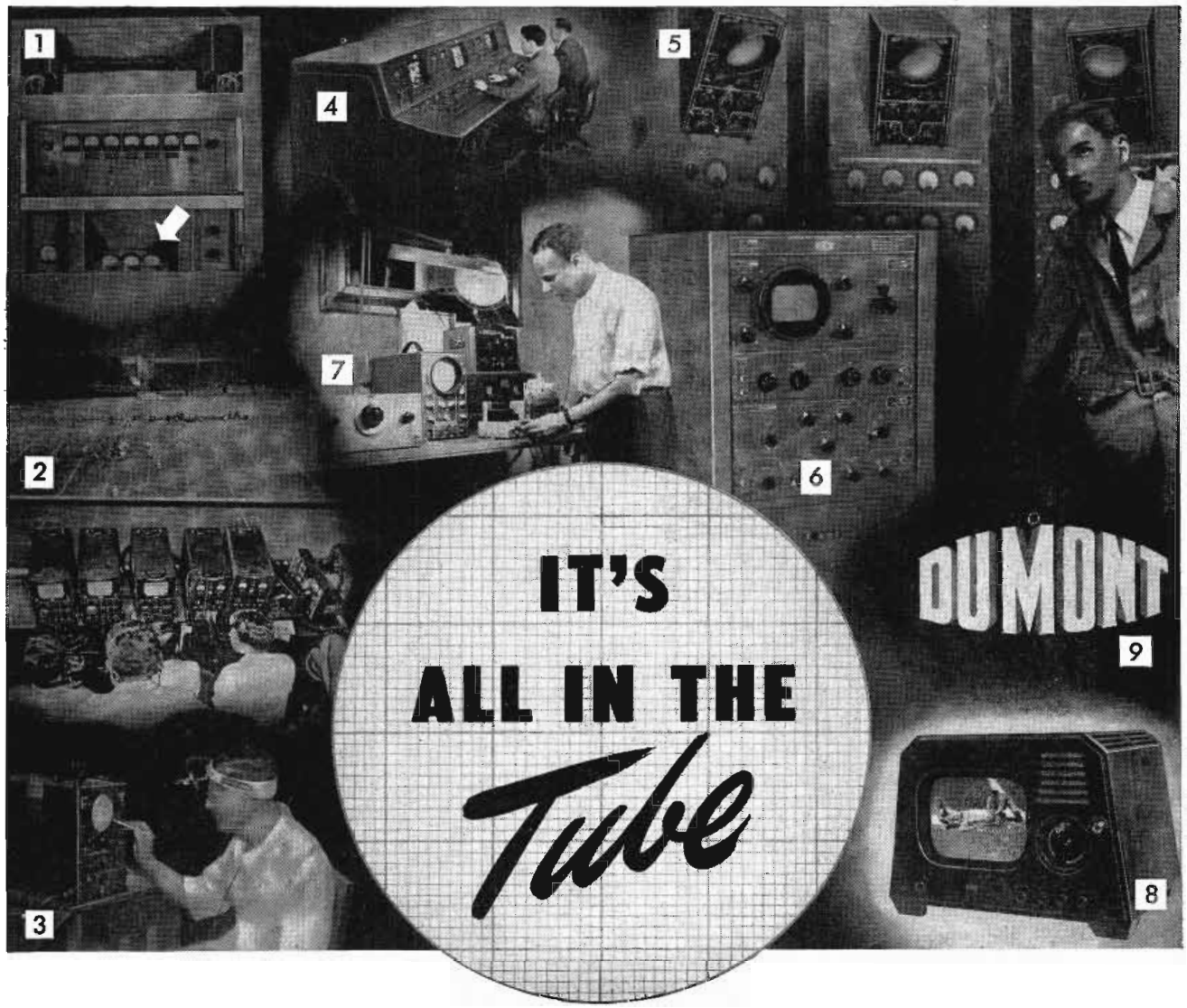
The One Equipment Source for Everything in BROADCASTING—is RCA

BROADCAST EQUIPMENT

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal



By way of illustration . . . **1.** Du Mont transmitter unit utilizing Du Mont cathode-ray tubes as indicators. **2.** Du Mont television field equipment for picking up remote programs. **3.** Scientific research in medicine, aided by Du Mont oscillography. **4.** Du Mont Television Transmitting Control Console utilizing Du Mont cathode-ray tubes. **5.** Du Mont Type 208-B oscillographs used in nuclear research. **6.** Du Mont Type 280 oscillograph for precision measurements of television waveforms utilizing the Type 5RP-A high-voltage tube. **7** Typical scene in most radio repair shops, where servicemen make their diagnosis with a Du Mont Type 274 oscillograph. **8.** Du Mont Chatham table set with a 12-inch Du Mont picture tube for clear, bright, truly superlative pictures. **9. The symbol of quality cathode-ray tubes—always your best buy**

Yes, it's all in the tube! No matter what the end use—in all fields of radio-electronics—you'll find the omnipresent cathode-ray tube—the DU MONT cathode-ray tube.

If it's nuclear research, transmitter signal studies, television monitoring, high-speed-transient oscillography, television receivers, examination of mechanical phenomena, medical research, production testing, or a multitude of other applications, experience teaches that ONLY the cathode-ray tube is always adequate as an indicating and measuring device.

And among the makers of cathode-ray tubes, DU MONT is foremost by virtue of many years' experience and ever-continuing pioneering.

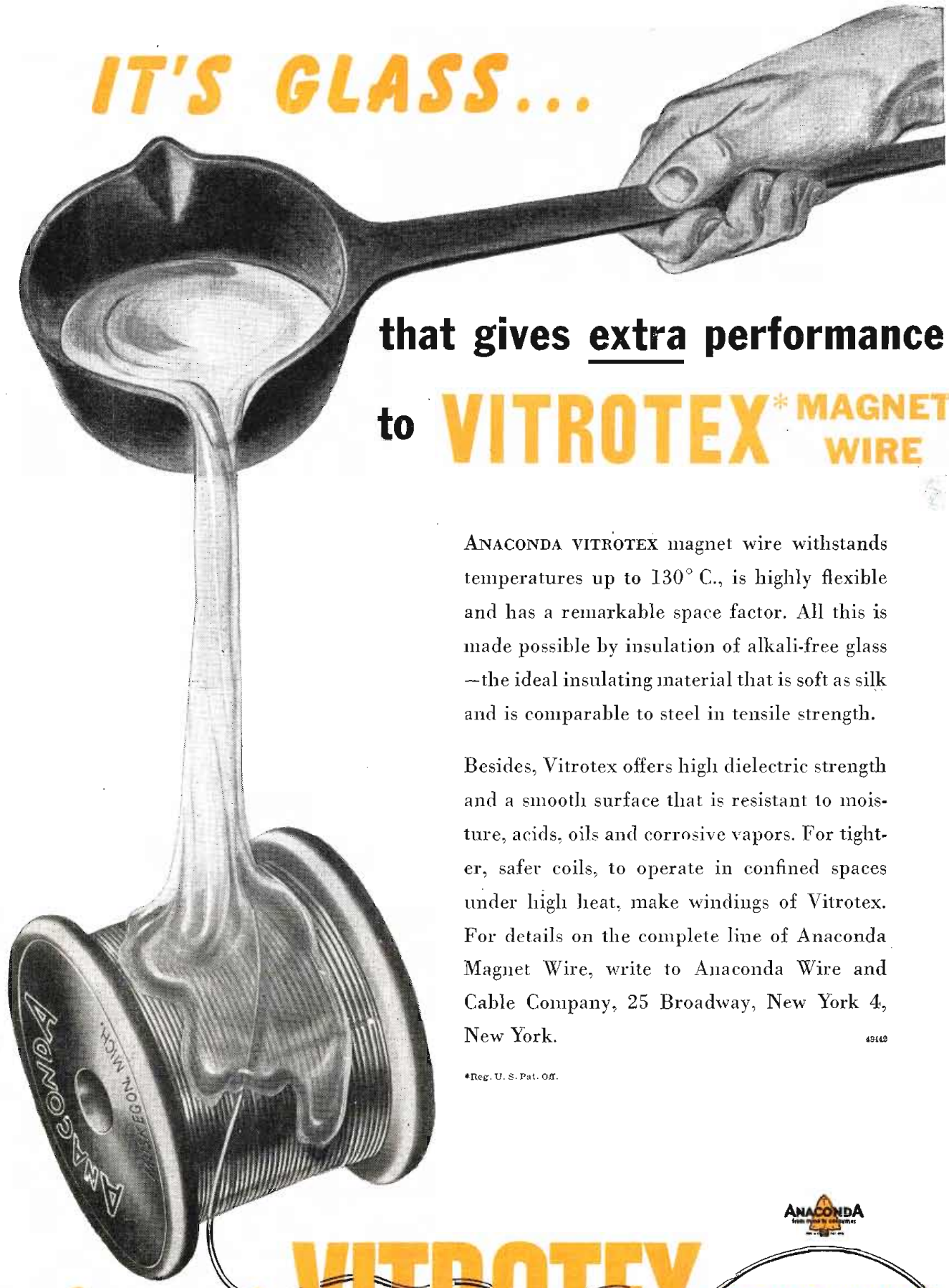
So it is wise, *always*, to specify DU MONT when ordering a new or when replacing an old cathode-ray tube. And remember, only DU MONT makes a full range of cathode-ray tubes.

Literature on request

DUMONT *for Oscillography*

ALLEN B. DU MONT LABORATORIES, INC., PASSAIC, N. J.
CABLE ADDRESS: ALBEEDU, NEW YORK, N. Y., U.S.A.

IT'S GLASS...



that gives extra performance to VITROTEX* MAGNET WIRE

ANACONDA VITROTEX magnet wire withstands temperatures up to 130° C., is highly flexible and has a remarkable space factor. All this is made possible by insulation of alkali-free glass —the ideal insulating material that is soft as silk and is comparable to steel in tensile strength.

Besides, Vitrotex offers high dielectric strength and a smooth surface that is resistant to moisture, acids, oils and corrosive vapors. For tighter, safer coils, to operate in confined spaces under high heat, make windings of Vitrotex. For details on the complete line of Anaconda Magnet Wire, write to Anaconda Wire and Cable Company, 25 Broadway, New York 4, New York.

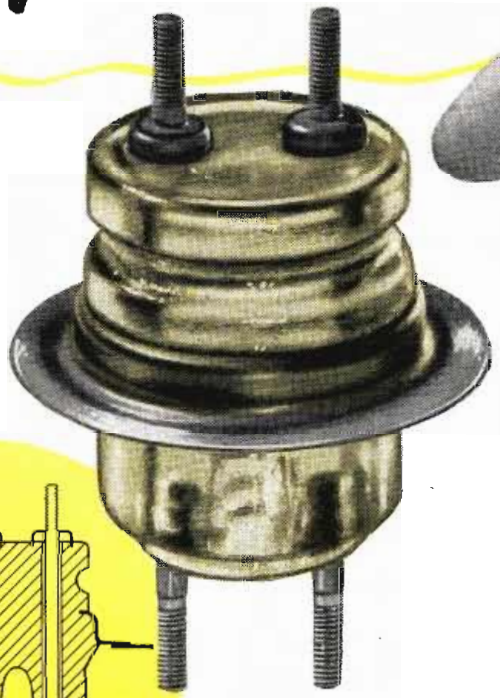
49142

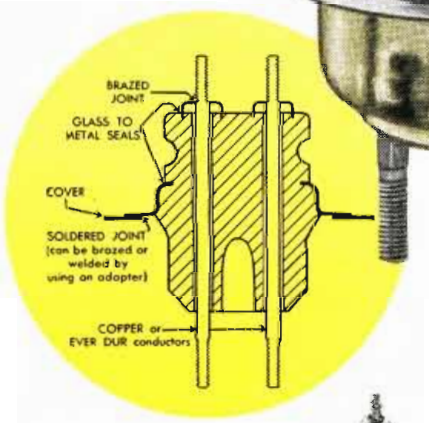
*Reg. U. S. Pat. Off.

ANACONDA

Anaconda VITROTEX THE GLASS INSULATED MAGNET WIRE

Glass bushings Now Available





to manufacturers of electronic equipment

Can be welded, brazed, or soldered to case, forming a strong, permanent, hermetic seal that eliminates moisture problems and often permits more compact, light-weight design.

General Electric is now offering to other manufacturers the glass bushings that it has used so successfully on capacitors, rectifiers, modulator and instrument transformers, and other electrical equipment. These bushings are cast of an exceptionally stable, low-expansion glass. Metal hardware is a special nickel-alloy steel, fused to the glass in casting. Bushings are attached directly to the apparatus without gaskets—by soldering, welding or brazing the metal bushing flange to the metal case.

The resulting joint between bushing and equipment is permanent, vacuum-tight, and of high mechanical strength. It is especially desirable for equipment subject to vibration, shock, fungus growth or severe changes in temperature. These glass bushings are currently available to meet dry, 60-cycle, flashover values of from 10 to 50 kv, and in current ratings of 25 and 50 amperes (large sizes up to 800 amperes). They may be single or multi-conductor and can be provided with a top flange to permit mounting tube sockets directly on the bushings. Diameters range from $1\frac{5}{8}$ to $3\frac{3}{8}$ inches and weights from $2\frac{1}{2}$ oz. to 4 lb.

The best way to evaluate these glass bushings for capacitors, modulator transformers, and other electronic equipment, is to see them. If you will send us a sketch and ratings of bushings you are now using, we will furnish you with samples of one or more of our standard glass bushings. Or write for Bulletin GEA-5093 which contains complete listings of our standard designs, allowing you to select the particular bushing you require. *Power Transformer Sales Division, General Electric Co., 16-215 Pittsfield, Mass.*

GENERAL ELECTRIC

401-63

DPi

HIGH VACUUM RESEARCH AND ENGINEERING

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.

For full information, write—

Vacuum Equipment Division

DISTILLATION PRODUCTS, INC.

777 RIDGE ROAD WEST • ROCHESTER 13, N. Y.

DPI

570 Lexington Ave.
New York 22, N. Y.

135 So. La Salle St.
Chicago 3, Illinois

Manufacturers of Molecular Stills and High Vacuum Equipment; Distillers of Oil-Soluble Vitamins and Other Concentrates for Science and Industry

AM · FM · TV
RAYTHEON SPEECH EQUIPMENT

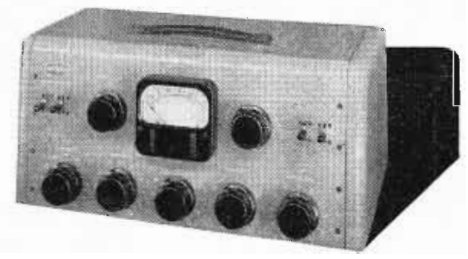
For the last word in complete, up-to-the-minute facilities
... or simple, low-cost equipment to suit your limited requirements ...

Look to RAYTHEON for All Your Needs

RC-11 STUDIO CONSOLE

NOW WITH CUE POTS FOR TWO TURNTABLES

Provides complete high-fidelity speech input facilities with all control, amplifying and monitoring equipment in one cabinet. Seven built-in pre-amplifiers, nine mixer positions, cue attenuators for two turntables. Simple, positive controls reduce operational errors. Frequency response—2 DB from 30 to 15,000 cycles; Distortion—less than 1% from 50 to 10,000 cycles; Noise Level—minus 65 DB's or better. Meets all FCC requirements for FM.



RPC-40 PORTABLE CONSOLETTE

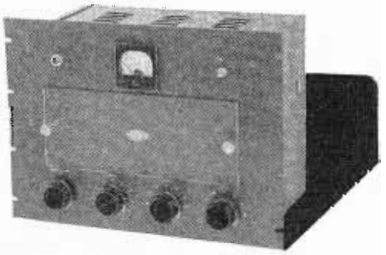
Ideal for remote pickups yet complete enough to serve as a studio console. Four input channels for microphones or turntables, high level mixing, two output lines. Two RPC-40's interconnected provide 8-channel mixing—a feature of special interest to new TV stations planning future expansion.

RR-30 REMOTE AMPLIFIER 3 CHANNEL

A lightweight, easy-to-carry combination of amplifier and power supply—simple and quick to set up. Provides three high-fidelity channels, excellent frequency response, high over-all gain.

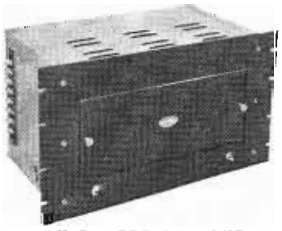
RR-10 REMOTE AMPLIFIER SINGLE CHANNEL

A complete, self-contained unit with built-in power supply. An excellent low-cost amplifier for remote pick-ups requiring only one high-fidelity channel.



RL-10 VOLUME LIMITER

Engineered for high-fidelity AM, FM or TV speech input. Increases average percentage modulation without distortion.

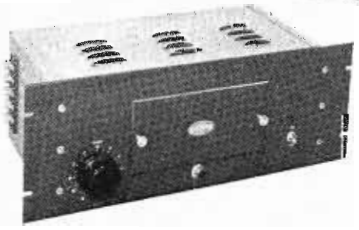


RZ-10 PRE-AMPLIFIER

A plug-in type pre-amplifier or booster for microphones or turntables. Handles high input level. Noise level below 85 db from 0 vu output. Low distortion. Plug-in construction permits using one to four units for maximum flexibility.

RP-10 PROGRAM AMPLIFIER

A high-fidelity, single-unit amplifier and power supply. Over-all gain, 65 db; frequency response flat from 30 to 15000 cps; distortion less than 2% at + 30 vu. Designed for rack or cabinet mounting.



RPL-10 LINE AMPLIFIER

A single-control, two-stage amplifier featuring wide frequency response, low distortion, low noise level, freedom from RF pickup. Push-pull throughout. Mounts in standard rack or cabinet.

RAYTHEON MANUFACTURING COMPANY
WALTHAM 54, MASSACHUSETTS

EXPORT SALES AND SERVICE IN FOREIGN COUNTRIES
Raytheon Manufacturing Company
50 Broadway, New York 4, N. Y., WH. 3-4980

Link FM—With Sylvania Lock-Ins—Covers New Jersey For Its State Police Radio System

Automotive equipment of the New Jersey State Police includes vehicles always on the alert to deal with every emergency. Fleet is spearheaded by 180 patrol cars of the department in addition to 42 patrol cars of the State Motor Vehicle Department which is served by the State Police. These vehicles are constantly in touch with fixed FM stations located at 26 strategic points throughout the state. In addition, emergency trucks carry complete radio equipment equivalent to that of a fixed station!

Link Radio Corporation, manufacturer of the communications equipment, makes extensive use of Sylvania Lock-In tubes to assure unfailing efficiency of this statewide network. Lock-In tubes stay put through vibration and jarring. They have few welded joints . . . no soldered ones. Elements cannot warp or weave . . . connections are short and direct. Top location of getter reduces losses . . . separation of getter material from leads cuts down leakage.

See Sylvania Distributors—or write Radio Tube Division, Emporium, Pa.

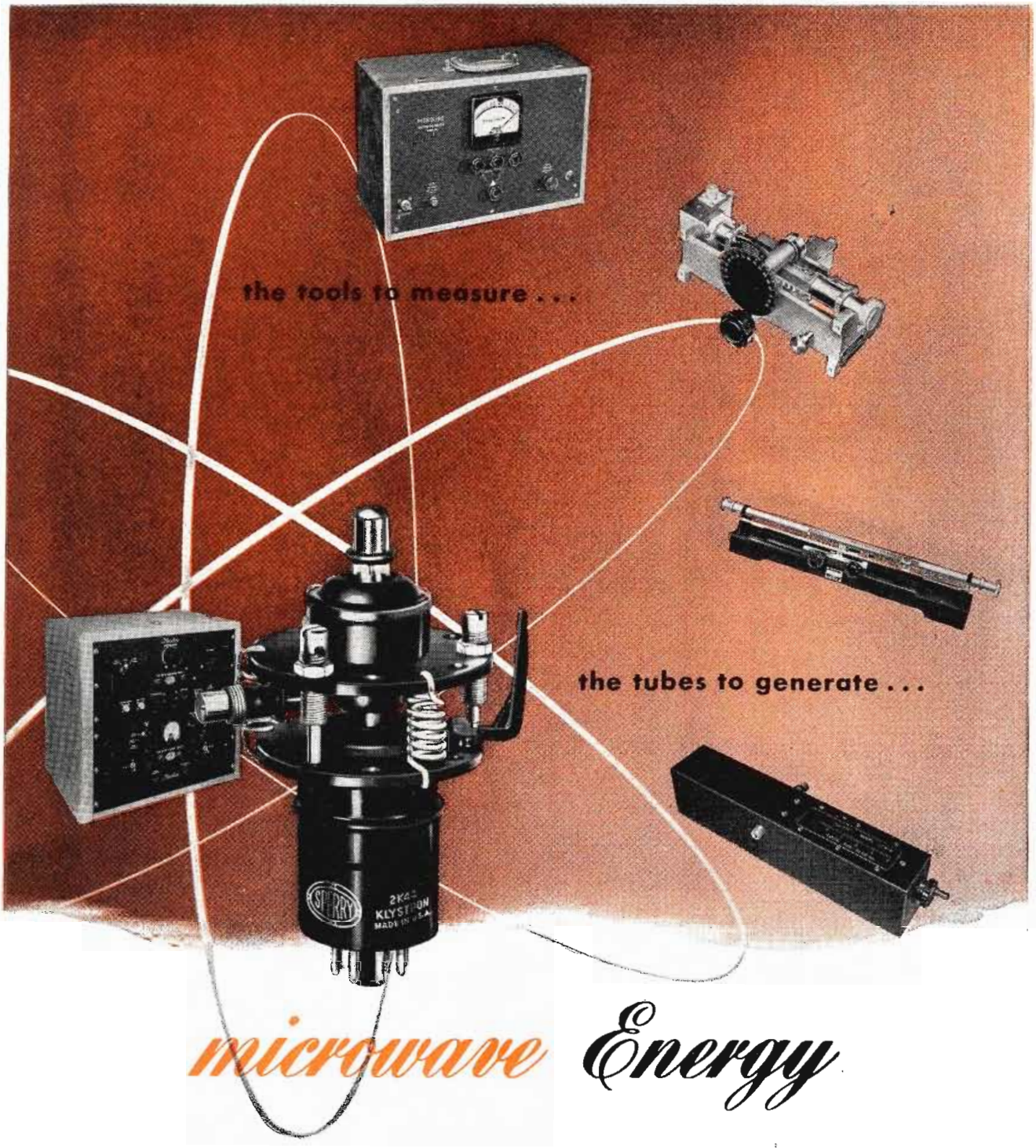
Drivers of both emergency trucks and patrol cars can maintain two-way communication with fixed stations.

Radio equipment in emergency trucks duplicates the set-up used in fixed transmitting stations.

SYLVANIA ELECTRIC

The superior mechanical and electrical features of Sylvania Electric's famous Lock-In tube make it the ideal choice for equipment on the road, in the air, on the rails, marine radar, FM and television.

MAKERS OF RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS



microwave Energy

The Sperry Klystron Tube to generate ultra-high-frequency microwaves . . .

The Sperry Klystron Signal Source to "power" them . . .

The Sperry Microline to test and measure them . . .

These Sperry products equip the research or development engineer with every essential for development or design in the microwave field.

The Sperry Klystron Tube has already opened up new vistas in navigation, aviation, medicine, radio, telephone, telegraph and other major applications. It is ready for many new local oscillator or high power uses.

The Sperry Microline includes practically every type of instrument for quick precision measurements in the microwave frequency bands.

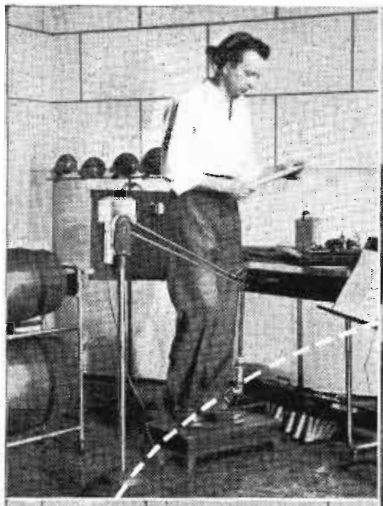
This Sperry service — beginning with a source of microwave energy, the Klystron, and following through with every facility for measuring microwaves — opens up almost unlimited possibilities for industry.

We will be glad to supply complete information.

SPERRY GYROSCOPE COMPANY

DIVISION OF THE SPERRY CORPORATION · GREAT NECK, N. Y.

NEW YORK · LOS ANGELES · SAN FRANCISCO · NEW ORLEANS · CLEVELAND · SEATTLE



REAL *Mike Flexibility*

for the SOUND EFFECTS MAN

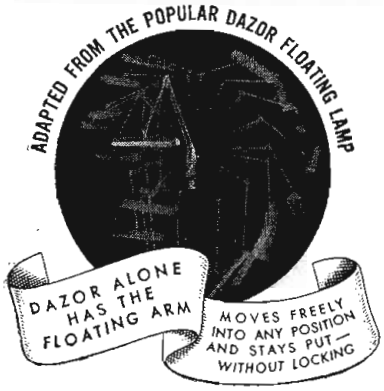
Your microphone, when attached to a Dazor *Floating* Arm, can be switched instantly from one sound-making device to another.

With the tips of your fingers—just a gentle push or pull—you can *float* the mike into hundreds of practical positions. You can tilt or turn it, raise or lower it, swing it from side to side and regulate its reach. This unique *floating* action results from a Dazor-patented mechanism which holds the arm firmly (*without locking*) wherever it is positioned.

As the accompanying photographs suggest, a Dazor-floated microphone picks up sound effects more easily and accurately. It facilitates directional pickup during group broadcasts . . . frees the emcee from manual mike adjustments . . . simplifies control-room operations. Its *flexibility* and stay-putness are conveniences which appeal greatly to plane, train and police dispatchers.

The Dazor *Floating* Arm is adaptable to any mike and can be individualized to meet space limitations. Choice of two bases—the Pedestal type pictured here and a Universal model which fastens to any flat, sloping or vertical surface.

Phone Your Dazor Distributor for full details. If you wish the name of this helpful supplier, write Dazor Manufacturing Corp., 4481-87 Duncan Ave., St. Louis 10, Mo. *In Canada* address inquiries to Amalgamated Electric Corporation Limited, Toronto 6, Ontario.



DAZOR FLOATING ARM FOR MICROPHONES

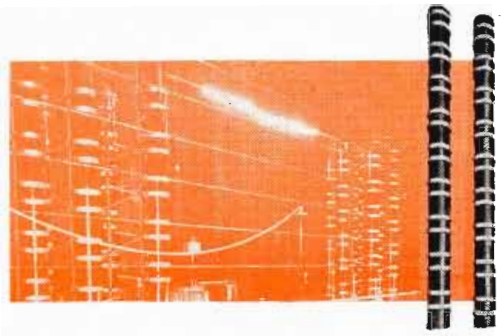
WE CAN HELP YOU WITH

Energy-Storage Capacitors!

Our experience—in engineering, designing, and building performance into energy-storage and discharge capacitors—may provide just the help you are looking for.

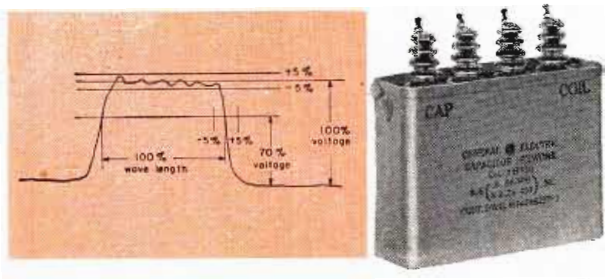
Do you make discharge welding or photographic flash-tube equipment? Radar equipment? Flash beacons, aircraft signalling, or similar devices? Or research tools, from spectroscopes to cyclotrons? We have furnished a large proportion of the capacitors used for all of these applications.

Unusual applications, too—like those listed below—are a specialty with us. Whatever your problem, let our engineers give you a hand. Apparatus Dept., General Electric Company, Schenectady 5, N. Y.



NEED ARTIFICIAL LIGHTNING? Potent artificial lightning bolts—at voltages up to 10,000,000—are not a usual need. But when required—for universities, laboratory testing, or exhibition—General Electric can build the capacitors. A typical example is the 100-kv d-c unit, about 3 feet in diameter and 2 feet high. Units can be stacked, as shown, for ease of installation and minimum space. In some instances as many as 100 separate units have been placed in series to produce 10,000,000 volt discharges.

NEED SQUARE WAVES? Pulse-forming networks can provide them. Networks are used where the normal capacitor discharge wave shape is not suitable and where an impulse must have definite energy content and duration. The Type E network, produced by General Electric, consists of capacitor and coil sections, adjusted to close tolerances, and hermetically sealed in single metal containers. Built by the thousands for radar, they are now available for commercial use.



OR DO YOU WANT TO TAKE A PICTURE? A maker of flash-tube photographic equipment wanted a lighter capacitor for his portable sets. Our designers went to work and came up with just what he desired—and one which he could use, also, for his studio equipment at a considerable saving in price. *(In case you're interested, this capacitor is rated 14 muf, weighs 2½ lb, and delivers 43.8 watt-seconds with 1000 hour service life or 58 watt-seconds at 400 hours. Used in pairs, they replace a 28 muf-studio capacitor, save in cost too.)*

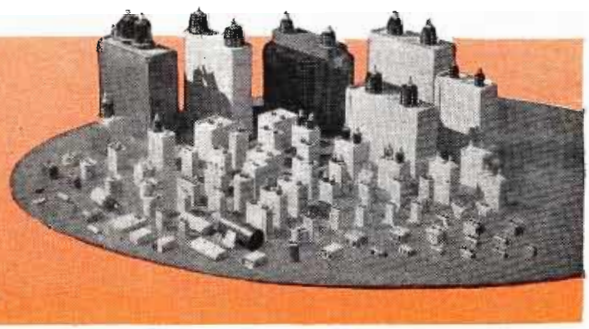
GENERAL ELECTRIC

407-175

Specialty Capacitors FOR

- Motors
- Luminous-tube transformers
- Fluorescent lamp ballasts
- Industrial control
- Radio filters
- Radar
- Electronic equipment
- Communication systems
- Capacitor discharge welding
- Flash photography
- Stroboscopic equipment
- Television
- Dust precipitators
- Radio interference suppression
- Impulse generators

AND MANY OTHER APPLICATIONS



TELE-TECH

TELEVISION • TELECOMMUNICATIONS • RADIO

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

RADIO ENGINEERS IN PUBLIC AFFAIRS—We have long urged that our engineering readers take a more active part in the business operations of their companies. We would like to see the day when radio and TV corporations are headed by engineers with sound business training, instead of letting top corporation posts fall opportunely to lawyers, salesmen and financial graduates.

In this connection we also second the proposal made by Dr. Lilienthal of the Atomic Commission that each citizen and engineer set aside some time in his career for service as a public official. Such jobs should rotate. Politics have come to mean so much to all of us, that it is high time the trained engineer or professional man took a hand in his local, city or state government. Such experts would have a better understanding of their own efforts and businesses, if they took a year off to serve as alderman, mayor, state legislator or national representative.

FOR EASIER FM TUNING—Designers of FM receivers can aid FM's general development and make their sets much more convenient for tuning if they will provide (1) means for indicating when the pointer is set for peak quality, and (2) some method for marking accurately favorite local-station positions on the dial after the set has stabilized. Because of side-peaks, FM has always had tuning difficulties for the layman. Most FM receivers indeed discourage the inexpert user and make it difficult for him to find quickly the wonderful tonal perfection FM actually has to offer. We must give FM set-owners every possible tuning aid, if FM as a whole is to achieve its great possibilities.

FM makers please get busy!

TIME FOR NEW METHODS!—Present models of radio receivers for the home, whether AM, FM or television have a disturbing similarity to the models sold 20 years ago, as far as chassis appearance and assembly methods are concerned, except for a change in sockets to take care of the newer types of tubes. The same construction arrangements and the same maze of wires and unsystematic placement of parts are still evident.

It would seem that the complexity of a modern television receiver at least would call for some ingenuity on the part of its manufacturer to set up some new assembly system which would provide for easier assembly and also would give service men a break at the same time.

RADIO'S VAGARIES YIELD TO COSMIC LAW—With the anticipated decline in sunspot numbers during 1948 and 1949, short-wave radio communications may be expected to improve during daytime hours for frequencies around 5 mc, but to become poorer both day and night for channels around 10 mc.

We are again on the descending curve of the 11-year solar cycle, and with decreasing ultra-violet and corpuscular bombardment from that great Atomic Pile of ours, 93 million miles away, radio men may expect many shifts in propagation characteristics, including a return to long-distance broadcast reception and a widening out of the fading-distortion ring around each fair-sized AM transmitter.

In all the apparent vagaries of radio reception, we are beginning to discover basic underlying causes. Pioneer interpreter in this field has been Dr. Harlan T. Stetson of the MIT laboratories at Needham, Mass., who reports his latest discoveries in the November issue of TELE-TECH.

SIGNAL CORPS Procurement

Latest and authoritative procedures to be followed by radio and communication manufacturers seeking defense contracts

By ROBERT HERTZBERG, Contributing Editor, TELE-TECH

IF you haven't had government contracts before and aren't familiar with the routine of selling communication-radio equipment to the Signal Corps, you can acquire the know-how simply and directly by addressing a letter to the *Signal Corps Procurement Agency,* 2800 *South* 20*th Street, Philadelphia* 45, *Pa.* This is all you have to say:

Gentlemen:

I am interested in qualifying for consideration as a source of supply for Signal Corps equipment. What requirements must I meet?

In reply, you will receive a two-page questionnaire. (See list of questions opposite.) Read and answer it carefully. As a new and untried supplier you will be investigated very thoroughly before you get even a trickle of government business. Make five copies of your answers and mail them to *Mr. C. Chanako, Items Bidders List Section, Contracting Division,* at the Philadelphia office and address given.

If you are a legitimate manufacturer, your name and address will be placed on the Procurement Agency's "Bidders List." In a surprisingly short time you will be asked to bid on supplies or services, according to your specialty or capacity. The communication will take the form of an "Invitation, Bid, and Acceptance, Short Form Contract." It may consist of only three or four sheets or it may be a stack a half-inch thick. It will include full technical specifications of the desired equipment and instructions for handling the paper work. Read all of this material carefully and thoroughly. Don't skip any of the fine print. Have your chief engineer read it. Then have your lawyer read it. Your bid is a binding legal record, and you shouldn't sign until you are thoroughly familiar with it.

You have to understand at this point that government buying agencies in general are required by law

to accept the bid of the lowest responsible bidder. The bids themselves, in sealed envelopes, are opened and read at the time and place specified in the invitation.

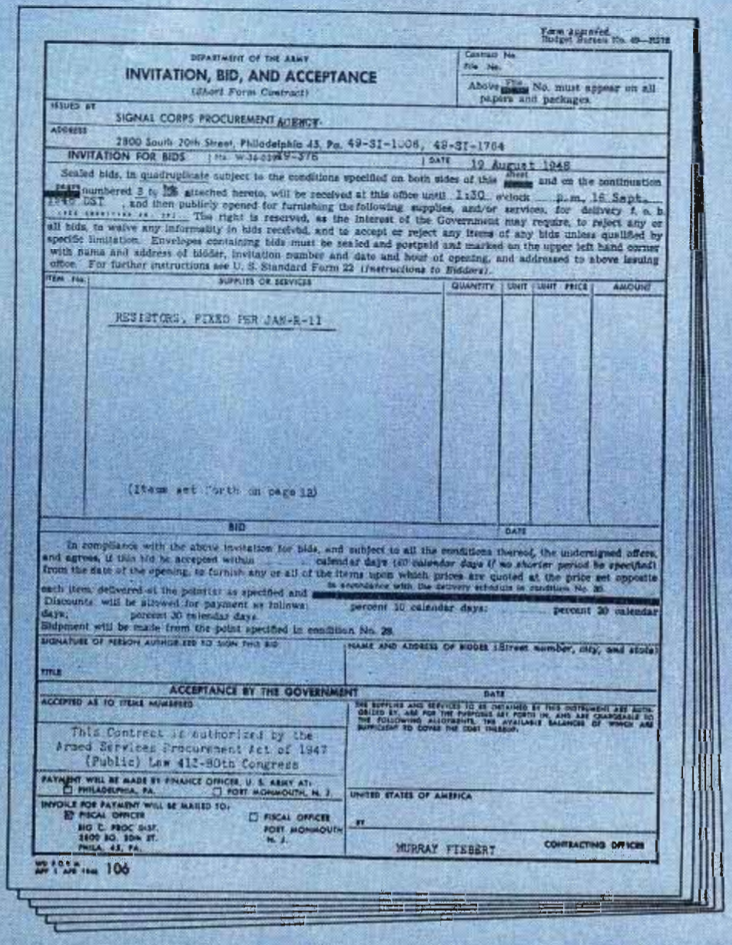
The bidders are welcome to attend this ceremony, and they do so in large numbers so that they can keep track of their competition. The contract is not awarded immediately at the meeting. The bids must first be studied carefully by the Procurement Agency to determine the lowest *responsible* bidder. The very lowest bidder in the strict arithmetical sense is not automatically the successful one. Sometimes a quoted figure doesn't even cover the cost of packing the equipment, much less manufacturing it. The Procurement Agency personnel, who have a keen sense of values, must ask themselves, "Can Bidder B really undertake the production of this needed equipment without going broke a month before scheduled delivery time? Is he bidding low in a desperate attempt to land a contract?"

If a bidder is new to the Agency, he will be checked carefully in every respect. If the firm has done work for the Army, its past performance will be studied. Only after very complete investigation and consideration is a decision made and a contract awarded. The Agency has to justify its action to the satisfaction of government officials all the way up the line to the office of the Comptroller General, and it makes pretty certain of its ground before notifying the successful bidder.

If you are one of the unsuccessful bidders on a contract, you can get part of the work in the form of a sub-contract. However, that's something you must handle directly with the winning bidder. The Procurement Agency itself deals only with prime contractors and holds them completely responsible for their

(*Continued on page 58*)

Typical requisition form used by Signal Corps



DEPARTMENT OF THE ARMY

INVITATION, BID, AND ACCEPTANCE

(Short Form Contract)

Form approved. Budget Bureau No. 49-R278

Contract No. / File No. / Above File No. must appear on all papers and packages.

ISSUED BY: SIGNAL CORPS PROCUREMENT AGENCY

ADDRESS: 2800 South 20th Street, Philadelphia 45, Pa. 49-SI-1006, 49-SI-1764

INVITATION FOR BIDS | No. W-36-039-SC-376 | DATE 19 August 1948

Sealed bids, in quadruplicate subject to the conditions specified on both sides of this sheet and on the continuation sheets numbered 3 to 5 attached hereto, will be received at this office until 1:30 o'clock p.m., 16 Sept. 1948 DST, and then publicly opened for furnishing the following supplies, and/or services, for delivery f. o. b. [illegible]. The right is reserved, as the interest of the Government may require, to reject any or all bids, to waive any informality in bids received, and to accept or reject any items of any bids unless qualified by specific limitation. Envelopes containing bids must be sealed and postpaid and marked on the upper left hand corner with name and address of bidder, invitation number and date and hour of opening, and addressed to above issuing office. For further instructions see U. S. Standard Form 22 (Instructions to Bidders).

ITEM NO.	SUPPLIES OR SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	RESISTORS, FIXED PER JAN-R-11				
	(Items set forth on page 12)				

BID — DATE

In compliance with the above invitation for bids, and subject to all the conditions thereof, the undersigned offers and agrees, if this bid be accepted within [illegible] calendar days (60 calendar days if no shorter period be specified) from the date of the opening, to furnish any or all of the items upon which prices are quoted at the price set opposite each item, delivered at the point(s) specified and in accordance with the delivery schedule in condition No. 20.

Discounts will be allowed for payment as follows: [illegible] percent 10 calendar days; [illegible] percent 20 calendar days.

Shipment will be made from the point specified in condition No. 28.

SIGNATURE OF PERSON AUTHORIZED TO SIGN THIS BID | NAME AND ADDRESS OF BIDDER (Street number, city, and state)

TITLE

ACCEPTANCE BY THE GOVERNMENT — DATE

ACCEPTED AS TO ITEMS NUMBERED

This Contract is authorized by the Armed Services Procurement Act of 1947 (Public) Law 413-80th Congress

THE SUPPLIES AND SERVICES TO BE OBTAINED BY THIS INSTRUMENT ARE BEING ORDERED BY, AND FOR THE PURPOSES SET FORTH IN, AND ARE CHARGEABLE TO THE FOLLOWING ALLOTMENTS, THE AVAILABLE BALANCES OF WHICH ARE SUFFICIENT TO COVER THE COST THEREOF.

PAYMENT WILL BE MADE BY FINANCE OFFICER, U. S. ARMY AT: ☐ PHILADELPHIA, PA. ☐ FORT MONMOUTH, N. J.

INVOICE FOR PAYMENT WILL BE MAILED TO: ☒ FISCAL OFFICER, BIO C. PROC. DIST., 2800 SO. 20th ST., PHILA. 45, PA. ☐ FISCAL OFFICER, FORT MONMOUTH, N. J.

UNITED STATES OF AMERICA

BY: MURRAY FIEBERT — CONTRACTING OFFICER

106

Potential Suppliers Must Answer These Questions

1. General

(a) Name and address of the company and location of plants.
(b) Names of officers, their official titles and professional background of each official. Person or persons authorized to sign bids and contracts.
(c) State whether the organization is a partnership, or is incorporated, the date of formation, and under what state laws.
(d) State the amount of capitalization of the company or partnership.
(e) List the annual gross income for the past three years.
(f) Estimate available working capital.
(g) Furnish current balance sheet and operating statement. (Periodically submit supplementary or late data to maintain current records.)

2. Production Data

(a) List the number of buildings, the area in square feet, the number of stories, their construction and use.
(b) Do premises have railroad siding?
(c) Give the normal number of personnel for normal production shift.
(d) List principal items for civilian market that the company has produced.
(e) What items are at present manufactured for civilian use?
(f) List existing government contracts and related agency. Describe.
(g) Was the company engaged in war production during World War II? If so, discuss briefly.
(h) Describe production facilities and list the principal items of production equipment and special machine tools.
(i) Describe testing facilities and list the main items of test equipment.
(j) List the background of the chief engineer, works manager, supt., etc.
(k) Describe plant labor situation.
(l) Give list of items or categories of Signal Corps equipment the company feels that they have the facilities and "know-how" to produce.
(m) List current monetary value of orders on hand.

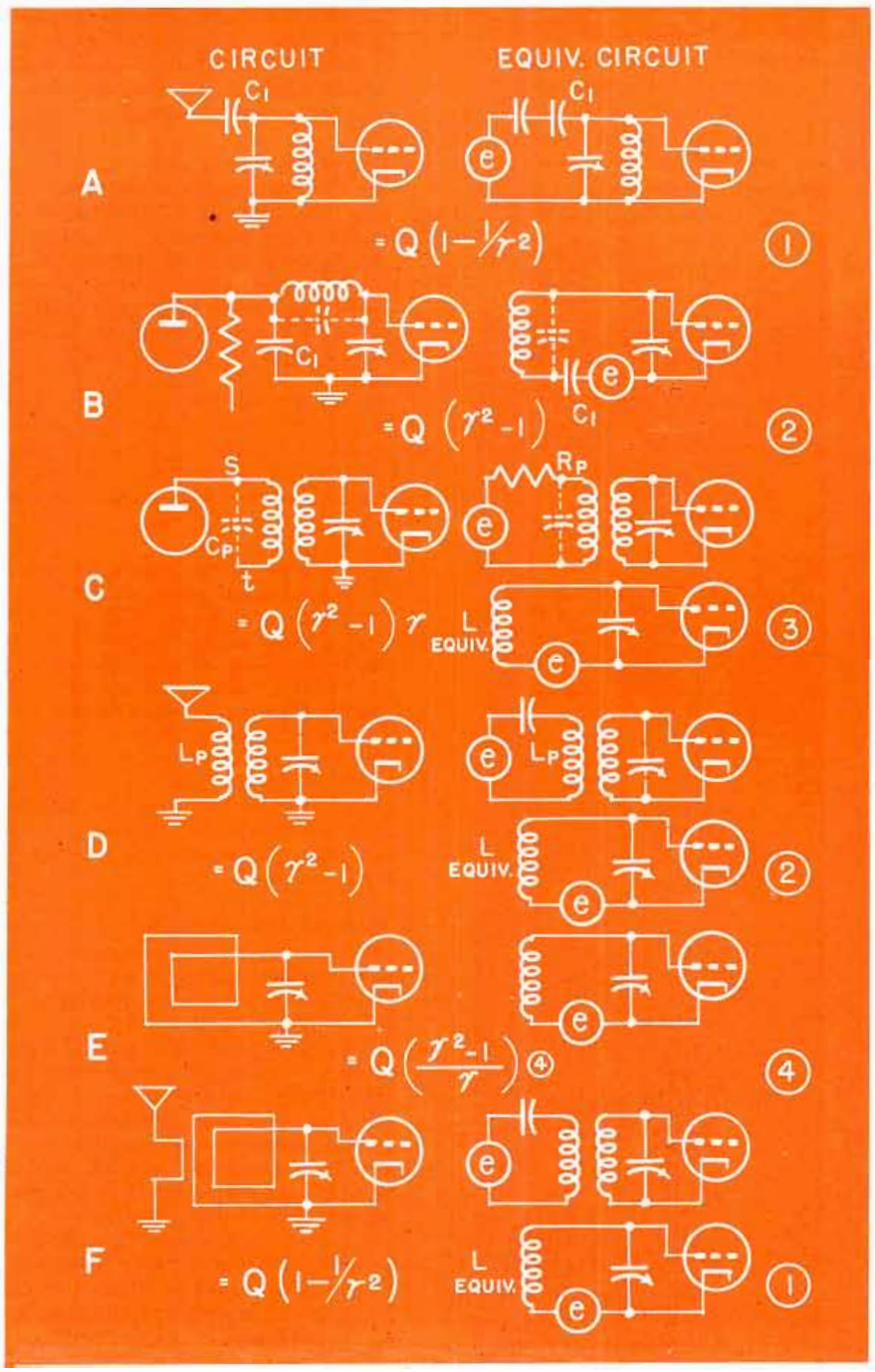
3. Research and Development

(a) Describe research program, past and proposed.
(b) Personnel normally employed in research laboratory.
(c) List the capabilities and affiliation of each scientist and key personnel in the research laboratory.
(d) List individual laboratories and special laboratory equipment.
(e) State phase of research and/or development for which it is felt your organization is best qualified.
(f) State whether your organization presently owns or controls patents for which licenses may be granted to the Government in pertinent contemplated research and/or development.

Formulas for
IMAGE REJECTION CALCULATIONS

Equations expressed in terms of modified Q are developed for five different types of tuned circuits that are commonly employed in radio receivers

By L. O. VLADIMIR, Engineering Section, General Electric Co., Syracuse, N. Y.



Figs. A-F: Schematics of various types input circuits and respective equivalent circuits used for developing image rejection formulas

IT is generally known that the image rejection of a tuned circuit is proportional to Q, since the ratio of response at resonance to the response off resonance is a function of Q. However, there are other factors which must be considered in the calculation of image rejection. Consider a simple series resonant circuit in Fig. 1.

Obviously the current I through C is the same as the current through L, but at a frequency far removed from resonance, the voltage across C will differ from the voltage across L in a manner related to the variation of impedances of these elements with frequency. For example, at a frequency above resonance, the voltage across L will be larger than the voltage across C by virtue of the fact that X_L is larger than X_C. At frequencies below resonance the reverse would be true. If we were to speak of the rejection of this tuned circuit to frequencies far removed from resonance (as for example, the image frequency of a superheterodyne receiver) it would be important to know whether we are speaking of the voltage across C or the voltage across L. A simple formula for the calculation of these voltages is given by reference 1 as:

E across L:

voltage at resonance ÷ voltage off resonance $= Q(1 - 1/\gamma^2)$ (1)

E across C:

voltage at resonance ÷ voltage off resonance $= Q(\gamma^2 - 1)$ (2)

Where γ =

Actual frequency ÷ resonant frequency

These equations are useful for frequencies which deviate from resonance by at least 3/Q times the resonant frequency. Some of the

various circuits to which they may be applied are shown in Figs. A through F.

Circuit A is a commonly encountered type, although not necessarily used for antenna coupling. It is characterized by a small capacitor in series with a resonant circuit. The equivalent circuit shows this to be in the category which can be calculated by means of equation 1.

Circuit B is one which is often used in connection with permeability-tuning, and occasionally to couple a capacitive antenna into a capacitance-tuned circuit. It can easily be seen from the equivalent circuit that calculation of image ratio can be made by means of equation 2. This circuit exhibits another interesting property in connection with image rejection, in that the coil may be tuned with its associated distributed capacity, or by means of an added capacitor, to resonate at one particular image resonate at one image frequency.

Circuit C is the familiar high-impedance primary rf transformer used to couple the plate of an rf tube to the succeeding grid. The primary circuit composed of L_P and C_P is resonant at some frequency below the tuning range. The voltage across the points s-t is, therefore, inversely proportional to frequency and the current through L_P is inversely proportional to the square of the frequency. The voltage induced in the secondary, however, is equal to $2\pi f MI_P$ where M is the mutual inductance. Hence, the secondary voltage is directly proportional to frequency multiplied by primary current. Since primary current is already inversely proportional to the square of frequency, it may be said for the entire circuit that secondary voltage is inversely proportional to frequency. This introduces the extra factor γ and accounts for equation 3.

Circuit D is the same transformer used in circuit C. In this instance it is used to couple an antenna to the grid. The antenna capacity and primary inductance form a series resonant circuit somewhere below the tuning range. The voltage across L_P is then nearly constant with respect to frequency throughout the tuning range. Following the same reasoning as in circuit C regarding primary current and secondary induced voltage, it may be concluded that secondary voltage is nearly constant with respect to frequency. Equation 2 is then the correct expression for the image ratio of this circuit.

It must be noted that in both of the preceding circuits, no consideration was given to capacity coupling between primary and secondary. Such capacity coupling will tend to make the image ratio approach the condition of equation 1, and in the limiting case where capacity coupling is much larger than the inductive, the circuit becomes similar to A.

Circuit E is that of a high-impedance loop antenna. Here the voltage induced in the loop is proportional to frequency. The equation for voltage ratio across C given by 2 must then be modified by dividing by γ, resulting in eq. (4).

In conjunction with a loop, a one-turn coil closely coupled is often used as a means of introducing voltage from an outside antenna. This is shown in F. Since the reactance of the antenna capacity is numerically much larger than the reactance of the one-turn coil, the current through this coil is proportional to frequency. The secondary voltage, as has been shown for

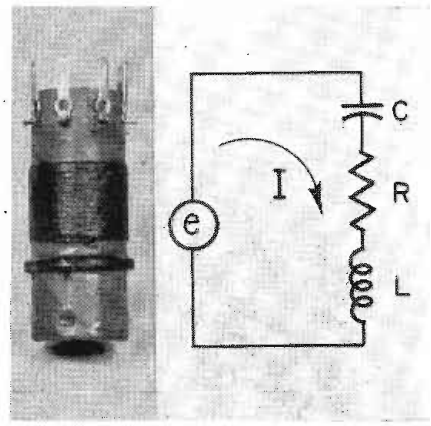


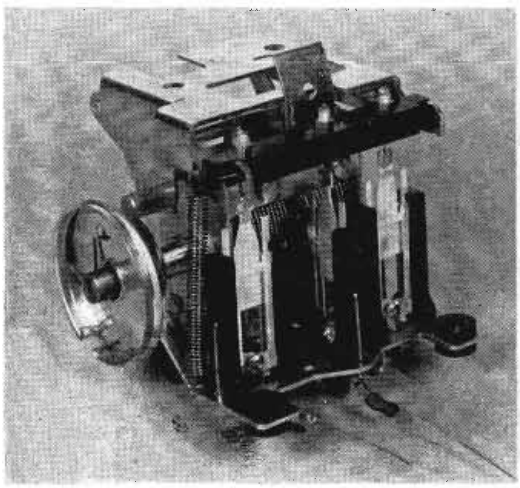
Fig. 1: Antenna coil with high-impedance primary (left). Basic series resonant circuit (right) used to derive equations (1) and (2)

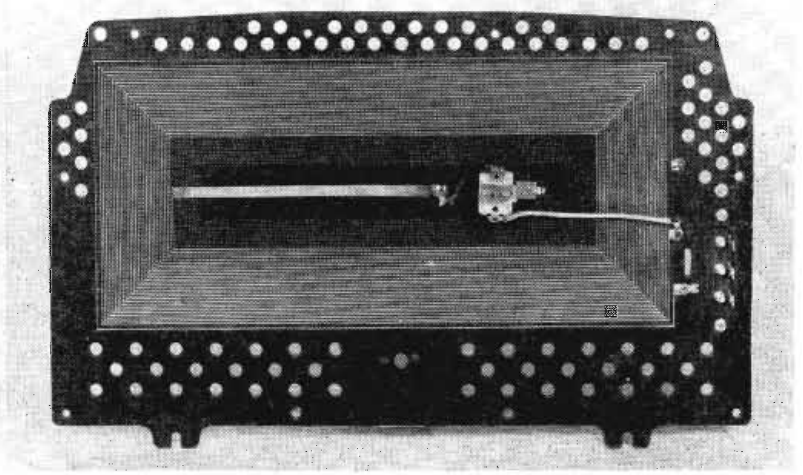
circuit C, is proportional to frequency multiplied by primary current. For the entire circuit then, secondary voltage is proportional to the square of frequency. Equation 2 must then be divided by γ^2, giving rise to the same expression as eq. (1).

The foregoing circuits are only a few of the more commonly encountered. However, all may be analyzed by the use of the two basic equations 1 and 2. In general, all capacity coupled circuits have an image ratio described by equation 1, and the image ratio will be highest when the oscillator is below the incoming signal. All inductively-coupled circuits fall within the scope of equation 2, but corrections must be made for frequency discriminating characteristics of the network. Inductively coupled circuits give an image ratio which is largest when the oscillator is above the incoming signal.

Reference 1: Radio Engineering Handbook, F. E. Terman, Page 139, McGraw-Hill Publishing Co.

FM guillotine tcner represented by circuit A. Right: die-stamped type broadcast loop antenna. (Shown schematically by circuit F)





RF Input Circuits for TV Receivers

Performance characteristics plotted in analysis of receiver input circuits; oscillator, mixer circuits will be discussed in later articles

By ***FRANK R. NORTON,*** *Principal Research Engineer, Bendix Radio Div., Baltimore*

THERE are several basic requirements which influence the design of rf input circuits for television receivers. In order to understand them thoroughly let us review certain transmission standards.

The ideal transmission amplitude characteristics is shown in Fig. 1. The total bandwidth is six megacycles for any one television transmission channel. The picture carrier is always 1.25 mc above the lower edge of the television channel. The center frequency for the television sound carrier, (which is frequency modulated) is 0.25 mc below the upper edge of the channel, and so the spacing between the two carriers of a television station is always 4.5 mc.

The television transmitter has a vestigial side-band filter which provides a sharp cutoff below the picture carrier. The transmitter has a flat amplitude characteristic in the region of the picture carrier and for approximately four megacycles to the right of that, and then cuts off sharply just below the sound frequency carrier. It should be pointed out that Fig. 1 does *not* imply that the actual envelope of amplitude modulation vs. frequency of a television picture signal would look like this, and in fact it would not, but this standard *does* mean that to avoid distorting the signal, the transmitter should have the transfer characteristic shown.

Fig. 2 shows the assumed ideal detector output. This would be the output of an rf envelope detector when the transmitter was being modulated with a very wideband sweep signal and the transmitter amplitude response curve was correct as shown in Fig. 1. The detector output curve drops six db between 0.75 and 1.25 mc above the picture carrier frequency and is then flat out to approximately four mc above the picture carrier and then drops sharply to 4.5 mc out. The increased output near the carrier frequency is, of course, due to the vestigial lower sideband.

Now let us see how the television receiver should respond to this transmission signal characteristic. Fig. 3 is the idealized receiver detector response curve. From the rf input to the second (video) detector of the receiver, the transmission at the picture carrier frequency should be half of that in the center of the video band or six db down with respect to the center of the band. The sharp cutoff at (a) corresponds to the idealized curve shown in Fig. 1. In curve (b) we have shown a more gradual cutoff such as actual receivers usually have. Some receivers cutoff at a considerably lower upper frequency. It has been shown experimentally that a two mc cutoff gives obviously reduced detail in a stationary test pattern but is scarcely noticeable in a scene with motion which is interesting to the viewer. In some receivers, therefore, the bandwidth is made considerably lower than we have shown, thus permitting some reduction in cost, and selling price, and so making it

Fig. 1: Characteristiss of idealized picture transmission amplitude

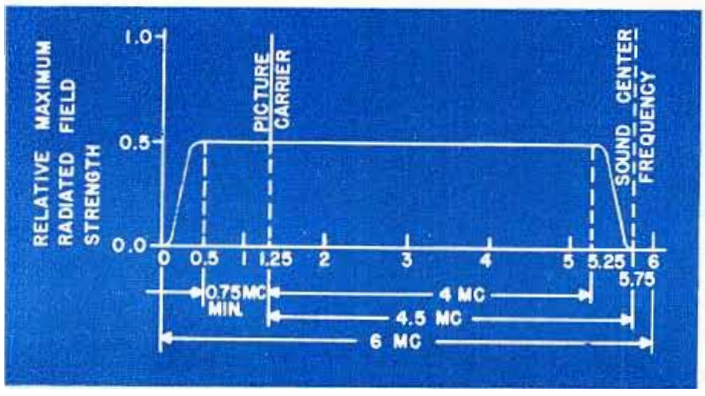
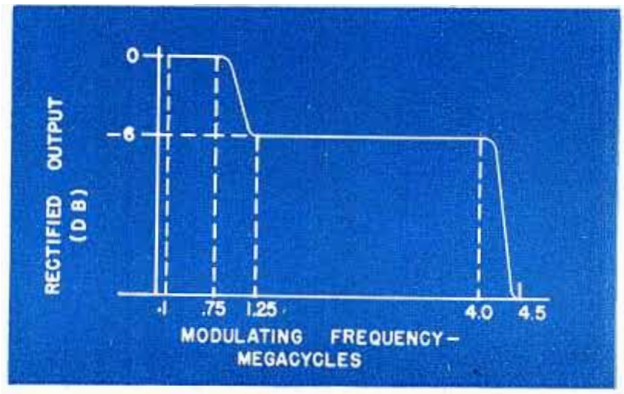


Fig. 2: Illustrating assumed ideal detector output characteristics



possible to widen the market.

A sharp cutoff is accompanied by phase distortion which introduces an undesired transient. However a crisper picture can be obtained in spite of that transient and some designers prefer to secure a sharp cutoff.

In Fig. 4 the equivalent receiver input to detector response is shown assuming that the receiver response as in Fig. 3 was correctly designed to be six db down at the picture carrier frequency so that the areas (c) and (d) in Fig. 4 shown between the dotted curve and the solid curve are equal. Then the response (c) due to the low frequency picture components which are received from the vestigial sideband just balances the transmission loss within the receiver in the (d) region. If this condition is not met, there will be low frequency smearing in the picture.

The video output of the detector should be quite flat from the carrier frequency up to the cutoff point, either (a) or (b). A variation up to about 25% in the amplitude response curve is generally satisfactory, provided any changes in amplitude are gradual.

In any one metropolitan area, adjacent television channels are not assigned, except those separated in frequency by other assignments as channels 4 and 5 are. But the picture carrier spacings of 10 or 12 mc between the lower channels and 12 mc between the higher channels in one city, to say nothing of the problem in an area where stations in different directions are on adjacent channels, almost necessitate the use of a superheterodyne circuit. In fact a superheterodyne circuit is now universal in U. S. commercial practice.

A television receiver should be tunable to any of the television channel assignments from 54 to 88 mc and 174 to 216 mc, a total of 12 channels. In some cases a receiver may be located where more than seven channels can be received simultaneously, although in any one metropolitan area there will not be more than seven stations.

Some receivers, therefore, for simplicity and to reduce cost, are designed to receive only 8 stations at any one time, provision usually being made to change the tuning to any 8 of the 12 available channels.

The transmitter output must be horizontally polarized to meet FCC standards, which affects the design of a receiving antenna. However,

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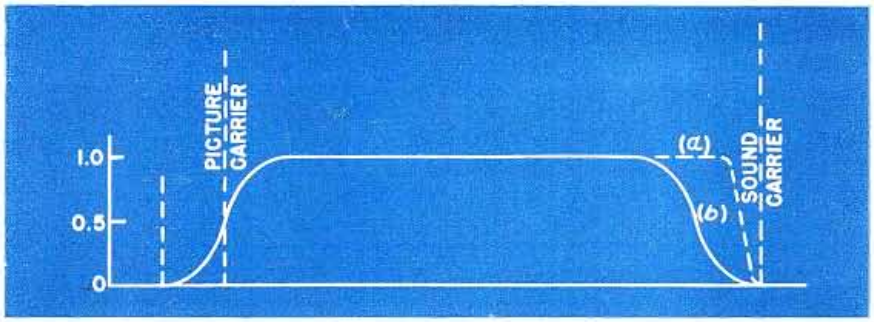


Fig. 3: Illustrating idealized receiver detector response curve corresponding to Fig. 1

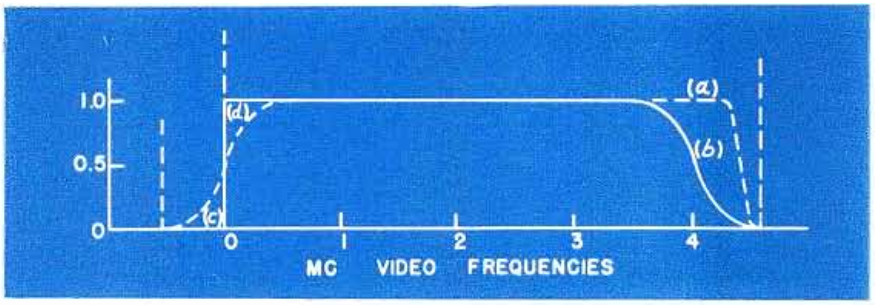


Fig. 4: Equivalent receiver detector response, assuming response in Fig. 3 is correct

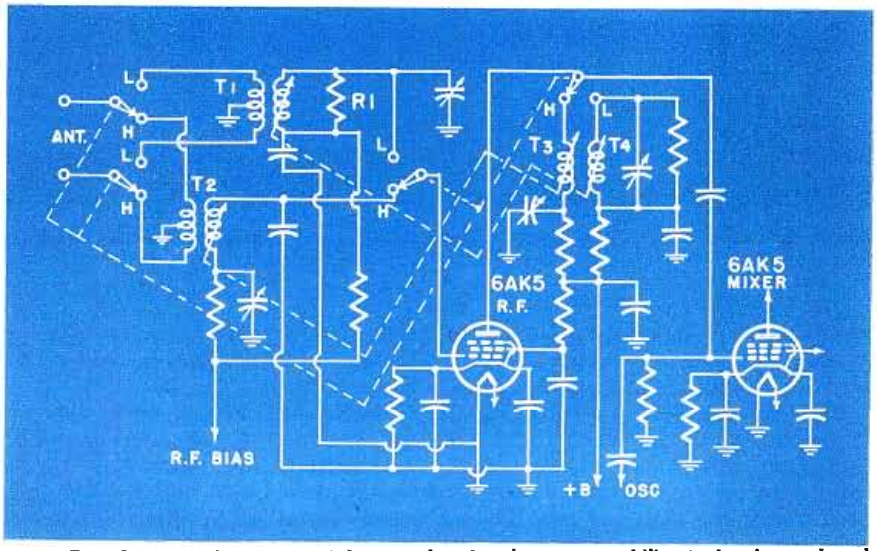
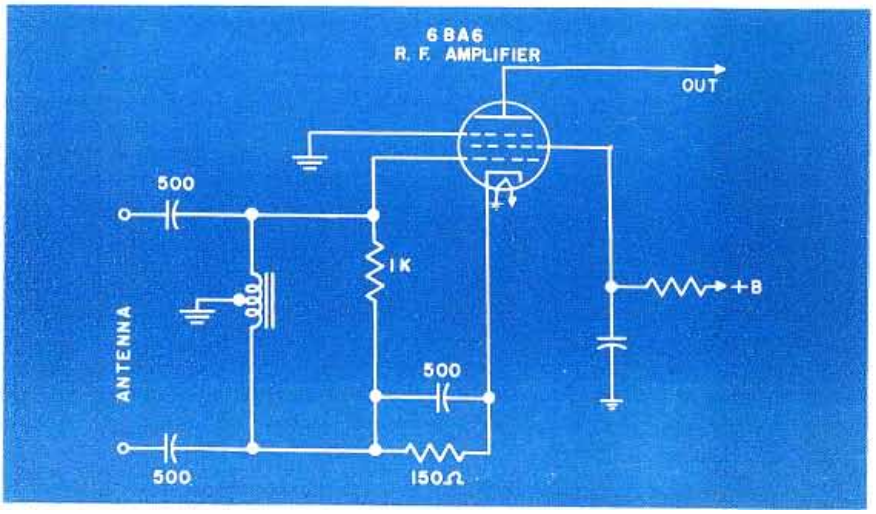


Fig. 5: RF schematic of a commercial tuner chassis where permeability tuning is employed

Fig. 6: RF input to grid and cathode is shown for a typical commercial receiver and tuner



RF INPUT CIRCUITS FOR TV RECEIVERS (Continued)

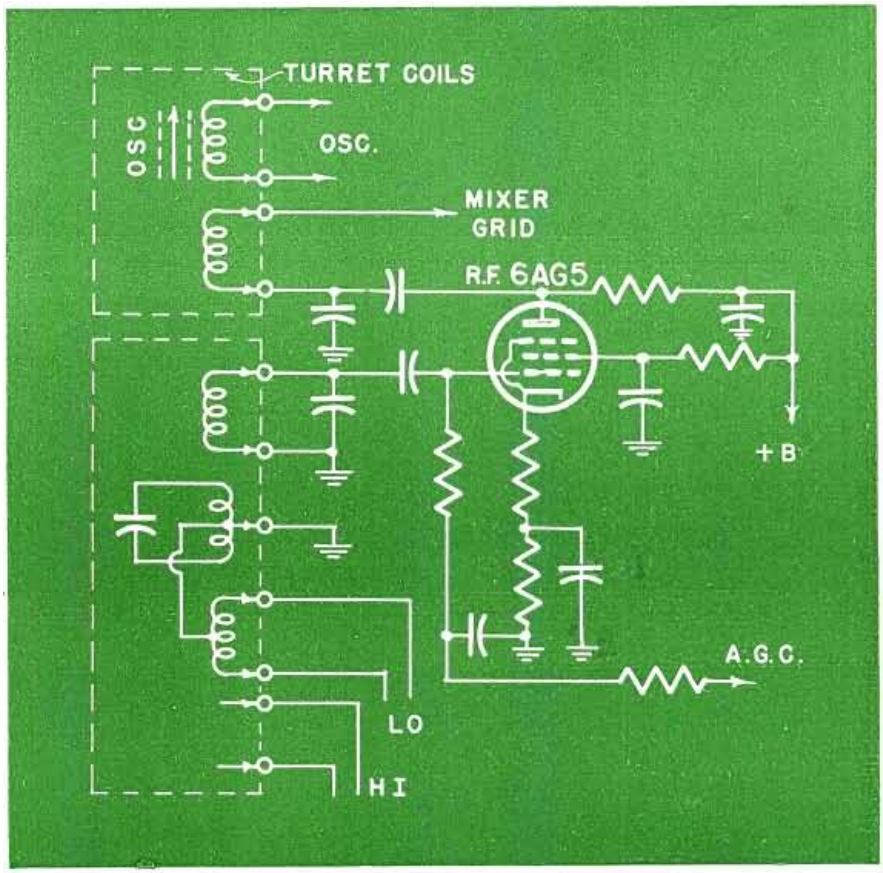


Fig. 7: RF input of a receiver using a turret providing for 8 sets of coils (one showing)

the receiver designer is at liberty to choose an input impedance and circuit to suit himself. An RMA committee, in considering various input impedances, recommended that a 300-ohm input be used. The 300-ohm balanced unshielded transmission line is the cheapest type available and is satisfactory in most locations. Also one of the reasons for the choice of 300-ohms was that for this very wide frequency band, from 54 to 216 mc., it is virtually impossible to maintain a constant impedance at the antenna, and a 300-ohm line, while it does not match the antenna perfectly over the entire frequency range, results in less mismatch on the average, than for ordinary coaxial lines.

The 300-ohm balanced line has relatively little noise pickup if it is properly installed. A coaxial line, although more expensive, will in some cases give a better signal-to-noise ratio at the receiver. Some balanced shielded lines have been designed but none are available with a 300-ohm impedance, and it does not appear likely that it will be possible to make one at a reasonable cost if the impedance is to be higher than approximately 100 ohms.

Hence we find that most receivers are designed for the 300-ohm balanced input line, although some are designed to use either the 300-ohm balanced or a 75-ohm unbalanced coaxial line and a few are designed only for a coaxial line.

Regardless of the type of input line that is used, it is possible by the use of an rf stage to improve the selectivity of the receiver, to reduce oscillator re-radiation (unless the design is deficient in shielding, or otherwise), and it should give a lower noise level in the set than would be obtained if the input were applied directly to the mixer, since in general the noise in mixer circuits is greater than that in rf amplifiers. Thus it is desirable to obtain fairly high rf stage gain.

The rf amplifier circuit may be balanced with a balanced input circuit, but perhaps more receivers use an unbalanced rf amplifier. In Fig. 5 we show the rf schematic of a commercial tuner chassis where permeability tuning is used. One set of coils is used for the high channels and a separate set for the low channels is selected by a switch near the tuning knob. The 300-ohm antenna input circuit, on the high position of the switch as shown, goes into the rf input transformer T2. This has a balanced primary input and an unbalanced secondary feeding the grid of the 6AK5 rf tube. The low frequency transformer T1 has a loading resistor R1 across the secondary to maintain the proper bandwidth. The high frequency transformer is loaded by the dynamic loading due to lead inductances and transit time effects in the tube.

A single-winding, high-frequency coil T3 tunes the interstage between the rf and mixer, a separate coil (T4) being used for the low channels. The input transformer, although it may be very well balanced for one position of the secondary tuning slug, is not as well balanced for other positions of the tuning slug since the stray capacities on the primary side become unbalanced. It is possible to wind transformers with reversed turns which maintain the primary balance very well for any position of the tuning slug. We believe permeability tuning will become more widely used in television receivers, because of its relative simplicity and low cost. Also a permeability tuner is capable of obtaining a better gain-bandwidth product than a variable capacitance tuner covering the same frequency range.

In Fig. 6 we have an input circuit which is typical of that used by some commercial receivers and in a number of tuners which are on the market for use in kits. Here the rf balanced input is fed into both the grid and the cathode of the rf amplifier tube. The input impedance of 300 ohms is approximately matched by use of dynamic loading on the cathode side along with the 1k (1000-ohm) resistor shown. This circuit is capable of a reasonably good noise performance but is somewhat lacking in selectivity.

The next circuit, Fig. 7, shows the rf input of a receiver using a turret with provision for eight sets of coils (only one set is shown). Thus eight channels may be received at any one time by rotating the turret selector knob. These coils are of a snap-in type which can easily be changed to accommodate any other desired channels. Provision is also made for two separate antenna inputs so that separate antennas may be used for the high and the low channels. This makes it possible to obtain a better antenna in-

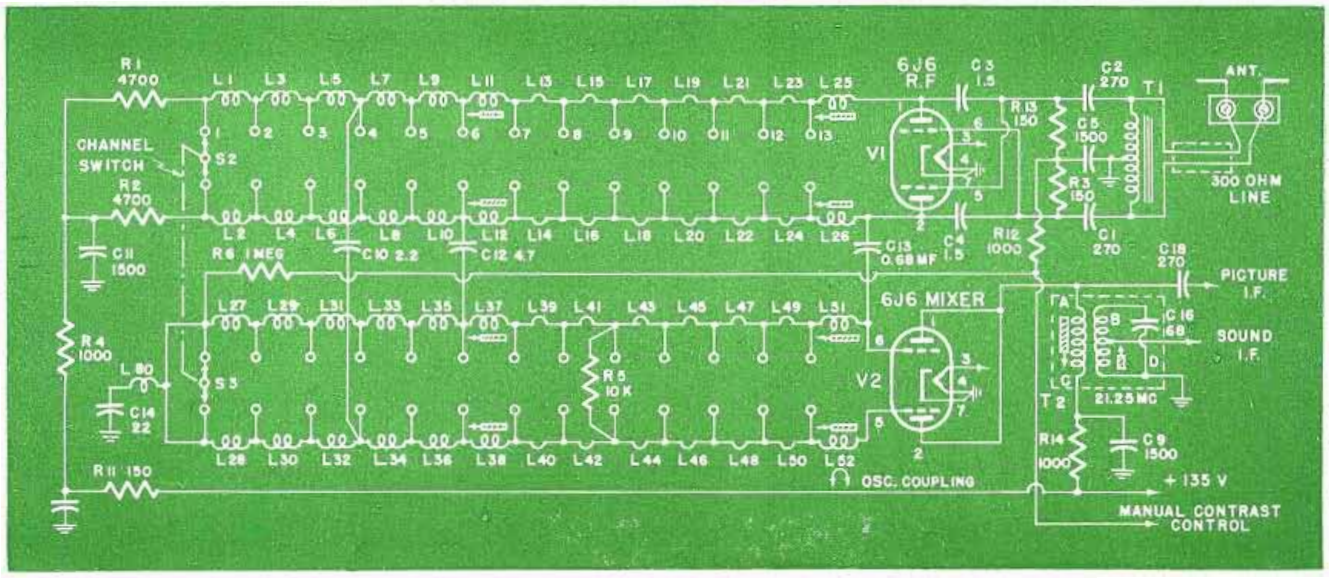


Fig. 8: Balanced input receiver circuit using balanced type of input feed achieving channel selection by means of a rotary switch

stallation, particularly if the desired high and low channels are in different directions. However, in practice these two lines are generally connected together at the set and only one antenna actually used. Each antenna input coil is balanced on the line side and coupled to an unbalanced coil which drives the rf amplifier (6AG5) tube. A good balance on the line side should be obtained since the coils are each designed for only one channel.

There are many other unbalanced rf television input circuits which might be of interest but those we have considered are typical. Now let us consider some balanced input receivers. Fig. 8 shows one circuit design which is widely used. The antenna input has a coil T1 across it to serve as a shunt at radio broadcast frequencies. The capacitors C3 and C4 are used to neutralize the grid to plate capacities. We might note that the 300-ohm resistance termination which is directly across the grids of the rf amplifier does not provide any selectivity at the television frequencies. It is generally agreed that some input selectivity is very desirable and the latest receivers using this circuit are provided with series-tuned traps from each side of the line to chassis ground to reduce image interference from adjacent FM transmitters.

The circuit between the rf amplifier and the mixer is essentially a double-tuned balanced circuit using wafer switches with the inductances sequentially placed between switch contacts, so that in alignment it is necessary to first align the slugs in L25, L26, L51 and L52 for channel 13 since these inductances form a part of the circuit for *all* channels. The tuning switch moves the shorting bar along to the contacts for each channel, as marked. Channel 6 is the next to align, the intermediate inductances L13 to L24 and L39 to L50 being fixed straps between contacts on the switch wafers. The coils L1 to L10 and L27 to L36 for the lower channels are also fixed, being figure 8 coils wound on fingers extruding from the switch wafers. The rf plates and mixer grids are coupled by a combination of capacity coupling and inductive link coupling to maintain an approximately constant bandwidth. A shunt trap for the IF is provided at the mixer grids to prevent regeneration.

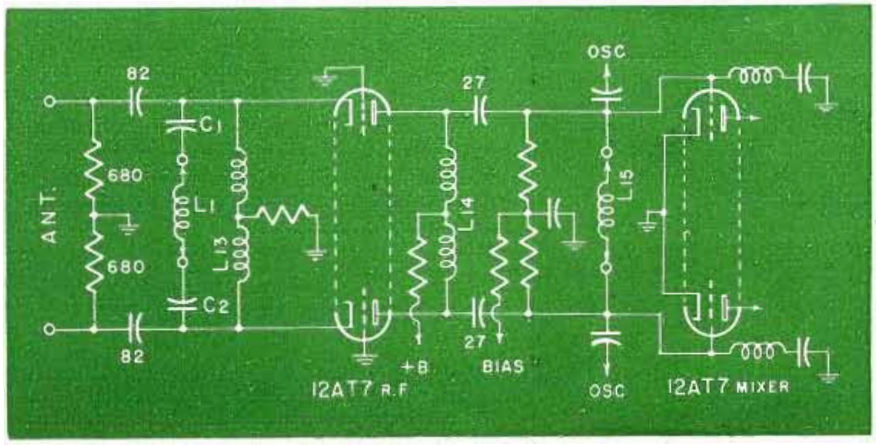


Fig. 9: RF input of an experimental Bendix television tuner using balanced push-pull input

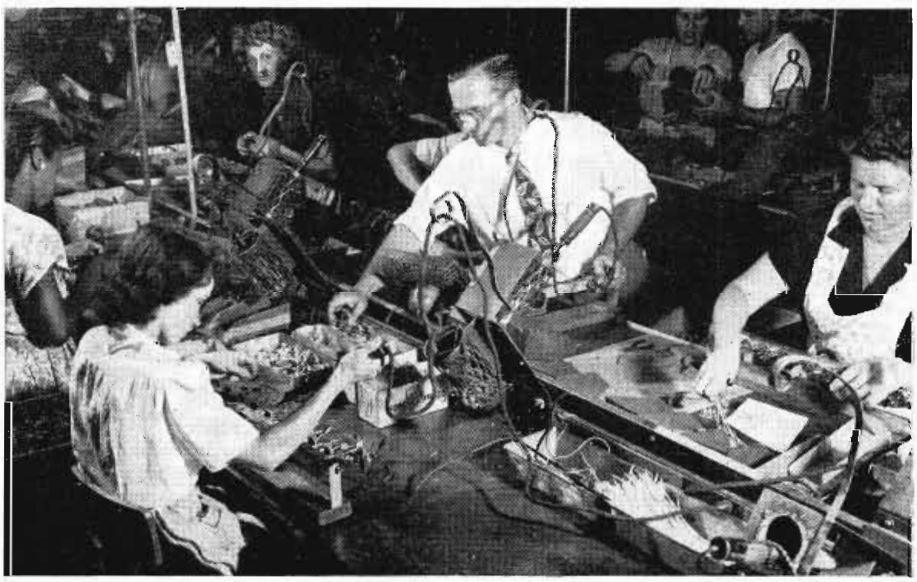
Fig. 9 shows the rf schematic of an experimental Bendix television tuner which was described at the 1948 IRE annual convention. This uses a 12AT7 tube in a balanced push-pull cathode input, or grounded grid stage. Pre-selection is provided by a tuned input circuit which includes the coil L1, in a 12-channel turret. A coil for each channel is slug tuned. The coil is in series with the capacitances C1 and C2 which provide a means of matching the high impedance of the coil to the relatively low impedance at the input terminals. The shunt coil L13 provides a dc path from the cathodes to the bias resistor. The input impedance is matched by a combination of the dynamic input conductance of the 12AT7 cathodes, in parallel with the fixed input resistors shown.

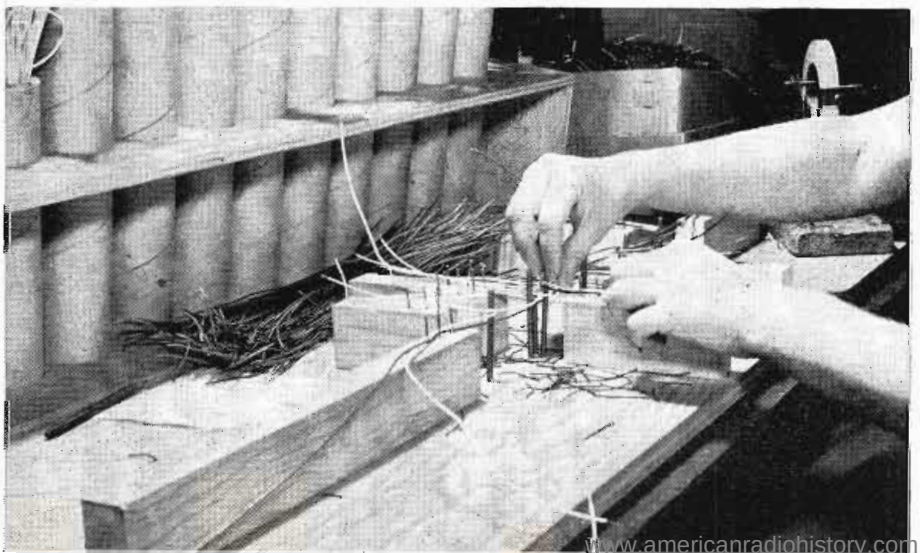
The rf amplifier plates have a shunt-feed coil L14 and the interstage tuning utilizes a slug-tuned, turret-mounted coil, L15, which resonates at the desired frequency with the shunt interstage capacities. IF traps are connected to the

(*Continued on page 57*)

TV Receiver and Parts Assembly Technics

ABOVE: Operations at Emerson begin with component parts assembly. Condenser and resistor leads being cut to size at 900-per-hour rate





Emerson know-how facilitates television receiver production; special jigs, cradles, racks are shown

PRODUCTION experience acquired over a period of years in manufacturing several million radio receivers is now being put to effective use by Emerson Radio & Phonograph Corp., New York City, in making its popular 10-in. television set. Several hundred completed units per day are now rolling off each production line. Accompanying photographs show production methods, types of jigs, cradles and rack facilities designed to expedite assembly operations.

Photos by Albert Freeman

LEFT TOP: Assembly operations on sockets and dummy lugs in component production line. Karl Shenkenberg shown supervising parts operations.

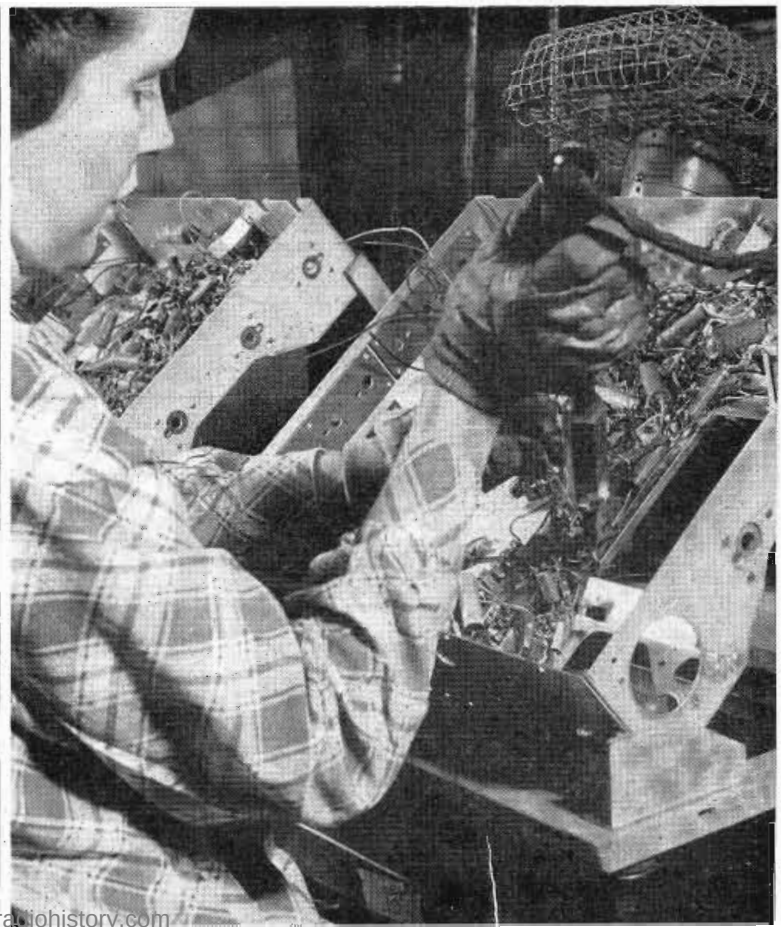
LEFT: Plywood jig for assembling master cable. Color-coded cut wires are in the upright tubes

ABOVE: After assembly of component parts, they are riveted to the chassis. Operation includes 23 tube sockets, 8 electrolytic condenser plates, 5 insulators for control units, 2 output transformers

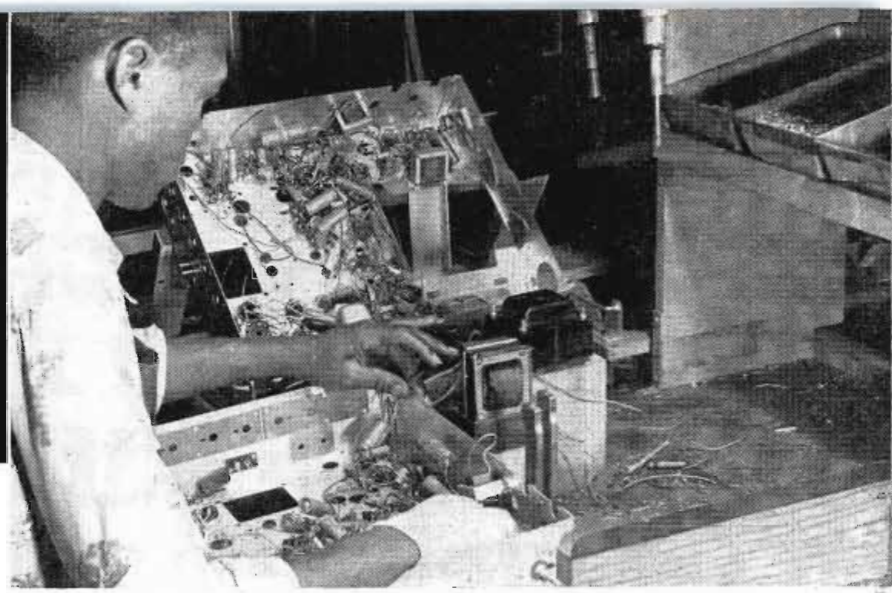
ABOVE: Horizontal output transformers, assembled near the receiver production line are attached to the chassis after it leaves the riveteers and before the chassis is started on production line

BELOW: Start of assembly line. The chassis with some parts already riveted in place are loaded on special aluminum cradles on casters which run in metal tracks. Chassis operations follow

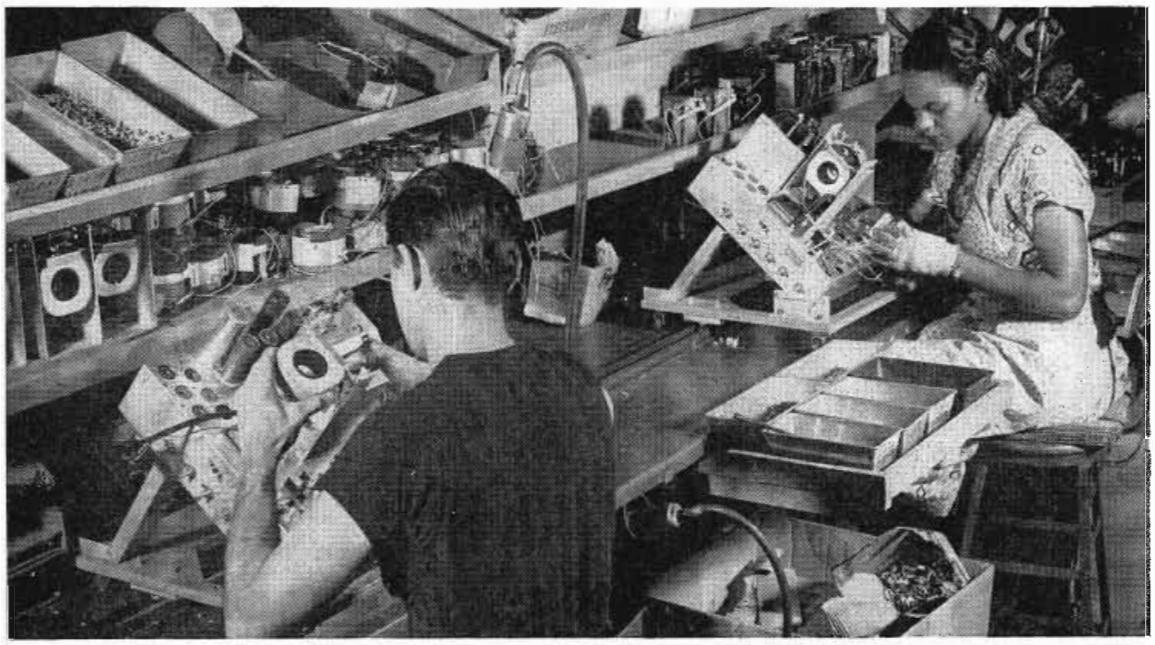
BELOW: One production-line operator performs about 50 assorted operations with the soldering iron. These are on the underside of the chassis and follow installation of resistors, condensers



TV Receiver and Parts Assembly Technics (continued)

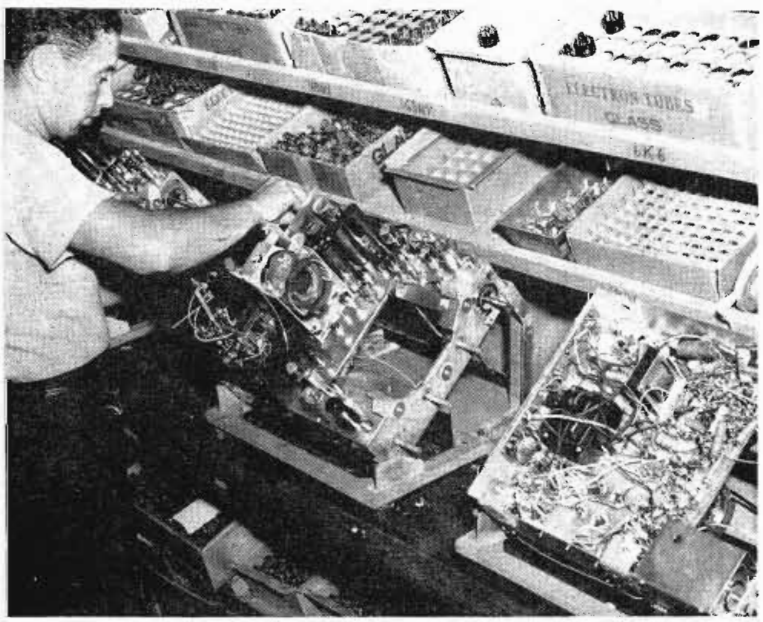


RIGHT: Chassis is removed from its cradle at this point where heavier units such as the vertical output and power transformers ae installed

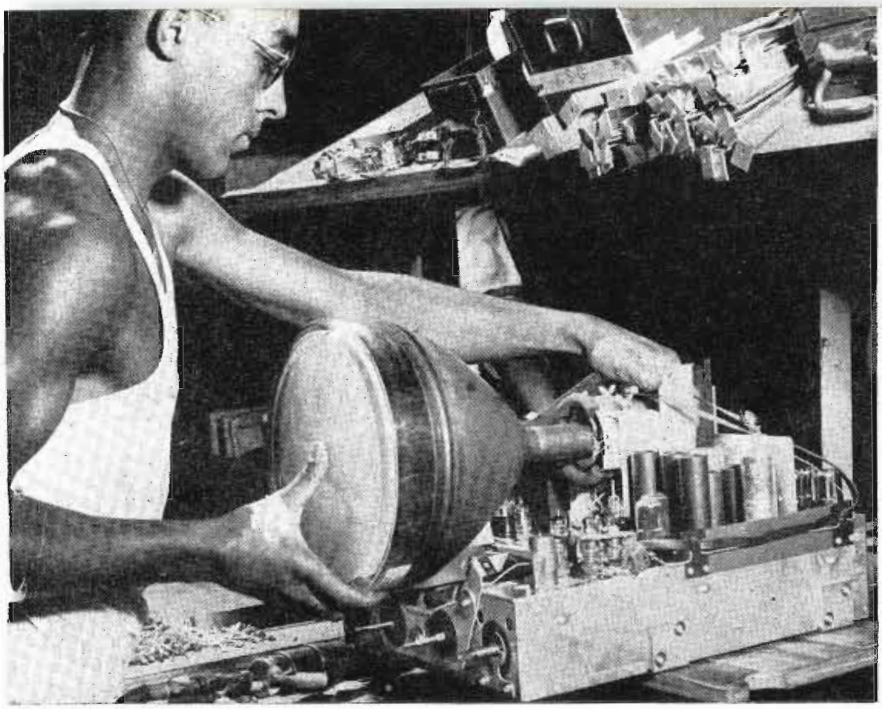


LEFT: Operation at left shows installation of the focus assembly and yoke bracket for the picture tube. Girl is mounting a horizontal output transformer and assorted small parts. Note storage racks

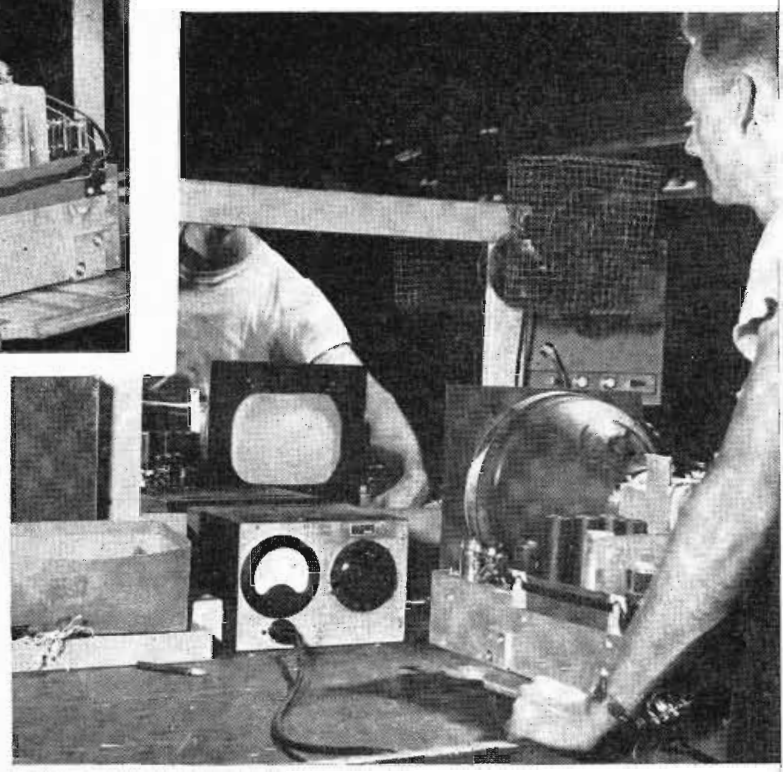
BELOW: Alignment of all circuits other than those which are directly a part of the image tube alignment operation takes place here. On shelf over table are RCA signal generator and a DuMont oscilloscope

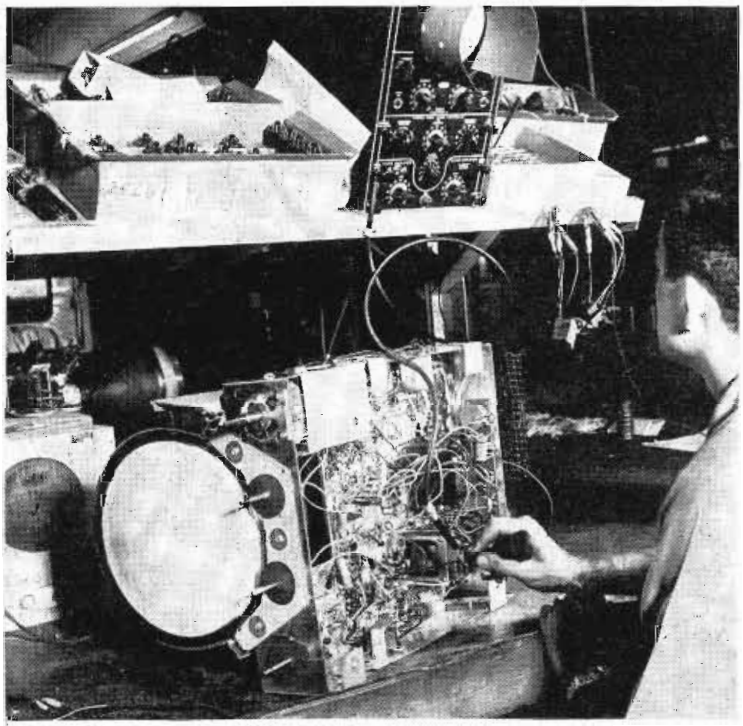


ABOVE: Installation of some of the 28 tubes used in this Model 571 TV receiver. Tubes are mounted in racks stepped-back for easy access. At this point in assembly only image tube is missing



LEFT: The nearly-completed chassis is removed from the cradle for installation of the picture tube which has been previously tested. From this point chassis is hand-carried for further test

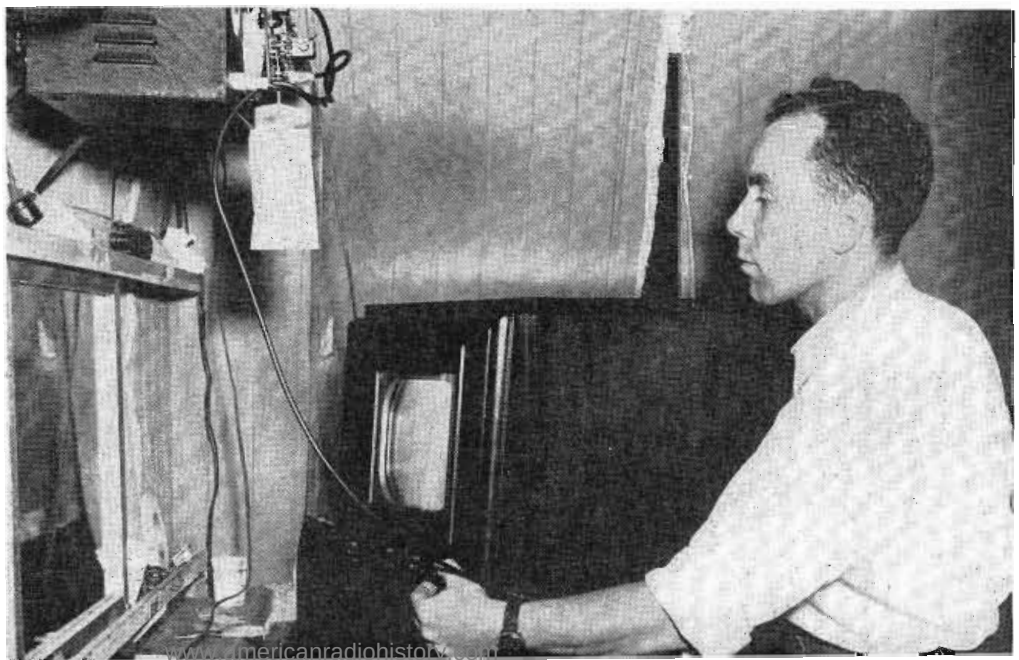


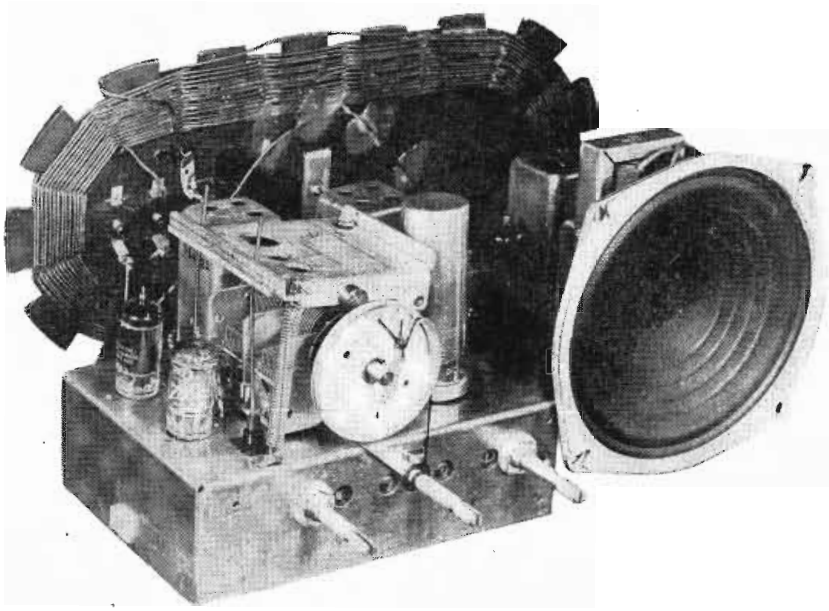


ABOVE: After the picture tube is attached, as described in the previous operation, the chassis is plugged in for a preliminary adjustment of all picture circuit elements. A conventional mirror arrangement enables operator to see the tube screen while making adjustments from the back. This is the final test before the completed chassis is mounted into cabinets. Note that at this point chassis is on a flat skid with ball-bearing rollers

ABOVE: TV receivers that show up defective during preliminary adjustment stage are shunted off the assembly line to trouble-shooting bench as shown

RIGHT: Final test of the completed, mounted chassis takes place in a sound-deadened room. Mirror aids tester see image while he works from the back. Shown is Thomas Bellavia, who is in charge of TV assembly at Emerson's New York plant





Low Cost FM-AM Receiver Circuit

By G. E. GUSTAFSON,
Vice-President in Charge of Engineering

JOHN L. RENNICK,
Project Engineer, Zenith Radio Corp., Chicago

AFTER two years of post-war production of FM receivers, the Zenith Radio Corp. decided the time had come to apply this experience to the design of a small FM-AM set which would be the modern counterpart of the popular, convenient, and economical 5 tube ac-dc broadcast receiver. Cost was to be a primary consideration, of course, but this was not to interfere with satisfactory performance in the hands of the user.

With these ideas in mind, a set of tentative specifications was drawn up as follows:

1. The set must be as compact as manufacturing realities will allow.
2. The performance in the standard broadcast band must equal that of the best 5 tube ac-dc sets.
3. The performance in the FM band must be adequate to take full advantage of the FM system without requiring the use of an external antenna within the primary service area. This calls for plenty of sensitivity and a real FM detector.
4. The audio quality must be good. Low frequency response must be adequate and the proper balance between lows and highs must be maintained.
5. The set must be economical to build and test from the standpoint of labor costs as well as material.

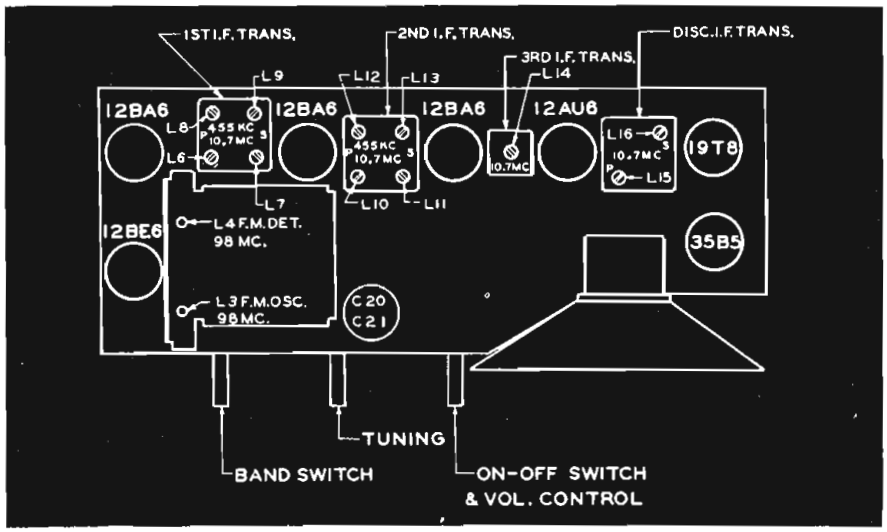
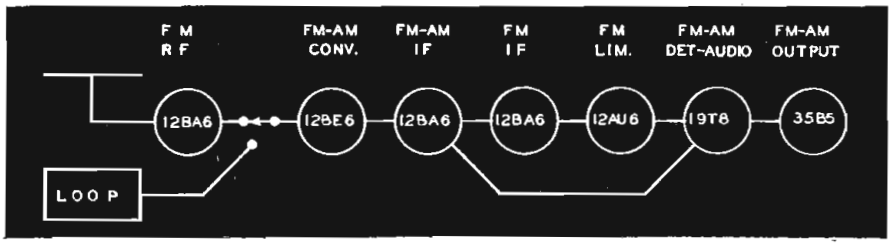


Fig. 1 (Above): Top view of the chassis shown in photo with major components identified

Fig. 2 (Below): Diagram showing the tube line-up for FM and for AM broadcast reception



We hoped to obtain a $49.95 retail price and we were successful in doing it in this set, known as Zenith Model 7H822.

The resulting design is shown in the block diagram of Fig. 1. The tube line-up makes use of popular miniature types which lend themselves quite well to the functions shown, and in addition help to keep down the size of the chassis. The selenium rectifier is used because its low voltage drop permits the use of simple filtering without sacrificing B+ voltage so necessary for adequate gain and power output. Everything needed in a good FM set is here. Since nothing has been left out, we must look further if we are to find the economies which make the set fulfill requirement No. 5 above. In other words, we must look inside the blocks of the block diagram.

A broad-band input circuit is used to couple the 300-ohm nomi-

Zenith model 7H822 boasts 7-tube ac-dc circuit with high FM sensitivity; sells at $49.95; economical production, test methods told

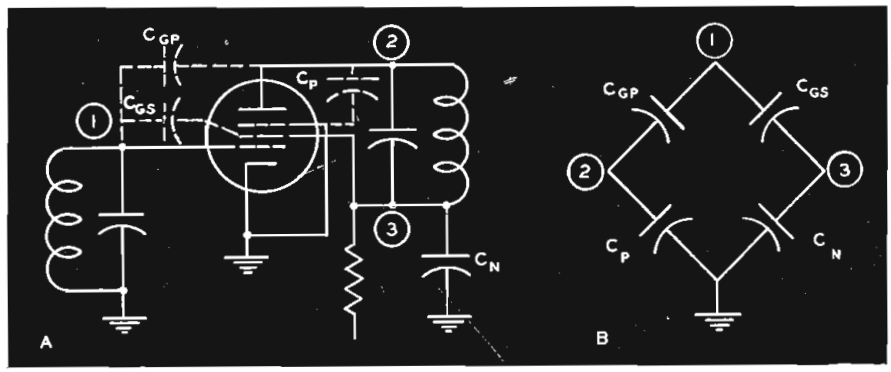


Fig. 3: Schematic and equivalent capacity diagrams showing how IF amplifier is neutralized

nal impedance of the antenna to the rf tube. This circuit must transform the antenna impedance up to that of the tube grid, provide rejection to signals outside of the FM band and, as a safety measure, provide isolation between the external antenna connections and the chassis which is connected to one side of the power line. Because there is no switching in the grid of the rf tube, the capacity is held down to that of the tube and socket plus a very minimum of strays. As a result a very simple two-winding coil provides antenna coupling over the band which is only one to two db below the best that can be obtained with a tuned input circuit.

Permeability tuning is used for the converter grid and oscillator circuits. A cam mounted on the AM tuning condenser shaft actuates a rocker arm which carries the tuning slugs. This simple mechanical arrangement has been used on all Zenith FM sets since the war and proves economical here as well. No adjustable condensers are provided across the permeability-tuned coils. These coils are designed so as to give a logarithmic relationship between frequency and slug position. When this is done it is possible to completely compensate for small manufacturing variations in capacity by a slight shift in slug position. Obviously the substitution of fixed condensers for trimmers saves space and labor and helps to cut down on drift.

Second harmonic operation of the converter is used. This scheme was originally proposed as a means of obtaining operation on the 45 mc band and the 100 mc band with simple switching. Experience has shown, however, that if properly handled, it has advantages over fundamental operation even when the 45 mc band is not required. In the first place, it permits the use of an oscillator tank condenser of about twice the capacity that would be used for fundamental operation. Thus the variation in tube capacity during warm-up is swamped out much more effectively. In the second place, since the resonant frequency of the input circuit is so much further removed from the oscillator frequency, no difficulty is experienced with stray coupling between the two circuits.

With fundamental operation the space - charge coupling between grids one and three of a pentagrid converter is great enough to cause some trouble. When the strays (which are unavoidable with simple bandswitches) are added, the result is usually instability, which can only be overcome by operating the tube at reduced gain or with external loading, which also reduces the overall gain. The net result of all this is that second harmonic operation gives almost as much gain and, in addition, is much easier to handle in production.

The IF channel is interesting be-

(*Please turn to next page*)

TABLE I — MEASURED PERFORMANCE CHARACTERISTICS

FM Performance

Maximum deviation sensitivity	30 μv
Quieting sensitivity	22 μv
Maximum sensitivity	6 μv
Deviation sensitivity	3kc
Image ratio	30 db
IF rejection	78 db
AM suppression	(16 db @ 11 μv (24 db @ 110 μv (28 db @ 1100 μv

AM Performance

Sensitivity	100 μv/meter
Image ratio	40 db
IF rejection	35 db
Overall band width	(x2 x10 x100 x1000 (10 Kc 16 Kc 31 Kc 52 Kc

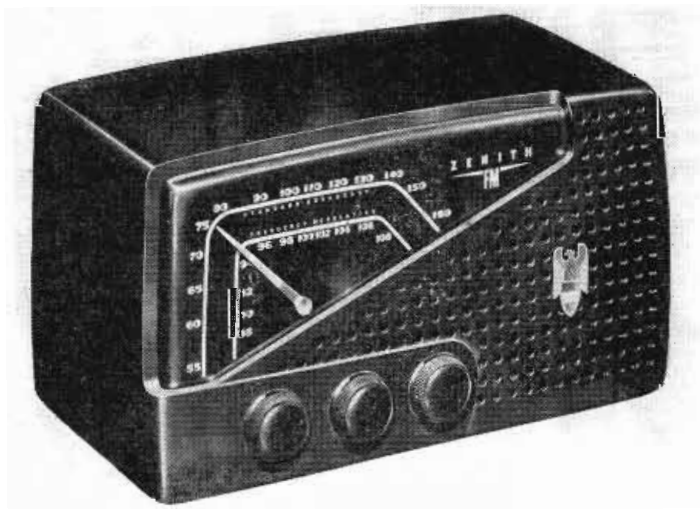


Fig. 4: Smartly designed Zenith Model 7H822 FM-AM receiver has 7 tubes, ac-dc circuit and is priced at $49.95

cause of its simplicity and stability, along with its high gain. Overall stability of any FM IF channel is achieved only if proper attention is paid to layout and isolation between stages. If care is used in these respects, the only remaining source of feedback is grid plate capacity. We are accustomed to thinking of pentodes as being free of this effect, but at 10 mc even .003 μμf can cause regeneration. In addition to the tube capacity there is an almost equal capacity associated with the socket and wiring which is practically unavoidable.

Consideration of these facts led to the use of an old scheme of neutralization which is particularly convenient and economical in this application. Fig. 3 shows the circuit used. As may be seen in Fig. 3A, the secret lies in the use of a common bypass, C_n, of the proper value, for plate and screen. Fig. 3B shows that this condenser, in combination with the interelectrode capacities, forms a capacity bridge which, if properly balanced, prevents the feedback of output voltage appearing across points two and three, to the input terminals, one and ground. In practice C_n works out to be approximately .002 mfd but is not particularly critical. The use of this principle makes possible the design of a stable, symmetrical IF channel which, besides simplifying the tuning of the receiver as far as the customer is concerned, facilitates production alignment, Fig. 5a.

The choice of the limiter-balanced discriminator type of FM detector was dictated by the desire to have a simple and reliable circuit in this critical part of the set. Experience has shown that this circuit may be depended upon to maintain its efficiency under field conditions. The curve of Fig. 5b shows that the 12AU6 makes an excellent grid bias limiter. The diode sections of the 19T8 are well balanced and make an efficient discriminator.

Audio System Circuit

The audio system makes use of the circuit shown in Fig. 6. By the addition of two resistors and a condenser we have greatly improved the response characteristic. The unbypassed cathode resistor, R_k, is a source of feedback voltage which is fed through C and R_2 to R_1 which is in series with the low side of the volume control. These values are adjusted so that at middle and high frequencies about 10 db of negative feedback is obtained. Due to the time constants in the feedback path and in the amplifier coupling circuits the feedback is reduced and its phase shifted at low frequencies so that there is about three db of positive feedback. The result is a low boost of 13 db plus the reduction in distortion and hum always associated with negative feedback.

Shock Hazard Approved

A word about shock hazard is in order since consideration of this item makes necessary a definite choice of procedure. For the past several years it has been customary to isolate the chassis of ac-dc receivers from the power supply circuits. When this is done there is no shock hazard associated with touching the chassis. In the case of conventional broadcast-band receivers such isolation costs only one paper condenser and is an economical answer to the problem.

When we try to apply the same procedure to an FM receiver we find that, because of the relatively high reactance of stray inductances and the low reactance of stray capacities at these frequencies, isolation of the chassis from the power supply is not so practical. It can be done, but only at the expense of several condensers and isolation chokes. Consequently it was decided to connect the power supply directly to the chassis, and by the use of a disconnect plug on the cabinet back, make it impossible for the customer to touch the chassis when it is connected to the power line. The Underwriters' Laboratories approve this type of construction.

Measurements of production receivers of this design as detailed in Table I show that the result is an inexpensive FM set having characteristics better in most respects than many consoles on the market today.

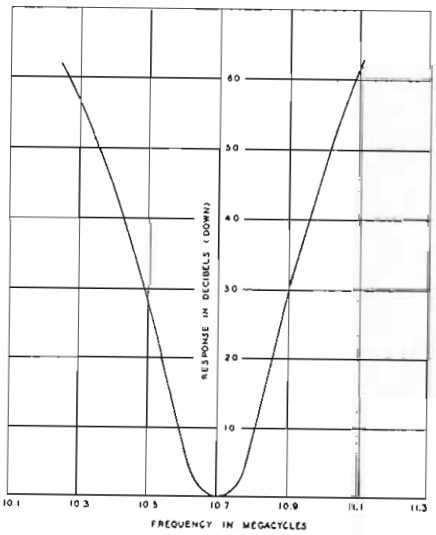


Fig. 5a: A symmetrical IF selectivity curve is achieved by insuring stability in design

Fig. 5b: Curves showing the input and output characteristics of the 12AU6 limiter stage

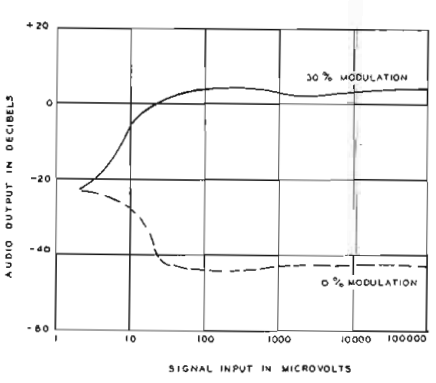
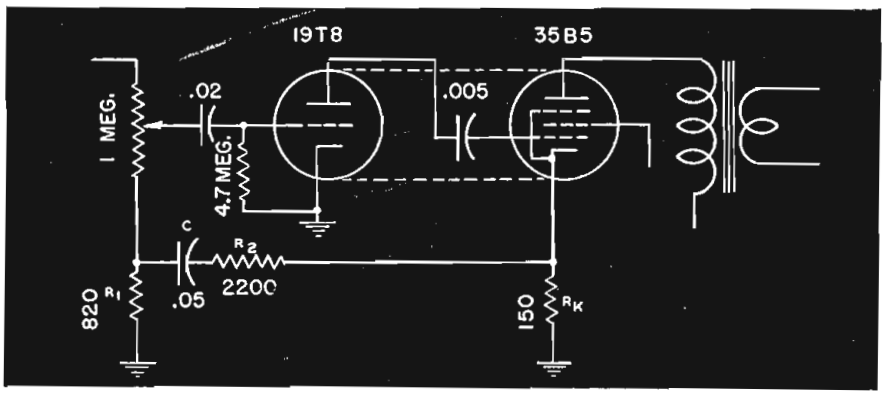
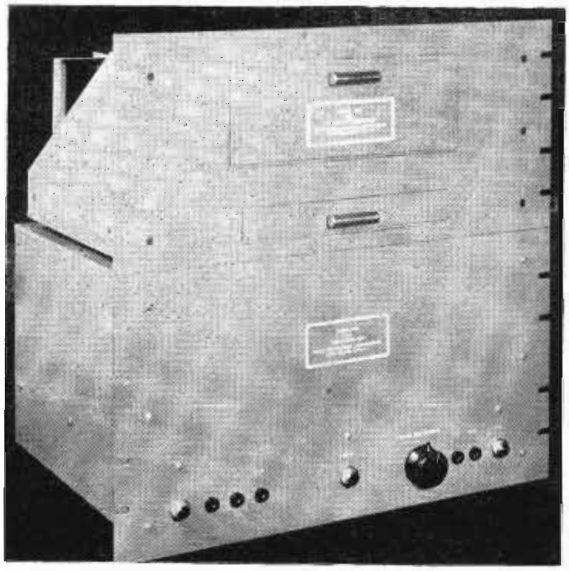


Fig. 6: The audio feedback network shown in the simplified schematic below provides a 13 db boost for the low frequencies and also reduces the effects of hum and distortion





Serrasoid modulator for phase shift FM broadcasting

New Modulator Principle for FM

Serrasoid circuit developed by REL results in wide phase shift swing with unusual linearity

THE technical features of a new method of converting the modulating signal to a phase shifted signal was disclosed by James R. Day, at the first fall session of the Radio Club of America, on Sept. 23rd. This system, developed by the speaker for Radio Engineering Labs., Inc., N. Y. C., is the first new modulator principle that uses only three common receiving tubes. The arrangement, called the Serrasoid modulator, uses a new circuit principle rather than an unusual tube, and produces a wide phase shift swing (±150°) with unusual linearity.

Along with using only three tubes with simple non-adjustable circuit components the system has direct frequency control from a crystal, and so avoids the use of elaborate mechanical or electrical follow-up circuits to keep the carrier in line. A 972-fold multiplier system is used to bring the phase shifted carrier up into the usual FM band. This is done with five triplers and two doublers, also using ordinary receiving tubes. The block diagram is shown in Fig. 1. The usual broadcast modulator panel, as described, utilizes a ±90° phase shift for 100% modulation, which is well within the circuit's capabilities.

Basically, the Serrasoid principle converts the output of the crystal oscillator to a series of pulses which are shifted back and forth along the time axis of a cycle in accordance with the modulation signal.

The electronic circuits that produce the time modulated pulses are of the passive type and are under the absolute control of the crystal. These pulses are then reconverted to sinusoidal waves in the subsequent multiplier and amplifier stages.

A feature of the system, aside from the unusual simplicity of equipment and adjustment, is the great linearity. In fact, almost negligible distortion is found in the modulator itself — at the ±90° swing with 100% modulation the modulator distortion is less than 0.1%, and for the whole system (with that added due to tuned stages in the multipliers) the system keeps within 0.25% with modulating frequencies of 50 cycles to 15 kc, at the 100% modulation level.

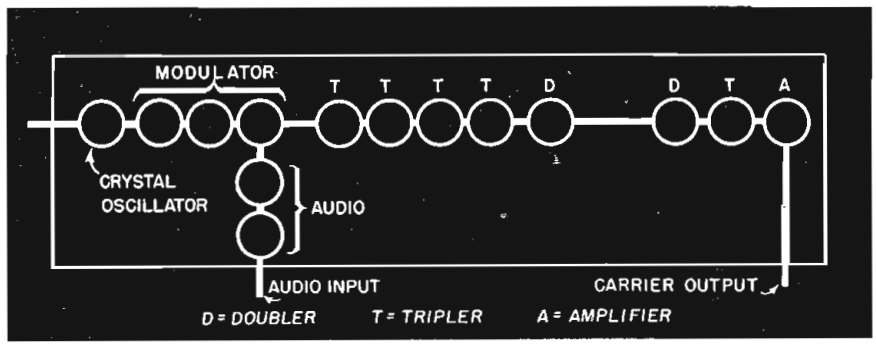
Other results of tests on the Serrasoid modulator and its amplifiers were mentioned as: The FM noise approximately 80 db below 100% modulation with negligible intermodulation products, carrier frequency stability ±.0003%, frequency response ±0.5 db from 50 to 15,000 cycles, modulation input +10 dbm (±2 db) for 100% modulation.

This REL development seems to offer many advantages in uhf relaying networks where many demodulating and remodulating points occur in the relay chain, in view of the excellent linearity and low distortion. The signal is not degraded as is found in certain other modulation methods.

Another interesting point is that two or more Serrasoid modulators can be connected in tandem to get greater phase shift excursions. The arrangement is being explored for more extensive applications in still other fields. It has industrial applications as a phase shifter. The modulator is available in packaged form for application to existing commercial FM transmitters of either REL or other makes.

The Serrasoid modulator has been in operation for five months at station W2XEA at Alpine, New Jersey. Major Edwin H. Armstrong says that this system is a great improvement over the two-channel method and it seems likely that it will become the accepted method of producing FM.

Modulation and carrier frequency control are secured by three tubes as shown in drawing



Performance Features

Full speed range, adjustability, quality recording are some characteristics of Rangertone model; suitable for duplication of recording for FM networking

THE new Rangertone magnetic tape recorder incorporates many desirable operating features in range, speeds, controls, adjustments and versatility such as its application (besides home recording) to monitoring and broadcast station networking, particularly FM.

In the case of network use, the high fidelity and versatility of the recorder permits immediate rerecording of the programs for distribution to broadcast stations.

In the case of monitoring, 1/15 of a second after recording has been made on the tape, that section passes the playback head for monitoring by headphone, loudspeaker or wave analyzer.

As shown with equipment in Fig. 1, a flick of the switch permits the output to be directly compared with the input. A rigorous test of fidelity may be made by putting a 1,000-cycle tone on the tape. Distortion and any warble to the note is much more readily discernible than with normal music or voice. With this constant ability to check the equipment, performance is perforce always on the upgrade. Likewise, the need of retakes is minimized.

In some comparison tests the listener guesses that the recorded musical program is "direct" more often than the other way around, due to the fact that distortion present in the recording skips the harsher second harmonic and goes on to the third. Odd harmonics are what give the pleasing wood-wind type tones and there may be an agreeable filling out of the tone by the tape recording.

For universal service, without complicated procedures, the tape recording process in the chain should be as impersonal as inserting a patch-cord in a jack; level-in and level-out: frequency-in and frequency-out should all be at no change in level. Research has shown it is possible to make the response as flat as desired. As seen in Fig. 2 it is flat within ±1 db from 40 cycles to well over 15,000 cycles, except for a slight dip at 70 cycles caused by a canceling action due to the physical dimensions of the core structure.

Considering the mechanical parts, the concentricity of the capstan is perhaps the most important element. This capstan, on the shaft of the synchronous motor, with the aid of the rubber idler grips the tape to move it forward rigorously constant. Its surface is hard chromium plated and precision-ground to an eccentricity of less than .0002 in. Any variation greater than this is readily detected on single tones; particularly 1000 cycles.

The rubber idler is likewise pre-

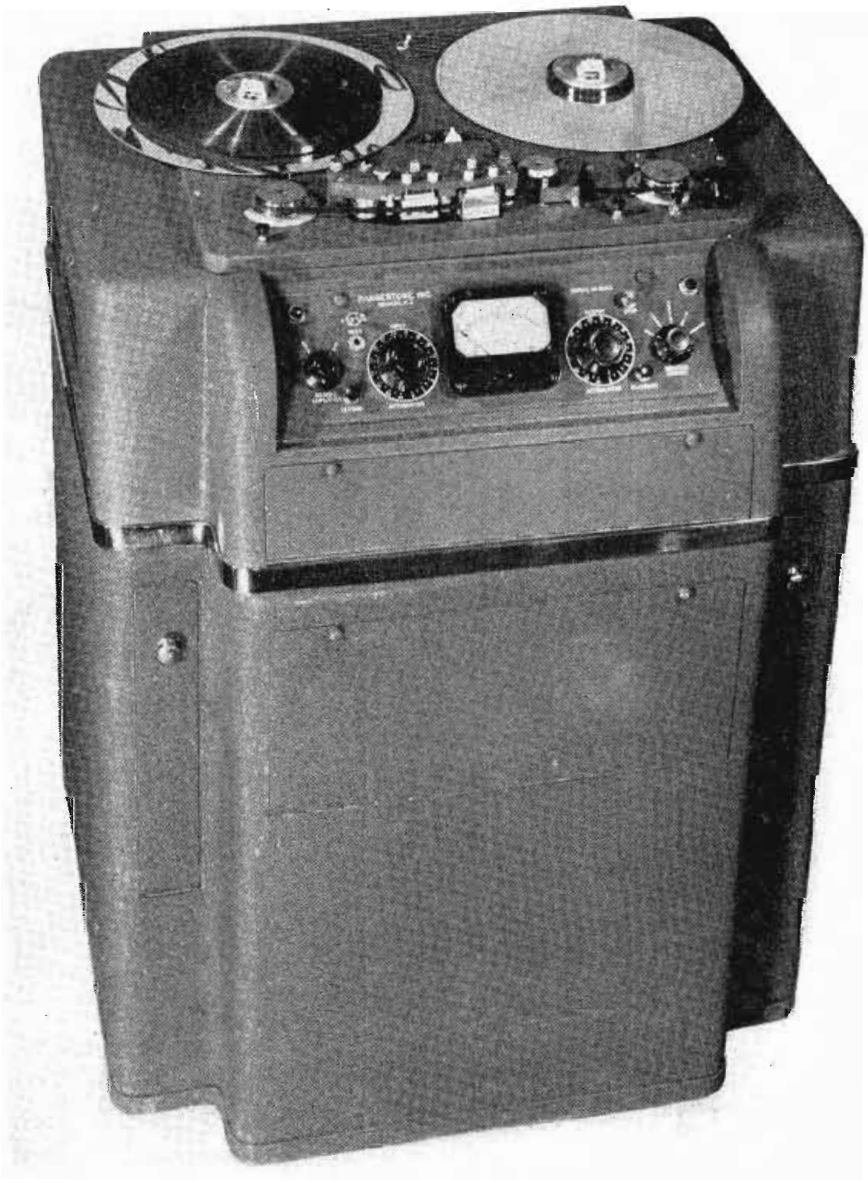


Fig. 1: Console tape recorder with half-hour spools has head assembly in front, control panel below, records left, plays right

New Magnetic Tape Recorder

By COLONEL RICHARD H. RANGER,
President, Rangertone, Inc., Newark, N. J.

cision-ground, and the ball bearings carrying it are of the highest type. Binding or eccentricity here will give rise to a wow of six cycles a second — the rps of the idler. Similar accuracy is demanded of the flywheel and its bearings, although these elements are not as controlling. Likewise, the take-up motors must be smooth in operation. Variations here are of second order however, for while they may be noticed on a steady tone, they are at such a slow rate as never to be noticed in program. The 30 cycles-per-second flutter of a capstan is right in the middle of the most acute sensitivity to disturbing frequency shift, and has no similarity to the pleasing tremolo rate around six cycles a second.

It is necessary to make these capstans removable for two reasons: First, although they bear against the back of the tape, still they do wear eventually and must be replaced. Second, a simple method of operating at any tape speed must be made available, and different diameter capstans are an answer to this requirement.

It would be desirable if all tape operation could be at a single speed. Steps to investigate this are being undertaken by committees of the National Association of Broadcasters and the Radio Manufacturers Association and others. But there are different applications, and the economics of the cost of the tape are so important that it does seem at this time that two or three speeds may be the ultimate answer. This corresponds in some measure with the two phonograph disc speeds universally employed; and the three film speeds so long in use at 8, 16 and 35 millimeter operation (although now with television using film, there is the possibility of still another film speed for the 30 frames per second).

To date, tape speeds have of themselves gravitated into the following niches: 7½ in. a second for home and dictating use, 15 in. a second for transcription service, 18 in. a second for transcription service,

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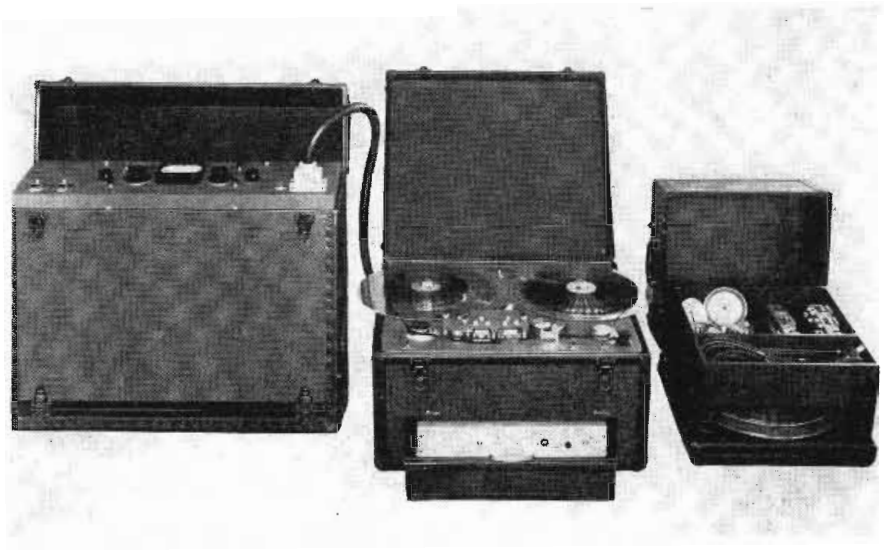


Fig. 2: Portable unit showing amplifier on left, tape unit in center and spares on right

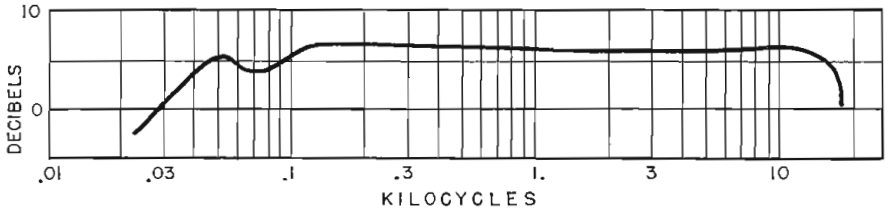
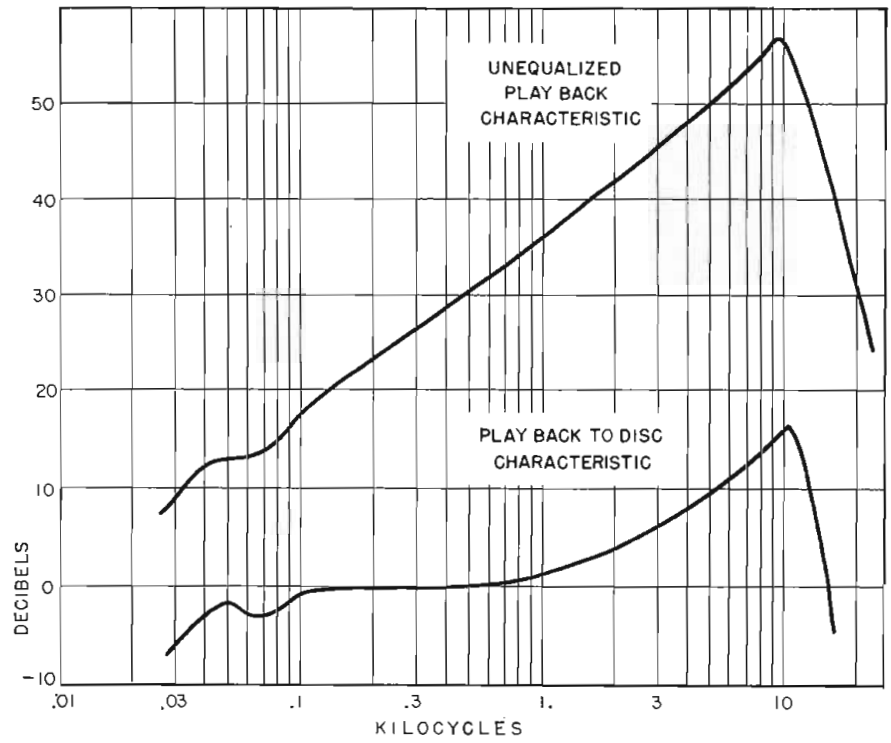


Fig. 3: Overall response curve after equalization; constant current input, 600-ohm output

Fig. 4: Top curve gives unequalized output; bottom curve shows normal NAB characteristic



NEW MAGNETIC TAPE RECORDER (Continued)

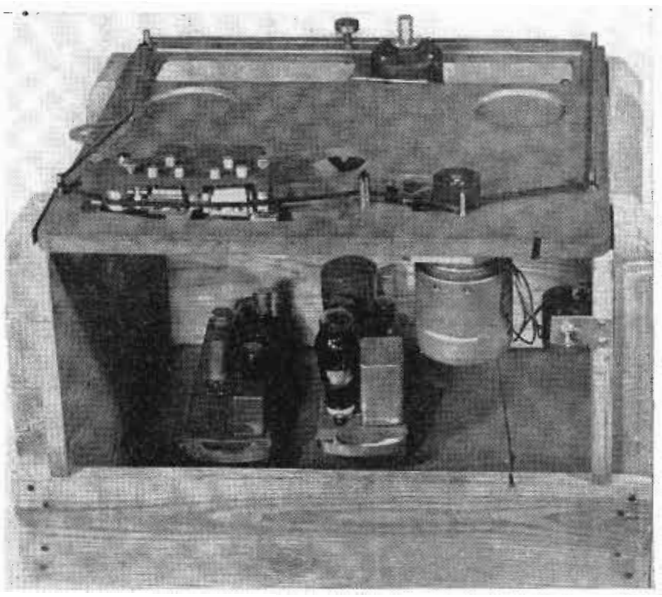


Fig. 5: Loop tester with ends of tape cemented together and driven continuously. Short loop test eliminates variations in coating

possibly tied in with 35 mm operation and 30 in. a second for highest quality recordings for FM and for tape originals. Another speed of 22½ in. a second is being considered as a single intermediate between the 30 and 18. All of these speeds may be obtained with Rangertone equipment. A dual-speed motor of either 900 or 1800 rpm gives instantaneous two-to-one speed change with any given capstan. For instance the following capstans are furnished as standard. One with a .3183 in. diameter gives a high speed of 30 in. and a low of 15 in. per sec. Similarly, another capstan of .1592 in. diameter gives 15 in. and 7½ in. speeds.

At a diameter of .191 in. a speed of 18 in. a second is realized. For 50-cycle operation, these diameters are all increased to 6/5ths to accomplish the same tape speeds.

If dubbing the tape or disc is the primary purpose for a magnetic tape recorder, it is wise to have the original recording which may never leave the premises as perfect as the system permits — and this is at the 30 in. a second speed.

For disc dubbing, the normal pre-emphasized NAB recording characteristic is flat to 1000 cycles and then rises approximately four db per octave up to 10,000 cycles. The normal un-equalized playback response curve from tape is that shown in Fig. 4. It is seen that these readily can be made to jibe. The overall emphasis from one kc to 10 kc is about 14 db when recording at the outside of the disc, and this may be moved up manually to about 16 db for the center recording lines. Discs made with this set-up are unusually clear. There is a definite reduction in the tendency for phase distortion.

With this facility of instant monitoring, the tape itself becomes the obvious gold-fish in the crystal bowl. For example, at one time it was noted that there was an increase in noise every third-of-a-second, not equivalent to any recurrent mechanical movement of the machine. A study of the tape itself showed that the tape and the noise were synchronized. This third-of-a-second represented 9½ in. of tape movement. Upon checking with the tape manufacture it was determined that one of the rollers used in the coating process had a circumference of 9½ in. Investigation disclosed that it was eccentric and therefore varying the thickness of the coating. Variations at other rates have similarly been found; i.e. at 1500 cycles and even as low as 20 cycles a second! In giving these tape experiences, it must be realized that this noise is much below what would normally be observed without increasing the playback amplifier gain greatly.

Another useful tool in analyzing the whole tape operation is a continuous loop tester as shown in Fig. 5. The ends of the tape loop are cemented together and the tape is driven around and around. With a 5,000 ft. length of tape, there are bound to be slow variations in tape coating and sensitivity which would cloud up measurements of other factors. Such a short loop eliminates these variations.

In connection with the loop tester, a high-pass frequency filter has proven most useful. Frequencies below 300 cycles are reduced 50 db by this filter. If the fundamental of the recording tone is below this frequency, its fundamental will not be

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Fig. 6: In adjustment of head, tilt by means of micrometer screws

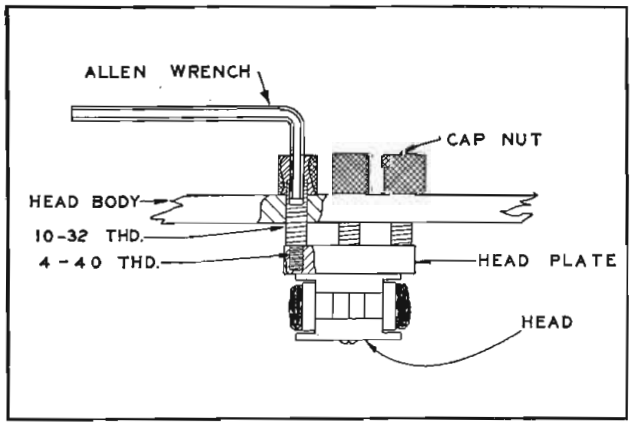
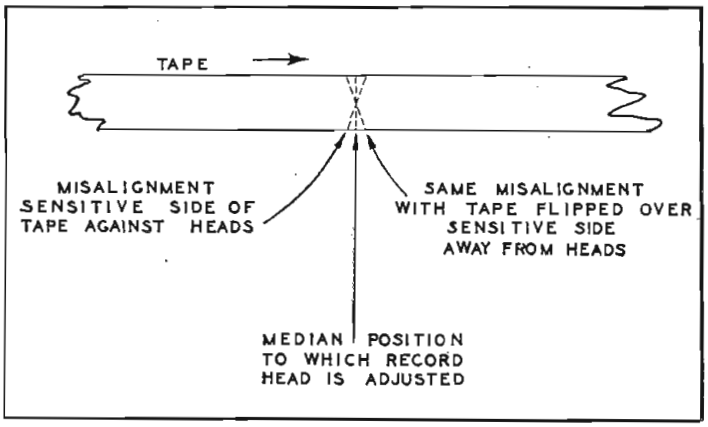


Fig. 7: Showing effect of misalignment of heads. Details in story



Oil-Filled Miniature Tuning Capacitors

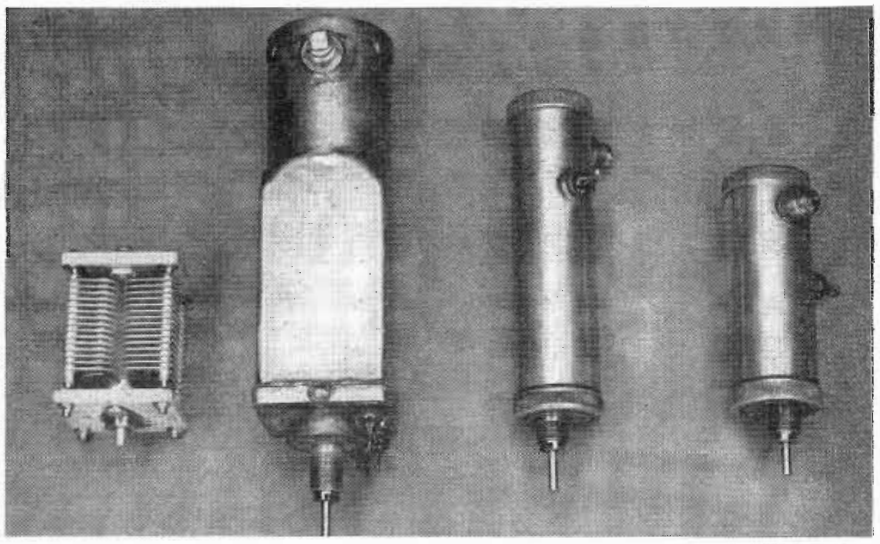
By SIDNEY WALD, Advanced Development Aviation Equipment Engineering, RCA, Camden, N. J.

Development and manufacturing technics for liquid-filled capacitors designed for high altitude operation up to 40,000 ft. at temperature ranges from —60° to +85° C

INCREASINGLY stringent space and voltage limitations, particularly in airborne equipment, have often resulted in the re-examination of practices in the light of new technical developments. The concept of immersing a variable air capacitor in a good liquid dielectric, such as mineral oil, falls in just such a category.

One of the attractive properties of the air dielectric capacitor is its electrical stability despite changes in ambient conditions such as temperature, humidity and atmospheric pressure. Air is classified as a loss-free dielectric regardless of frequency so one might well conclude that the parallel plate air capacitor is an almost perfect component. Practically speaking, however, it is too large in size for what it accomplishes. For example, using standard capacitance formula, and assuming a spacing of .02 in. and an effective area of one sq. in. with a dielectric constant of unity, we arrive at a capacitance of 11.2 μμf per sq. in. The peak voltage required to break down this gap, (the breakdown gradient for air is about 138 kv per inch for .02 spacing) is theoretically .02 x 138,000 = 2560 volts. Actually, due to surface imperfections, breakdown occurs at about 1900 volts. At an altitude of 40,000 ft., this gap will break down at about 400 volts.

If we substitute a well-processed mineral oil for the dielectric, the puncture voltage rises to a value of 6000 and the capacitance per square inch more than doubles, going from 11.2 to 24.6 μμf. If we use maximum stored charge as a figure of merit for a capacitor, we may achieve a stored charge gain of 6.6 over air: $G = C_o E_o / C_A E_A$. This may be roughly interpreted as a six to one volume advantage through the use of oil immersion, a value not fully realized in practice because of the necessity for providing a device such as a sylphon bellows to permit fluid expansion with temperature.



Showing typical oil-filled tuning capacitors. When well-processed mineral oil is used as the dielectric, the breakdown voltage and capacity per square inch is more than doubled

The liquid-filled variable capacitors described here were the result of about a year of intensive development work on tuning components for the XN/ARC-2 aircraft transmitter. Specifications for this equipment called for normal operation despite variations in temperature from —60 to +85° C., relative humidity up to 95%, and altitudes up to 40,000 ft. These requirements were, of course, only a few of the more difficult aspects of the development. One of our early conclusions was that we would require receiver-size tuning capacitors to handle from 2000 to 5000 volts in the frequency range of two to nine mc. Maximum capacities ranged from 200 to 600 μμf.

The development problem resolved itself into four projects:

1. Selection of the most suitable liquid.
2. Development of an adequate physical purification routine.
3. Design of a container which would include a rotatable shaft seal, expansion facilities, and feed-through insulator bushing.
4. Determination of best filling technic including methods of cleaning condenser and case prior to filling.

These four objectives were successfully attained but items two and four were not developed for quantity production. It is anticipated that considerable thought will be required there if a large number of units are to be manufactured.

The selection of the best liquid, in view of the time available, was necessarily based on the testing of a large number of existing compounds and mixtures, keeping in mind the temperature range to be covered. The choice narrowed down to the light petroleum hydrocarbons, particularly the naphthas, because this class of liquid proved to have the lowest capacity and Q variations with temperature, and at the same time was sufficiently fluid at the lowest temperature checked; namely, —55° C. The chief disadvantage

(*Please turn to next page*)

of the petroleum naphthas is their low dielectric constant, approximately 2.1.

A number of silicon fluids of varying viscosities were checked as possible liquid dielectrics. The results were disappointing in that the Q fell to a low of 650 at −55° C. and the temperature coefficient of capacitance proved to be about −1350 PPM/°C. These tests were performed at a frequency of two mc. In contrast, similar measurements on a good petroleum naphtha gave a minimum Q of 2600 at −5° and a temperature coefficient of 600 parts per million per °C. The dielectric constant of the silicon fluid was found to be 2.77 as against about 2.1 for the naphtha.

The problem of treating the commercial fluid to have good dielectric strength proved that at least three distinct extraneous substances had to be removed before any remarkable voltage breakdown improvement was obtained. In their order of importance, these impurities are:

1. Solid particles, such as dusts, lint and fibres. Such material is present in what would be considered commercially clean liquids.

2. Dissolved air and other gases, principally carbon dioxide. The latter is highly soluble in hydrocarbons.

3. Dissolved water. This type of contamination has, it is believed, been much over-emphasized. While the presence of moisture does reduce the ultimate puncture voltage, it does not have the disastrous effects of 1 and 2 above.

The basic technic involved in processing the fluid consists of three operations. The first causes the liquid to pass through a long column of silica gel. This substance has a great affinity for both moisture and any aromatic constituents present in the commercial liquid. The removal of these fractions improves the heat stability of the resulting dielectric fluid.

The fluid is then filtered through two micro-porous clay barriers. This type of filter is commercially available in a number of graded pore diameters. For the process being discussed, the pore size is of the order of six microns in diameter. A sample of liquid after having been subjected to this treatment offers a striking visual contrast to the original material. The filtered liquid has such a brilliant appearance that clay filtration is often referred to as a polishing process.

The removal of dissolved gases can best be accomplished by a vacuum treatment at room temperature. While raising the temperature would accelerate the release of gas bubbles because of the reduced solubility, the petroleum naphthas have too low a boiling point to permit application of heat and vacuum simultaneously.

The vacuum treatment must continue until there is no further formation of gas bubbles. At this point the fluid should attain a puncture voltage of at least 8500 peak volts for a parallel plate gap of .03 in. at a frequency of two mc. It was found advantageous when checking the breakdown potential for the first time to increase the voltage gradually to its ultimate value.

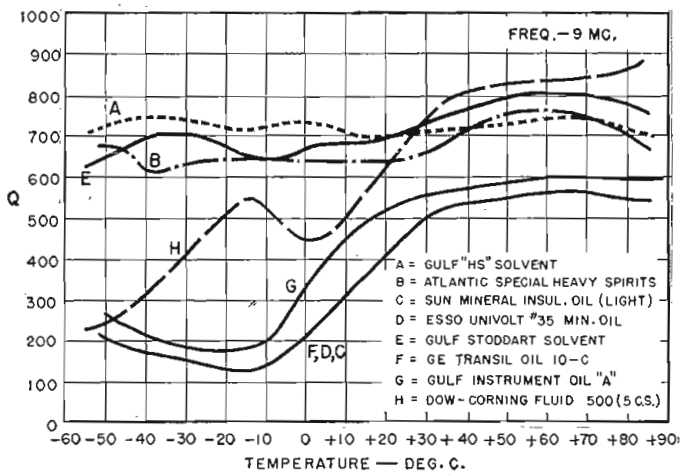
In case it is possible to utilize a commercial air variable capacitor, one must be on guard against a number of pitfalls which do not occur when the capacitor is used normally with air dielectric. The insulation material should be inorganic and non-porous, preferably a high grade of steatite. Likewise, it is essential that there be no air pockets such as blind tapped holes in the assembly to make de-gasification difficult. Particular attention should be paid to bearings to be certain that they will not rust or seize during the cleaning operation. Ball bearings should be of stainless steel.

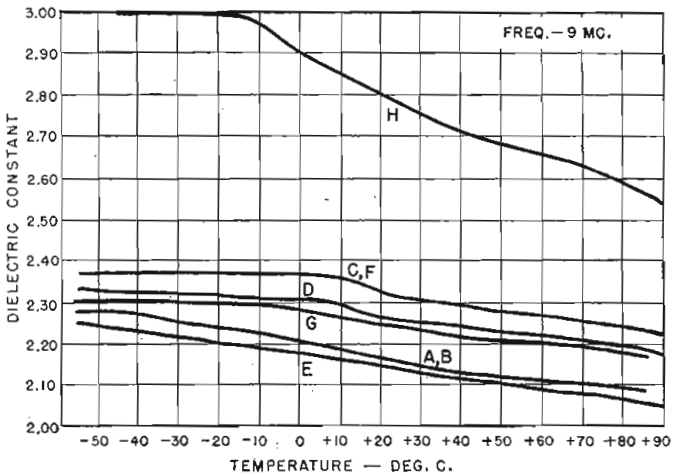
If sleeve bearings are employed, contact between similar metals should be studiously avoided. Bronze or brass in contact with stainless steel has worked out well in practice. The capacitor plate material is not critical as the petroleum naphthas have no action on metals unless sulphur is present as an impurity. Most commercial specifications for petroleum call for a sulphur-free analysis.

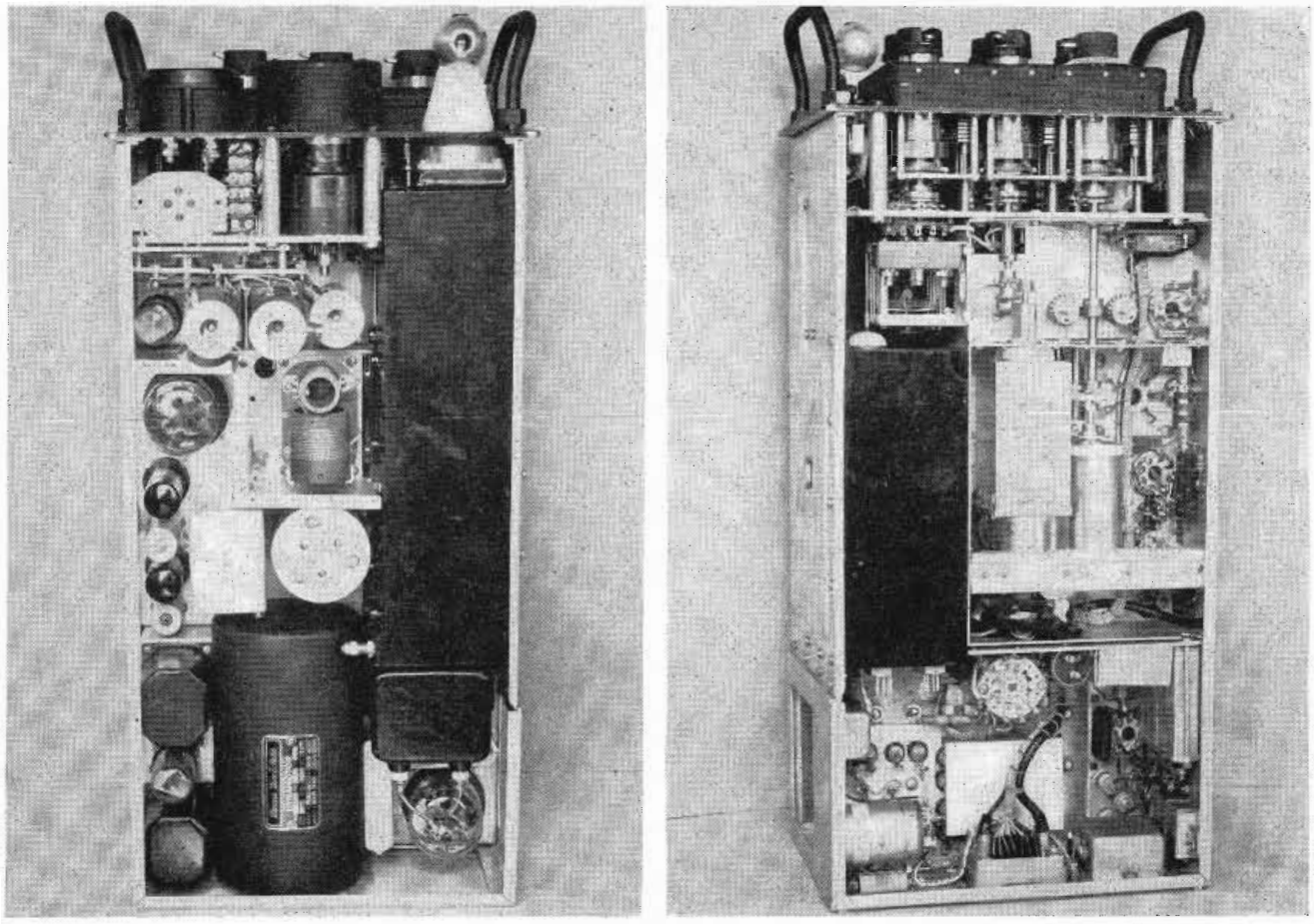
Turning to the design of the container, two important considerations present themselves. One is the provision for liquid expansion and the other a gland that permits shaft rotation without liquid leakage under extreme temperature conditions. The first problem is undoubtedly the simplest. Knowing that the petroleum naphthas have volumetric expansion of .009° C., a metallic bellows is selected which will permit the calculated volume change over the specified temperature range. It is important to so proportion the movement of the bellows that a sufficient degree of travel is available from the filling temperature down to the lowest to be encountered and likewise up to the maximum expected.

The shaft seal in present designs consists of a spring-loaded synthetic rubber ring in a cylindrical cavity

Performance curves showing Q and dielectric constant temperature variations for some of the various liquid dielectrics tested







Photos show top (l) and bottom (r) of airborne transmitter with 4 liquid-filled variable capacitors for PA tuning and antenna coupling

surrounding the shaft. Where low turning effort is important, the dimensioning of the packing gland parts becomes quite critical. However, hermetic seals have been obtained and thoroughly tested where the shaft torque was less than four inch-ounces for a 5/32 diameter brass shaft. When selecting the elastic material for the shaft seal, the material of which the shaft seal is made should withstand solvent action of the naphtha. It is ordinarily not sufficient to specify "neoprene" since this is a general name for synthetic elastomers and not all neoprenes are naphtha resistant.

Formulations that will not swell in contact with aromatic gasoline will prove satisfactory provided they will remain flexible at the lowest anticipated ambient temperatures. One other point which is of importance in the design of the condenser case is the provision of smooth interior surfaces. Re-entrant shapes which might form bubble traps during vacuum treatment are to be avoided.

Assuming one now has a suitable capacitor assembly, the next problem is to clean it and fill it completely with processed fluid. It should be fairly obvious at this point that the capacitor assembly itself must be as scrupulously clean as the liquid with which we proposed to fill it. This phase of the process should embody the following steps as a minimum requirement:

1. A petroleum ether (benzine) wash to completely degrease the assembly of capacitor and case.

2. Agitation with a water solution of a good synthetic wetting agent to permit dusts and fibres to be flushed away.

3. Flushing with hot distilled water and subsequent drying in a vacuum oven at about 110° C. As an alternative to the vacuum oven, an ordinary air drying oven may be used, followed by cooling in a vacuum chamber to room temperature. It is not permissible to handle any portions of the capacitor assembly which will ultimately be in contact with the liquid dielectric.

The actual filling technic will vary with the quantity of capacitors to be made and may range from a simple pouring in of the filtered liquid to an elaborate piping system with automatic controls. All that must be remembered, however, is that the assemblies are to be completely filled with fluid and must be free of all bubbles. To be certain of meeting this condition, the filled capacitor is subjected to a prolonged vacuum treatment prior to being sealed off.

After completion the capacitor assembly is subjected to a number of electrical and mechanical tests. Some typical test results are tabulated below:

Test frequency: 2 mc
Capacity (min.): 50 μμf
At 25° C. (max.): 600 μμf
Plate spacing: .030 in. (Hammarlund type HFB)
Operating voltage: 7500 volts (peak)
Puncture voltage: 8500 volts (peak)
Q (at 25° C.): 3500
Temperature range: −55 to +85° C.
Temperature coefficient of capacity: 640 ppm negative per deg. C.

(*Continued on page* 57)

FCC Hears TV Reallocation Views

Manufacturers and networks agree to need for new standards; urge 12 channels should be retained; disapprove proposal to freeze TV actions; disagree on UHF timing

By ALBERT FRANCIS

TO REVISE OR NOT TO REVISE TV allocations was the subject of the conference held in Washington September 13 and 14 in which the Federal Communications Commission called upon the television industry to state its views regarding the modification of existing rules and standards. Present regulations omit the effect of tropospheric* propagation. Should this factor and the possible interference arising from it be included in revised Rules?

The conference centered around the three issues listed by the FCC as follows: (1) Should the rules be revised prior to a decision on Dockets 8975 and 8736? (2) If rules are to be revised should pending applications be processed or frozen? (3) What should be done so that revised rules can be based on best engineering information?

For the hurried reader let us at once get the answers to these issues by jumping for a moment to the closing remarks of FCC chairman Wayne Coy made after all parties had been heard. It appeared that there was: (a) disagreement concerning the processing of pending applications; (b) agreement that engineering conferences should be held, and only after this had been done would a decision on revising the rules be made. It was estimated that a revised allocation plan would take the FCC nine months to prepare.

Chairman Coy's opening statement pointed out that our position today is (a) We have 12 channels in the VHF region. Construction authorizations number 116, with 304 applications pending. (b) Geographical allocation plan now pending strives for maximum number of stations. Minimum distance between stations has now been so reduced that tropospheric interference is experienced. (c) Conflicts exist within industry to obtain stations having large service areas and at the same time a large number of assignments are desired in various cities; conflicting proposals have been advanced by engineers on increasing power, directional antennas, tropospheric interference, and closer spacing between stations.

K. A. Norton, Frequency Utilization Research Section, Central Research Propagation Sales, National Bureau of Standards, presented the results of his research on the efficient allocation of TV stations. In this thorough-going report it is stated that for covering the largest areas there is needed: (1) the largest available power and the greatest antenna height and (2) sufficient spacing between stations to avoid mutual interference.

George P. Adair, consulting engineer, suggested that assignments in the UHF band would place an unfair economic burden on the smaller cities; that it was too late to consider tropospheric effects in Area I and parts of II, and that difficulties should be minimized by the use of directional antennas and by allocating power according to the needs of the area.

E. K. Jett, WMAR-TV, ex-FCC Commissioner, recommended that a metropolitan station be protected throughout its metropolitan area; that 500 μv/m contours be protected but not 5000 μv/m contours; the FCC might have to have different standards for different areas; grant applications that do not interfere with the 500 μv/m contours of other stations. In Jett's interesting and helpful testimony a group of letters from listeners located more than 30 miles from Baltimore were introduced. Reception was reported in northern New Jersey, Pennsylvania, etc. This was due to tropospheric effects. Only one listener complained of interference! Jett thinks there should be more field tests but the processing of new applications should not await further "proof of performance" tests; the 100 to 1 ratio is too high; we should not strive for "ideal" reception and that 150/75 mile spacing rule is satisfactory.

W. S. Duttera, NBC-RCA, testified in favor of revising the standards to include tropospheric effects, possibly employing interim standards; in favor of 150/75 mile spacing; directional antennas which will provide for additional transmitters; in favor of an industry committee to work with the FCC.

R. F. Guy, of NBC, speaking for the Television Broadcasters Assn., recommended that the rules be revised, taking tropospheric effects into account; spacing of 150/75 miles is satisfactory at present, what interference there is will have to be accepted; engineering information should be pooled; directional antennas can be constructed to meet CAA regulations.

T. A. M. Craven, Cowles Broadcasting Co., said the public's stake in TV is high and must be protected by the FCC; rural areas must be served; the minimum number of channels needed is about 50. The only solution to national coverage was adding to the VHF the UHF band.

W. B. Lodge, CBS, very realistically said that the future course of television has to be down one of

(*Continued on page 60*)

FCC Directional Antenna Ruling

Asked to clarify its stand on the directional type of antenna for television broadcasting, the FCC declared on Sept. 13 that: "According to rule 3.606 directional antennas will be authorized to increase a station's coverage. But application for the use of such an antenna to make possible the adding of a channel, which otherwise would not be allocated, will be rejected."

*TROPOSPHERIC PROPAGATION, which permits reception of TV or higher frequencies at greater than ground-wave distances, is that which takes place, in a somewhat erratic manner, in the atmosphere. It is due to "bending" of the waves or transmission through "ducts" which often follow temperature inversions and other meteorological conditions. It is not the same as Ionospheric Propagation due to reflection from sporadic E or F_2 layers.

NEWS LETTER

MILITARY PROCUREMENT PROGRESS—Approval of the establishment of a top-level advisory committee representing all branches of the electronic-radio manufacturing industry to aid the Munitions Board, agency of the Armed Services in coordinating mobilization of industry and procurement, and the National Security Resources Board was assured at the deadline of this issue of TELE-TECH. With a membership of between 25 and 28 leading executives of the electronics-radio manufacturing industry, the committee was organized to represent both the large and small manufacturing companies, particularly those in the latter category engaged in specialized radio fields, and the components and parts manufacturers. Since the fields are quite far apart, a separate advisory committee of manufacturers was being set up for the wire communications (telephone and telegraph) industry.

ADOPTION OF POLICY—Appointment of Electronics Manufacturing Industry Advisory Committee to the Munition Board and NSRB was slated to implement sanction of the policies advocated by the Radio Manufacturers Association's mobilization committee, headed by Western Electric's Fred Lack and with RCA-Victor's Folsom and Hazeltine's MacDonald as top leaders. This RMA plan advocates that the Army, Navy and Air Force endeavor to spread as widely as possible the flow of procurement contracts for military electronic-radio equipment to as many manufacturing companies as possible—in other words to encourage military production by the smaller plants. This would gear up the nation's electronic-radio industrial potential to full strength to be ready for any future war emergency. National Security Resources Board helped along this objective with its plan for so-called "phantom" contracts running into several billions of dollars under which potential suppliers of the Armed Services would be advised as to the specifications, amounts of equipment to be contracted for from each producer, the material and manpower and component requirements of the manufacturers.

STATUS QUO FOR PRESENT TV SYSTEM—Despite fanfare slated to accompany FCC hearings which started Sept. 20 on progress being made by television industry and particularly manufacturers in high-band (475-890 mc) television, every indication was that the FCC would not be precipitate in pushing along the "upstairs" move of video because of the impact on the television industry, manufacturers and broadcasters, which has the promise of becoming the nation's outstanding "boom" enterprise. The decision late in August of the British to maintain television for a number of years on their present 405-line system so as not to make the present video receiving sets obsolete was considered an excellent guidepost and the British viewpoint last year that color TV needed further development, research and field testing, it can be recalled, was possibly a significant element in the FCC's later determinination along the same line of reasoning.

TELEVISION PIECE DE RESISTANCE OF REGULATORY AGENCY—Video and its problems became the FCC's major topic of study in the latter part of last month. First came the mid-September informal engineering conference to review the 2½-year old technical standards of TV, together with tropospheric conditions and channel allocations of present band assignments. Then the Sept. 20 proceedings with top-flight luminaries of TV industry such as Dr. C. B. Jolliffe, RCA executive vice-president in charge of RCA Laboratories, Philco's engineering vice-president David B. Smith, CBS director of engineering Lodge, DuMont's research director Goldsmith, WOR chief engineer and TBA president Poppele with technical developments toward eventual high-band TV were to be described to the FCC but it was brought out that it would take at least a year for formulation of allocations and standards. However, the concensus was that the problems of producing high-band receivers and converters would consume five to 10 years before high-band TV would become commercially useful.

MOBILE RADIO ORAL ARGUMENT—Myriad of mobile radio services, which are now being used by many of the country's vital industries and utilities as one of their communications lifelines, is slated to appear before entire FCC in series of oral arguments starting Oct. 6 and scheduled to last from week to 10 days, on Commission's proposed allocations and rules and regulations. Demand for mobile radio frequency space has been tremendous and several major segments of mobile radio users are dissatisfied with proposed allocations. FM broadcasters again are expected to wage fight to oust mobile-safety services like police, fire and forestry out of former FM low-band but FCC is certain to turn cold shoulder on pleas. Television industry will present, undoubtedly, experience of interference from some mobile services despite its surrender of video channel 1. Amateurs may repeat proposal of the taking over of channel 2 for mobile service to eliminate interference but FCC, with its desire to boost video, would be cool to such ideas.

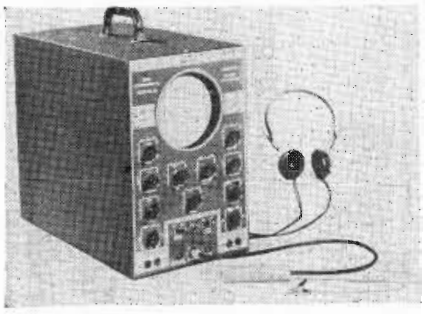
ROLAND C. DAVIES
Washington Editor

National Press Building

New Lab and Test Equipment

Cathode Ray Stethoscope

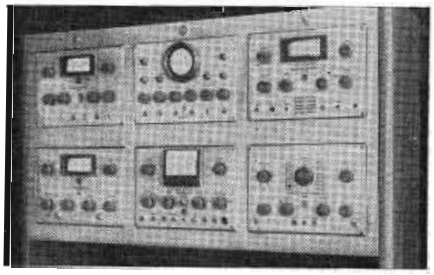
Production of the cathode ray stethoscope, a new type instrument which combines a



5-in. cathode-ray oscilloscope and the Feiler stethoscope, has been announced. The unit can be used in conjunction with a stetoscope probe and earphones, enabling the operator to see and hear the signal simultaneously.—**Feiler Engineering Co., 947 George St., Chicago, Ill.**

Test Equipment Rack

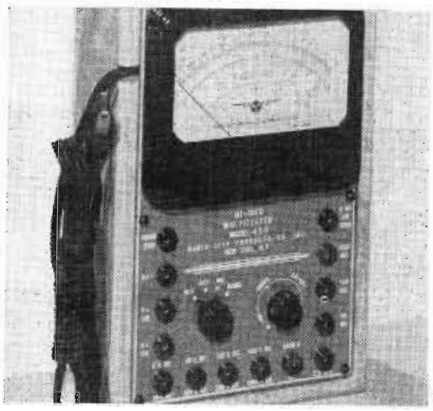
When mounted on top of a workbench, the six instruments in the WS-16A test equip-



ment rack are within easy reach of the operator whether he is standing or sitting. A flush-fitting front panel which exposes only the faces of the equipment is hinged and easily removable. Construction is of metal; the front panel is satin-aluminum and the remainder is blue-gray hammeroid finished steel. It is approximately four ft. wide, three ft. high, and one ft. deep. The lower shelf is eight inches above the bench top.—**RCA Victor Div., Radio Corp. of America, Camden, N. J.**

Multitester

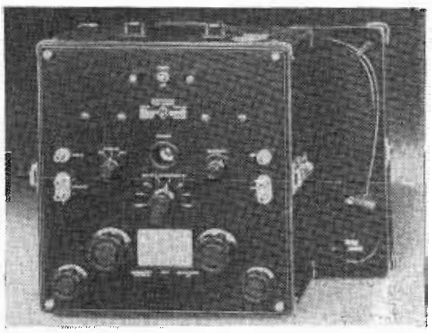
A scale for making resistance measurements as high as 50 to 1,000 megohms without the use of tubes or batteries is one of the features of model 450 HI-MEG multitester. Available in three meter sensitivities (1,000;



5,000; 20,000 ohms per volt), these multitesters use germanium crystal rectifiers for the meter and consequently are free from the usual frequency and temperature errors that exist with conventional multimeters. High degree of accuracy is maintained by individually calibrating shunts and multipliers within 1%.—**Radio City Products Co., 152 West 25th St., New York 1, N. Y.**

Capacitance Test Bridge

Capacitances from 1μμf to 10,000 μf may be measured by the 1611-A capacitance test bridge with an accuracy over the entire range

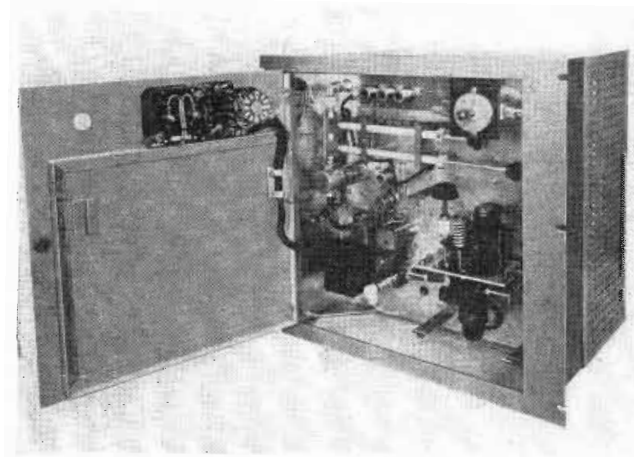


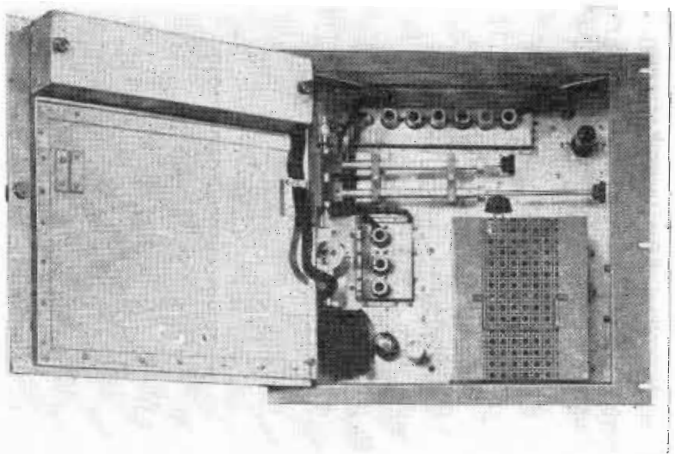
of ∓(1%+1μμf). Dissipation factor range is 0 to 60% and the frequency of the test voltage is 60 cycles. A provision is made for the introduction of a polarizing voltage for measurement of electrolytic capacitors. The unit is completely self-contained and features a unique zero-compensating circuit that balances out the initial capacitance and dissipation factor at zero setting of the dials.—**General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.**

Cathode Ray Oscillograph

A 5 UP cathode ray tube is utilized in the new Hickok model 505 cathode ray oscillograph. Phonograph pick ups and microphones can modulate the wide and narrow band FM oscillator which is built into the unit and a self contained mixer circuit facilitates FM output with any good signal generator. The demodulator enables any rf signal to be viewed and a signal tracer jack permits any signal being viewed to be heard by phones. There is a sinusoidal sweep generator with phasing control and a three range frequency compensated attenuator network in the vertical amplifier.—**Hickok Electrical Instrument Co., 10528 Dupont Ave., Cleveland 8, Ohio.**

High Fidelity STL Developed for FM Broadcasting by Federal

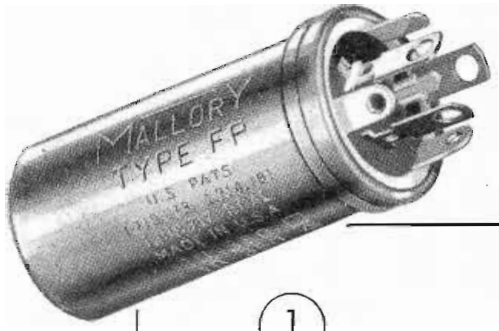




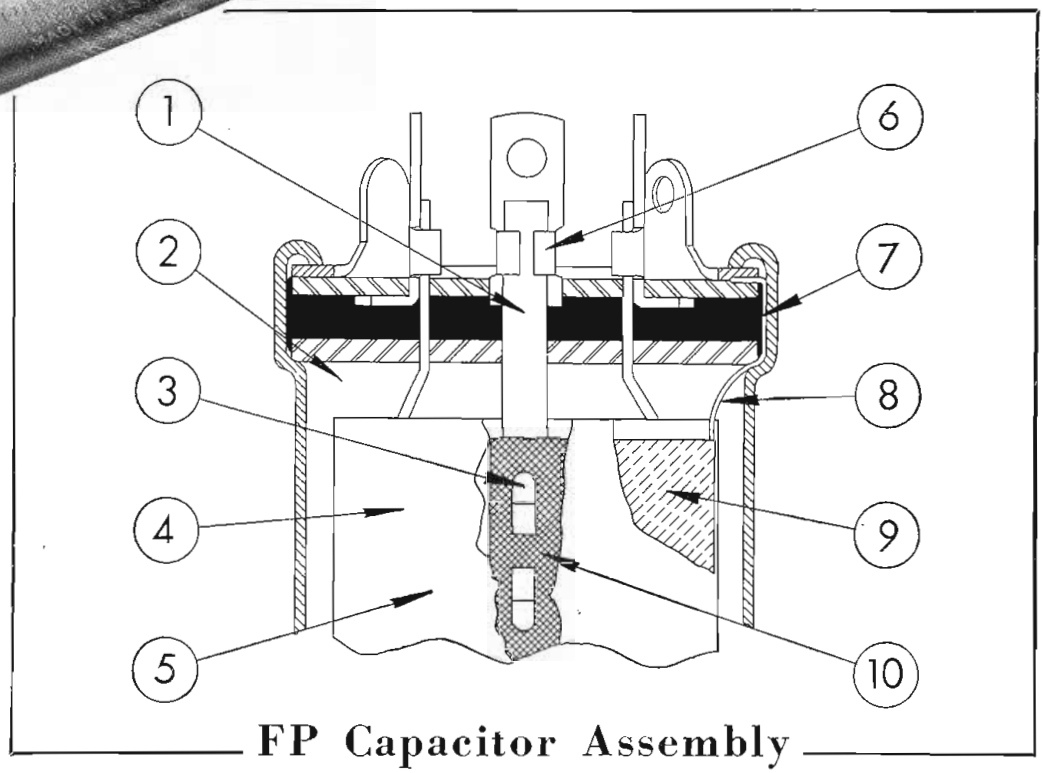
A high fidelity studio-to-transmitter radio link meeting all applicable FCC regulations for FM broadcasting has been developed by Federal Telecommunications Laboratories, Clifton, N. J. Designated FTL-11-A, it operates in the 940 to 952 mc band. The outstanding feature claimed is its high quality-combining low distortion and noise characteristics with a wide audio frequency bandwidth. Measurements taken of this equipment indicate that the distortion in the overall system is less than 0.5% for all frequencies between 50 and 15,000 cycles, with the noise level 65 db below 100% modulation.

The transmitter consists of a direct frequency modulated, crystal-controlled klystron oscillator with a power ouput of approximately 3 watts at any frequency within the 940 to 952 mc band. All necessary transmitter monitoring facilities are incorporated in this unit including provision for power and frequency measurements, vacuum tube metering, and aural monitoring.

The receiver is a single superhetrodyne utilizing the same type klystron as employed in the transmitter as a local oscillator. Preselection is incorporated to reduce the possibility of spurious interference. Automatic frequency control maintains the relative stability of the receiver and transmitter within 0.01 percent. As in the transmitter, all necessary monitoring facilities are included in this unit.



NEW!



FP Capacitor Assembly

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TELE-TECH's NEWSCAST

Reports On German Klystron and Crystal Research Available

German wartime developments in velocity modulated tubes (klystrons) are the subject of one of two reports on German electronics research now available to the public, the Office of Technical Services, Department of Commerce, announced recently.

The second report deals with wartime research and manufacture of crystals. Both reports were made by representatives of the Vacuum Tube Development Group of Columbia University.

The Klystron report has been condensed from a variety of Allied intelligence reports and indicates that German development in this field was fundamentally influenced by Allied improvements as successive tube models were captured.

Separate accounts deal with work at various German research centers. An index of the Klystrons discussed and their operating characteristics is provided at the end of the report.

The report on crystals is also a condensation from various sources. It discusses the stringent economy exercised by Germany over the usc of natural quartz due to the absence of deposits in countries under Nazi control, and an inability to replenish stocks from Brazil.

According to the report, Germany's crystal manufacturers lagged far behind their Allied counterparts in the application of modern test apparatus to the quantity production of crystals. The quality of workmanship, however, was indisputably high. This report dealt with the German quartz industry 1940-1944; synthetic quartz crystals; the production of crystal units by Steeg and Reuter and by Zeiss at Jena; quartz crystal clocks; millimeter waves by crystal oscillation; and crystal detectors.

Section Authorization Asked at Nebraska IRE Meeting

An organizational meeting for the establishment of a new section of the Institute of Radio Engineers has been held in Omaha, Nebr. A petition was circulated among the 40 people who attended the meeting, requesting the national board of directors of the IRE to authorize the formation of an Omaha-Lincoln section. John A. Green, secretary-treasurer of Region 5, assisted George Hixenbaugh, chairman of the Cedar Rapids section, and T. A. Hunter, regional director with organizational activity.

Audio Society Hears Talks on Recording

The first fall meeting of the Audio Engineering Society was held September 14 at the Western Union Auditorium, New York City. Mr. R. A Lynn of the National Broadcasting Co., in presenting a paper on "Vertical vs Horizontal Recording", pointed out that in a blindfold listening test he would be unable to tell which system had been employed in making the recording provided the equipment used was comparable on the basis of cost and design.

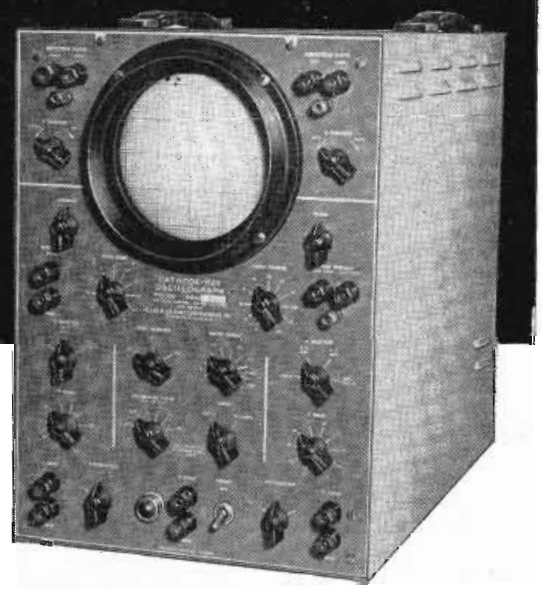
In another paper, Mr. V. J. Liebler of Columbia Records, Inc. showed the development of the new long-playing microgroove recordings to be the result of recent technological advances in reducing pickup needle pressure. His talk was supplemented by a demonstration of classical, popular music and speech LP recordings using a new nonresonant tone arm developed by W. S. Bachman, director of research, Columbia Records, Inc.

Tube Sales Low During July

Radio receiving tube sales dropped to 9,637,244 in July due to vacation plant shutdowns in the radio industry and other seasonal marketing conditions. June sales were 15,114,272.

Members of the 25th Board of Directors of the RMA, 1948-49

Introducing the *New* DU MONT CATHODE-RAY OSCILLOGRAPH Type 250



FEATURING...

- ✓ a-c and d-c amplifiers
- ✓ Built-in voltage-calibrator
- ✓ Three horizontal and three vertical input choices
- ✓ Recurrent or driven sweep
- ✓ Z-axis modulation
- ✓ Provision for photography
- ✓ Brilliant traces
- ✓ Automatic beam blanking
- ✓ High-sensitivity amplifiers
- ✓ High-impedance input probe

TYPICAL APPLICATIONS REQUIRING TYPE 250...

Application No. 1: If a machine component is to be studied for its reaction under shock-load conditions, what characteristics must the oscillograph have?

Characteristics required:

1. Single sweep, variable in duration. The single sweep of the Type 250 is continuously variable from 1 second to 20 microseconds.

2. Adequate light output. The Type 5CP-A Cathode-ray Tube in the Type 250 operates at 3000 volts accelerating potential for brilliant traces.

3. High-sensitivity amplifier. Type 250 provides either d-c to 200 kc at 1 d-c volt/in. sensitivity, or 5 cps to 200 kc at .02 rms volt/in. sensitivity.

4. Automatic beam blanking, so that the fluorescent screen is excited only when signal is present on driven sweeps. This too is a feature of the new Type 250.

Application No. 2: Quantitative measurements and permanent records are to be made of the waveforms at various points in an electronic circuit.

Additional characteristics required:

1. Built-in voltage-calibrator that can be switched in before attenuator and gain control of Y-axis amplifier — a feature of the Type 250.

2. Provision for photography. Du Mont Types 271-A and 314 Oscillograph-record Cameras are designed to fit the Type 250.

3. d-c levels, a-c signals, or both, can be recorded with the new Type 250.

Other possible applications of the new Type 250 . . . Since the Type 250 was designed as a versatile general-purpose oscillograph of laboratory quality, it therefore has a wide range of applications in such fields as medicine, biology, welding, mechanics, and many other fields where a high-quality instrument for medium- and low-frequency work is required.

Why not consult us now about the possibility of applying the new Type 250 to your particular problem? Detailed specifications on request.

PRICE: $635.00 with Type 5CP1-A tube. Cat. No. 1303-E.

DUMONT *for Oscillography*

ALLEN B. DU MONT LABORATORIES, INC., PASSAIC, N. J.
CABLE ADDRESS: ALBEEDU, NEW YORK, N. Y., U.S.A.

General Electric Television Lighting Conference held at Nela Park, September 13-14 was attended by 80 engineers who received basic information on studio lighting technics. They were: Top Row: R. J. Diefenthaler, GE, Chicago; P. Huhndorff, KLEE-TV, Houston; J. W. Howard, GE, Los Angeles; J. H. Tudor, KLEE, Houston; H. C. Vance, RCA Tube Dept.; L. Wingard, WGAR, Cleveland; G. Lewis, WCAU-TV, Philadelphia; K. R. Dunphy, Canadian GE, Toronto; R. R. Thalner, Farnsworth Television & Radio Corp.; R. M. Morris, ABC; C. A. Rackey, NBC; Beatty; L. H. Naizger, WBNS, Columbus, Ohio; A. L. Hammerschmidt, NBC; R. E. Shelby, NBC; M. S. McIlwain, GE, Cleveland—SECOND ROW FROM TOP: H. B. Fancher, GE, Syracuse; G. A. Davis, WCPO, Cincinnati; P. G. Adams, WEWS, Cleveland; J. H. Roe, RCA Victor; J. L. Bowden, WKBN, Youngstown, Ohio; L. E. Kilpatrick, WSAZ, Huntington, W. Va.; G. E. Makinson, WEWS-TV, Cleveland; N. McNaughten, NAB; G. M. Nixon, NBC; E. F. Kock, Century Lighting, N. Y., N. Y.; L. M. Druckenbrod, Jr., Austin Co., Cleveland; J. E. Risk, WSD-TV, St. Louis, Mo.; S. Davidson, WPIX, New York; A. B. Allen, WWJ-TV, Detroit; P. Adanti, GE, Schenectady; C. M. Crysler, GE, Pittsburgh—MIDDLE ROW: J. F. Wiggin, GE, Syracuse; O. P. Kidder, Jr., GE, Schenectady; C. R. Stover, GE, Chicago; C. C. Bopp, Crosley Broadcasting Corp., Cincinnati; S. H. Hazleton, GE, Oakland, Cal.; D. Newborg, RCA; W. R. Walker, GE, N. Y.; K. Kiggens, Television Assoc., Inc., Chicago; H. Holland, WFBM, Indianapolis; G. E. Ryan, WBBC, Flint, Mich.; R. L. Casselberry, GE, Syracuse; Noth; H. R. Weibel, GE, Kansas City; F. R. Walker, GE, Cleveland; G. J. Stoetzel, CBS-TV; L. Cooke, GE, Boston; J. S. Hill, WHKK, Akron, Ohio; R. M. Pierce, WGAR, Cleveland; SECOND ROW FROM BOTTOM: R. A. Fox, WGAR-WJR-KMPC, Cleveland; W. C. Eddy, Television Assoc., Inc., Chicago; T. G. Veal, Eastman Kodak, Rochester; P. G. Arvidson, WOC-TV, Davenport, Iowa; P. R. Holmes, GE, Philadelphia; G. H. Gill, Kliegl Bos., New York, N. Y.; B. W. Saveland, Austin Co., Cleveland; W. T. Meyer, Architect, N. Y., N. Y.; M. W. Kitchen, NBC-WTAM, Cleveland; J. W. Fleming, Philips Labs Inc., Orvington-on-Hudson, N. Y.; Vanzile; A. S. Austin, Austin Co., Cleveland; E. C. Frase, Jr., WMCT, Memphis, Tenn.; T. Friedman, Cleveland; J. B. Epperson, Scripps-Howard Radio, Inc., Cleveland; W. P. Williamson, Jr., WKBN Broadcasting Corp., Youngstown, Ohio; E. Price, Display Lighting Inc., N. Y., N. Y.; BOTTOM ROW: R. E. Snyder, Central Broadcasting Co., Des Moines; D. G. Reik, GE, Syracuse; R. A. Plank, WFUE, Grand Rapids; M. A. Mayers, Display Lighting Inc., N. Y., N. Y.; R. E. Lauth, WHIO, Dayton, I. W. Bateman, Canadian GE Co., Toronto; J. M. Sherman, WTCN, Minneapolis; L. Biederman, Paul Bunyan Network, Traverse City, Mich.; R. J. Brown, GE, Syracuse; C. H. Singer, WOR, N. Y., N. Y.; E. Altman, Capitol Stage Lighting Co., N. Y., N. Y.; R. G. Berk, WAKR, Akron; I. L. Knopp, WAKR, Akron; S. Gerstin, Tele-Tech, N. Y.; W. L. Braun, WAAM-TV, Baltimore; H. F. Tank, WWJ-TV, Detroit; D. A. Weller, WISN, Milwaukee.

FCC Hearings on New Rules

Nine proposed rule-making proceedings which were announced last Spring by the FCC are scheduled for oral argument commencing Oct. 6. The proposed rules were published in the June 23, 1948 issue of the *Federal Register* which may be purchased by mail or in person from the Superintendent of Documents, Washington 25, D. C. The nine proposed rules concern general mobiled radio service, domestic public mobile radio telephone services, land transportation radio services, industrial radio services, public safety radio services, and allocation of frequencies between 25 and 30 mc, 44 and 50 mc, 152 and 162 mc, 72 and 76 mc, and the 450-460 mc band.

TV Stations on the Air

Completion of WNBQ's 70-ft. television-FM antenna mast atop the Civic Opera Building, enabled NBC's Chicago outlet to transmit a test pattern to midwestern viewers in September. WENR-TV, NBC's Chicago station, initiated transmissions to the Chicago area on Sept. 17. KFRE, Fresno, Cal. will probably be on the air about the first of next year with the first postwar 50 kw AM transmitter to be shipped by General Electric.

Construction of KTTV's office-studio and transmitter plants is scheduled for completion in October at a cost of more than $250,000. The Los Angeles station's transmitter site atop Mt. Wilson is considered by the station as the best location in Southern California.

Cornell-Dubilier Adds Products

Cornell - Dubilier Electric Corp., South Plainfield, N. J. is offering light duty vibrators, heavy duty vibrators and vibrator power supplies to the trade through its regular jobber and manufacturing channels. The light duty vibrators are a development of the C-D engineering laboratories.

Rochester IRE Meeting

Fall meeting of the IRE scheduled at the Sheraton Hotel, Rochester, N. Y., November 8, 9 and 10, will feature important technical papers, by engineers from Emerson, Franklin, RCA, Sylvania, Philco, General Electric, Colonial Radio, Hazeltine, Bell Telephone and Stromberg-Carlson who will discuss various aspects of radio and communication problems.

Coming Events

Oct. 6-8—RMA Fall Conclave, Roosevelt Hotel, N. Y., N. Y.

Oct. 18-22—American Institute of Electrical Engineers, Fall Meeting, Hotel Schroeder, Milwaukee, Wis.

Oct. 18-21—Associated Police Communication Officers, Annual Meeting, Houston, Texas.

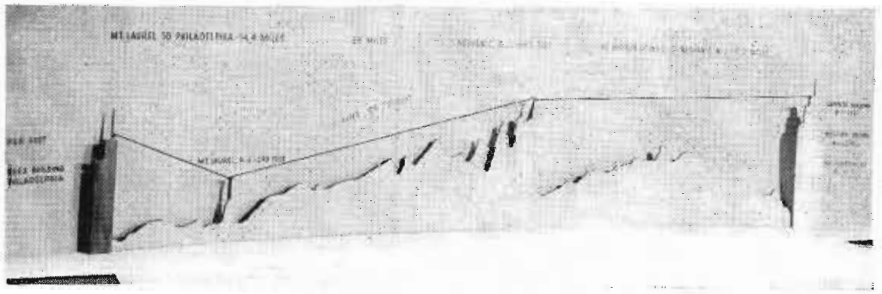
Nov. 4-6—National Electronics Conference, Annual Technical Forum, Edgewater Beach Hotel, Chicago.

Nov. 8-10—IRE and RMA Engineering Dept., Rochester Fall Meeting, Sheraton Hotel, Rochester, N. Y.

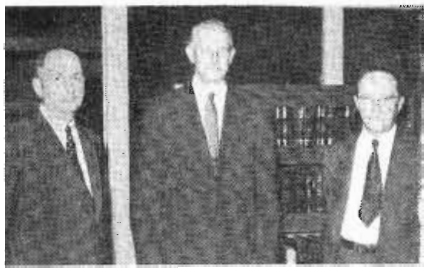
Nov. 14-20—National Radio Week, sponsored by the RMA.

Nov. 29-Dec. 1—Conference on Electronic Instrumentation in Nucleonics and Medicine, Engineering Society Bldg., 29 W. 39th St., N. Y., N. Y.

Dec. 10-11—Southwestern IRE Conference, Baker Hotel, Dallas, Texas.



Model of The Western Union Television Radio Relay Network designed and built by the Philco Corporation. The system provides two video channels between Philadelphia and New York and employs two repeater stations at Neshanic and Mount Laurel, New Jersey



Earl R. Mellon, president of Weston Electrical Instrument Corp.; W. H. Goodwin Jr., retired vice president in charge of research and engineering; and Edward F. Weston, chairman of the board of directors are shown left to right at ceremonies marking 50th year of Mr. Goodwin's association with Weston

New Franklin Sales Offices

Norman H. Lawton, vice-president in charge of sales of A. W. Franklin Manufacturing Corp., and the Franklin Airloop Corp., manufacturers of radio sockets, components, stamped circuits, and the new push-button and radial

N. H. Lawton H. D. Sarkis

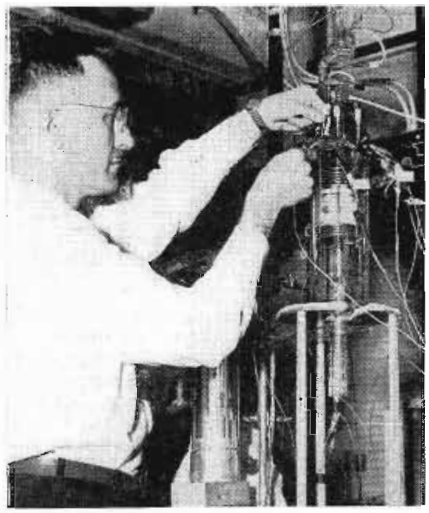
television selectors, Long Island City, N. Y., announces the appointment of sales engineers: Harry A. Lasure, Los Angeles, for California and the western states; Henry D. Sarkis, Chicago, for the mid-western states; Dixie M. Hilliard, Jenkintown, Pa., for the state of Pennsylvania; David Sonken, New York City, for metropolitan New York; William (Bill) Franklin, Syracuse, N. Y., for New York state; Harry Gerber, Boston, for the New England states.

Laurance S. Racine, sales manager of the Chicago Transformer Div., Essex Wire Corp., has been appointed chairman of the Transformer Section, RMA Parts Div. for 1948-49

TELEVISION-RADIO PRODUCTION BOX SCORE

(RMA Members)

Receiver Production	Jan.	Feb.	March	April	May	June	July	August	1948 Totals
Television	30,001	35,889	52,137	46,339	50,117	64,353	56,089	64,953	399,938
Consoles	13,261	10,295	15,304	12,536	12,535	11,256	10,234	12,489	85,375
Table M.	16,740	25,594	37,833	33,803	37,642	47,588	42,193	52,464	248,939
AM & FM	1,339,256	1,379,605	1,633,435	1,182,473	1,096,780	1,113,870	1,683,438	934,997	9,363,854
AM-FM	136,015	140,629	161,185	90,635	76,435	90,414	74,988	110,879	881,180



Dr. Willard H. Bennett of the National Bureau of Standards adjusts the new simplified, flexible radio-frequency spectrometer for detecting, separating, and identifying negative atomic ions of the heavier atomic elements. Experiments begun by Dr. Bennett in 1946 resulted in development of an experimental method of identifying and separating such ions within distances of a few centimeters

San Francisco Audio Group

The recently-organized San Francisco section of the Audio Engineering Society ratified the national constitution and took a listening test of 20 different commercial loudspeaker types at its August meeting. A new "tweeter-tweeter" speaker, developed by two San Francisco engineers was described and demonstrated.

RMA Export Commitee

Appointment of personnel of the RMA Export Committee for 1948-49 has been announced by RMA President Balcom. James E. Burke of the Stewart-Warner Corp. has been re-appointed chairman and E. E. Loucke of Zenith Radio Corp. has been named vice-chairman. The Export Committee distributes special statistics to its members every month on U. S. radio exports.

Philco TV Production Gains

Philco television production is exceeding 4,000 receivers a week, representing a production rate of over 200,000 sets a year.

NEW NAMES AND ADDRESSES

Arthur C. Ansley, founder and president of Ansley Radio Corp. has announced the formation of a new company, the Arthur Ansley Manufacturing Co., of Doylestown, Pa.

* * *

Sylvania Electric Products, Inc., has opened a new plant at Ottawa, Ohio, for the construction of television viewing tubes.

* * *

Cook Research Laboratories, Chicago, is expanding its facilities at 1457 Diversey Parkway with the addition of a one-story structure.

PERSONNEL

Toivo M. Liimatainen, formerly of the Sylvania Products Co., has been appointed to the staff of the Electron Tube Laboratory, National Bureau of Standards. He will take part in the engineering and development of microwave tubes.

Victor E. DeLucia has been named president-director of Northeastern Research, Inc. (not "Northwest" as stated in August Tele-Tech), 20 Bouton Street, South Norwalk, Conn.

D. Gordon Clifford, formerly chief engineer of Industrial & Commercial Electronics has become field engineer for Lenkurt Electric Co. of San Carlos, Calif.

Frank W. Walker has joined the Motorola Corp. as radio communication engineer in state of Michigan. Formerly he was associated with Greyhound Bus

Rear Admiral Ellery W. Stone (USNR) has been elected president and **General William H. Harrison** has been named chairman of the board of Federal Telephone & Radio Corp, and its manufacturing and sales subsidiary, the International Standard Electric Corp.

Mitchell P. Miller has been appointed manager of product design for the service and parts division of Philco, Corp. He joined Philco in 1923.

Thomas Morrin has become chairman of electrical engineering research at Stanford Research Institute, Calif. He was formerly chief of the microwave engineering dept. of Raytheon Mfg. Co., Waltham, Mass.

Two sales and engineering appointments have been made in the industrial and transmitting tube division, General Electric Co **A. C. Cable** has been appointed division engineer and **E. H. Fritschel** has been named manager of sales. Also, **George F. Murphy** has assumed the managership of the equipment development works.

Robert A. Kirkman has joined the engineering staff of Cook Research Laboratories, 1457 Diversey Parkway, Chicago, to assist in the design of high-frequency communication equipment.

Conda P. Boggs has been elected president of Victor Electric Products, Inc., Cincinnati, Ohio, a subsidiary of the W. L. Maxson Corp. He was formerly vice-president of Sylvania Electric Products Co, Inc.

New Parts For Design Engineers

Television Capacitors

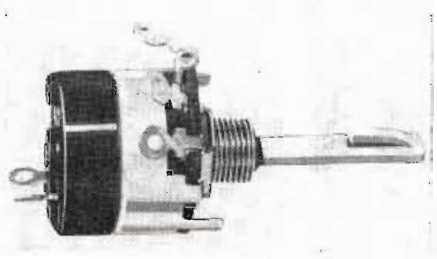
RC-111 and RC-112 capacitors are small, compact cylindrical types, occupying a minimum of space for television receivers and are equipped with ring brackets for inverted or upright mounting. Their ratings are .005 mfd. at 6,000 volts dc, and .05 mfd. at 6,000 volts dc, respectively. The two capacitors are designed for safe operation from —55° C to +100° C and have a hermetic seal that will withstand salt water immersion tests and extremes of humidity.—**Cornell Dubilier Electric Corp., South Plainfield, N. J.**

Core Solder

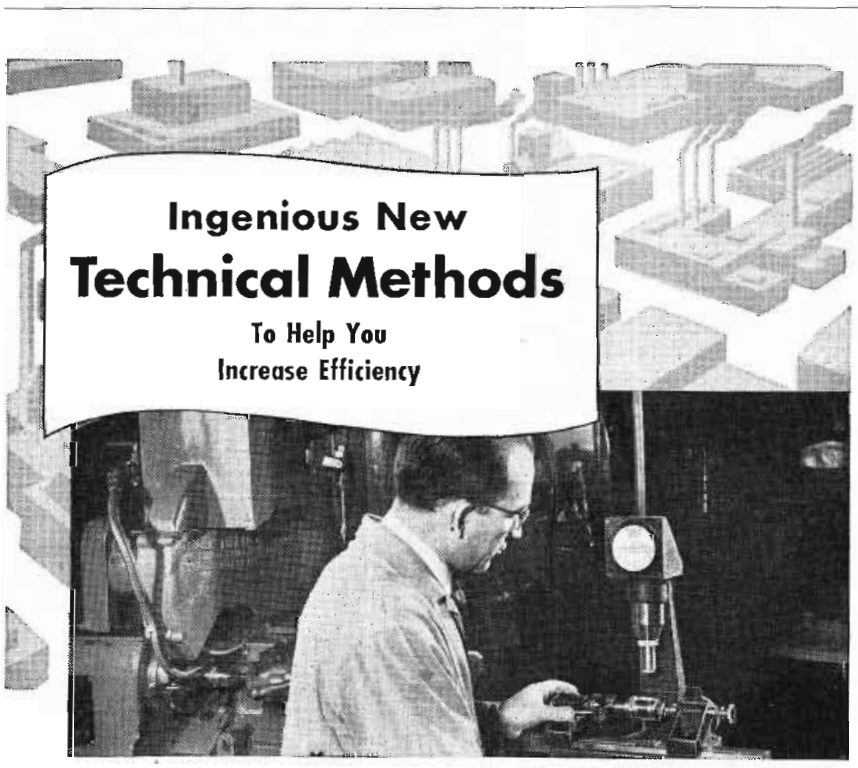
"Resin-Five" core solder is non-corrosive, non-inductive, virtually odorless and will easily solder zinc, brass, nickel silver, nickel-plate, copper and fer-four alloys. It is not a mixture of rosin with another flux, but a resin involving chemical interaction at the anhydride structure of the rosin itself, converting it from a naturally inactive state to an active state, yet preserving its original non-corrosive and electrically non-conductive physical character.—**Kester Solder Co., 4201 Wrightwood Ave., Chicago 39, Ill.**

Variable Resistor

Featuring a flat shaft which is easily adapted to fit any type of knob now in use, a 15/16 in. variable resistor known as the "Mallory



Midgetrol," is now available. It has electrical characteristics which make it suitable for many applications previously requiring a 1½ in. control. Two-point shaft suspension provides even contact pressure at all points of rotation and machine-coated carbon elements produce highly accurate resistance values and smooth tapers.—**P. R. Mallory & Co., 3029 W. Washington St., Indianapolis, Ind.**



Light Projector Increases Thread Grinding Production

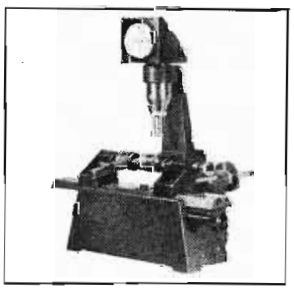
Production of thread grinding machines can now be increased through the use of a light projecting device called the Thread Pick-up Projector. The thread profile appears in a viewing screen, magnified 20 times, thereby permitting accurate visual adjustments.

In operation the Thread Pick-up Projector is placed alongside the thread grinding machine. A Dalzen Thread Grinder, Model No. 1, is shown above. While the machine is grinding the thread, the operator, using the Light Pick-up Projector, adjusts a "dog" on the next piece to be ground. When the "dog" and piece are then placed in the thread grinder the thread profile is automatically in location and ready for grinding immediately.

Even the most inexperienced personnel can "pick up the thread" using this instrument after only a few minutes demonstration. Grinding is also done more accurately and the viewer permits measurements of reliefs, notches, etc. to .0005 inch.

Efficiency of production can also be increased through the use of chewing gum. The act of chewing helps relieve nervous tension and seems to make the work go easier and faster. For these reasons, Wrigley's Spearmint Chewing Gum is being made available more and more by plant owners everywhere.

Complete details may be obtained from
Acme Scientific Company
1457 West Randolph, Chicago 7, Illinois

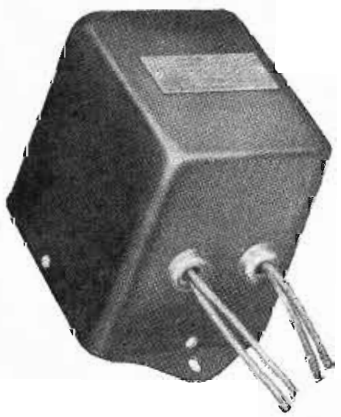


Thread Pick-up Projector

AC-75

Automatic Voltage Stabilizers

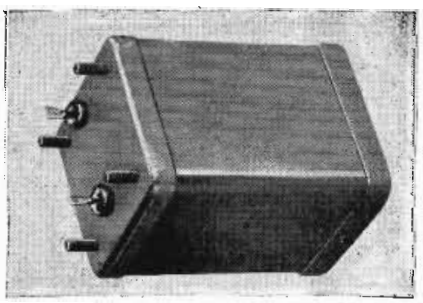
Redesign of three GE automatic voltage stabilizers in the 100 (illustrated), 250 and 500 VA ratings has resulted in totally closed



construction of the 100 VA unit and exposed core design of the 250 and 500 VA equipment. A steady output of 115 volts (1% for fixed, unity power loads) with input voltages ranging from 95 to 130 volts is produced by each one of the three models.—**General Electric Co., Schenectady 5, N. Y.**

Capacitors

Unicon Mykaplast capacitors are available in hermetic or wax-sealed assemblies and in single or multiple units with ratings as high



as five μf at 25 kv. Dielectric hysteresis is claimed to be only one tenth that of similar mica dielectric units. They are especially suitable for low frequency power oscillators, timing circuits, computing equipment.—**United Condenser Corp., 422 East 138th St., New York 54, N. Y.**

Tuning Capacitors

(*Continued from page* 45)

The units pictured in Fig. 1 are typical of the sealed, oil-filled units which have been produced. As might have been expected, their size and weight advantages over standard air condensers are not quite commensurate with the capabilities of the liquid dielectric employed. Thus, the necessity for an expansion space almost doubles the volume occupied by the immersed capacitor. The practical size reduction obtained using this technic is of the order of four to one for severe temperature variation. This ratio approaches six to one when no expansion facilities are required.

Weight measurements on completed units indicate that a gain of about two to one may be realized for the oil-filled units over air capacitors of equal performance at sea level. At higher altitudes the volume and weight reduction is even more spectacular. For example, at 40,000 ft. the breakdown voltage between flat plates is between one-quarter and one-third the sea level value. Table 1 below summarizes the practical size and weight gains at both sea-level and at 40,000 ft.

Table 1

	Sea Level	*40,000 Ft.*
Reduction in Size	4	12
Reduction in Weight	2	6

RF Input Circuits

(*Continued from page* 31)

mixer grids to prevent regeneration in the mixer.

Another type of tuner consists of three coils on a common shaft which can be rotated to move the contacts along and so obtain a continuous tuning range. This covers the entire frequency range from 44 to 216 megacycles, thus including the FM band. However, the very wide bandwidth in the FM channel does not give as much selectivity as is usually desired, and of course various non-picture signals may be obtained at points on the dial between the television channels. In addition to the types and variations in tuning circuits described, other means such as plug-in coils are used in a few receivers.

The ideal detector response which we showed in Fig. 3 is mainly obtained in the IF amplifier but with some contribution from the selectivity in the rf and mixer stages.

The image rejection ratio is largely determined by the rf and mixer selectivity. A value of about 100 times or 40 db is very desirable, but none of the commercial receivers tested were consistently that good on the high channels. RF selectivity at approximately 200 mc. is a serious problem due to severe tube transit-time loading and other troubles. Fortunately, if the IF frequency is high enough to avoid the image of any high channel falling in another television channel, the requirement need not be 40 db at the higher frequencies.

On the low channels, at least one channel has its image in the FM band for present day receivers and hence a strong FM signal will give trouble even for a 40 db-image figure. Unfortunately some designs are still quite deficient in this respect. But progress is being made and as experience is gained throughout the industry, better performance at lower cost can be expected.

Admiral's International Div.

Admiral Corp. has formed an international division to handle the marketing activities of Admiral products. George Kende will head the new division with headquarters in Chicago.

Signal Corps Procurement

(*Continued from page* 25)

completed end product. However, the Agency is of considerable informal assistance in suggesting possible sub-contractors to prime contractors who figured from the start on letting out some of their work. It merely digs into its Bidders List and determines from the answers to the questionnaires just which firms will fill the bill. The actual choice of the sub-contractor is made by the prime contractor, not by the Agency.

The mailing of invitations to bidders is one way of meeting a government regulation calling for "formal" advertising of bids. In addition, the Procurement Agency runs actual ads in two specialized publications: "Market Service," 330 West 42nd Street, New York 18, N. Y.; and "U. S. Government Advertiser," 511 11th Street, N.W., Washington, D. C. Copies of open invitations are also posted on large bulletin boards the Agency and in the Purchase Information Office, Logistics Div., General Staff, U. S. Army, Pentagon Bldg., room 3B650, Washington, D. C. These boards are free to public inspection daily during normal business hours and are well patronized by alert sales representatives.

In addition to production contracts calling for quantities of manufactured articles, the Signal Corps issues many research and development contracts. These involve laboratory and experimental work, usually terminating in the acceptance of samples or pilot models of new devices. The results of the research may quite possibly be negative, in which case the project is shelved or another one started.

Research projects usually are initiated in the Signal Corps Engineering Laboratories located at Fort Monmouth, N. J. The Laboratories write-up procurement requests and the Ft. Monmouth office of the Signal Corps Procurement Agency in Philadelphia then solicits firms for bids. Because of the special nature of these research and development jobs, further complicated by security restrictions, dealings with prospective contractors are on a face-to-face basis, and the contracts are negotiated rather than set by altogether blind bidding. Naturally, it is advisable for technical organizations interested in research and development contracts to establish and maintain close contact with the Laboratories,

in addition to informing the Procurement Agency.

The dollar transactions of the Procurement Agency run from one figure to seven figures. To facilitate small buying and to reduce paper work, the Agency is authorized to negotiate purchases involving less than $1000. What this means in a practical way is that an Agency buyer can pick up the phone and order a piece of urgently needed equipment right out of the stockroom of a conveniently located manufacturer or distributor. A purchase order follows, and the supplier collects his money in routine fashion. While the agency prefers to deal directly with manufacturers wherever possible, it often gives orders to "local" distributors because the latter can make immediate delivery of standard items in small quantities. This quick service is sometimes of great importance. The Agency invites large distributors to register with it, specifying the makes of equipment they carry, the stocks normally on hand, delivery facilities, etc.

The present director of the Signal Corps Procurement Agency is Colonel Benjamin Stern, a Regular Army officer of wide experience. His working staff includes a few other Signal Corps officers, but for the most part consists of civilians having Civil Service ratings. What impressed this writer when he visited the establishment recently was the whole-hearted spirit of cooperation and helpfulness manifest throughout. The Agency is in the business of obtaining radio, electronics and communication material, and it is succeeding because it is operating in a businesslike manner.

Southwestern IRE Conference

Sponsored by the Dallas-Fort Worth section, the Southwestern IRE Conference will be held Dec. 10-11, 1948 at the Baker Hotel, Dallas, Texas. It will be a regional convention covering the states of Texas, Louisiana, Arkansas, Oklahoma, and New Mexico.

FM Coast-to-Coast Program

Probably the first time that simultaneous airing of a program coast-to-coast has been achieved on FM was demonstrated at the FMA convention in Chicago Sept. 27-29 when the Army Air Force Band originated a program in Washington. It was recorded on tape by WASH in that city, duplicates were made and shipped to FM stations in New York, Chicago, San Francisco and Hollywood and the half-hour recording rebroadcast simultaneously as a network operation. Rangertone recording equipment was used in the experiment.

FCC Hears TV Views

(*Continued from page* 46)

these four paths: (1) get along with the 12 channels, VHF, that we now have; (2) add to these the channels in the UHF band; (3) assign the VHF channels to the large cities and the UHF channels to the smaller ones; (4) open up a UHF region for color TV and for black-white TV. CBS recommendations were: make no changes because of tropospheric effects; process new applications without delay; authorize the use of directional transmitting antennas where required. Jett brought out the fact that WMAR-TV and WCBS operated on the same frequency, without interference, at a spacing of 185 miles (however, neither station is yet operating at maximum power).

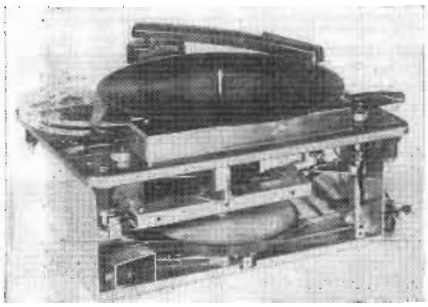
Allen B. DuMont, DuMont Labs., presented his views on the usability of the UFH band for TV. He indicated that separation of 150/75 miles was desirable; there should be no changes in the VHF band now; it is important to strive for more than two stations per city, otherwise there is insufficient observer interest for the wide sale of receivers; that the total channels, VHF plus UHF, would be about 69; there should be no co-mingling of VHF and UHF stations in the same area because this would cause increased costs to set owners. DuMont said the time to consider utilizing UHF for TV is now and his company could make delivery of TV transmitters, up to 1 kw, for the UHF band in 9 months.

G. D. Gillette, consulting engineer for several groups, reported that he had been making measurements and believed that: (a) received antenna voltage will decrease with increasing frequency; (b) with a 30 ft. antenna, channel 2 and 13 will give about the same signal, slightly less on channel 13 because of the absorption by trees, etc.; (c) if the receiver does not get as much voltage on the high channel as the low one, then the power of the former should be pushed up until equal signals are received when simple dipoles are used for the reception of the different frequencies; (d) it would be easy for the engineers skilled in this field to work out the desired answers if the FCC would only formulate a *policy answer* to this question: "Should the number of TV stations operating be reduced in order to provide service to a 5% 'fringe' population?" The hearing ended on this note.

Sound Equipment

Recorder Chassis

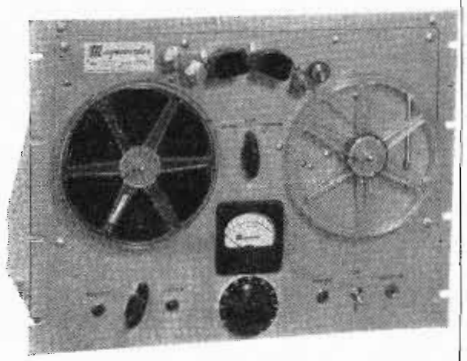
Facilities for recording, monitoring, re-recording, stereophonic and expansion control are provided by the Twin-Trax tape recorder chassis. Recorder playing time is one hour



with a standard 7-in. reel of ¼-in. magnetic tape (not ½-in. as erroneously noted in these columns in August) because two signal tracks are used on the tape instead of one. No rewinding is necessary as the Twin-Trax chassis plays continuously during forward and reverse travel.—**Magnephone Div., Amplifier Corp. of America, 398-26 Broadway, New York 13, N. Y.**

Tape Recorder

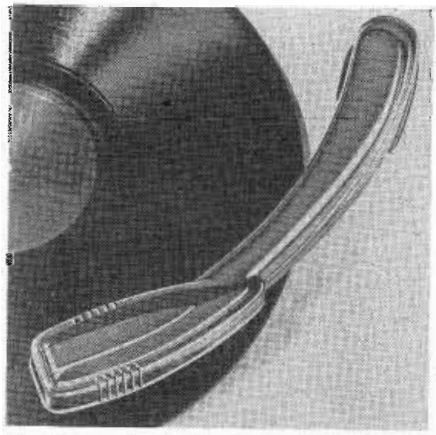
Unit construction and plug-in design using four basic units in the Magnecorder simplifies recording technic in studio, field, and lab-



oratory. Series PT6-A, the basic recorder unit, is combined with rack mount amplifier PT6-R for studio applications (see illustration).—**Magnecord, Inc., 360 North Michigan Ave., Chicago 1, Ill.**

Crystal Phonograph Pickup

Maximum reproduction of micro-groove record fidelity is achieved by the new 900MG crystal phonograph pickup. It tracks at seven grams, has a needle force of nine



grams, uses a special offset osmium-tipped needle with a point radius of only .001 in., and has an output of one volt.—**Shure Bros., Inc., 225 West Huron St., Chicago.**

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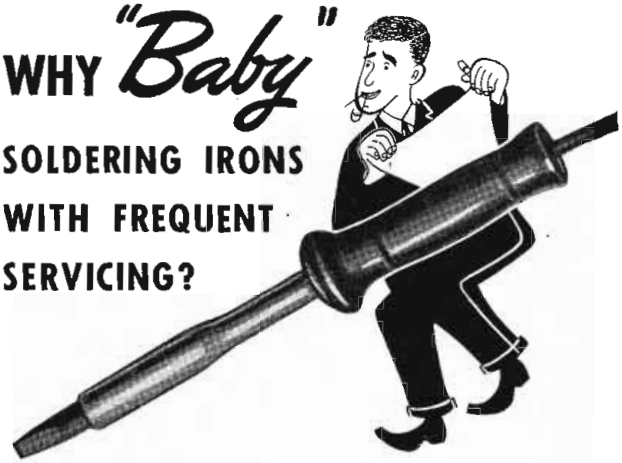

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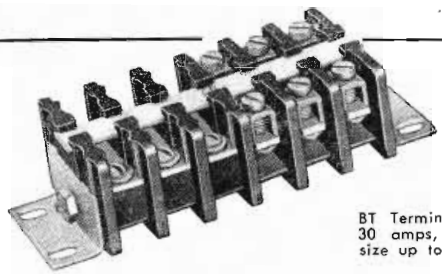

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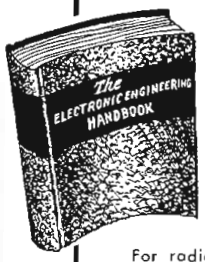

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Columbia LP Record Specifications

Specifications for Columbia long-playing records in ten and 12-in. sizes are given in the accompanying table. The LP characteristic is approximately 3 db higher below 100 cycles. These records may be played back very satisfactorily through any NAB lateral reproducer channel in which the reproducer is fitted with a .001" tip radius reproducer bearing upon the record with a force of 6 grams. The recording characteristic has gradually changing slopes so that exact equalization may be obtained with simple RC networks.

Dimensional Specifications	10" Records	12" Records
Diameter	9⅞" ± 1/32"	11⅞" ± 1/32"
Thickness (To be measured at 1" from the edge at 4 points 90° apart)	0.075" ± 0.010	0.075" ± 0.010"
Center Hole Diameter	(———.286" ±	.001———)
Concentricity	(—The indicated run-out of—) the music grooves relative to the center hole shall not exceed .010".	
Lead-in Spiral	(—To start at outer edge of—) record and to consist of at least one complete turn before going to recording pitch.	
Diameter First Groove at Recording Pitch	9½" ± .02"	11½" ± .02"
Minimum Inside Diameter of Recording	4¾"	4¾"
Eccentric Stopping Groove:		
Diameter	4 7/16"	4 7/16"
Runout Relative to Center Hole	250 ± .015	.250 ± .015
Groove Shape	(—Contour approximately same—) as music grooves; minimum depth .003".	
Groove Shape:		
Included Angle	87° ± 3°	87° ± 3°
Tip Radius	Under .0002"	Under .0002"
Width of Groove	.0027" to .003"	.0027" to .003"
Rotational Speed	33-1/3 RPM	33-1/3 RPM
Playing Time Per Side	13½ Min.	22½ Min.

IRE Medal to Dr. Bown

Dr. Ralph Bown, research director of Bell Telephone Laboratories, has been awarded the IRE medal of honor for 1948 in recognition of "distinguished service rendered through substantial and important advancement in the science and art of radio". He was president of IRE in 1926.

Philco Sues AT&T

Suit has been filed by the Philco Corp., against American Telephone and Telegraph charging interference with its television station operations. Specifically, the Philco complaint claims that (1) AT&T has refused interconnection of television facilities with private relay facilities; (2) AT&T is requiring telecasters not to use facilities that compete with AT&T. Philco charges that AT&T cut its Philadelphia WPTZ-TV station off the air on Sept. 9 and 16 while using AT&T facilities.

Motorola Purchase

Motorola, Inc., Chicago, has purchased the inventory and certain assets of International Detrola Corp., Detroit. As a result of this transaction, Motorola will supply car radios directly to automobile manufacturers.

A television studio in miniature is discussed by W. W. Watts (with hands on model), vice president in charge of RCA Engineering Products Dept., at the company's first seminar for consulting engineers. Aug. 30-Sept. 1 session was attended by 40 leading technical experts

MAGNETIC TAPE RECORDER (Continued from page 42)

heard, but harmonics at a higher frequency and noise-under-the-signal will come through readily. The gain of the playback amplifier may be greatly increased without fear of overload to make these observations.

An example of the use of this filter is shown in its effective determination of the proper bias intensity. This high-frequency bias of the order of 90,000 cycles is fed to the recording head superimposed on the audio recording signal to cycle the magnetic effect on the tiny iron particles around their hysteresis loops. As a result of these gradually decreasing cycles as the tape particles move out of the gap, the particles come to rest in a condition magnetically far more linear with respect to the instantaneous values of the audio signal. A particular tape coating requires a particular bias intensity for maximum results.

With the loop tester and the high-pass filter operating, it is very interesting to vary the bias intensity and hear the harmonics come up on either side of the optimum bias intensity.

Another important point is the tape noise itself. This noise results from non-uniformity in the magnetic characteristics of the tiny particles of iron oxide which constitute the sensitive tape coating. If by any chance there is a permanent magnetic bias in one direction, be it ever so slight, all of the tape will be magnetized slightly in one direction. Now, due to the individual particle differences this magnetism will not be uniform and the result will be noise created in the manner of a Schotte effect, as the tape passes the fine analyzing gap of the playback head.

This magnetism may be induced by distorted high-frequency bias which goes further in one direction than it does in the other with respect to the zero axis. This means that the little hysteresis loops will likewise not be symmetrical with respect to the zero axis and a magnetic bias in one direction results. The actual high-frequency oscillator is the place to correct this, and has been done by a careful adjustment of the tube parameters and by the use of good high Q coils at this frequency. By concentrating on this feature of the equipment it has been found possible to reduce distortion from this source.

In spite of all precautions, the sudden shutting off of a strong recording signal may leave the recording head slightly magnetized. To avoid this, it is always wise to have the recording gain at zero when starting and stopping the machine. But if there is a definite indication that the noise rises on an erased tape, when the tape comes in contact with the recording head, it is a pretty sure sign that the head has become magnetized, and must be demagnetized. This is readily accomplished on the Rangertone equipment by the use of a built-in demagnetizer. This consists of a push-button in series with a rheostat by means of which decreasing amounts of a six-volt ac source may be applied to the recording head. By bringing this current down two or three times, the head is cleared.

As another caution, high permeabilty materials are very hard to demagnetize completely once they have become magnetized. So it is wise to avoid this as completely as possible on the pickup head. For example, it should not be tested for continuity across a dc ohmmeter.

If all tapes made on any machine are to be interchangeable, not only

must the recording curves correspond, but even more to the point is the necessity of absolute alignment of the gaps in the respective heads. To be sure of the interchangeability of heads, the loop tester is again brought into service. By substituting one head for another, recorder or playback, careful check of the effectiveness of each is made. Low and constant capacity in the windings of the coils is a most important part of this quality control. The coils are checked for their resonant frequency before they are even placed in a head assembly.

In grinding the cores, great care must be exercised to make the faces of the core absolutely flat and parallel. This is a watchmaker-precision grinding operation. Then the beryllium copper shim is carefully introduced. The thickness of this shim is .0004 in.

When the heads are mounted in a head assembly, they must have their gaps absolutely in line. The tape is ¼ in. wide, and if the gap is out of line one-quarter of its width, an appreciable diminution in high frequency signal will be noted. This therefore means that the alignment must be accurate to .0001 in. in ¼-in. or .2500 in. This means that the alignment must be accurate to 1/2500 or about two minutes of angle.

Gap alignment may be made on Rangertone equipment while the tape is running. For this purpose, each of the heads is on a little tilting table which is on a three-point suspension with three micrometer screws for making the necessary adjustments. This is shown in Fig. 6. Adjustment is made by these screws which have two different threads at each end. This makes for a differential movement, so that effectively they are 200 threads to the inch. The actual adjustment is made with an Allen wrench against a locking nut.

Adjustment of the gap alignment is made as follows:

(a) With the heads aligned optically to their best, a steady zone of 7,000 cycles is recorded on the tape. While monitoring, the playback head is then adjusted for maximum response.

(b) The tape is now rewound to the start of the test; it is then flopped over so that the magnetic coating is now away from the heads. The tape is replayed, without the recording on, and the playback is again re-adjusted for maximum, careful note being made of the change necessary. It is then returned

(*Continued on page 72*)

16-in. Metal TV Tube in Production

SIXTEEN-inch TV picture tubes made with spun-steel cones joining the plate-glass image fronts and glass necks, are now being produced at the rate of 100 a day by the Tel-o-Tube Corp., 167 Marshall St., Paterson, N. J., which is headed by Samuel Kagan, a practical tube-maker having previous experience with the DuMont 20-in. glass TV tube. In form and design, the new metal Tel-o-Tube follows closely the lines of the metal 16-in. tube recently announced by RCA, of which Tel-o-Tube is a licensee. The manufacturer is planning an output of 4,000 tubes a month by the end of the year.

Major portion of the "envelope" of the new tube consists of a cone of spun chrome-steel alloy. Only (1) the image screen and (2) the neck or stem which houses the cathode-ray gun assembly, are made of glass. These are fused by a special process to the steel cone, which has the same coefficient of expansion as the glass.

Advantages claimed for the metal tube include light weight — about one-sixth that of an all-glass tube of the same size; better shielding for the removal of ambient light; greater safety (the tube will not shatter if broken); and a larger and better scanning surface.

Curvature of the glass screen in the metal tube is so slight that it can be scanned without distortion practically to the edge where it is joined to the metal cone, giving nearly 150 sq. in. of clear image area. For greater clarity, the image screen utilizes drawn glass, polished on both sides, instead of the usual pressed glass.

Each of the new tubes is subjected to close control and frequent inspection and tests during its manufacture. These tests include measurement of screen efficiency, several vacuum tests during exhaust operations, and measurements of beam current and cut-off voltage. The new metal tube has also undergone a rigid life test, indicating a longevity equal to or greater than that of all-glass tubes.

Tel-O-Tube's 16-in. metal picture tube

Mr. Kagan is standardizing on the production of 16-in. metal tubes because he feels that this diameter is as large as is desirable for home sets.

Some of the first-production metal tubes are already being used in the 16-in. "Ambassador" table-model TV receiver made by the Starrett Television Corp., 601 W. 26th St., New York City, and priced at $695 retail.

Classified Section

TELE-TECH

Advertisers October 1948

While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

Magnetic Tape Recorder

(*Continued from page* 65)

to a point half-way between the front and back maxima. This is to average out misalignment which must be present to give rise to the difference in adjustment. (The fact that the response through the back of the tape is so much less than the front is of no consequence, as it is only maxima that are being observed.)

(c) Now a new recording is made at 7,000 cycles, but this time the playback head is left alone, and the recording head is adjusted to give a maximum response to the playback in its new position.

(d) The tape is again returned to the starting point, and played through the back, and this time the playback is again adjusted to a median position.

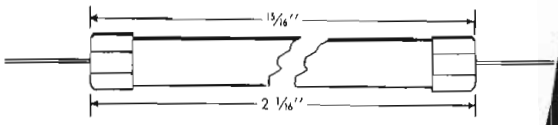
This process is repeated until the final playback head adjustments show that they have approached a real mean position. The recording frequency is then increased to 10,000 cycles as a final check. Tapes made on machines adjusted by this process show very faithful interchangeability up to 15,000 cycles.

On recording, we hold closely to the plan of giving equal current to the recording head, regardless of frequency. It is perfectly true that a certain measure of noise reduction may be accomplished by pre-emphasizing with increasing frequency as is done with disc recording. But this runs into the very real danger of overloading the highs. The curve of response with intensity takes a very definite dip at a certain point as is shown in Fig. 6 for the higher frequencies. There is a real demagnetizing action that occurs for the shortwave lengths on the tape, corresponding to the higher frequencies. Fortunately, there is a definite drop-off in average energy with music and voice at the higher frequencies, so that in view of the Fletcher energy-distribution charts, there is a fair margin of safety in this direction.

The over-all result is that 2% harmonic distortion matches the frequency distribution over the whole range very nicely. Two percent harmonic distortion is taken as the normal signal level at 1,000 cycles, and with all other measurements made with respect to this setting. This brings the equipment noise down to better than 60 db, and with the tape now available the dynamic range from silence to full signal is 55 db.

NOW for precision applications

DCF: Overall body size, including caps, 15/16" long x 9/32" dia.



DCH: Overall body size, including caps, 2 1/16" long x 9/32" dia.

2 New IRC Deposited Carbon resistors

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Type DCF—for applications up to 1 watt, and DCH—for applications up to 2 watts, depending on the allowable change in resistance. Each is supplied in 3 tolerances—1%, 2% and 5%. Voltage coefficient on a statistical average is 10 parts per million per volt. Standard resistance: Type DCF—200 ohms to 5 megs, Type DCH—500 ohms to 20 megs.

New IRC Deposited Carbon Resistors are ideally suited to electrical and electronic applications where the maintenance of maximum stability over long periods of use is required. Write on your letterhead for Catalog Bulletin B-4 and samples for testing. International Resistance Company, 401 N. Broad Street, Philadelphia 8, Penna. In Canada: International Resistance Company Ltd., Toronto, Licensee.

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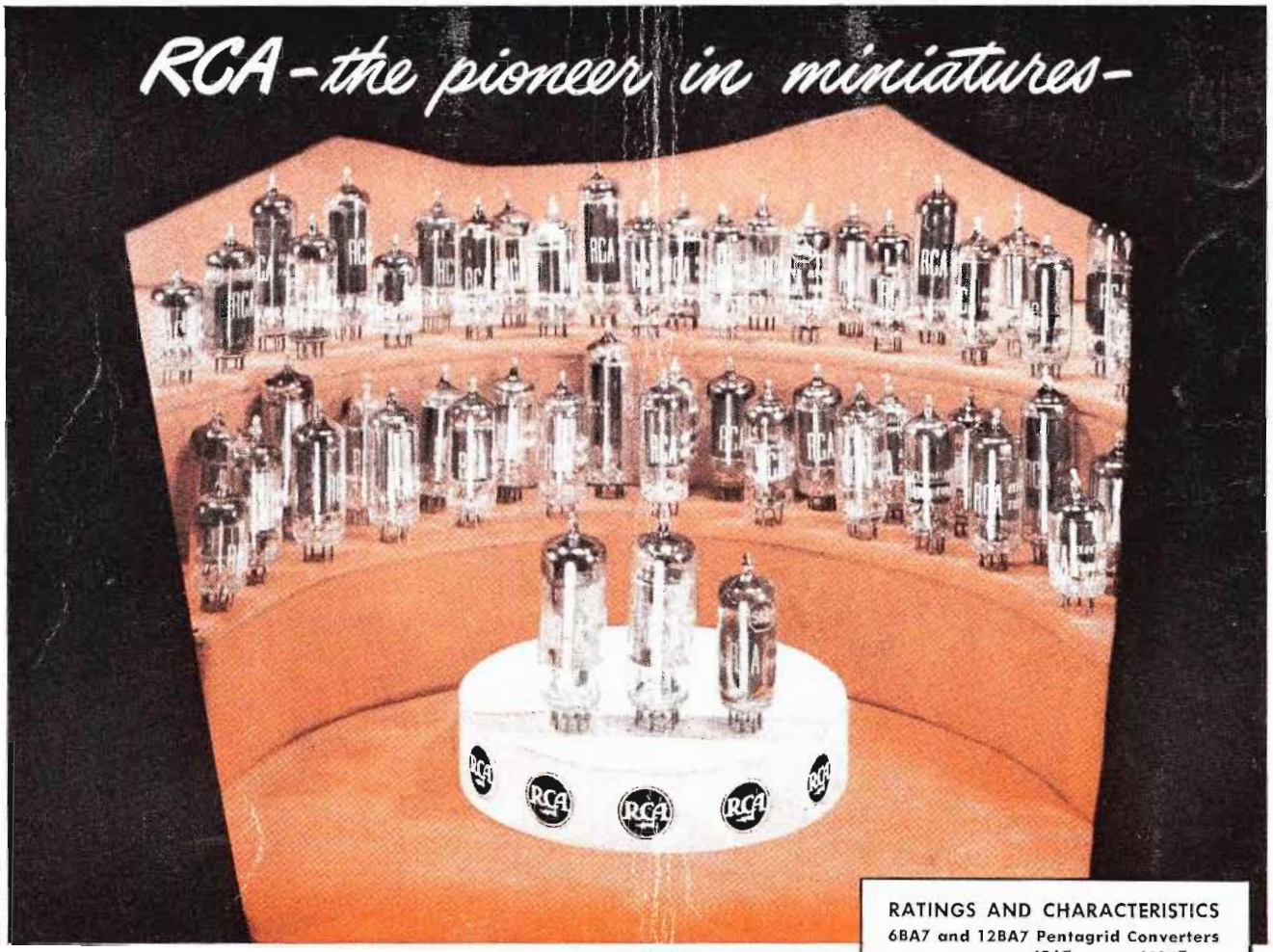

. . . presents three new types of major importance

● Here are three new miniature tubes . . . additions to RCA's large family of miniature types . . . that have particular significance in FM receiver design and voltage reference applications.

RCA 6BA7 and 12BA7 are pentagrid converters—alike except for heater ratings. They have high conversion gain, because of their high conversion transconductance; and a separate connection for direct grounding of the suppressor. These features in combination with the short internal leads characteristic of miniature tubes, result in efficient operation of either type in the 88 to 108-megacycle FM band. In addition to realizing substantial gains at the higher frequencies, the RCA 6BA7 and 12BA7 contribute a highly favorable signal-to-noise ratio.

RCA-5651 is a voltage reference tube of the cold-cathode, glow-discharge type. It maintains a dc operating potential of 87 volts, has an operating current range of 1.5 to 3.5 ma., an operating characteristic essentially independent of ambient temperature, and a voltage stability at any current level of better than 0.1 volt.

• • •

RCA Application Engineers will be pleased to consult with you on the incorporation of these new miniatures in your equipment designs. For further information write RCA, Commercial Engineering, Section JR63, Harrison, N. J.

RATINGS AND CHARACTERISTICS

6BA7 and 12BA7 Pentagrid Converters

	6BA7	12BA7	
Heater Voltage (ac or dc)	6.3	12.6	Volts
Heater Current	0.3	0.15	Ampere
Characteristics — Separate Excitation*			
Plate Voltage	100	250	Volts
Grid No. 5 and Inter-not Shield	Connected directly to ground		
Grids No. 2 and No. 4	100	100	Volts
Grid No. 3	—1.0	—1.0	Volt
Grid No. 1 Resistor	0.02	0.02	Megohm
Plate Resistance (Approx.)	0.5	1.0	Megohm
Conversion Transconductance	900	950	Micromhos
Conversion Transconductance (approx.) Grid No. 3 at —20 volts	3.5	3.5	Micromhos
Plate Current	3.6	3.8	Ma.
Grids Nos. 2 and 4 Current	10.2	10	Ma.
Grid No. 1 Current	0.35	0.35	Ma.
Total Cathode Current	14.2	14.2	Ma.

*Characteristics correspond very closely with those obtained in a self-excited oscillator circuit operating with zero bias.

5651 Voltage-Reference Tube

	Min.	Av.	Max.	
DC Starting Voltage	—	107	115	Volts
DC Operating Voltage	82	87	92	Volts
DC Operating Current	1.5	—	3.5	Ma.
Regulation (1.5 to 3.5 Ma.)	—	—	3	Volts
Stability*	—	—	0.1	Volt
Ambient Temperature Range	—55 to +90° C			

*Defined as the maximum voltage fluctuation at any current level within operating current range.

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