# RADIO-ELECTRONICS

formerly

RADIO CRAFT

IN THIS ISSUE
Installing Two-Way Radio in Taxicabs

HUGO GERNSBACK, Editor

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DEC 1948

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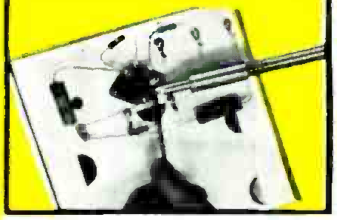
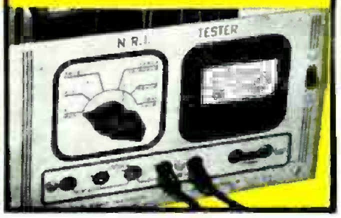
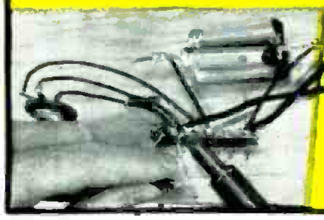


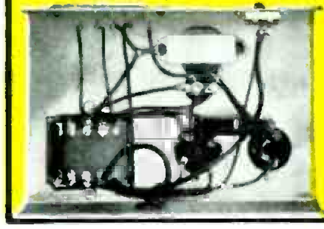
**YOU BUILD** this Tester with parts N. R. I. sends early in course. Soon helps you fix neighbors' Radios and EARN EXTRA MONEY in spare time.




**YOU TEST** Radio Circuits like this built with parts I send. Build special circuits; learn how to locate and repair circuit defects.



**YOU BUILD** Vacuum Tube Power Pack; make changes which give you experience with packs of many kinds. Learn how to correct Power Pack troubles.



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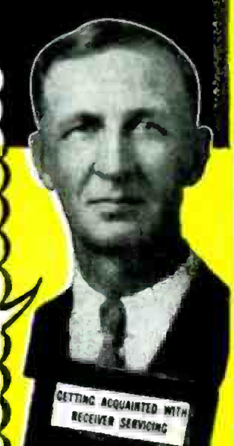


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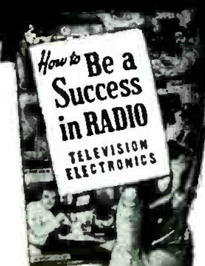


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**formerly RADIO-CRAFT**

Incorporating

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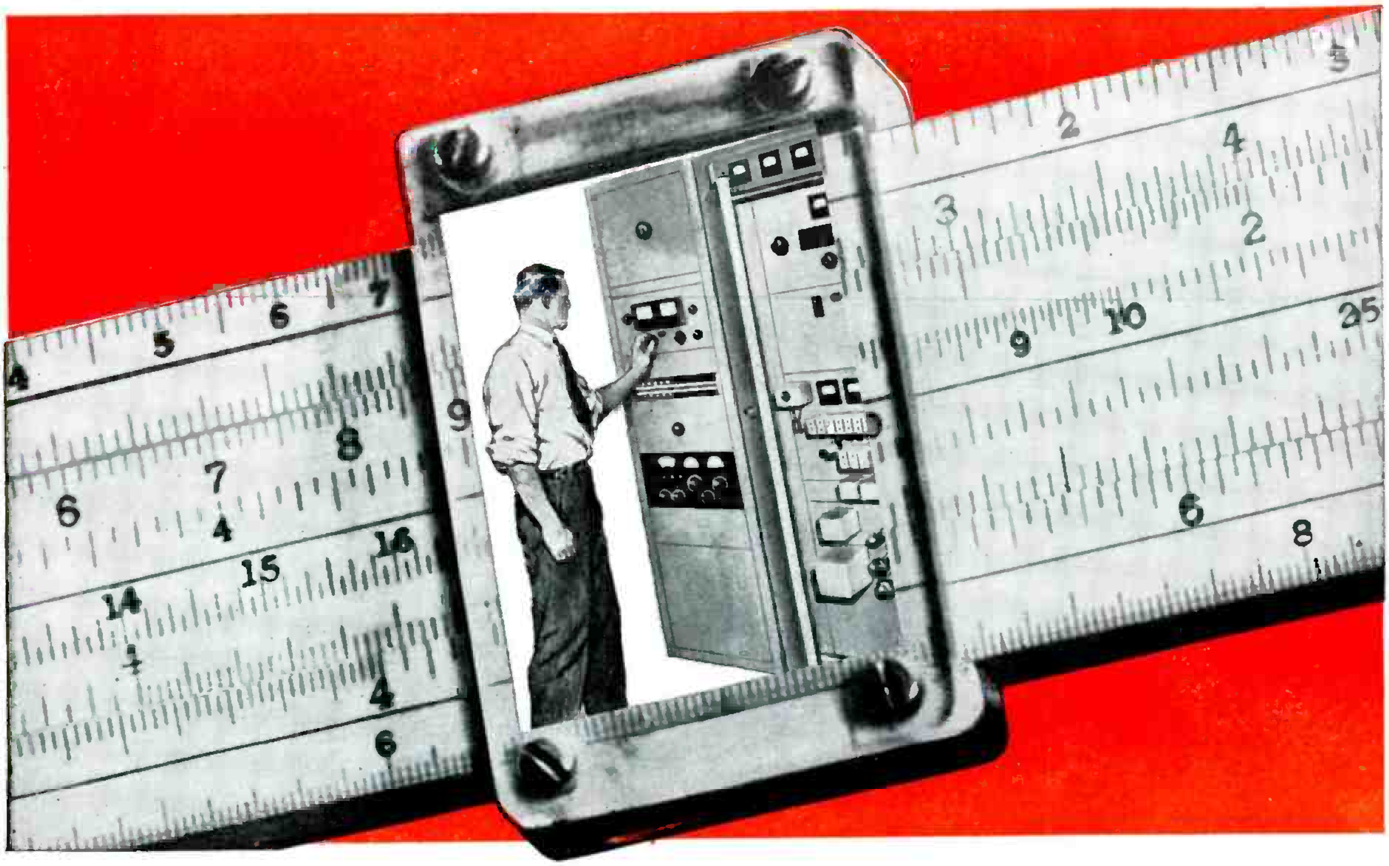

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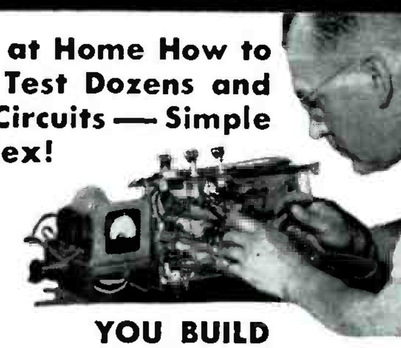

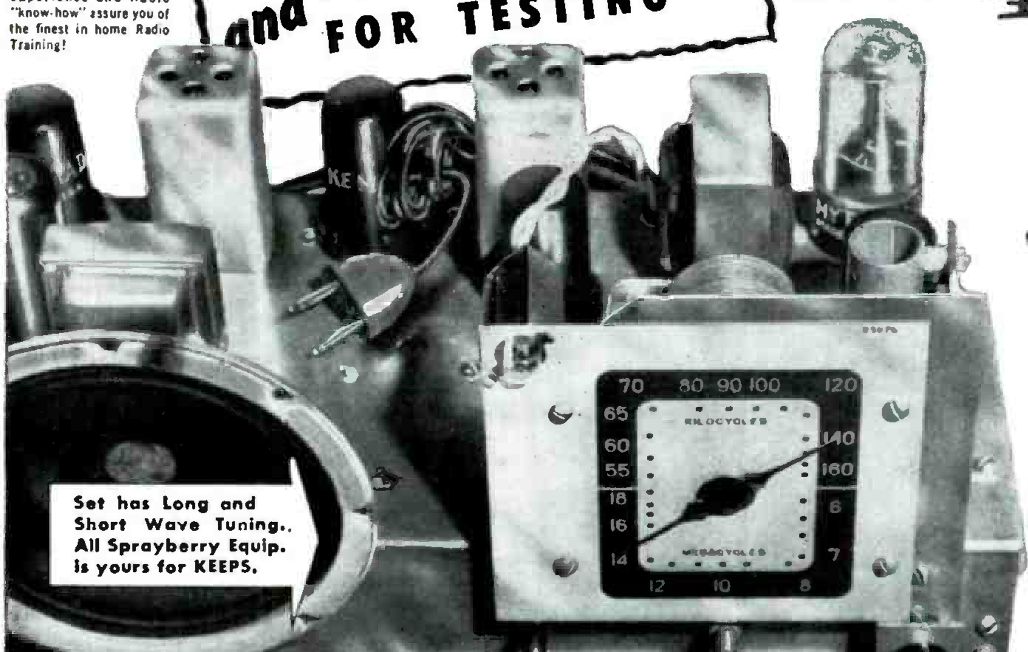

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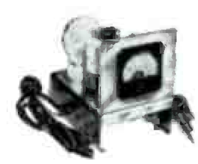
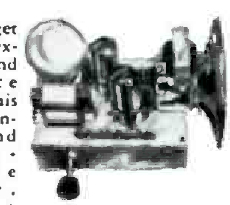
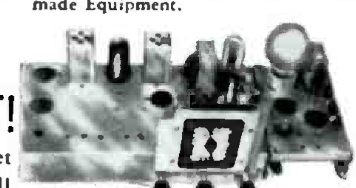


I give you a fine, moving-coil type Meter Instrument on Jewel Bearings — with parts for a complete Analyzer Circuit Continuity Tester. You learn how to check and correct Receiver defects with professional speed and accuracy.



You'll get valuable experience and practice building this Signal Generator and multi-purpose Tester. Makes a breeze out of fixing Radios and you don't have to spend money on ready-made Equipment.



Soldering, wiring, connecting Radio parts . . . building circuits with your own hands — you can't beat this method of learning. When you construct this Rectifier and Filter, Resistor and Condenser Tester, etc., you get a really practical slant on Radio that leads to a money-making future.

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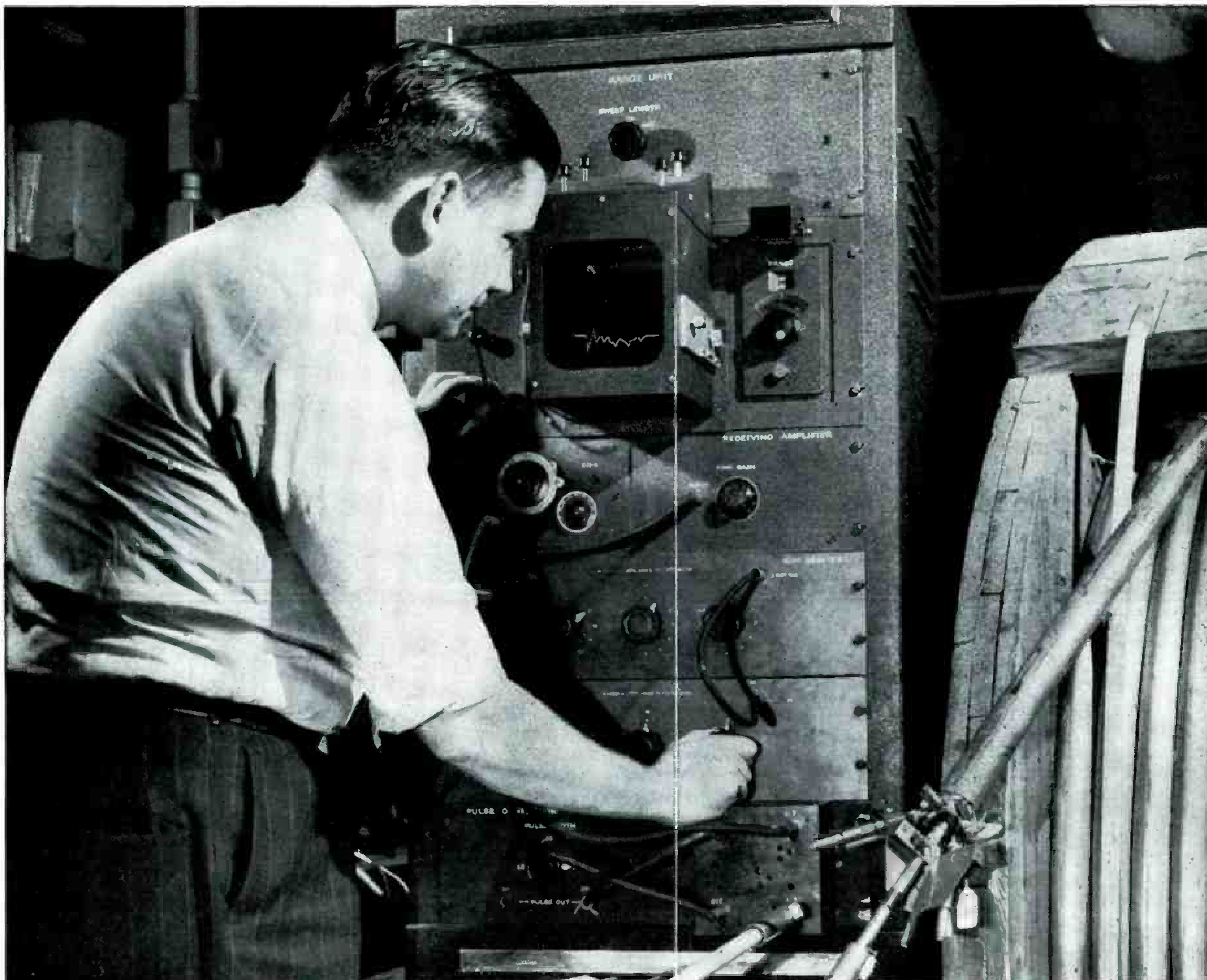

# He asks an echo

Radar sends out pulses of electric waves which, reflected from a target, return to reveal the target's location.

Likewise, the apparatus pictured above sends electric waves over a coaxial telephone cable. Minute irregularities reflect the waves back to their origin; the echo makes a trace on an oscilloscope screen and so tells where to look for the trouble.

Telephone messages need smooth "highways" over which to travel across country: circuits able to transmit every talking frequency, without distortion. Television needs even smoother highways and at many more frequencies. So Bell Laboratories devised this method of spot-testing the cable over the entire frequency band needed for telephone or television. It is so delicate that any possible interference with transmission is detected at once. Its use makes sure that every inch of highway is clear.

This is another important example of how Bell Telephone Laboratories constantly develop finer communications for the nation.

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Exploring and inventing, devising and perfecting for continued improvements and economies in telephone service.

**TOWN MEETING** of Radio Servicemen held its second session in New York City September 27, 28 and 29. About 1,500 technicians registered for one or more of the sessions—roughly the same number as attended the first session at Philadelphia last January.

Highlight of the first evening was a paper "Antenna Installation" by Ira Kamen. RMA's president Max Balcom was also well received when he stressed the importance of television to the servicing technician, as was a symposium "TV Installation in the Home." Less well received was a paper "How to Collect Your Bills," presumably because the bulk of the radiomen present were operating on a cash basis.

Other papers which attracted special attention were "Case History of a Successful TV Service Shop," by Harold Suss, "Television Service in the Shop," by Carl Quirk, and John F. Rider's talk on sweep generators. Listeners said the latter's only fault was that he had only 40 minutes in which to talk.

On the business side, Austin Lescarboura's "Advertising and Public Relations" was considered the best paper. Others were given a lower rating by the assembled servicemen chiefly because they seemed aimed at the larger shops, whereas the majority of the attending technicians came from one- and two-man establishments.

Next Town Meeting was scheduled for Boston, November 15, 16 and 17.

**RADIO TECHNICIANS** of Massachusetts and New York discussed the question of wider organization of servicemen, at a meeting held in Rochester, N. Y., October 10, 1948. The meeting was called by the Radio Technicians Guild of Rochester to discuss national organization. Delegates from Boston, Springfield, New Bedford, Binghamton, Rochester, Watertown, New York City, and several other points attended.

Failing to agree on whether formation of a national organization or a state federation was the best immediate step, the group proceeded to form both organizations. The State Federation was set up with Lawrence Raymo of Rochester as president, Wayne Shaw of Binghamton as secretary, and Max Liebowitz of New York as organizer. The first meeting of the new organization was set for Binghamton on the 31st of October, with delegates and visitors from all interested radio servicemen's organizations invited. Steps were also taken to incorporate a national organization based on the Radio Technicians Guild of northern New York and Massachusetts, and a temporary board of directors was named.

Officers of the new board are Frank Keefe, Indian Orchard, Mass., president; Ray Mattraw, Watertown, N. Y.; vice-president; Lewis L. Sharrard, Springfield, Mass., secretary, Bertram L. Lewis, Rochester, N. Y., executive secretary, and Herbert Gamer, Roxbury, Mass., treasurer.

**EUROPEAN BROADCASTERS** are affected by the signing of a new treaty at Copenhagen in September. To add more channels to the European long- and medium-wave broadcast bands, channel width was narrowed down to 8 or 9 kc depending on the assigned frequency. In the reallocation of frequencies the U. S. was given three channels in Occupied Germany instead of the former 13. The treaty takes effect in March, 1950.

**TV IN BARS** and other public places can legally be stopped by station owners if they wish, said David M. Solinger, New York attorney, in the *Columbia Law Review* last month. The article, entitled "Unauthorized Uses of Television Broadcasting," points out that television is protected by copyright laws, as well as by other common-law property rights.

"An owner of a television receiver," wrote Mr. Solinger, "by performing a program in a tavern, hotel, restaurant, private auditorium, or motion-picture theatre, has thereby infringed on the copyright of the creator to the same degree as he would have had he reproduced the material on his own stage with his own live cast."

Five presidents of local radio organizations were in attendance at the Rochester meeting. From left to right are: Al Saunders, Boston, Mass.; Wayne Shaw, Binghamton, N. Y.; T. Lawrence Raymo, Rochester, N. Y.; Max Liebowitz, New York, N. Y.; Ben De Young, Ithaca, N. Y.

**FM-EQUIPPED CAR** is being used by E. A. Merryman, chief engineer of WBUZ-FM, Bradbury Heights, Md., to check on reports of bad reception. The receiver installed in the car was made from a Pilotuner and an old AM auto radio. The antenna is a dipole. The car, Merryman says, has enabled him to assist many listeners.

**RAILROAD TELEVISION** was demonstrated successfully aboard a Baltimore & Ohio train travelling from Washington to Jersey City, N. J. A receiver installed in one of the cars picked up nearly all of the second game of the World Series.

In the Washington railroad station the broadcast was received from WNBW, WTTG, and WMAL-TV, Washington. About half-way between Washington and Baltimore, the receiver was switched to a Baltimore station, and as the train neared Jersey City, Philadelphia and New York stations were utilized.

The antenna mounted atop the railroad car picked up interference-free signals over most of the route except when the train passed under tunnels and through yards with large numbers of electrical signal devices.

William M. Snyder, assistant general passenger agent of the railroad, said that the reception was about as good as in the average home. If tests continue to be successful, he added, the railroad may make permanent video installations on its crack trains.

**TV TUBE SHORTAGE** will last until late 1949 or 1950, predicted Hamilton Hoge, president of U.S. Television, last month. Although 1.6 million cathode-ray tubes will be made next year, there will not be nearly enough to satisfy the demand. The tube shortage is the only important one hampering television.

Mr. Hoge pointed out that not all of the tube output would go into new receivers. With the increasing military use of TV, the shortage may be aggravated by heavy government demands. Replacements for existing receivers will also reduce the number of tubes available for new sets.

Basic cause of the shortage is the time required for tube makers to tool up. Plans announced this summer, for example, will not be in effect until late 1949 or early 1950.

**U.S. VIDEO STANDARDS** would be established in foreign countries if plans disclosed last month by the RMA were successful. Members of the RMA, apparently concerned over British efforts to spread their standards in other countries, pointed out that receivers must be made to conform to transmission standards. Sale of American receivers abroad would thus depend largely on the standards used in Europe. Since no American sets are presently available for export, the plans are long-range, anticipating a time when the American market will have been satisfied.

**MINE DETECTORS** may soon be used by veterinarians, at least in principle. A new device for the detection of metal is designed to locate foreign objects in animals. A bit of baling wire swallowed by a cow or a bullet fired into a farm animal or pet by a trigger-happy hunter may be located by passing the detector over the animal's body. Developed by the Army Medical Department, the device is awaiting final clinical tests.

**TELEVISION GRANTS** were halted by the FCC last month for a six-month period. During this time no action will be taken on applications for TV station licenses. In announcing the freeze, Wayne Coy, FCC chairman, said that evidence presented at an industry-commission conference held in Washington on September 13 and 14 raised serious questions about the present and proposed frequency-allocation scheme. An engineering conference will be called to discuss the question; meantime, no further allocations will be made.

Operation of the 37 stations now on the air and construction permits previously authorized will remain unaffected. Mr. Coy emphasized that the usefulness of presently owned and marketed television receivers will not be impaired.

**BRAZILIAN TELEVISION** plans were completed last month and South America's first television station will be in operation within a year, according to an announcement made by Cesar Ladeira, one of the founders of the newly organized Radio Televisaõ do Brazil. The station will be at Rio de Janeiro.

A 28-30-hour weekly schedule of programs will be carried, including live shows, news films, educational programs, and sports.

The 5,000-watt transmitter and all other studio and transmitter equipment will be furnished by General Electric.

**FINE OF** $10,000 or two years' imprisonment may be the price of operating a phonograph oscillator so as to cause interference to radio reception, readers of the *New York Daily News* were informed last month. The paper had reported a suggestion from a reader that neighbors' sets whose volume controls were turned up too high might be jammed with a phono oscillator.

In a letter to the newspaper the FCC warned of the Communications Act, which states that any radio transmission—no matter how low the power—which interferes with the reception of other stations is illegal and punishable.

**THE QUARTER CENTURY** Wireless Association will hold a dinner meeting in New York's Fraunces Tavern on December 3rd, John DiBlasi, W2FX, the association's president, announced last month. The association, membership in which is open to those who have been active hams for at least 25 years, now has more than 100 members. Among the recent joiners is FCC Commissioner George E. Sterling, W3DF.

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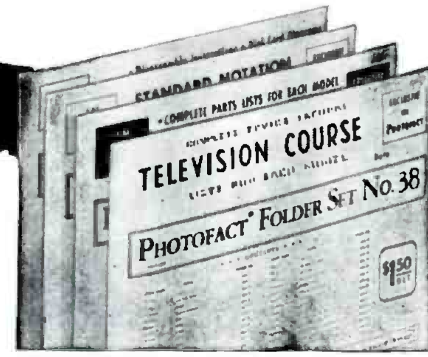


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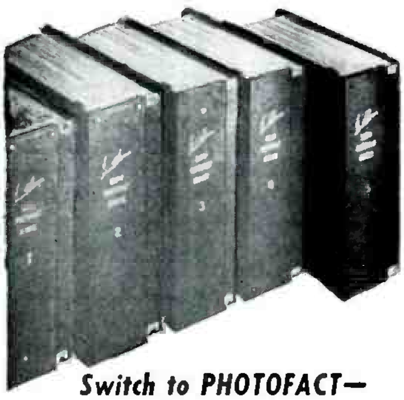

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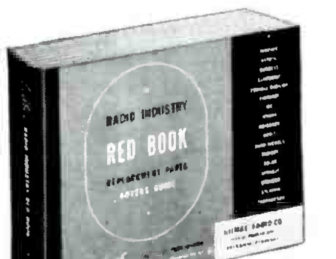


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NOW—stop wasteful hunting through dozens of incomplete parts manuals. The RED BOOK tells you *in one volume* what you need to know about replacement parts for approximately 17,000 sets made from 1938 to 1948. Includes complete, accurate listings of all 9 major replacement components—not just one. Lists correct replacement parts made by 17 leading manufacturers—not just one. Covers original parts numbers, proper replacement numbers and valuable installation notes on: Capacitors, Transformers, Controls, IF'S, Speakers, Vibrators, Phono-Cartridges. *Plus*—Tube and Dial Light data, and Battery replacement data. 448 pages, 8½ x 11; sewed durable binding. ONLY...... **$3.95**

### 1947 Changer Manual

Complete, accurate service data on over 40 postwar Record Changer models. Shows exploded views, photos from all angles. Includes change cycle data, adjustment notes, service hints, complete parts lists. PLUS—complete data on leading Wire, Ribbon, Tape and Disc Recorders. 400 pages; hard cover; opens flat. Order now! ONLY.............. **$4.95**

### Tube Placement Guide

Shows you exactly where to replace each tube in 5500 radio models, covering 1938 to 1947 receivers. Each tube layout is illustrated by a clear, accurate diagram. Saves time—eliminates risky hit-and-miss methods. 192 pages; handy index. ONLY.. **$1.25**

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**W. L. Parkinson,** manager of the Technical Service Section of *General Electric,* predicts a sale of approximately 120,000 television receivers in the New York metropolitan market within the next six months. He stressed the point that there must be an increase in dealer service facilities if this market is to be satisfied.

"The sale of television receivers," he said, "is directly dependent upon the service provided. Sales can only increase as fast as the radio service industry assumes the service obligation. The problem now is not how fast can we sell television receivers, but how fast can we, the service industry, install and provide service."

"We know that the time is not too far distant when the need for factory supervised service will no longer exist. We know that the wholesale distributor also is eager to turn the obligation over to the service industry. In the past two years, the service industry has made great gains in technical knowledge, and the manufacturers have invested many thousands of dollars in television training for the service industry. However," he concluded, "no one in the industry can predict just when the service industry will be able to take over full responsibility for television receiver installation and maintenance."

---

**Trend toward heavy fall production** of radio and television receivers was reflected in August as TV set output again reached a new monthly peak, the *Radio Manufacturers Association* reported.

RMA member-companies manufactured 64,953 television receivers in August for a new monthly record and an increase of almost 10,000 over the July output. Average weekly production of 16,238 TV sets in August showed an increase of 51 per cent over the weekly production for the first half of this year. FM-AM set production by RMA member-companies totalled 110,879 in August to record the largest output of this type of receiver since last March. Radio receiver production of all types totalled 870,044 in August compared with 627,349 in July. Production of automobile and portable radios aggregated 256,594 and 178,323, respectively.

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**Paul V. Galvin,** president of *Motorola, Inc.,* Chicago, has announced that as a result of its recent purchase of the "inventory and certain assets" of the Car Radio Division of International Detrola Corp., Detroit, *Motorola* will now for the first time supply sets to automobile manufacturers. For 20 years, the Motorola Company has sold automobile radios to consumers only.

---

**The Department of Commerce** reported that during the month of July sales by independent radio stores throughout the nation were 2 per cent below July, 1947.

---

**Westinghouse Electric Corp.** has disclosed a plan called the *Westinghouse Equity Plan,* designed to encourage local banks to handle the financing of radio and electrical appliances purchased by local Westinghouse dealers and their customers.

L. H. Lund, vice-president and treasurer of *Westinghouse,* said that banks participating in the program would be afforded many protective assurances, not before available.

The plan, which is being sent to the nation's 15,000 banks, "has been carefully scrutinized by sixteen of the leading consumer credit bankers of the country, acting as an advisory council to *Westinghouse.*"

"To the consumer, these agreements mean more equitable financing of the appliances and radios he buys as the result of economies the plan makes possible for the local banks," explained Mr. Lund. "They mean also that the consumer encounters less 'red tape' in getting his installment purchase arranged."

---

**Copies of the 1948 complete roster** of *The Representatives of Radio Parts Manufacturers, Inc.,* are available and will be furnished without charge to any manufacturer of radio and electronic parts and equipment who sends his request on his business letterhead to L. C. McCarthy, Secretary of The Representatives, 9 South Clinton Street, Chicago 6, Illinois.

The 72-page booklet, prepared by the Industry Relations Committee, lists more than 350 members of The Representatives alphabetically and by geographical regions.

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**The Department of Commerce** reports independent radio and musical instrument dealers showed an average gain in sales of 5% during the first six months of 1948 over a similar period last year.

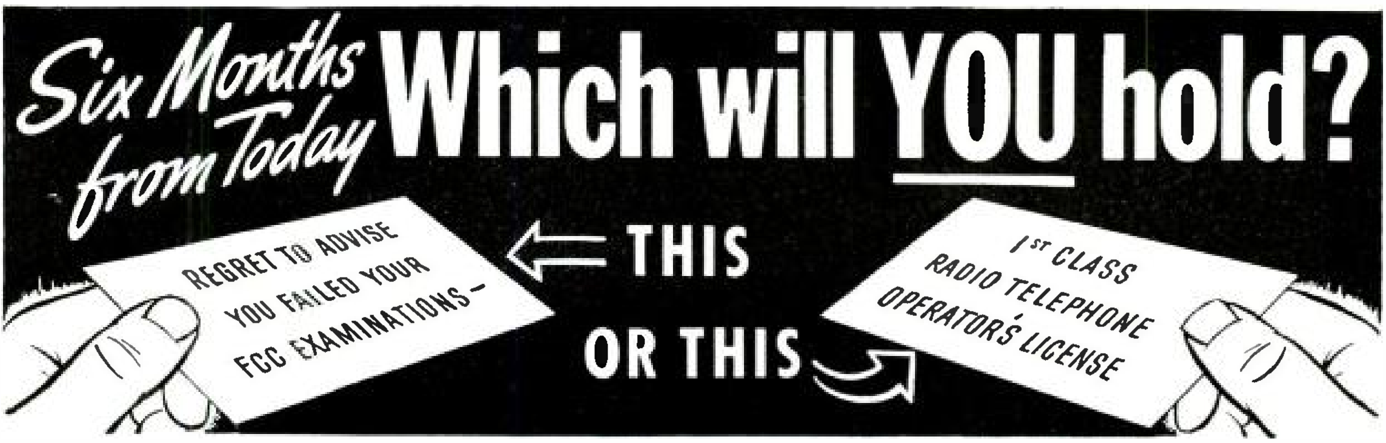
---

**John Pell,** manager of television service for the *Philco Corp.* of Philadelphia, has announced that the company has started a long-term program to train radio servicemen in the technique of television servicing.

"All Philco distributors in television cities are co-operating in this program aimed at developing many additional thousands of competent technicians familiar with all phases of servicing modern television receivers and in proper antenna installation, whether outdoor or indoor," Mr. Pell stated.

"The new course is available to all servicemen who have a sound basic technical knowledge of radio. These men include dealers, service managers and servicemen employed by dealers and independent servicing contractors."

"The Philco training course in television is designed to make it easy for every serviceman or technician with a fundamental knowledge of radio and preferably some practical experience, to obtain the technical schooling necessary to keep pace with the latest developments in television."

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"Transmitter engineering is great, especially in the job I am on. Thanks again for all you have done, and you can take the credit for the fact that my 'ticket' is now posted on the wall of a 1000 Watt broadcast station."
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Student #2355N2

"I take great pleasure in informing you that I have taken the examination for radio telephone first class license on June 29th, and passed and have received my license. I am now working at WCNH, a local 250 watt station."
Student #3171N12

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A genuine college-level radio engineering course, completely mathematical in treatment. For the advanced radioman with considerable practical experience and training.

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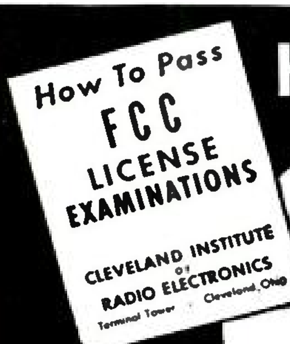


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# *Features* THAT MAKE HEATHKITS

## HEATHKIT FM and TELEVISION SWEEP GENERATOR KIT

A necessity for television and FM. This Heathkit completely covers the entire FM and TV bands 2 megacycles to 230 megacycles. The unit is 110V 60 cy power transformer operated. Uses two 6J6 tubes, two 6C4 tubes and a 6X5 rectifier. An electronic sweep circuit is incorporated allowing a range of 0 to 10 MC. A sawtooth horizontal sweeping voltage and phase control are provided for the oscilloscope.

The coils are ready assembled and precision adjusted to exact frequency. As in all Heathkits, the best of parts are supplied, Mallory filter condenser, zero coef. ceramic condensers, all punched and formed parts, grey crackle cabinet, 5 tubes, test leads, etc. Better get it built now and be ready for the FM and TV business. Shipping wt. 6 lbs.

**$24.50**

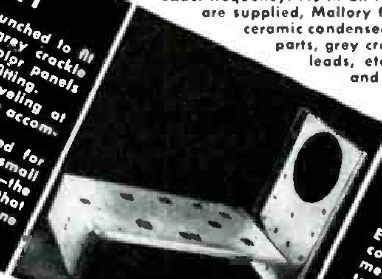
*Nothing* ELSE TO BUY . . .

### KITS THAT FIT

Heathkit chassis are precision punched to fit the quality parts supplied. The grey crackle aluminum cabinet and the two color panels are die punched to assure proper fitting.

Many builders have written marveling at the ease with which assembly can be accomplished.

The chassis are specially engineered for easy assembly and wiring—there are no small tight corners which cannot be reached—the ends of the chassis are left open in order that installation of parts and soldering can be done with both hands.



### COMPLETE INSTRUCTION MANUALS

Everyone is pleased at the thorough instructions covering the assembly of each Heathkit instrument. Every detail of the assembly is covered, together with sections on the use of the instrument and trouble shooting instructions in case of difficulty. Actual photos of the assembled instrument enable fast and accurate assembly, clear schematics and pictorial diagrams of the confusing parts such as rotary switches enable the wiring to be completed quickly.

## *Heathkit* SIGNAL GENERATOR KIT . . .

**$19.50**

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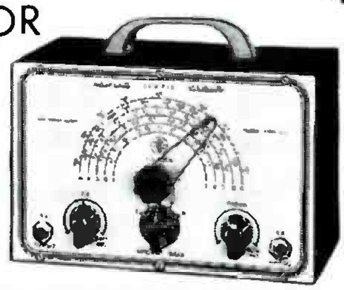
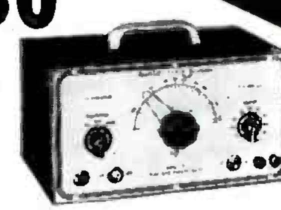


Every shop needs a good signal generator. The Heathkit fulfills every servicing need, fundamentals from 150 Kc to 30 megacycles with strong harmonics over 100 megacycles covering the new television and FM bands. 110V 60 cycle transformer operated power supply.

400 cycle audio available for modulation or audio testing. Uses 6SN7 as RF oscillator and audio amplifier. Complete kit has every part necessary and detailed blueprints and instructions enable the builder to assemble it in a few hours. Large easy to read calibration. Convenient size 9″ x 6″ x 4¾″. Shipping weight 4½ lbs.

## *Heathkit* SINE AND SQUARE WAVE AUDIO GENERATOR KIT . . . $34.50



The ideal instrument for checking audio amplifiers, television response, distortion, etc. Supplies excellent sine wave 20 cycles to 20,000 cycles and in addition supplies square wave over same range. Extremely low distortion, less than 1%, large calibrated dial, beautiful 2 color panel, 1% precision calibrating resistors. 110V 60 cycle power transformer, 5 tubes, detailed blueprints and instructions. R.C. type circuit with excellent stability. Shipping Wt. 15 lbs.

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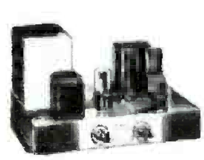
## HEATHKIT HIGH FIDELITY AMPLIFIER KIT

**$14.95**



Build this high fidelity amplifier and save two-thirds of the cost. 110V 60 cy transformer operated. Push pull output using 1619 tubes (military type 6L6's), two amplifier stages using a dual triode (6SL7), as a phase inverter give this amplifier a linear reproduction equal to amplifiers selling for ten times this price. Every part supplied; punched and formed chassis, transformers (including quality output to 3-8 ohm voice coil), tubes, controls, and complete instructions. Add postage for 20 lbs.

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Ideal way to convert military sets. 110V 60 cy. transformer operated. Supplies 24 Volts for filament—no wiring changes inside radio. Also supplies 250V D.C. plate voltage at 50-60 MA. Connections direct to dynamotor input. Complete with all parts and detailed instructions. Shipping wt. 6 lbs.

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## HEATHKIT CONDENSER CHECKER KIT

**$19.50**

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Checks all types of condensers, paper mica—electrolytic—ceramic over a range of .00001 MFD to 1000 MFD. All on readable scales that are read direct from the panel. NO CHARTS OR MULTIPLIERS NECESSARY. A condenser checker anyone can read without a college education. A leakage test and polarizing voltage of 20 to 500 volts provided. Measures power factor of electrolytics between 0% and 50%. 110V 60 cycle transformer operated complete with rectifier and magic eye tubes, cabinet, calibrated panel, test leads and all other parts. Clear detailed instructions for assembly and use. Why guess at the quality and capacity of a condenser when you can know for less than a twenty dollar bill. Shipping wt. 7 lbs.

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### HEATHKIT SIGNAL TRACER KIT

Reduces service time and greatly increases profits of any service shop. Uses crystal diode to follow signal from antenna to speaker. Locates faults immediately. Internal amplifier available for speaker testing and internal speaker available for amplifier testing. Connection for VTVM on panel allows visual tracing and gain measurements. Also tests phonograph pickups, microphones, PA systems, etc. Frequency range to 200 MC. Complete ready to assemble. 110V 60 cycle transformer operated. Supplied with 3 tubes, diode probe, 2 color panel, all other parts. Easy to assemble, detailed blueprints and instructions.

Small portable 9" x 6" x 4¾". Wt. 6 pounds. Ideal for taking on service calls. Complete your service shop with this instrument.

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**$8.75**

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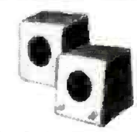

Ideal call and communication system for homes, offices, factories, stores, etc. Makes excellent electronic baby watcher easy to assemble with every part supplied including simple instructions. Distance up to 1/5 mile. Operates from 110V A.C. 3 tubes, one master and one remote speaker. Shipping Wt. 5 lbs.

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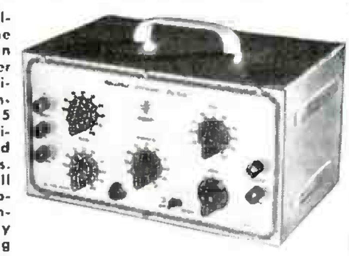
DOUBLES THE UTILITY OF ANY SCOPE

An electronic switch used with any oscilloscope provides two separately controllable traces on the screen. Each trace is controlled independently and the position of the traces may be varied. The input and output traces of an amplifier may be observed one beside the other or one directly over the other illustrating perfectly any change occurring in the amplifier. Distortion—phase shift and other defects show up instantly. 110 Volt 60 cycle transformer operated. Uses 5 tubes (1—6X5, 2—6SN7's, 2—6SJ7's). Has individual gain controls, positioning control, and coarse and fine sweeping rate controls. The cabinet and panel match all other Heathkits. Every part supplied including detailed instructions for assembly and use. Shipping weight 11 lbs.



**$34.50**

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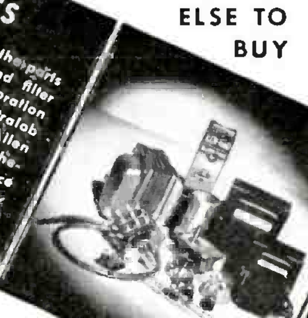
### COMPLETE KITS

When you receive your Heathkit, you are assured of every necessary part for the proper operation of the instrument. Beautiful cabinets, handles, 2 color panels, all tubes, test leads where they are a necessary part of the instrument, quality rubber line cords and plugs, rubber feet for each instrument, all scales and dials ready printed and calibrated. Every Heathkit is 110V 60 cy. power transformer operated by a husky transformer especially designed for the job.

### BEST OF PARTS

You will find many famous names on the parts in your Heathkit. Mallory switches and filter condensers, Chicago Transformer Corporation and Electrical Assembly Transformers, Centralab Potentiometers, Belden Cable, IRC and Allen Bradley resistors, G. E. tubes, Cinch and Amphenol sockets with silver plated contacts, Defiance variable condensers, Eby binding post and many other quality parts. The finest of parts are used to assure long trouble-free service from Heathkits.



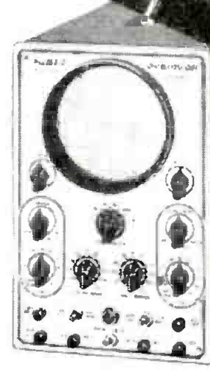
### *New* 1948 HEATHKIT 5" OSCILLOSCOPE KIT

A necessity for the newer servicing technique in FM and television at a price you can afford. The Heathkit is complete, beautiful two color panel, all metal parts punched, formed and plated and every part supplied. A pleasant evening's work and you have the most interesting piece of laboratory equipment available.

Check the features—large 5" 5BP1 tube, compensated vertical and horizontal amplifiers using 6SJ7's, 15 cycle to 30 M cycle sweep generator using 884 gas triode, 110V 60 cycle power transformer gives 1100 volts negative and 350 volts positive.

Convenient size 8½" x 13" high, 17" deep, weight only 26 pounds.

All controls on front panel with test voltage and ext. syn. post. Complete with all tubes and detailed instructions. Shipping weight 35 pounds. Order today while surplus tubes make the price possible.



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NO. 203. Model TU10B covers 10 Mc. to 12.5 Mc. New complete with aluminum cabinet. The best buy of surplus. Over $30.00 worth of new variable condensers, coil, dials, switches, etc. Add postage for 20 lbs.
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G.E. 50 AMP CIRCUIT BREAKER
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NO. 211. Tiny Delco motor only 1" x 1¼"x2" 10,000 RPM. Operates from 6 to 24 V. Excellent for models. Add postage for 1 lb.
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PE 125 TRANSMITTER POWER SUPPLY
NO. 223. Operates from 12 to 24 Volts and supplies 500 Volts at 160 MA. Extremely rugged construction used in Army tanks. Complete with fuses — relays — filters, etc. Ideal for boats. Shipping Weight 73 lbs.
$12.95
FM PUSH BUTTON TUNER
NO. 224. Brand new ten push button tuning assembly from Army FM receiver. Contains 4 gang 100 MMF silver plated tuning condenser. Add postage for 10 lbs. $2.50 EACH
RG 8/U FLEXIBLE COAXIAL CABLE
4¢ PER FOOT
NO. 225. Standard television lead in 52 ohm. Any length up to 1,000 ft. Add for postage.
274N COMMAND SET ACCESSORIES
NO. 238. 5" PM Speaker with output transformer matching headphone output ........ $2.80
NO. 239. Dual receiver rack FT277A with connecting plugs........ $1.00
NO. 240. Single transmitter rack FT234A ........ $1.00
NO. 241. Spline shaft for tuning command receivers. Allows use of regular tuning knob on BC 453-4-5 receivers ........ $ .39
BC 451 CONTROL BOX
NO. 236. Control box for 274N transmitters. Contains proper cw-voice switch, 4 channel switch, power switch, mike jack and telegraph key.
Add postage for 2 lbs........ $1.95
P. E. 103 6 VOLT DYNAMOTOR
NO. 212. Dynamotor only from PE 103 power supply. Input 6 or 12 Volts, output 500 Volts at 160 MA. Brand new original cartons. Shipping Weight 29 lbs.
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NO. 213. An ideal dynamotor for mobile operation in taxicabs, police cars, sound systems and amateur stations. Supplies above voltage from 12 Volts or 500V. at 350 MA from 6 Volts. Complete with starting relay, and fuses. New. Our Dynamotor A. Shipping Weight 72 lbs.
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NO. 215. Western Electric 24 Volt input, 220V. at 60 MA out. With filter assembly. Shipping Weight 6 lbs........ $2.95
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NO. 226. Primary 117V. 60 cycle. Secondaries supply 746 V.CT at 220 MA, 6.3V. at 4.5 A., and 5V. at 4A, Will handle 13 tube radio receivers. Supply is limited, order early. Shipping Weight 11 lbs. each.
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NO. 231. Matches any aerial to 150 Watt transmitter, used on BC 375. Brand new. Add postage for 20 lbs........ $2.95
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NO. 229. Convert your military receivers without rewiring the filament. "A" type supplies 500 VCT at 50 MA, 5V. at 2A. and 24V. at ½ A. "B" type supplies 500 VCT at 50 MA, 5V. at 2A. and 12V. at 1 Amp. State whether A or B type desired. $2.95
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W.E. BC456 MODULATOR
NO. 217. Modulator from 274N command transmitters contains 3 husky relays, 3 tubes, VR150, 12J5 and 1625. Brand new. Add postage for 11 lbs. $3.95
A-62 ARMY PHANTOM ANTENNA
NO. 206. Contains tuning condenser, coil, resistors, tuning dial, tuning indicator, binding posts, steel case, useful for building amateur transmitter. Add postage for 8 lbs........ $1.95
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NO. 218. Contains zero center volt-milliammeter, switches, relays, voltage divider resistors, neon indicator, etc. Excellent foundation for radio tester. Shipping Weight 10 lbs.
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BENDIX MN 20E DIRECTION FINDER LOOP
NO. 219. Ring type loop excellent for use on boat or aircraft. Extremely rugged construction. Low impedance manual type. Add postage for 8 lbs. $9.95 EACH
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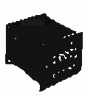

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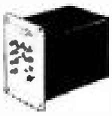

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NO. 253. A husky vibrator used on army transmitter. Rated 30 amperes at 6 Volts 220 cycle with contacts for 12 and 24 Volts, Synchronous type, has many industrial applications. Ship. Wgt. 3 lbs. Each .....

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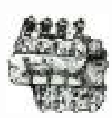

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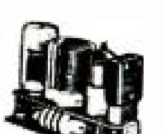
**BC 746 TUNING UNIT**



NO. 257. Plug in transmitter tuning unit from army Walkie Talkie. Contains antenna and tank coils, tuning condenser, transmitting and receiving crystals. Ideal transmitter foundation. Shipping Wgt. 1 lb. Each **$1.00**
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**BRAND NEW ARMY AIR FORCE**

## ASTROGRAPH

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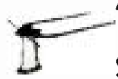
**AN27/ARN5 ANTENNA**

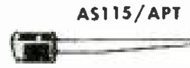


NO. 260. Standard blind landing antenna system. Brand new in original crate. Ship. Wgt. 14 lbs. **$9.50**

**AS114/APT ANTENNA SYSTEM**

NO. 261. New blade type antenna complete with case assembly in original carton. Shipping Wgt. 9 lbs. $7.50

**AS115/APT ANTENNA SYSTEM**



NO. 262. New blade type antenna complete with case assembly, in original carton. Ship. Wgt. 11 lbs. $7.50

**AT38A/APT RADAR ANTENNA**

NO. 263. New radar dome type antenna with mounting base and connections, in original carton. Ship. Wgt. 11 lbs. **$14.50**

**AN104A BLADE ANTENNA**

NO. 264. Standard blade antenna used on many military fighting planes with coaxial connection at base. Shipping Wgt. 3 lbs. **$1.50**

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**BK 22 RELAY ASSEMBLY**

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NO. 267. Heavy duty type 7 Amp. 24 Volt D.C. Many uses around shop. Shipping Wgt. 2 lbs. Each **$1.00**

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NO. 285. Rated 10 ohms. 3.2 Amps. Maximum. 6½" diameter with knob and mounting feet, can be used to regulate generator output voltage. Shipping Wgt. 5 lbs. Each **$2.50**

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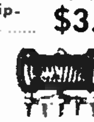
NO. 268. Thermo Relay with a range of 45 to 100 complete with 5 Ft. flexible cable to immersion bulb. Shipping Wgt. 6 lbs. **$3.50**

**B & W 11 to 14 MC TANK COIL**



NO. 281. Plug in type used on BC 610 Transmitter. New, original cartons. Shipping Wgt. 2 lbs. Each **$1.50**

**DM 64A 12 VOLT DYNAMOTOR**

NO. 269. Input 12V at 5 Amps. Output 275 Volt 150 MA. New. Shipping Wgt. 7 lbs. Each **$5.50**

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NO. 270. Part of 274N Command Receivers. Input 28 Volts, output 250V at 60 MA. Shipping Wgt. 4 lbs. Each **$5.50**

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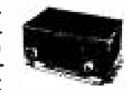
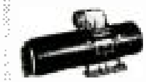
NO. 271. Used in Army BC 312 Communication Receiver. Input 12 Volts at 3.3 Amps. Output 235 Volts at 90 MA. New, original cartons. Shipping Wgt. 8 lbs. Each **$5.50**

**PE94C SCR 522 POWER SUPPLY**



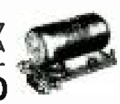
NO. 272. Complete dynamotor power supply for the SCR 522. operates from 28 Volts. Complete with controls, filters, etc. Original carton. Shipping Wgt. 34 lbs. Each **$8.75**

**PE101C BC645 POWER SUPPLY**



NO. 273. Complete power supply for BC 645. Operates from 12 or 24 Volts. Supplies both AC and DC required. Shipping Wgt. 13 lbs. Each **$3.95**

**DM 35 12 VOLT DYNAMOTOR**



NO. 274. New input 12 Volt at 18.7 Amperes. Supplies 675V at 275 MA or ½ above voltage from 6 volts. Excellent for auto use. Shipping Wgt. 11 lbs. Each **$7.50**

**PE 86 DYNAMOTOR**

NO. 214. A popular 28 Volt receiver dynamotor used on present military equipment. Supplies 250V at 60 MA. Shipping Wgt. 4 lbs. Each **$5.50**

**GN 58 HAND GENERATOR**

NO. 275. Makes excellent home lighting plant, operated by wind propeller, waterfall, gas engine, or hand crank. Reduction gear allows full output at slow speed; supplies 6 volts at 2.45 amp., 425 volts at .115 amp. New. Add postage for 28 lbs. Each **$7.95**
Handles for GN 58 $ .50 each
Connecting cord for GN 58 with plugs CD1086 $1.50 each

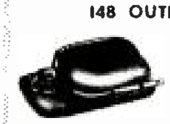
**COLLINS AUTOTUNE CONTROL HEAD**

NO. 278. Brand new controls used on the ART/13, 100 Watt, Transmitter. Types 7, 8, 10, and 11 available. Get a spare while available as new cost is over $22.00 each. Shipping Wgt. 3 lbs. Price any type (mention when ordering) Each **$4.50**

**MC 432 VHF ANTENNA LOADING UNIT**

NO. 279. Contains 2 pole, 5 position rotary switch with silver ceramic variable condensers, and coils for matching VHF Transmitter to AN109 antenna with 50 ohm line. Many useful parts. Shipping Wgt. 2 lbs. Each **$1.50**

**148 OUTDOOR TELEGRAPH KEY**



NO. 280. Rugged enclosed type for outdoor use, built for army to withstand hard useage. Complete with cord and PL55 plug. Shipping Wgt. 2 lbs. Each **$2.00**

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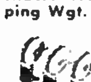
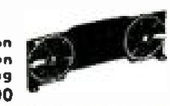
**300 MA SELENIUM RECTIFIERS**



NO. 209. Rated 300 MA at 36 Volts, complete with mounting brackets. Shipping Wgt. 1 lb. 3 FOR $1.00

**DUAL SELENIUM RECTIFIER**



NO. 283. Two units mounted on single bracket, each section rated 15V. at ½ Amp. Shipping Wgt. 1 lb. 2 FOR $1.00

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# MULTIPERCEPTION

## Television will change our habits even more than radio . .

By HUGO GERNSBACK

PSYCHOLOGISTS are insistent in pointing out that human beings do not make the most of their brain power. Each new technical advance, every new tool, many new inventions open up entirely new avenues of human progress. We take most of these things for granted and seldom realize that we are still at the beginning of exploiting our mental powers.

Radio not only changed a number of our former habits, but also brought us numerous new accomplishments not known before the advent of broadcasting. The masses are today much better informed in almost every line of human endeavor. Our musical appreciation has taken on new meaning and risen to new heights. A wealth of information and knowledge only known to serious students before Radio, is commonplace today.

Our perception also has been greatly enhanced in a manner not even dreamt by Dr. de Forest when he first launched broadcasting at the turn of the century.

The new rising generation now already uses radio in a way that the older generation totally fails to comprehend. The younger people now listen routinely to radio practically constantly—irrespective of what they may be doing at the time. Thus, recently we noted how students of both sexes in the midst of preparation for their Regents examinations —a most difficult and harrowing experience—kept their radios going full blast while they were completely immersed in their studies. Our questioning brought out the fact that the youngsters could study and listen simultaneously—a thing the older generation has never learned to do.

Here we have to do with a phenomenon—*multiperception of the human brain.* If this were an isolated example, perhaps it might be thought unusual. But, as we look around us we see that all the younger people are doing precisely the same thing, whether they are stenographers, switchboard operators, factory hands, accountants, or working at countless other professions and endeavors.

At first we might doubt that this double perception would be sufficiently deep to be retained for all practical purposes, but we soon find that, indeed, the human being *can* listen and study or work at the same time and absorb *both.*

This, after all, is not any more difficult to understand than specialized multiperception endeavors with which we have been familiar for centuries.

We will give only a single example. An organist can and does play the organ not only with both hands, but also with both feet at the same time. On top of this he not only reads his notes, but if necessary he can also read the words of the theme and sing at the same time. This is *five-fold multiperception:* playing the organ by hand, by foot, reading the notes, reading the words, and singing. Once the organist is properly trained he finds no difficulty in doing all these functions routinely. This would seem a most complex undertaking of the human machine and, indeed, it is just that.

If a psychologist were to analyze and enumerate *everything* that happens while the organist is at work, a good-sized book could be filled with all the processes involved.

Remember that the brain must give the impulse to everything that goes on; even such a "simple" thing as reading a note and striking exactly the right key without looking at the keyboard, would fill many pages of the book on nerve impulse-muscle coordination, etc.

It should be well understood that all new endeavors are best learned in youth. Older people find it difficult to coordinate. The youngster, for instance, has no trouble in learning to typewrite—whether sight or touch— while older people find it difficult to master it—if they ever do.

We now come to television, where a most interesting possibility of multiperception exists. Listening to the radio means only sound—with closed eyes if necessary. Or, you may have your back turned to the receiver. Not so with television.

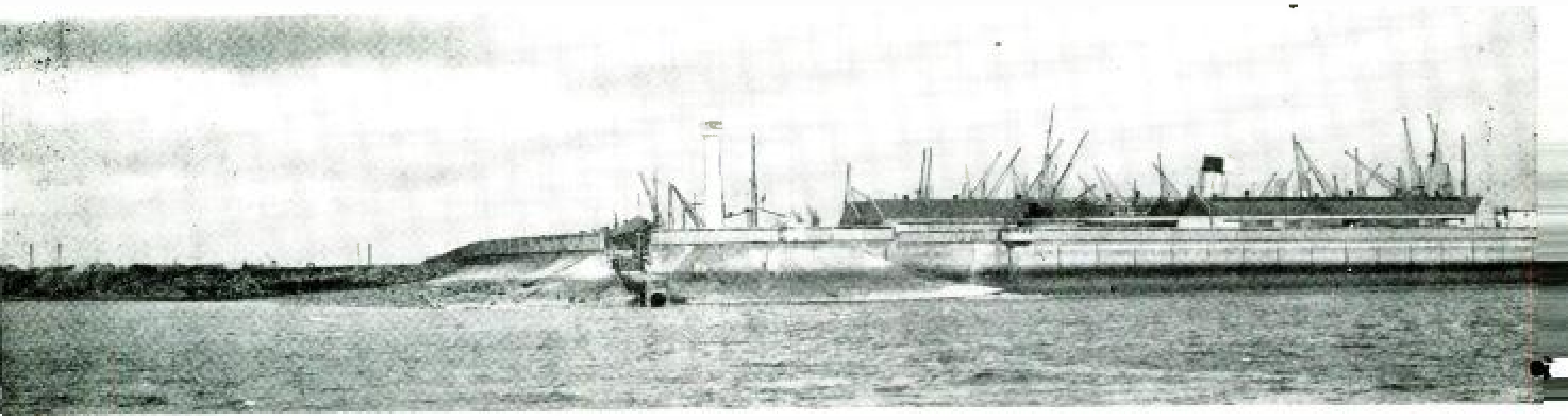
*Here you must look at the image.* But present-day civilization being what it is, television is going to be a terrifically time-consuming undertaking for all of us. Are we in the future going to sit motionless before our television receivers as we do now? Certainly not. The present generation now, not even in their teens, will act differently. They will find it easy to study, read books, listen, and look at the television set simultaneously. We might think this a difficult order, but it really is not.

Television table models are already being made. Soon they will be built into tables and desks with the screen at the correct angle so when we sit at our desks and work, we will train our eyes not only to read our books or do our work, but also manage to see what is on the television screen as well.

This means coordination of a different sort than we have been accustomed to up to now. It means our eyes will have to be trained to quickly look up, then down through a small angle. This is not so impossible as it sounds. When the piano student learns to play he has to watch his hands and read the notes at the same time. All this takes time, but can be mastered to perfection within a few years. Moreover, the angle through which the eyeball has to move in piano playing is far greater than the angle from book to television screen. (If the tele-set is on the desk.)

Will the new and coming generation perceive everything on the television screen in addition to doing its work, or reading books efficiently? The answer is yes. You may not be able to view everything 100% in this manner, but if you see 80% or 90% of the action this will be sufficient to give you a good comprehension even if a fast baseball game is in progress. Will all this extra work fatigue or damage the eye? Not in the slightest. We do not work our muscles sufficiently anyway, nowadays, according to physicians.

The only strain caused by our present-day television sets is due to insufficient illumination in our cathode-ray tubes. This, however, is only a passing condition of the new art. Future television receivers will have such brilliantly lighted screens that they can be viewed in bright daylight, or at night with a strong table lamp on the same desk.



The radar installation is at the northwest corner of Gladstone Dock, a strategic position which adds to the efficiency of the equipment.

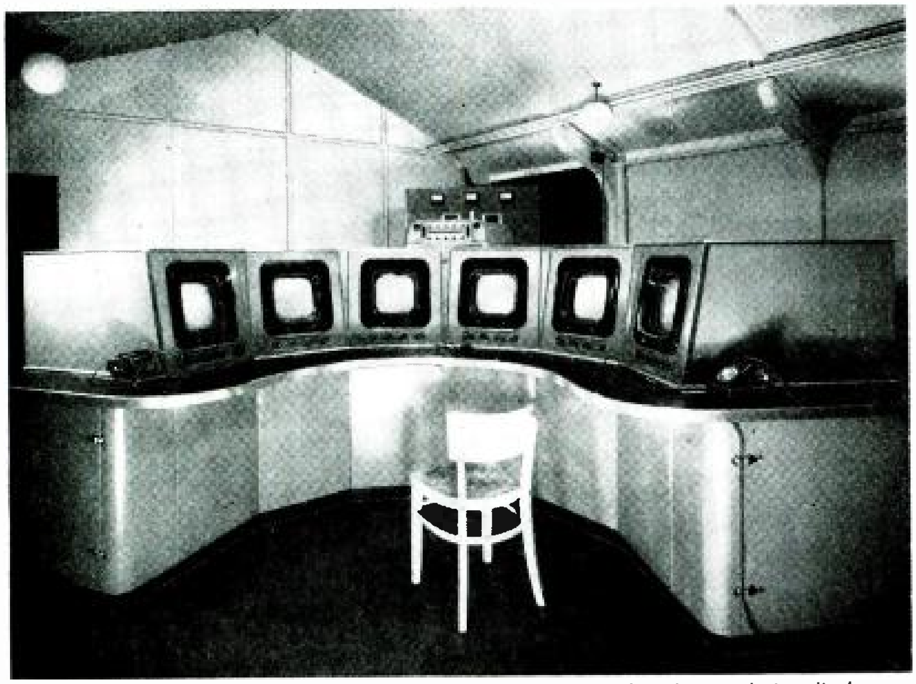
# Radar Eyes Bring Safety To Fog-Bound Liverpool

By
Major RALPH W. HALLOWS

HANDLING more than 10 million tons of goods each year and serving the densely populated northwestern industrial areas, Liverpool is one of the most important of Britain's seaports. It is also one of the most difficult in the world for shipping. A glance at the map will make one of the reasons for this clear. The port lies at the head of a winding channel 12 miles in length and nowhere much more than a quarter of a mile wide. The channel divides the great sandbanks of Liverpool Bay. On that stretch of coast, with its 30-foot tides, the sand is always on the move; in the last 60 years the annual amount of it dredged from the Mersey Channel has averaged 14 million tons. The channel is very carefully marked by three light vessels and between 50 and 60 powerful acetylene buoys (every black dot on the map shows the position of one of those buoys); in fact, its appearance on a clear night has been likened to that of the main street of a great town.

No map, though, can show the greatest of all menaces to shipping in narrow waters, *the demon fog;* and Liverpool is subject to dense and frequent fogs in the colder months of the year. In the past that fog or falling snow might bring the business of the port to a standstill and keep it inactive for days on end.

Because of the narrowness of the channel big ships can neither turn round nor anchor in it. An average of a score of ocean-going vessels enters and leaves the port every day; and once the captain of one of them has decided either to enter the channel at the Bar light vessel or to put to sea from the Liverpool docks, there is no turning back. He must go on. On this account many vessels in the past missed one or more tides for reasons of prudence. And missing even one tide is an expensive business for a big ship; the average loss is about $2,000.



The screens show four main areas, a complete view of the channel, and a wandering display.

Today Liverpool and the ships using the port no longer dread the fog menace. The first complete radar approach system in the world is in use. No matter what the weather, the whole of the channel from the Bar lightship to the Liverpool docks and for some miles upstream is seen on the radar screens as clearly as the proverbial back of one's hand. Liverpool, in a word, has installed a radar system which may well revolutionize the traffic systems of half the world's great harbors. The Liverpool port authorities emphasize that it is *not a control system.* The responsibility for deciding what his ship shall do in any circumstances must always remain with the captain. In other words, he does not and will not receive orders from the shore. But he can at any time receive by radio telephone the exact position of his own vessel, of other vessels in the channel, or of any obstruction. In combination with the information provided by his own shipborne radar, this knowledge will enable him to sail safely inward or outward in weather conditions which in the past would have meant missing one or more tides.

The radar installation is entirely of

British design. The work was carried out by the British Sperry Gyroscope Company (an associate of the American company of the same name) in conjunction with the Cossor Radio Company, both working with the collaboration of Sir Robert Watson-Watt, the originator of Britain's wartime radar chain. The screens of its presentation unit (see photo) give complete coverage of the whole channel. The normal maximum seaward range is 14 miles, but this can be increased to 22 miles when required, by the use of a switch.

These are six 15-inch presentation tubes, the "picture" occupying about 100 square inches around the central and least distorted part of each. No. 1 screen gives a small-scale view of the whole channel. The areas covered, on a scale about four times as great, by Nos. 2, 3, 4, and 5 are shown by the squares on the map. Notice that the areas have a slight overlap and in combination give a large-scale view of the entire channel. The sixth picture is in some ways the most interesting of all. It is known as the wandering display and can be moved at will to any one of 22 positions so as to give large-scale coverage of any desired part of the Mersey Estuary or of Liverpool Bay. It can thus be used to give an additional picture of any area in which there is congestion. Or, it can, if need be, replace temporarily any of the four fixed large-scale displays if necessary.

The scanner is a "cheese" antenna 15 feet in diameter by 2 feet deep, mounted at the top of an 80-foot ferro-concrete tower at the northwest corner of the Gladstone Dock. Close to the foot of the tower is a building containing the transmitter, receiver, power supply, and display unit.

The scanner itself is built of horizontal slats with gaps between them, not from a continuous sheet of metal. This is to reduce resistance to the high winds which often occur. It is heated to prevent icing in the coldest weather and rests on rollers arranged to prevent distortion of the reflecting surface by temperature changes. Driven by a 6-h.p. motor housed in a weatherproof compartment in the tower, it makes 10 revolutions per minute.

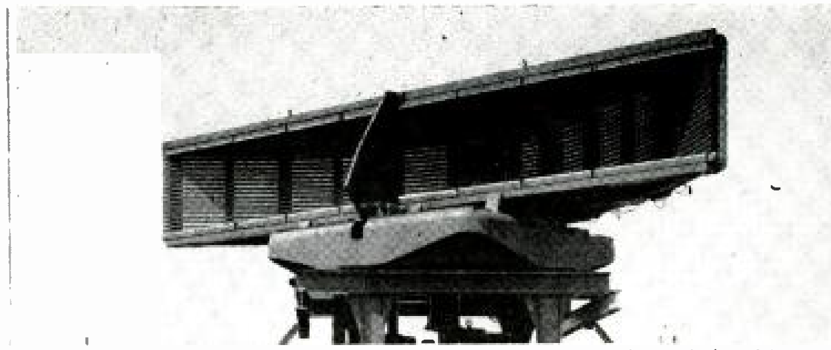
The peak pulse power of the transmitter is 30 kw, with a 0.25-microsecond pulse and a repetition frequency of 1,000 per second. The frequency band used is 9,425 to 9,525 mc (wavelength = approximately 3 cm). Special precautions have been taken in the design of the mirror to reduce side lobes. The width of the beam is 0.7 degree horizontally and 5 degrees vertically. The discrimination is better than 45 minutes in bearing and 40 yards in range.

Now for some particulars of the displays, which have already been briefly mentioned. These are an entirely new type of P.P.I. (plan position indicator), which gives true plan presentation without distortion. An interesting point is that, owing to the long afterglow, a moving ship leaves what looks like a wake on the tube; therefore, it is easy to see at a glance the direction in which any vessel is moving. In front of each tube is a transparency on which all light buoys and other floating sailing marks are shown in green. It is most important that the positions of these should be constantly checked and any displacement announced at once. Formerly this was a laborious business needing a large staff. Now checking is automatic, for operators can see at a glance whether or not the radar echoes coincide with the green marks on the transparency.

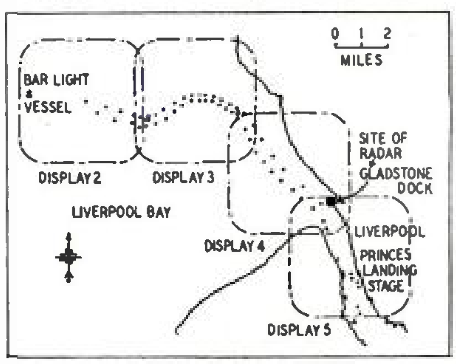
The transparency carries also a red lattice of grid lines. In this way the position of any ship can be plotted in the display room in a matter of seconds on a large-scale chart, which carries the same grid lines. Should a vessel require a quick "fix" of her position, this can be read straight off the P.P.I. screen and radioed instantly to her.

At the present time the movements of all ships up and down the river and their positions from moment to moment are telephoned continuously to the administrative headquarters of the port from the radar operating room. At headquarters they are plotted on a large chart. It is intended shortly to replace this telephone communication by a television link.

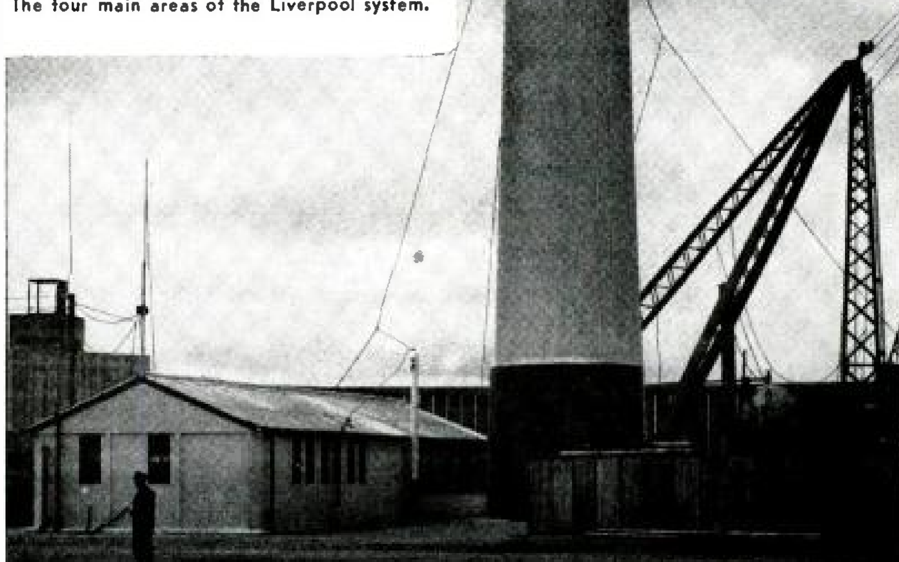
An important part of the Liverpool radar scheme is the direct service from radar operating room to ship by radio telephone. This is conducted on a special frequency, and when the pilot boards any ship, he takes with him a portable pretuned transmitter-receiver.



Close-up of the rotating "cheese" antenna, built of strips to reduce wind resistance.




The four main areas of the Liverpool system.



Apparatus and operating room are in the building at foot of the 80-foot concrete tower.

Cover Feature


By VIRGINIA WALTERS*

WHY use waveguides? At microwave frequencies (frequencies above 300 mc) the inductance of a twin-lead or co-axial line becomes so high and the capacitance so low that such transmission lines cannot be used.

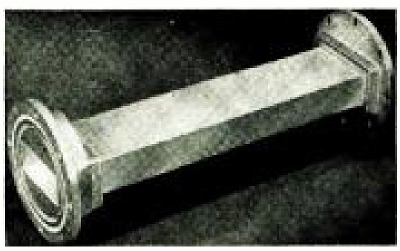


Fig. 1—Waveguide section for 3950-5850 mc.

Skin effect is practically negligible at lower frequencies. The current is distributed almost uniformly through a conductor. At higher frequencies most of the current is confined to the outer surface of the conductor, and a transmission line which conducts lower frequencies well looks like a resistance to microwaves. Electromagnetic energy cannot be conducted by one of these transmission lines. Instead it must be propagated in a waveguide.

Waveguides are hollow rectangular or circular pipes (see Fig. 1). They have tremendous advantage over co-axial lines as far as high power is concerned, and can carry up to five megawatts with very low losses. This is the highest power ever obtained. Waveguides are broad-band as well. A variation of 35 to 40% in the frequency is possible without serious attenuation.

Everyone who has worked with short waves is familiar with the natural waveguide that causes skip. Sometimes reception is surprisingly good at some distance from the transmitter, sometimes it is distorted, and sometimes the signal is not received at all. Fig. 2 helps to illustrate this problem. The transmitted signal may bounce back and forth between the earth and the Heaviside layer. If a receiver happens to be at a point where a signal of a particular frequency is reflected from the Heaviside layer, reception will be good. If the Heaviside layer is higher or lower because of atmospheric conditions, time of day, or other reasons, reception may be poor at this same point for the same frequency as before, but it may be good for another frequency. Reception is affected by a relationship between the transmitted frequency and the height of the Heaviside layer.

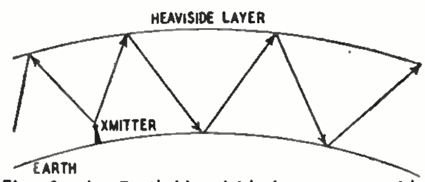



Fig. 2—An Earth-Heaviside-layer waveguide.

Actually this is simply a waveguide problem where the earth and the Heaviside layer are two walls of a waveguide. In the same way as a transmitter radiates power into the air, an antenna or metal *probe* introduces power into a waveguide. This electromagnetic energy bounces back and forth between the walls of the guide, but because of the particular frequency and the spacing between the walls, there is only one pattern the electromagnetic wave can take.

Figs. 3 and 4 help give a better understanding of the propagation of the wave. Fig. 3 shows the electrostatic field of a sine wave travelling in free space. A, C, and E are wavefronts. B and D are nodes or zero points. A and E are positive maxima, and C is a negative maximum. From A to E is a wavelength in free space. A to C or C to E is a half wavelength in free space. The direction of propagation is from E to A in the figure.

**TABLE I**

| | COLUMN A CLOSED OR SHORTED LINE | COLUMN B OPEN LINE |
|---|---|---|
| IF THIS LINE IS LESS THAN 1/4 WAVELENGTH | IT LOOKS INDUCTIVE | IT LOOKS CAPACITIVE |
| IF THE LINE IS 1/4 WAVELENGTH | IT LOOKS OPEN | IT LOOKS CLOSED |
| IF THE LINE IS BETWEEN 1/4 AND 1/2 WAVELENGTH | IT LOOKS CAPACITIVE | IT LOOKS INDUCTIVE |
| IF THE LINE IS 1/2 WAVELENGTH | IT LOOKS CLOSED | IT LOOKS OPEN |

The capacitive or inductive effects of different lengths of open or shorted waveguide.

*Staff Physicist, DeMornay-Budd, Inc., New York, N. Y.

A probe inserted in a waveguide will radiate waves. Fig. 4 shows what happens along two of these wavepaths. Positive maxima and negative maxima

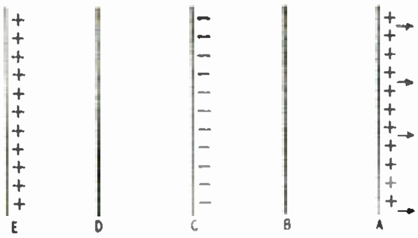


Fig. 3—An electrostatic field in free space.

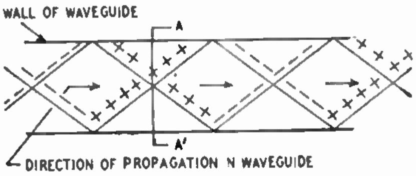


Fig. 4—How waves cancel at the walls and reinforce at the center of the waveguide.

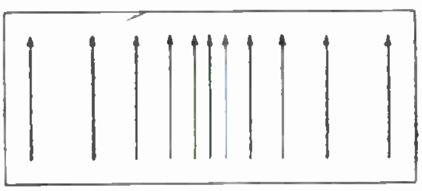


Fig. 5—Cross-section of guide, $TE_{0,1}$ mode.

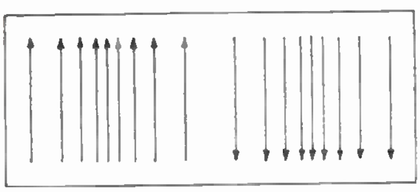


Fig. 6—An electric field of the $TE_{0,2}$ mode.

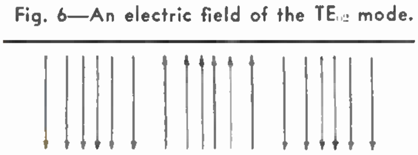


Fig. 7—Electrostatic field, guide of Fig. 5.

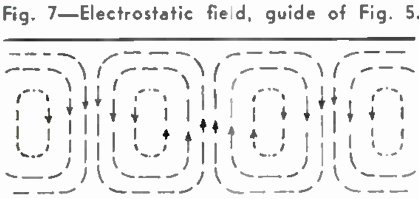


Fig. 8—Electromagnetic field of above guide.

meet alternately and add up to make a strong field at the center of the guide. The walls of the waveguide pass through points where the positive and negative maxima meet and cancel, so no electric field exists at the walls and there is no current along them. Fig. 5 shows the electric field of a cross-section of the waveguide at A-A' in Fig. 4. The field is strongest where the arrows are most closely grouped. The number of arrows goes from zero (near the left and right edges) to a maximum (at the center). This is known as a half-wave pattern. (Fig. 6 illustrates a full-wave pattern.)

The pattern of the wave described above is known as the $TE_{0,1}$ mode. This wave, like all electromagnetic waves, has electric and magnetic components. In this case TE means transverse electric because the electric field is across the guide or transverse to the direction of propagation. See Fig. 7, which is a side view of the waveguide of Fig. 5. The top view, Fig. 8, shows the magnetic field components.

In a *transverse magnetic* (TM) mode, the magnetic instead of the electric field is across the guide, with no part of a magnetic field line running along the guide, as it does in the TE mode illustrated in Fig. 8.

The subscripts 0 and 1 signify the number of half-wave patterns of the electric field along the two sides of the guide. The subscript 0 refers to the short side in Fig. 5 and the subscript 1 refers to the long side.

The size of a waveguide determines the lowest frequency it can carry. Above this frequency, known as *cutoff*, radiation may be propagated down the guide. When the frequency used is too high, there are other modes than the $TE_{0,1}$ which may be propagated. The wavelengths are shorter so there may be more half-wave patterns across the guide. These higher modes are known as $TE_{1,1}$, $TM_{1,1}$, etc. Higher modes complicate transmission problems, so it is common practice to operate a waveguide at frequencies where only the $TE_{0,1}$ and no other modes can exist.

## Microwave radio parts

Conventional resistors, condensers, and inductances cannot be used for microwaves, because their sizes are very nearly equal to the lengths of waves at frequencies above 300 megacycles. In place of the conventional parts, special microwave components are used. These give the same effects as resistors, capacitors, and inductances. Inductance or capacitance may be introduced by using guides of varying length. Table I is based on transmission line theory and shows the effects of the length of line when the line is closed or shorted (column A) or open (column B).

Instead of a resistor, a waveguide *attenuator* is used. It is constructed to absorb power and is used to cut down power in the line or to terminate the line. Fig. 9 shows a variable attenuator. It is usually a strip of dielectric material coated with a power-absorbing material, such as carbon. The strip is mounted in the section of waveguide and may be moved in and out through the slot in the guide. The strip has no effect when it is out of the guide, and reduces the power as it is moved into the guide.

Although capacitive and inductive effects appear at certain distances from the end of a shorted or open line as in Table I, it is not always convenient to terminate the line. Then capacitance or inductance must be introduced somewhere along the guide instead. *Windows*, as illustrated in Figs. 10 and 11, are used for this purpose. A window consists of two thin metal plates extending from opposite sides of the waveguide toward the center. The inductive or capacitive reactance increases with the depth of the metal plates.

## Microwave measurements

In microwave apparatus, it is important to know if the power is being propagated without losses. If there are losses, it is necessary to locate and measure them, so that they may be reduced. With the waveguide components so far described as a basis, many others have been designed for the most direct and obvious measurements of r.f. energy. The impedance of a waveguide is determined by its dimensions. For maximum power transfer, an impedance match is required. Impedance mismatch may be caused by discontinuities in the transmission line. Examples are: junction of two sections of waveguide where misalignment may occur, change of direction of propagation, variation of the internal dimensions. Such discontinuities partly or completely reflect the waves propagating forward, and set up another set of waves propagating backward. This is the effect you find if you attach one end of a rope to a wall and shake the other end. Waves travel to the wall, are reflected there, and start back again. If you shake the free end with the right timing, the waves going forward meet the waves coming backward so that they appear to stand still. These *standing waves* occur when waves propagating down a waveguide meet a discontinuity.

The mismatch may be measured in terms of the *voltage standing wave ratio*. This ratio is defined as the maximum voltage reading divided by the minimum voltage reading. The maximum voltage reading occurs at the crest of a standing wave and the minimum

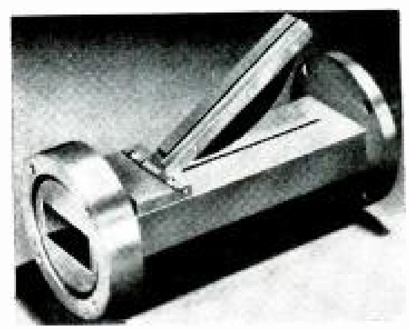
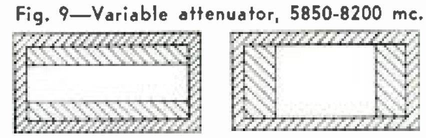


Fig. 9—Variable attenuator, 5850-8200 mc.


Figs. 10 and 11—Cross-section view of waveguides with capacitive and inductive windows.

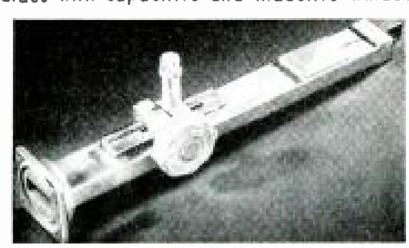


Fig. 12—A tuned load for 8200-12400 mc.

voltage reading occurs at the lowest point. If there is no reflection, the maximum and minimum readings will be the same, and the voltage standing

Fig. 13—Cavity wavemeter for 8400-9800 mc.

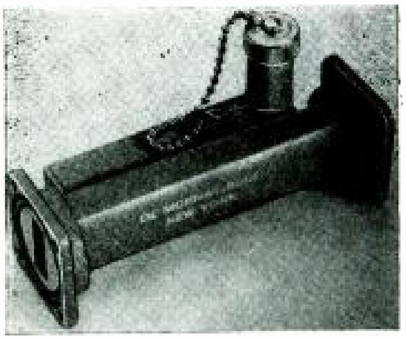


Fig. 14—Directional coupler, 8200-12400 mc.

wave ratio will be one. In this case there are no standing waves and so there are no stationary maxima and minima. (The maxima and minima of Figs. 3 and 4 are moving steadily down the guide.) If there is total reflection the ratio will be infinite because the minimum reading will be zero. Under normal conditions the standing wave ratio will be somewhere between one and infinity.

The standing wave ratio is measured with a *standing wave detector*. This instrument is made by slotting the top of a waveguide and inserting a probe which is supported by a movable carriage. The probe picks up the radiation, which is then fed through a detecting device such as a crystal and into an amplifier to a meter, which may be calibrated directly in standing wave ratio. The probe is first moved to a voltage maximum, and the meter is set to full scale. The probe is then moved to a voltage minimum, and reading on the meter then shows the standing wave ratio.

It is necessary to find the standing wave ratio to determine the amount of mismatch of a component which is to be included in a microwave device. A component to be measured is inserted in the transmission line, *which must be terminated by a perfectly matched impedance*, so that any reflections are due to the component alone and not to the termination. This requires some type of termination which must be adjustable to meet the requirements of different test set-ups. In general a *tuned load* is used (Fig. 12). A tuned load consists of (a) a probe whose depth of insertion and whose position along the length of the guide may be controlled and (b) an absorbing strip. The probe has a capacitive effect which increases with the depth of insertion. If the probe is moved a quarter wavelength along the guide, an inductive effect will appear where before there was a capacitive effect. At intermediate positions of the probe, it will look as if there were more or less inductance or capacitance at the original position. In this way, any amount of reactance due to the reflections set up by the connecting flanges and the absorbing strip may be matched out. The ideal absorbing strip is pure resistance and absorbs all the power. But some reflections are caused by the edge of the strip in spite of the fact that it is usually tapered to minimize the surface area presented to the oncoming waves.

For each different frequency at which a test is to be made, the load must be tuned. The load is connected directly to the standing wave detector. The two tuning controls are varied until the standing wave ratio is one; this means the line is perfectly matched. The waveguide component to be tested is then inserted between the standing wave detector and the tuned termination. The standing wave ratio under these conditions is due only to the component under test and not to the termination.

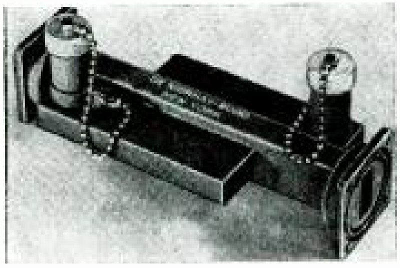


Fig. 15—Example of a bidirectional coupler.

## The cover picture

The test set-up pictured on the cover is arranged for just such measurements. Three tubes are used, one operating at each frequency at which a measurement is desired. These are fed into the main line through a triple input guide. A switch enables the technician to select one tube at a time, eliminating the delay of changing the frequency by adjusting a single tube.

In such a test set-up, frequency is measured by a *wavemeter* (Fig. 13). If a waveguide is completely closed except for a small hole for the power to enter, it is known as a *cavity*. A cavity resonates at a particular frequency dependent upon the dimensions of the cavity. In general a wavemeter is a cylindrical cavity which has an end plate that can be moved to vary the height of the cylinder. This wavemeter is inserted in parallel with the line so that when it is in resonance it draws power from the line and reduces the output reading. When the point of reduced output power is reached, the position of the end plate may be read on the micrometer and the frequency determined from a calibration chart based on the size of the cavity.

A few waveguide components used in measurements have no analagous low-frequency component. For example, a *directional coupler* (Fig. 14) can tap off power for measurement from the waveguide system without affecting the line. A probe or a loop would cause some reflections and set up standing waves of its own. A directional coupler has the advantages of being broad-band, of not setting up standing waves, and of measuring only the wave going forward and not any reflections. One can see that the coupler is really two sections of waveguide side by side. In the wall between them are holes spaced so that energy coupled through them will add up for a forward-going wave. An attenuator strip or *pad* is placed in the coupler to absorb reflected waves, so that only the forward-going wave is propagated.

Developed from the directional coupler is the *bidirectional coupler* (Fig. 15), which will pick up the waves going in either direction, each independently of the other. A directional coupler always picks up a certain proportion of the power in the main guide. The power received in the coupler is a certain number of decibels down from the power in the main line—usually about 25.

Sometimes it is necessary to change the polarization of the wave to meet the mechanical requirements of microwave apparatus. Polarization is changed by a twisted section of waveguide (Fig. 16). The outgoing wave is at right angles to the incoming one, and the electric field anywhere along the twist is as shown in the cross-sectional illustration of Fig. 5.

The connecting flanges in many of the illustrations here are grooved. The outer groove may be used for a gasket to make tight fits. The inner groove is

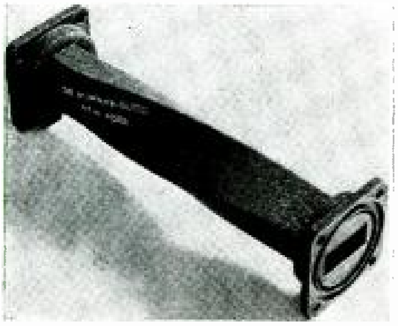


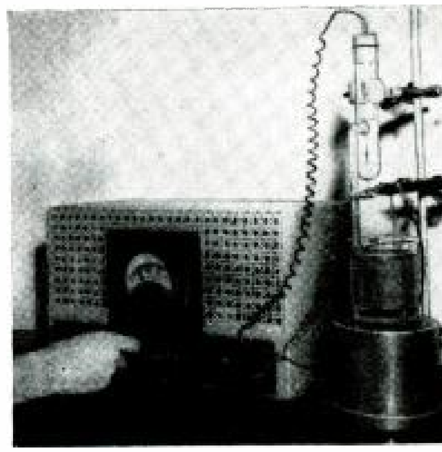
Fig. 16—This section changes polarization.

precision-cut so as to absorb any leakage power and cause a minimum of reflection at the junction.

These examples of components show the simplicity of waveguides for transmission and measurement of microwaves. All a.c. effects commonly developed with transformers, resistors, condensers, inductances, and insulators at lower frequencies may be developed by waveguide components at frequencies up to 30,000 megacycles. This will be described in a series of articles in succeeding issues.

# New A.F. Power Supply

**By S. R. WINTERS**



The regulated supply in use for electrolysis.

A NEW power supply for use in electrolysis has been developed by the National Bureau of Standards. It has the proverbial constancy of Caesar's wife in that the apparatus, functioning from a 117-volt a.c. line, affords stable and yet continuously adjustable d.c. voltages at currents up to 2 amperes or even more.

The new electronic power source bypasses faults of previous instruments. The voltage is governed by a precisely engineered, compact electronic circuit that utilizes standard radio parts. The new apparatus can produce a controlled output of several volts in loads as low as a single ohm, and identical techniques can be employed in equipment built for higher outputs. In numerous applications, the usual series-regulated power supply is handicapped because of the high load currents which must be handled directly by vacuum tubes.

In the separation of metals by electrolysis—a function served by this novel instrument—it is necessary to govern the power supplied to a load, the plating electrode, with respect to the potential of a reference electrode. An excessively high potential spells an excessive load power. Thus the function of the Bureau of Standards' electronic circuit is to curtail its output automatically until the control potential reaches the required value.

Inside the device are an amplitude-controlled oscillator (V1 and V2 in the diagram), a power amplifier (V3 and V4), and rectifier (V5), and two direct-coupled stages of amplification (V6 and V9). The oscillator, a multivibrator, functions at about 2,000 cycles, turning out a variable-amplitude square wave. This is amplified by a couple of audio beam-power tubes in push-pull. These tubes are linked through a step-down transformer T2 to the low-voltage, high-current selenium rectifier. An L-C filter cuts ripple and noise to a negligibly low value. The filtered voltage is the output of the instrument.

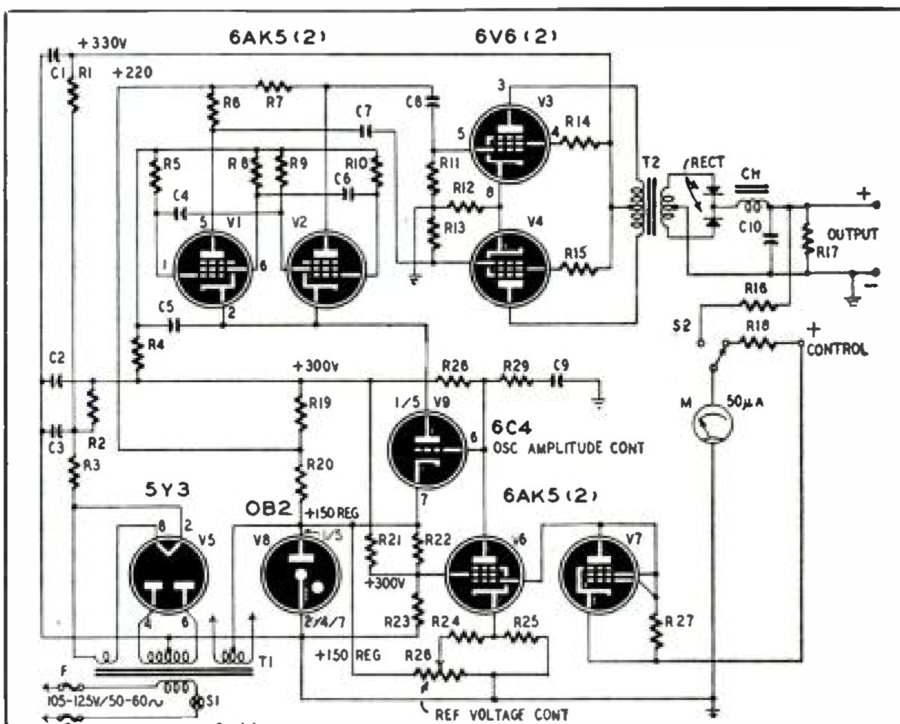
For regulation a portion of the output voltage is compared to another output voltage stabilized by a gaseous regulator tube V8. The difference between the two is amplified by the two direct-coupled stages and is employed to govern the amplitude of the signal from the oscillator.

The circuit connections are made in such a manner that the amplitude of the oscillator is increased when the output voltage drops below the reference valve. The two stages of amplification insure exact regulation of the power supply and its output deviates very little from the reference voltage.

The reference voltage is adjustable by a knob on the panel of the instrument. This control, acting as the output voltage regulator, has a range of adjustment from 0 to 2 volts. Higher voltages may be obtained by employing only a portion of the output for comparison. If the proper voltage divider is added, the power supply can deliver as much as 8 volts.

In consequence of such a high degree of regulation, the new instrument has a low effective internal impedance. This is about .005 ohm when the entire output voltage is employed for comparison with the reference voltage. Thus, the voltage drop due to heavy load currents is small. The low internal impedance of the device suggests its adaptability as a substitute for a storage battery where constancy of output under varying loads is required. The regulation ratio is about 0.5%. To duplicate the performance of this apparatus with a storage battery at an output of 1 volt, it would be necessary to use a voltage divider with 200-ampere fixed drain.

The regulated voltage supply may also be connected as a constant current source, if desired. The voltage drop caused by passage of the load current through a selected fixed resistance becomes the index which is compared to the reference potential. When applied in this manner, the device affords about the same advantages as when employed as a constant voltage source.




R1, R3—200 ohms
R2, R14, R15—1,000 ohms
R4—30,000 ohms
R5, R10—1 megohm
R6, R7, R21—150,000 ohms
R8, R9, R24—10,000 ohms
R11, R13, R27—500,000 ohms
R12—300 ohms
R16, R28—400,000 ohms
R17—50 ohms
R18—40,000 ohms
R19—3,000 ohms
R20—4,000 ohms
R22, R29—50,000 ohms
R23—22,000 ohms
R25—500 ohms
R26—25,000-ohm potentiometer
C1, C2—20 µf
C3—40 µf
C4, C6—500 µµf
C5—0.1 µf
C7, C8—.001 µf
C9—.05 µf
C10—1,000 µf
CH—20 mh, 2 amp
REC—2-amp., full-wave selenium rectifier
T1—power transformer, 5 v; 6.3 v; 750 v c.t., 150 ma
T2—output transformer (special)
M—50-µa meter
S1—s.p.s.t. toggle switch
S2—s.p.d.t. rotary switch

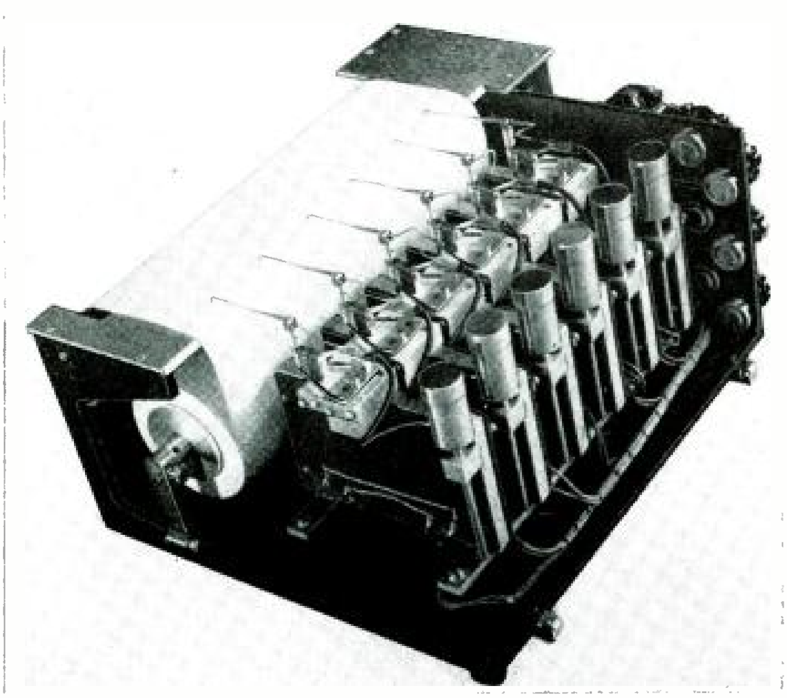
# Electronics in Medicine

## Part IV — Apparatus and methods for the detection and measurement of the brain's electrical activity

By EUGENE THOMPSON

ELECTROENCEPHALOGRAPHY is an electronic method for recording the brain's electrical activity. This activity consists of trains of brain waves called action potentials. Their frequency and amplitude depend upon the age, health, activity, emotional state, and other characteristics of the patient. Children's waves tend to be faster than adults', and extremely rapid, sharply peaked potentials are characteristic of epileptics. Movement of an arm or leg, hearing a loud noise, or even opening or closing the eyes will affect the action potentials. Strong emotions such as rage or fear may produce very interesting patterns. For these reasons, electroencephalograms are recorded with the subject reclining in a quiet, semi-darkened room, eyes closed. Under these standard conditions, the brain of a normal adult emits an approximately sinusoidal signal which varies continuously in frequency from 1 to 100 cycles and in amplitude from 1 to 100 microvolts. However, the predominant components have a frequency of about 10 cycles and an amplitude of 10 to 50 microvolts. In most cases, the frequency and amplitude vary oppositely.

Although a great deal is known about the appearance of brain waves in health and disease no one knows how or where they arise, or what their purpose is. It is interesting to note, however, that they are not unilke FM signals. Some experts regard this as evidence that they are nerve impulses and are frequency-modulated to prevent interference from other electrical discharges within the body.



*Photos courtesy Offner Electronics, Inc.*

Each pen of six-channel recorder is actuated by a Rochelle salt crystal.

The photographs and diagram show a rack-mounted electroencephalograph. It is essentially a four-stage, push-pull, resistance-capacitance-coupled amplifier. Except for slight circuit variations made by individual manufacturers, the design shown is the basic pattern around which all these devices are constructed.

The three stages of voltage amplification have a gain of over 2,000,000 (about 126 db). This is more than enough to detect and amplify signals in the microvolt range. Triodes are employed in the first stage to keep tube noise at a minimum. The relatively slight loss of gain is counteracted by the two pentode stages which follow. Some manufacturers use nonmicrophonic pentodes in the first stage instead of triodes. Noises from x-ray or diathermy equipment or from similar sources are reduced by placing the patient in a screened room, by shielding pickup cables, and by the bucking action of the push-pull circuit. All three stages are decoupled to prevent the effects of coupling through the common impedance of the power supply. Push-pull 6L6's are used in the output stage to provide sufficient power to overcome the inertia of the mechanical recording device, thus insuring faithful reproduction of the higher-frequency complexes.

The coupling condensers are larger than those employed in conventional amplifiers to assure good low-frequency response. The lowering of the high-frequency limit is not a problem because frequencies higher than 150 or 200 cycles are of no significance in electroencephalograms. No bypass condensers are needed because of the push-pull design, which bucks out the unwanted a.c. components because they are 180° out of phase. If it were not for this action of the push-pull circuit, screen bypass condensers with a capacitance of several thousand microfarads would have to be used to maintain the low-frequency response.

The instrument incorporates an electronically regulated power supply because even slight variations in plate voltage would distort the low-level signals. The supply can maintain the plate and screen voltages to within a fraction of 1%.

To permit accurate measurement of the voltages picked up from the patient despite slight changes in the gain of the amplifier, a calibrating circuit consisting of a 1.5-volt dry cell and a series of calibrating resistors is employed. This circuit is shown at the input of the 6SF5 grid. By proper selection of resistors, a standard calibrating signal of 1, 10, 50, 100, or 1000 microvolts may be introduced into the amplifier while the record is being made.

Because of the cost and difficulties in processing long photographic records, they have been replaced in modern equipment by plain paper or plastic-coated-paper tape. Electrically driven pens or heated styli are used to record on these surfaces. The pen is fastened to a moving coil, similar to the voice coil in a loudspeaker. This coil is fed by the output of the 6L6's. Either an electromagnet or a permanent magnet may be used as the field supply.

A recording device which operates on a more novel principle is illustrated in the photograph. This instrument works like a crystal cutting head. The amplified brain waves are applied to a Rochelle salt crystal. The crystal is distorted in step with the variations in the applied voltage and the resulting movement is mechanically magnified by levers which actuate the pen. The pen reproduces the wave form of the brain's action potentials. In the photo there are six recorders, each of which is driven by a separate amplifier.

The brain's potentials are picked up from the surface of the scalp with small metal electrodes. These are dipped in salt paste to reduce the skin resistance, and held in place with a drop of collodion. From the electrodes, small flexible wire leads pass through a shielded cable to the input of the amplifier.

Two wires are needed to pick up the brain waves. Each pair is referred to as a lead. There are two types of leads, unipolar and bipolar. In the former type, one wire is located over some part of the brain, and the other is attached to some neutral point on the body, such as an ear lobe. In bipolar leads the second wire is placed over some area of the brain rather than on a neutral point. In general, bipolar leads give more information than unipolar ones.

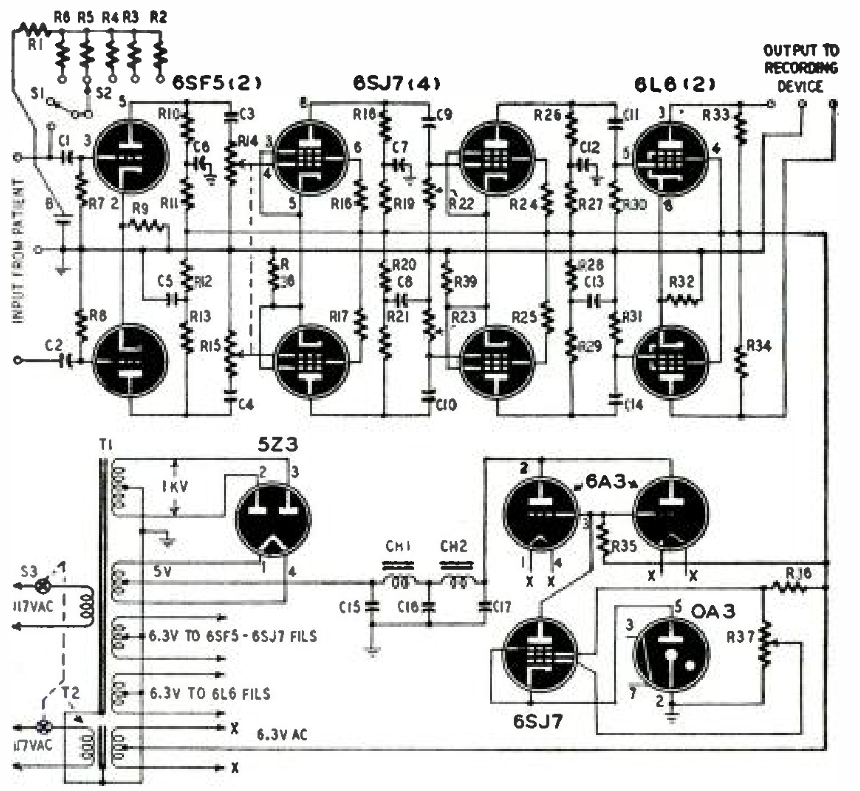
The various leads are named according to the lobe of the brain over which they are placed and whose action potentials they record. Thus in the unipolar leads, there are right and left temporal, frontal, and occipital leads, etc. The bipolar leads are called bifrontal, bitemporal, and so on. The positioning of the various electrodes requires a highly specialized knowledge of the topographical anatomy of the brain.

The combination of a lead, its amplifier, and a recording pen is referred to as a channel. A minimum of four bipolar or six unipolar channels is required. Most clinical units have eight channels.

Electroencephalographic diagnosis is largely based on experiment although some attempts have been made to reduce parts of the technique to a mathematical basis. At present, however, there is no substitute for the experience of a trained electroencephalographer. Most diagnoses are established by inspection of the record for an abnormal preponderance of fast or slow wave forms compared to the normal, or for phase reversals between the signals picked up from different points on the surface of the head.

Electroencephalography has been used with great success in the diagnosis and localization of brain tumors, for the diagnosis of various forms of epilepsy, and for following the progress of patients being treated for these conditions. Thus far there has been no correlation between various types of psychoses, neuroses, and the intelligence quotient of the patient, and the pattern of his brain waves. Thus, idiots and college professors may have very similar electroencephalograms—no reflection intended upon the gray matter of the professors! It must be added, however, that electroencephalography is still a young science, and that intensive investigations are continually being conducted which may lead to new uses.

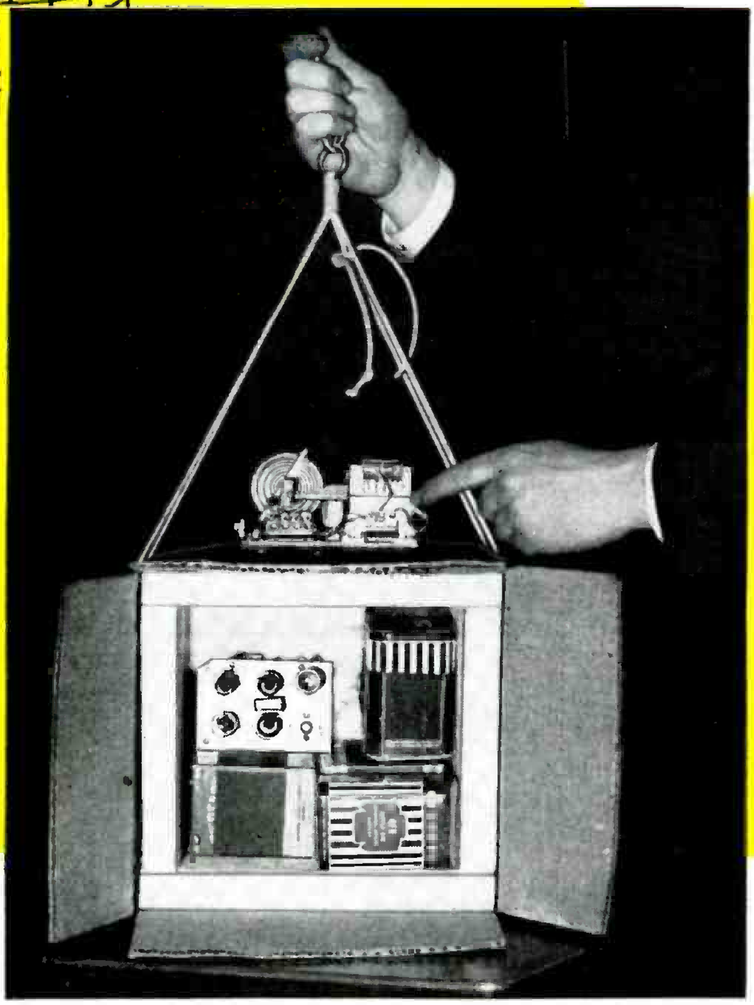
Six amplifiers are mounted in rack at right.




Note—screen resistor of 6SJ7's should be connected to junction of tube s plate resistor, decoupling capacitor, and decoupling resistor instead of direct to the B-supply.

R1—1.5 megohms, ½ watt, 1%
R2—1,000 ohms, ½ watt, 1%
R3—100 ohms, ½ watt, 1%
R4—50 ohms, ½ watt, 1%
R5—10 ohms, ½ watt, 1%
R6—1 ohm, ½ watt, 1%
R7, R8—5 megohms, ½ watt
R9—1,750 ohms, ½ watt
R10, R13—250,000 ohms, ½ watt
R11, R12—50,000 ohms, ½ watt
R14, R15—1-megohm potentiometer
R16, R17, R24, R25—2 megohms, ½ watt
R18, R21, R22, R23, R26, R29, R30, R31, R35—500,000 ohms, ½ watt
R19, R20, R27, R28—100,000 ohms, ½ watt
R32—125 ohms, ½ watt
R33, R34—5,000 ohms, 50 watts
R36—10,000 ohms, 2 watts
R37—50,000 ohms, 10 watts, with slider for adjustment
R38, R39—650 ohms, ½ watt
C1, C2, C3, C4, C9, C10, C11, C14—4-µf, 600-volt paper
C5, C6, C7, C8, C12, C13, C15, C16, C17—8-µf, 600-volt electrolytic
CH1, CH2—20-h, 200-ma filter chokes
T1—power transformer, 1,000 volt c.t., 200 ma, 6.3 volts, 6.3 volts, 5 volts
T2—filament transformer, 6.3 volts
S1—s.p.s.t. switch
S2—5-position tap switch
S3—d.p.s.t. toggle switch
B—1.5-volt battery

# FM Telemetering Transmitters



Transmitter ready for flight. Atop box is a registering aneroid barometer.

By LEON HILLMAN*

THROUGH balloon telemetering research meteorologists and physicists are gaining new tools with which to probe the mysteries of the upper atmosphere. As always, the electronic engineer is playing an important role in the steady progress of science.

Two new small transmitters for radio telemetering have been developed at New York University for weather balloon use. The transmitters include modulation circuits, one for FM and the other for AM. Their unique, simplified modulation circuits and their compact design make these transmitters useful for voice communication, radio remote control, as well as telemetering systems.

Of particular interest is the new FM transmitter circuit shown in Fig. 1. Frequency modulation offers considerable advantage in signal-to-noise ratio for line-of-sight transmission at the higher frequencies.

Several transmitters were constructed, at first using the conventional reactance tube to obtain FM. Only a small amount of deviation can be achieved by this method and doublers must be used to obtain a 150-kc swing.

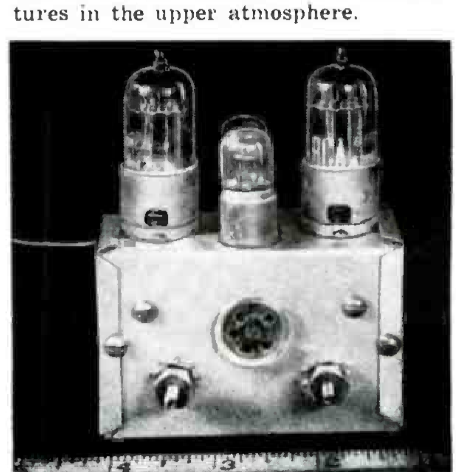
The new circuit does not require frequency multipliers, since the required deviation may be obtained at the fundamental frequency. To do this a vacuum tube (V2-a in Fig. 1) is used as a variable resistance in series with the cathode of the oscillator V1.

The frequency of a self-excited oscillator depends to some extent on the plate voltage. Impressing an audio signal on the grid of V2-a varies the resistance of its plate circuit, increasing the plate current when the grid is positive and decreasing it when the grid is negative. Since the voltage drop across the tube is proportional to the current flowing through it, the tube acts as a variable resistance.

These changes in voltage across the modulator vary the oscillator plate voltage at an audio rate. The plate voltage changes on the oscillator vary the oscillator frequency. To stabilize the oscillator against changes in frequency due to variations in battery voltage, a neon-bulb voltage regulator is used. Thus, only changes in the modulation signal produce a carrier swing.

The output of the oscillator is capacitance-coupled to a class-C r.f. amplifier V2-b, which acts also as an r.f. limiter. To obtain a wide tuning range, the resonant circuits of both the oscillator and the amplifier are composed of a combination of slug-tuned coils and variable mica trimmers. The slug-tuned coils are adjustable from the outside and are used for fine tuning.

The transmitter operates on any plate voltage between 180 and 270. This wide range is desirable because the batteries may have to be used for a long period of time though they depreciate due to current drain and low temperatures in the upper atmosphere.



Power is supplied through the 5-prong socket. Antenna and control leads come through side.

* New York University College of Engineering

The tuning range is from 20 to 100 mc. Power output is approximately 1 watt. The transmitter uses two 3A5's. These are dual triodes and therefore are equivalent to four separate tubes. One section is used for the modulator, a second for the oscillator, and a third for the r.f. amplifier. The extra triode is unused.

The amplifier and oscillator coils are wound on ½-inch forms with adjustable powdered-iron cores. Both coils consist of 5 turns of No. 14 enamel wire tapped at the center. The turns are spaced the diameter of the wire. The antenna coupling coil consists of 2 turns of plastic-covered wire around the center of the amplifier plate coil.

A blocking oscillator (Fig. 2) converts meteorological data into an audio signal which may be transmitted. The blocking oscillator is, in effect, a feedback oscillator which quenches itself periodically due to the time constant of R1-C1. By varying R1 the audio frequency may be set between 10 and 500 cycles.

The blocking oscillator operates on approximately 1 megacycle. The plate coil is tuned by TC which is the sum of the distributed capacitance of the coil, the stray capacitance of the wiring and the interelectrode capacitance of the tube. The coil is wound with 10/40 litz wire on a ¼-inch form. The plate coil has 100 turns wound in a pie ⅛ inch wide. The grid coil, L, (Fig. 2) consists of 75 turns in a pie similar to the plate winding. The windings are spaced ⅛ inch apart.

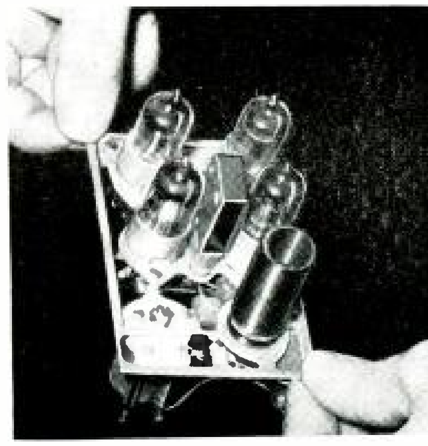
The audio frequency may be used for operating frequency-sensitive relays in a control receiver. To show how the blocking oscillator is used for temperature measurement, consider what happens when a high resistance with a large temperature coefficient is exposed to the atmosphere. The resistor replaces R1 in Fig. 2. Since its resistance varies in proportion to the temperature, the blocking oscillator produces an audio frequency which is dependent on the temperature. Using a chart showing frequency as a function of resistance and temperature, the ground operator compares the received audio frequency with the values on the chart to determine the atmospheric temperature.

The antenna is important, since signals must be transmitted for long distances. A conventional half-wave vertical dipole is best for the purpose. For receiving, a vertical dipole is used in most cases, although some experiments with an omnidirectional circularly polarized antenna have been successful. Sometimes it is necessary to locate the position of the balloon in flight. In such cases a highly directional antenna with 32 elements in a broadside array and a receiver provided with lobe scanning and an oscillograph for observation are used.

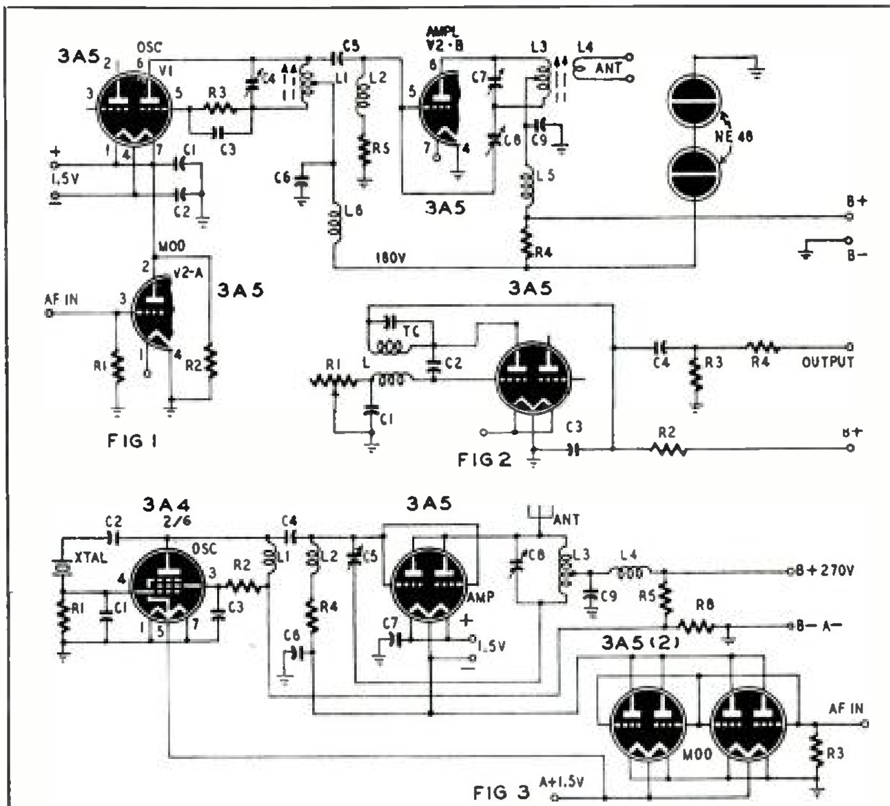
The transmitter is built on a U-shaped frame and is completely shielded with an aluminum cover. The r.f. amplifier is shielded from the oscillator with a thin aluminum partition which does not extend completely across the chassis but separates the r.f. coils and leaves room for the coupling condenser and filament- and plate-supply leads. A small five-prong plug is used for connecting the battery supply. The antenna and signal leads are brought out through grommeted holes in the aluminum cover. To eliminate weight and extra components the neon bulbs are not mounted in sockets. Instead, they are force-fitted into a slightly undersize hole in the aluminum chassis. Since the underside of the chassis, containing all of the wiring and most of the circuit components, measures only 3 x 2 inches, the transmitter is built in planned stages. After the tube sockets and power plug are mounted, the tube filament leads and the plate power leads are wired in. The r.f. coils are mounted next and connected. These are followed by the r.f. chokes, tuning trimmers, and the remaining components.

## Adjustments

The transmitter is tuned with the cover removed by adjusting the oscillator trimmer until the desired frequency is reached. The amplifier trimmer is adjusted next with the antenna disconnected, until the amplifier plate current drops to a minimum. The cover is then replaced and the tuning repeated by adjusting the cores of the r.f. coils. A 10-mc tuning range can be



The AM transmitter. Metal sections are removed from the chassis to reduce weight.




**FM TRANSMITTER PARTS LIST—Fig. 1**

R1—47,000 ohms, ½ watt
R2—4,700 ohms, ½ watt
R3—270,000 ohms, ½ watt
R4—4,200 ohms, 1 watt
R5—8,200 ohms, ½ watt
C1, C2—200-μμf, mica
C3—100-μμf, mica
C4, C7, C8—3-30-μμf mica trimmer
C5, C6, C9—.001-μf, paper
L1, L3—iron-core r.f. coils
L2, L5, L6—2.5-mh r.f. chokes
L4—antenna-coupling coil (see text)

**BLOCKING OSCILLATOR PARTS LIST—Fig. 2**

R1—1-megohm potentiometer
R2—82,000 ohms, ½ watt
R3—100,000 ohms, ½ watt
R4—20,000 ohms, ½ watt
C1—0.25-μf, paper
C2—150-μμf, mica
C3—.05-μf, paper
C4—0.1-μf, paper
TC—1-mc tuned circuit (see text)
L—Tickler coil (see text)

**AM TRANSMITTER PARTS LIST—Fig. 3**

R1, R2—47,000 ohms, ½ watt
R3—470,000 ohms, ½ watt
R4—4,000 ohms, ½ watt
R5—15,000 ohms, ½ watt
R6—200,000 ohms, ½ watt
C1, C4—100-μμf, mica
C2, C3, C9—.001-μf, paper
C5—3-30-μμf mica trimmer
C6, C7—500-μμf, mica
C8—100-μμf variable
L1, L2, L4—2.5-mh r.f. chokes
L3—r.f. coil (see text)

covered with the slug-tuned coils. For greater variations, the cover is removed and the trimmers are readjusted.

In preparation for a balloon flight, the transmitter is placed inside a corrugated carton lined with 1 inch of Styrofoam insulation to minimize the effects of the outside temperature. The battery pack consists of as many 67½-volt batteries, connected in series-parallel, as are required for the flight duration. Several 1½-volt batteries are included in the pack for filament supply.

## Other circuit designs

In addition to the FM transmitter, several other circuits have been tested and flown. For transmission ranges exceeding the line of sight, it was necessary to employ frequencies below 20 mc. An AM transmitter with a power output of 2 watts was developed. To obtain modulation with a minimum of components an unconventional circuit was used. This is shown in Fig 3. Three paralleled 3A5 sections are used as a series resistance, as in the FM transmitter. With AM, however, the tubes are in series with the plate-voltage supply of the r.f. amplifier. Fig. 3 erroneously shows four sections of the 3A5's in parallel. In practice, only three sections are used. The remaining triode section can be used as the blocking oscillator if one is used.

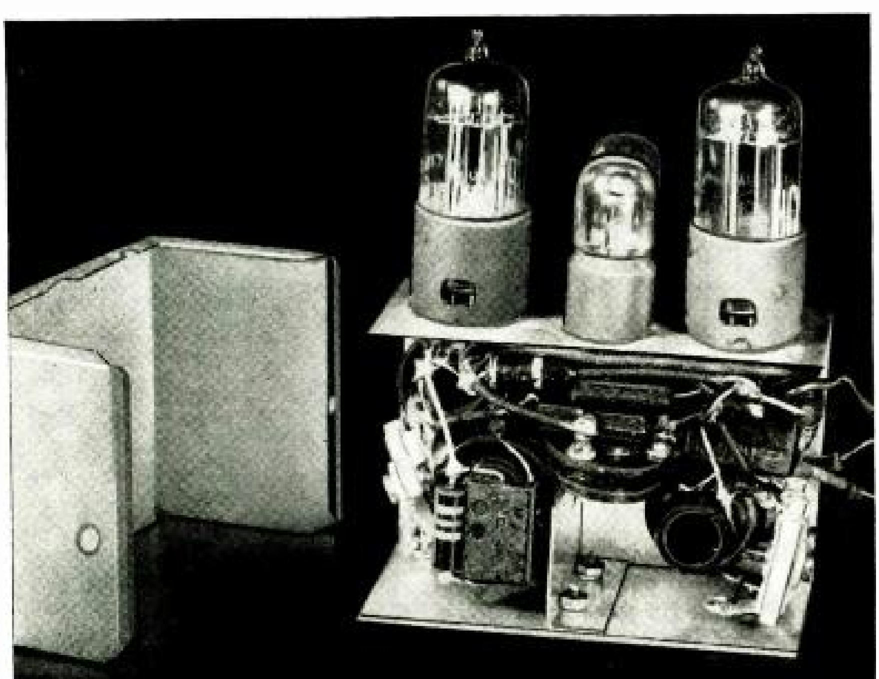
The AM transmitter is crystal-controlled, using a Pierce oscillator. The three 3A5 sections provide a high percentage of modulation. Plug-in coils are used in the r.f. amplifier. The circuit is tuned with a variable air condenser. The amplifier may be used as a doubler by tuning the tank circuit to twice the oscillator frequency. It is neutralized with a small mica trimmer condenser C5. The tube is neutralized with the B-plus lead disconnected from the amplifier. A pickup coil connected directly to the plates of a cathode-ray oscilloscope is used as a detector of r.f. The neutralizing condenser is rotated until no r.f. envelope is seen on the 'scope screen for any position of the tank condenser.

To measure the power output of the transmitter, a three-turn loop is wound around the tank coil and connected in series with a coil, variable condenser, r.f. milliammeter, and a 22-ohm noninductive load resistance. With the inductance and capacitance tuned to series resonance, the power output is calculated from Ohm's law, where P equals $I^2R$. With the transmitter as shown, the r.f. current is about 300 ma, corresponding to a power output of 2 watts. With the plate voltage set at 270, the transmitter will draw approximately 20 ma at no load. With the dummy load applied the plate current rises to about 35 ma.

If a half-wave or other resistive antenna is coupled to the transmitter, the plate current will also read 35 ma. A half-wave antenna connected directly to the plate of the amplifier tube is most satisfactory. The transmitter will operate on any B-voltage between 150 and 300. Two separate 1½-volt filament supplies are required. The four tubes and tank coil are mounted on top of an aluminum plate measuring 3 x 4 inches. Total weight of the transmitter without batteries is 8½ ounces.

The AM design has been tested thoroughly—on many occasions it has transmitted signals from the upper atmosphere for over 9 hours and for a distance of 400 miles.

These transmitters have been useful to meteorologists for making upper-air measurements and for obtaining information on the movement of an air mass. Attached to meteorological balloons which move with the air currents, the miniature radio transmitter relays vital data to a ground receiving station.



The FM transmitter. The vertical shield separates the oscillator and amplifier.

## Not standard radiosondes

The equipment differs from the standard radiosonde in the long period over which it is required to operate and the longer distance from which reception is required. The standard radiosonde transmitter is sent aloft and the balloon continues to rise until it reaches approximately 60,000 feet. Then the balloon bursts and the equipment descends to earth on a parachute. The total time for ascension takes about an hour. With the new balloons and control equipment the flight lasts many hours, frequently eight or nine, and the transmitter provides required data continuously.

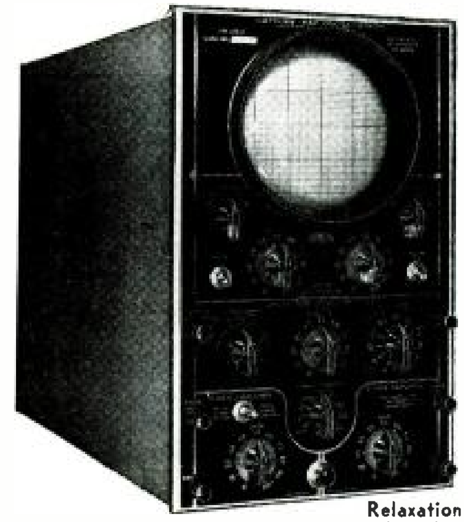
To achieve a range of several hundred miles, it has been found necessary to use transmitters with a power output of at least four times that of the standard radiosonde, which is usually only 250 mw. The transmitters developed at New York University College of Engineering are unique for their compactness, low weight, high efficiency, and novel circuit arrangement. Though designed basically for balloon telemetering, they can be applied to other services where lightweight, low-drain transmitters are required. They may be used for amateur or point-to-point communication.

A photo of a transmitter ready for flight is shown on page 30. A chronometric pressure unit is shown on top of the case. This is a unit used to produce the pressure-indicating signals. It consists of an aneroid cell, a small 3-volt d.c. motor and an insulated drum with a metal helix and two closely-spaced metal contacts on its surface. The diaphragm of the aneroid cell is linked to a metal arm that rests on the surface of the drum. The position of the arm on the drum depends on the atmospheric pressure. The helix and the two contacts are arranged to close a series circuit consisting of a 90-volt battery and a 15,000-ohm resistor when the arm touches either of them.

The drum is driven by the motor. As it revolves, the arm touches the two contacts in turn and produces two *reference* pulses. As the drum continues to rotate, the arm touches to helix momentarily to produce a single *key* pulse. The time interval between the second reference pulse and the key pulse depends on the position of the arm on the drum. Since the arm is controlled by barometric pressure through the aneroid cell, the unit can be calibrated so pressure can be determined by the interval between reference and key pulses.

This type of pulsing mechanism can be used in a number of ways. The pulses could be used to key an audio oscillator that has been blocked with a high negative bias or even used to key the blocking oscillator so temperature and pressure signals can be transmitted simultaneously.

# GAS-TUBE OSCILLATORS



Relaxation oscillator furnishes time base for Dumont oscilloscope.

**The author discusses relaxation oscillators and points out the advantages of using thyratrons**

By ALLAN LYTEL*

THE relaxation oscillator has been used as a sweep generator in television sets, but it has a number of definite disadvantages and has been practically superseded by other types. Its stability is not as great as that of the sweep oscillators used in modern television receivers, and the problem of getting a perfectly linear sweep is much greater. It is a fundamental circuit, however, and the student of television sweep circuits should be familiar with it as an aid in understanding such circuits in general. Moreover, it does find a wide practical field in oscilloscope time-base sweep generators, in which it is almost universally used.

The time-base generator is one of the most important parts of an oscilloscope. It furnishes to the horizontal amplifier a signal which sweeps the spot across the screen at the same time the test signal is moving it vertically. Without the horizontal sweep, the test signal would simply trace a thin vertical line, and it would be impossible to observe the shape of the wave.

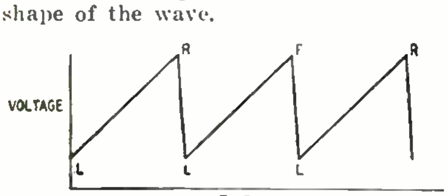



Fig. 1—Ideal oscillator gives sawtooth wave.

The signal needed for the sweep is shown in Fig. 1. When the voltage is lowest (the point marked L), the spot is at the left of the screen. As the voltage rises linearly, the spot sweeps across the screen at a uniform rate of speed. When the voltage is maximum (at R), the spot is at the right of the screen. The voltage then collapses very quickly, and the spot returns to the left of the screen so fast that it cannot be seen.

Because of the resemblance of the wave's shape to the teeth of a rip saw, the wave is called a sawtooth. For ideal results the rise in voltage should be uniform; if it is not, a sine wave would appear compressed on one side of the screen and expanded on the other. The collapse of voltage must be as fast as possible—that is, the lines in Fig. 1 from R to L should be as nearly vertical as possible—so that the spot will be invisible when it is traveling from right to left back across the tube face. If this collapse is too gradual, the 'scope will show a horizontal line trailing from the right end of the observed wave toward the left.

The time-base generator which furnishes this saw-tooth wave in almost every general-purpose oscilloscope is essentially a simple relaxation oscillator. The basic circuit is shown in Fig. 2-a. High voltage is applied to a capacitor C in series with which is a resistor R and across which is a gas-filled tube V. This may be a neon lamp or a voltage regulator, such as the OA3, OB3, OC3, or OD3, depending on the B-voltage.

When voltage is first applied to the uncharged capacitor, the electron flow—electrons passing from one plate of the capacitor through the B-supply to the other plate—is very rapid. The rate of flow becomes slower and slower, however, as the capacitor becomes charged. All this time R slows up the charging of the capacitor because the current passing through R creates a voltage drop across it. This drop detracts from the voltage available to the capacitor. However, as the current gets smaller and smaller, this drop gets less and less, finally dropping off to zero when the capacitor is fully charged.

The gas tube has two electrodes, a plate and a cathode. There is no heater. The tube is filled with an inert gas which is responsible for the action of the tube. Neon in the tube is quite common, although there are several other gases that would serve as well.

With only a small applied d.c. voltage, the tube does not conduct. At a certain potential, the gas breaks down into electrons and ions. The electrons are negative and go to the plate; the ions are positive and go to the cathode. The tube conducts heavily. The voltage that causes the tube to ionize and conduct is the ionization potential. After the tube breaks down the applied voltage may be reduced and the conduction will continue. At another voltage, lower than the ionization voltage and greater than zero, the tube stops conducting. This is the deionization potential.

The capacitor is capable of charging to the full potential of the B-supply. In practice, however, the B-voltage is made greater than the breakdown voltage of V. When the capacitor has charged enough so that its voltage equals the tube breakdown value, the gas within the tube ionizes. The tube conducts.

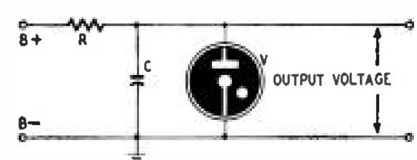



Fig. 2-a—This is basic gas-tube oscillator.

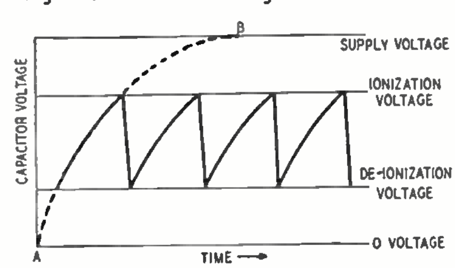



Fig. 2-b—AB shows normal capacitor charging.

Now the conducting tube across the capacitor is in effect a low resistance. It shorts the capacitor and causes it to lose its charge. The loss continues until the capacitor voltage is so low that the tube no longer has enough potential across it to maintain the ionization. It stops conducting. The effective low resistance is removed from across C, which is then free to charge up again.

Fig 2-b is a graph of the action just described. The dotted curve AB shows how a capacitor ordinarily charges. At the beginning voltage rises fast and

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fairly uniformly; but, as the capacitor nears full charge, the rate of change becomes smaller.

In the circuit of Fig. 2-a, however, the maximum capacitor charge is limited to the ionization voltage of the tube. After the initial cycle, the minimum charge is limited to the deionization voltage of V. The circuit thus does two things: it causes the capacitor to charge and discharge periodically, and it restricts the changes in capacitor voltage to a certain part of the normal charging curve.

Note the resemblance between Fig. 2-b and the ideal saw-tooth sweep voltage in Fig. 1. The voltage rise is not quite straight; but if the supply voltage and the breakdown voltage of the tube are chosen correctly, only a comparatively straight portion of the curve will be used and the 'scope trace will be linear enough for most purposes. To get a fast discharge so that the return traces will be invisible, the tube should conduct as heavily as possible when it breaks down.

The frequency of the saw-tooth voltage can be controlled by choosing various values of resistance and capacitance. If the resistor is large, it will create a large voltage drop when the charging current passes through it. This will delay the application of full power-supply voltage to the capacitor and lengthen the charging time.

If the capacitor is large, more current must flow before it will charge to a given voltage. This, too, takes more time. To lower frequency, then, the capacitor or resistor (or both) must be increased in value. To raise frequency these values are reduced.

Fig. 3 shows one possible type of oscilloscope sweep generator. The switch selects various values of capacitance to allow a rough adjustment of the sweep frequency. The resistor R1 is variable and is used to make fine adjustments in frequency.

In order to stop the pattern on the oscilloscope screen so that it can be examined, the sweep frequency must be either equal to that of the signal or else a submultiple of it. To examine a 5,000-cycle signal, for instance, a sweep of 5,000 cycles will allow one cycle of signal to appear on the screen. A 2,500-cycle sweep would show two cycles, and a 1,250-cycle sweep would show four cycles. Sometimes sweeps higher than the signal are used. A 10,000-cycle sweep would show one-half cycle. In such cases the sweep frequency must be an exact multiple of the signal frequency.

Using the resistor (R1 in Fig. 3) to set the sweep frequency exactly (and it must be exact to make the pattern stand still) is a very difficult job. Even steady hands are not the solution because the frequencies of signal and sweep are always at least slightly affected by temperature and changes in line voltage. Some method of synchronizing the sweep with the signal frequency is always used. R2 in Fig. 3 is the potentiometer used for synchronization control.

A portion of the test signal that is to be viewed is applied across R2. (This is done within the 'scope.) Let us suppose that this tube will fire at 100 volts. If the cathode is a ground potential, the tube will fire with 100 volts on its plate. As soon as the condenser reaches this voltage in its charging curve, the tube will conduct.

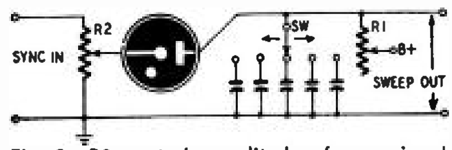



Fig. 3—R2 controls amplitude of sync signal.

If the test signal is a sine wave, it will increase and decrease the voltage at the cathode of the gas tube. Suppose that the signal that is applied across the resistance R2 has a peak value of 10 volts.

If the resistance arm is at the top, the full voltage of this 10-volt sync is applied to the cathode. When the sine wave reaches its positive peak, the cathode is 10 volts positive. However, this tube requires 100 volts from plate to cathode before it will fire or ionize. This means that the plate voltage will now have to increase to 110 volts before the tube will fire.

When the sine wave reaches the negative peak, the cathode will be 10 volts below ground or 10 volts negative. Since the tube needs 100 volts across it, the tube will now fire with 90 volts on the plate since the cathode is 10 volts negative. This means that the tube will fire *at every negative peak of the applied sine wave.* The sweep will then be at the same frequency as the signal being observed.

To make the sweep frequency one of the submultiples of the signal, the sweep frequency controls SW and R1 are adjusted to approximately the frequency desired and R2 is again advanced. If it is adjusted to one-third of the signal frequency, for instance, every third sine wave will cause the tube to conduct.

Advancing R2 too far and introducing too much sync voltage will destroy the linearity of the sweep voltage. Therefore, when using the 'scope, it is important to set the sweep controls as close as possible to the correct frequency—so that the pattern very nearly stands still—and then advance the sync control as little as possible until the pattern is stationary. On most 'scopes it should never be necessary to rotate the sync control more than a few degrees unless the signal being observed has a very low level.

A somewhat better (and more usual) sweep generator appears in Fig. 4. It uses a gas-filled triode or thyratron, such as the 884, 885, or 6Q5-G. In these, the grid can be used to set the breakdown voltage; if grid voltage is made more negative, the voltage necessary to fire the tube is higher. For this reason, the sync voltage can be applied to the grid instead of the cathode.

Another advantage of the thyratron is that it passes more current when it breaks down than the neon or voltage-regulator tubes shown in previous figures; that is, its resistance is lower. As a result, the capacitor discharges faster, the return trace is less likely to be visible on the screen, and the generator can be used at higher frequencies. In addition, the breakdown voltage of a thyratron can be predicted more accurately, thus making it a more stable device. Since firing and deionizing potentials are adjustable (by means of grid bias), it is possible to adjust any given tube to operate on the most linear portion of the capacitor charging curve to obtain the most linear sweep.

Two refinements are included in the generator of Fig. 4. A limiting resistor R2 is in series with the usual charging resistor R3 to make adjustment of R3 easier. Without a limiting resistor, the lowest resistance settings of R3 would not be very useful, and some of the 270 degrees of rotation usually possible for a potentiometer would not be used. A second rotary switch SW is provided to change the source of sync voltage. In the INT position, sync is taken from the signal being fed to the vertical amplifier (or plates). The EXT position is connected to a terminal on the front panel so that any desired source can be used for sync. And placing the switch in the LINE position connects the 60-cycle line to the sync input for use as a sync source.

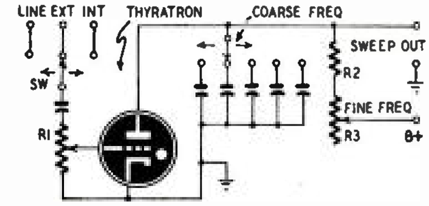



Fig. 4—This is a typical 'scope oscillator.

Ordinarily, oscilloscopes are provided with a vertical and a horizontal amplifier. Usually, the signal under test is fed through the vertical amplifier to the vertical plates. Almost invariably, the sweep generator signal (when it is used) is fed through the horizontal amplifier because it does not have sufficient amplitude to be fed directly to the plates. This has the additional advantage of providing a gain control (the horizontal amplitude control) which can be adjusted to make the sweep cover the screen or any portion of it which may be desired. Amplitude of the sweep signal determines the width of the pattern on the screen.

'Scope amplifiers must have good frequency response past the audio range. This is especially important for the horizontal amplifier because the saw-tooth wave form includes much harmonic energy. If this is not transmitted to the C-R-tube plates faithfully, sharp corners of the wave will be rounded off with resultant distortion of the pattern.

# Radio Set and Service Review

***The "Candid T-V" Model TV-37 is America's lowest priced televiser, selling for $99.50***

A LOW-PRICE portable television receiver has finally been made available to the TV-conscious public. Pilot has come out with its "Candid T-V" Model TV-37. Its 3-inch cathode-ray tube produces a picture 2 inches high and 2½ inches wide. Housed in a mahogany-finished Masonite cabinet 14½ inches wide, 13¾ inches deep and 9¼ inches high, it is just the right size for a student's desk or for a small table in a busy executive's office.

It operates from 105-120-volt 60-cycle a.c. lines and tunes channels 2 through 13 in two bands.

Weighing only 14½ pounds, it is easy and convenient to carry on vacations and business trips. An indoor-type antenna made of 300-ohm ribbon transmission line convenient for placing under a rug or hanging on a wall is furnished with the set. A leatherette-covered carrying case with a built-in telescopic dipole antenna can be obtained if desired.

The set is easy to operate. Panel controls are: ON-OFF VOLUME, BRIGHTNESS, TUNING, and CONTRAST. The power switch is on the volume control and operates in the usual manner.

The tuning control consists of a variable condenser shaft and bandswitch with concentric shaft. Channels 2 through 6 are tuned with the bandswitch in the Low position and 7 through 13 with the control set on High. Continuous tuning is used between stations on each band. The variable-condenser tuning, a novelty in TV receivers, appears to work very well. Pilot's copper-plate condensers, first seen in the Pilotuner, are used.

Hold, centering, and focus controls are on the rear chassis skirt. They are provided with insulated knobs with slots for screw-driver adjustment when necessary.

The set uses transformerless power supplies with one side of the line connected directly to the chassis. This does not constitute a shock hazard because the set must be fully enclosed in the cabinet before power can be applied through an interlock type of power cord. The control shafts are insulated from the chassis so as to avoid shock, even with the control knobs removed.

### The circuit

The circuit of the set is shown on page 37. The 21 tubes and their functions are: 12AT7, high- and low-band r.f. amplifier; 12AT7, high- and low-band mixer; 12AT7, high- and low-band oscillator; four 6AU6's, i.f. amplifiers; 6AU6, ratio-detector driver; 6AL5, ratio detector; 35B5, a.f. amplifier; 6BA6, video amplifier; 6AU6, sync amplifier and d.c.-restorer; 12SN7-GT, horizontal multivibrator; 12SN7-GT, horizontal amplifier; 12SN7-GT, vertical multivibrator; 12SN7-GT, vertical amplifier; 35W4, negative rectifier; 25Z6-GT, positive rectifier; 25L6-GT, oscillator (r.f. power supply); 1B3-GT, high-voltage rectifier; and 3KP4 cathode-ray tube.

The front end or tuning assembly of the set uses separate oscillators, r.f. amplifiers, and mixers for the high and low bands. Each band has its own coils, tuning condensers and tube circuits. The bandswitch connects antenna and B-plus to the section in use. The tubes in the front end are duo-triodes, one-half of each tube operating on the high and the other half on the low band.

The r.f. amplifiers are of the grounded-grid type, coupled to the antenna through fixed-tuned band-pass transformers adjusted with 30-μμf trimmer condensers. The r.f. amplifier plate circuits and mixer grid circuits are coupled through band-pass transformers with primaries and secondaries tuned by the front and middle sections of their respective tuning condensers.

The oscillators use tuned-plate untuned-grid circuits. The underside of the set is shown in Fig. 2. The front-end assembly is on a sub-chassis at the front of the set. The oscillator and r.f. coils are on the forms on each side of the three tube sockets on the sub-chassis. The construction of the oscillator tickler coils is novel. These coils, L1 and L2, are silver-plated brass

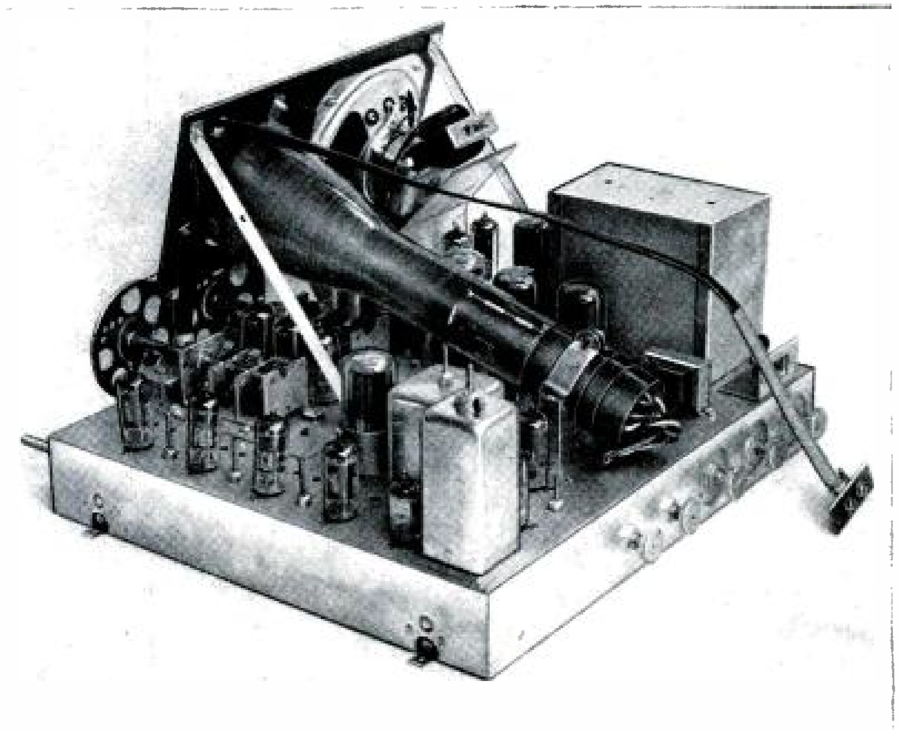


Fig. 1—This set employs separate tuning condensers for high- and low-band TV channels.

right-angle brackets fastened to the chassis so the sides pass close to the oscillator plate coils. The coupling between the ticklers and the mixer grid coils is sufficient to provide injection for the mixer. L1 and L2 are pointed out in Fig. 2.

The receiver uses the inter-carrier system—the common i.f. amplifier strip passes both video and audio signals simultaneously. Impedance coupling is used between the stagger-tuned i.f. amplifiers. The first i.f. stage is fed from a 23.5-mc permeability-tuned coil common to both mixers. The first, second, third and fourth stages are tuned to 25.6, 22.0, 21.6 and 24.8 mc respectively.

Semi-fixed bias is used on the grids of the r.f. amplifiers and on the first, second, and third i.f. amplifiers. The amount of bias is adjusted with the contrast control.

The video detector is a 1N34 germanium diode. It is in a can along with a sound trap, L3, tuned to 21.25 mc to prevent sound from reaching the grid of the video amplifier. The detector is followed by a 6BA6 video amplifier compensated for flat response to about 3.8 mc. The output of the 6BA6 is capacitance-coupled to the cathode of the 3KP4 cathode-ray tube.

The sync voltage developed across the 5,600-ohm video amplifier load resistor is coupled to the grid of a 6AU6 sync amplifier. This tube, a class-AB2 amplifier, amplifies the sync signals and passes them through integrating and differentiating networks to the horizontal and vertical multivibrator-type sweep oscillators.

Since the sync amplifier operates class AB2, the d.c. voltage across its cathode resistor varies with the average peak-to-peak signal amplitude. This voltage corresponds to the d.c. component of the picture. A part of the voltage is tapped off and applied to the grid of the C-R tube for d.c. restoration.

The sweep voltages are developed by 12SN7 multivibrators. Each one works into a 12SN7 push-pull deflection amplifier. The horizontal oscillator plates are grounded through load resistors and the cathodes are connected to a negative supply used for bias. The horizontal size is controlled by a trimmer, T8, across the output of the oscillator. Linearity is controlled by the combined settings of T8 and another trimmer, T9, between the plate of T1 and the grid of T2 in the horizontal amplifier tube.

The vertical oscillator has its plates connected to B-plus and cathodes to ground in the conventional manner. The vertical size is controlled by the setting of the 5-megohm resistor, a part of the load resistance of T2, one of the multivibrator triodes. Vertical linearity is maintained by the feedback network consisting of two .0015-µf capacitors and a 1.2-megohm resistor between the plate of the multi-vibrator triode T2 and the grid of the vertical amplifier T1.

The vertical and horizontal hold controls are variable resistances in the grid returns of the second multivibrator triodes. They control the frequencies of the oscillators by changing the time constants of the circuits.

Focusing is adjusted by varying the voltage on the focusing electrode.

The plates of both deflection amplifiers are connected to the B-plus supply and the cathodes to the output of the negative or bias supply. This arrangement increases the effective plate voltage on the amplifiers and provides sufficient sweep voltage for the deflection plates.

High voltage for the C-R tube is developed by an r.f. power supply. This is in the large can on the rear of the chassis, Fig. 1. The plate and screen of the 25L6-GT oscillator are returned to ground and the cathode to the negative supply. R.f. feedback to the oscillator grid is picked up by a spring clip around the lower end of the 1B3-GT high-voltage rectifier envelope.

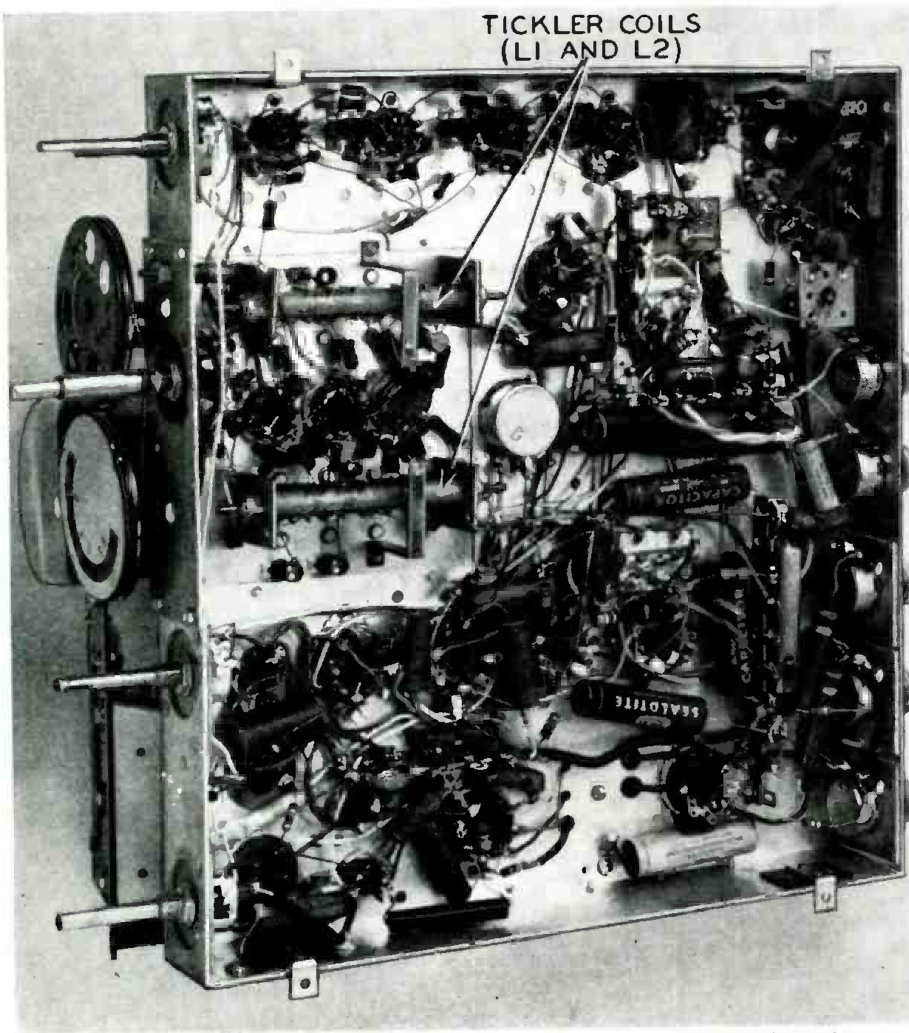


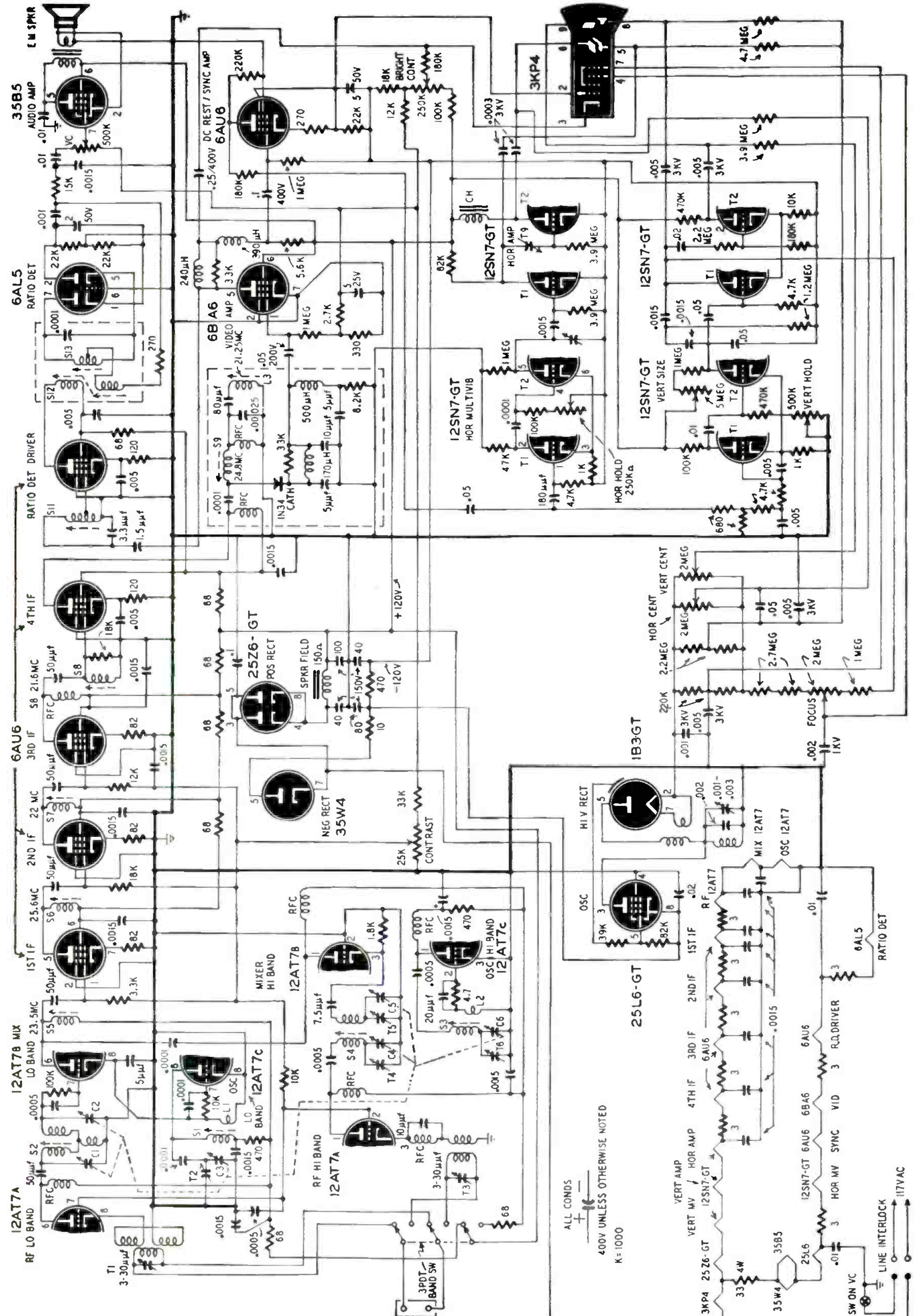

Fig. 2—Dial drums are on the two tuning condensers. Arrows show novel tickler coil straps.

There are two B-supplies in the set. One, using a 25Z6-GT, delivers about 120 volts positive with respect to the chassis. This tube feeds all tubes in the set except the sync amplifier, horizontal oscillator, and high-voltage oscillator. The other, using a 35W4, develops a negative voltage and supplies bias throughout the set as well as operating voltage for tubes not supplied by the 25Z6-GT.

The heaters of the tubes are connected in series-parallel filament strings with R-C filtering between most of the tubes.

The set was tested for several weeks in a number of New York City locations and was found to work nicely in all of them—even when using the 300-ohm indoor antenna. It was not possible to eliminate ghosts in all locations. This, of course, is to be expected when no special precautions are made to orientate the antenna. The set is very stable and it was not necessary to retune the set after it was turned on.

The line cord is connected permanently to the back of the cabinet. This prevents the set owner from operating the set with the cover removed, thus exposing himself to shock. This is an excellent feature for the owner but not for the poor serviceman who tries to service the set. He can't check the receiver without removing it from the cabinet and he won't be able to supply power to the set until it is in the cabinet. This handicap to servicemen was mentioned to the manufacturer and it was stated that very likely in the near future, line cords minus cabinets would be made available to servicemen on request.




Pilot Radio's Candid Television Receiver Model TV-37, an a.c.-operated televiser with a picture 2 x 2½ inches in dimensions, and weighing only 14½ pounds—almost a portable television set.

# Rolling Our Own Output Transformer

## *Another Langham high-fidelity adventure*

*All photographs courtesy U. S. Navy*

This is one of several ways to make the form.

Finishing the form. Forms may also be made of electrical fiber scored and folded square.

**By J. R. LANGHAM**

THE first time I ever wound an output transformer was way back when. I was just getting interested in radio, and the XYL was just a YL. I wasn't even in the radio business—I was just an amateur. Money being very scarce those days, I could not afford to buy a decent output transformer for my amplifier. I had a little open-frame 39¢ special and blamed it for the distortion and the short frequency range. I ached to be able to spend ten or twelve bucks for a hi-fi job, but I just didn't have the long green stuff.

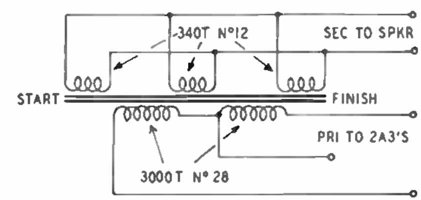
It was the YL who put this particular bug into my head. "Why don't you make your own?" she suggested.

"Me? Wind a transformer myself?" It was absurd. Transformer winding was an esoteric art reserved for the mysterious high-priests of electronics. It was unthinkable—but I thought of it just the same. I heard of a guy who wound transformers, and I made a pilgrimage to see him. He talked, I listened. I bought some beer and was respectful, and he gave me an old burned-out 300-ma power transformer and some insulating paper.

"Here," he said. "This'll make you a honey of an output transformer."

I gulped. "How do I go about it?"

"First un-pot it and knock the laminations apart. Heat them up and then let them cool slowly so they'll get soft. Measure your window carefully and decide how many turns you want of what size wire. You know your impedance ratio, so you know the turns ratio. Get a wire table. Make the primary about half the space available. Put in at least

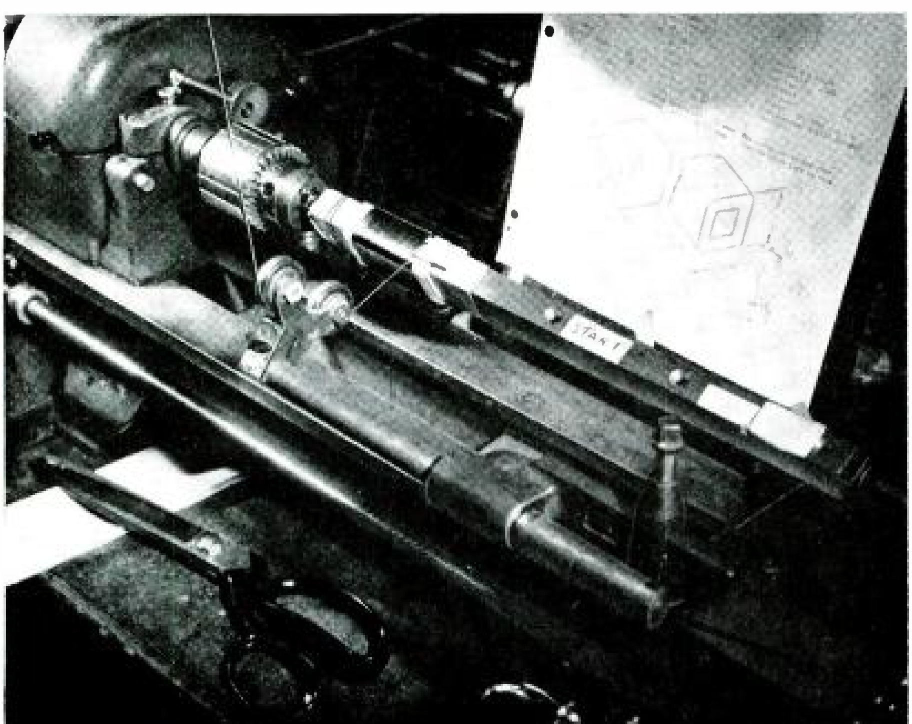


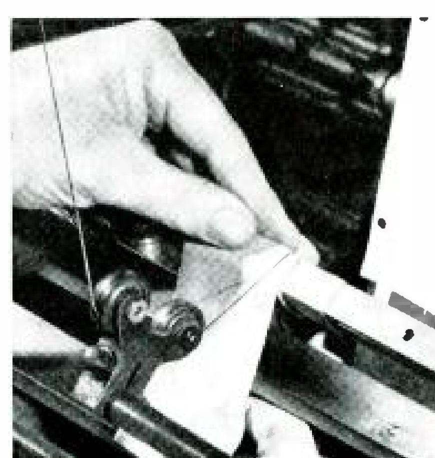

Schematic and specifications of the windings.

three secondaries and parallel 'em. That's to give good highs. Design it."

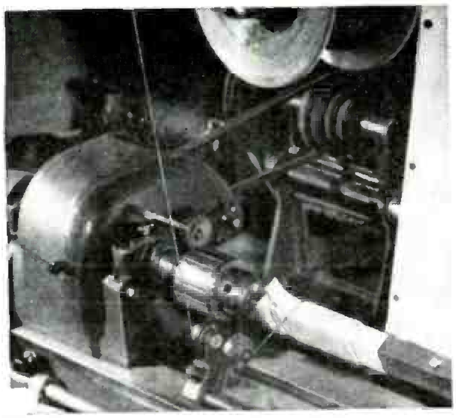
I gulped and went home with my booty. I melted the tar out and pulled the ugly thing out of the case. I hammered the laminations apart and cooked them in an electric oven over at the technical school. That was to anneal the iron and soften it. It had to cool slowly to do it. I spent a morning easing the temperature up slowly, and then I just shut the oven off and left the laminations in there with the door closed. That was on a Saturday, and I came back on Monday to take them out.

Well, the textbooks gave me most of the dope: the efficiency varies with the amount of copper in the window; bass response is determined by the primary inductance; treble response depends on the leakage inductance (mostly). I knew I wouldn't have to worry about capacitance because it was to be used

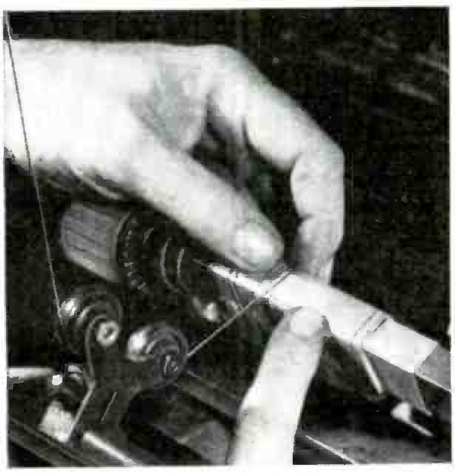




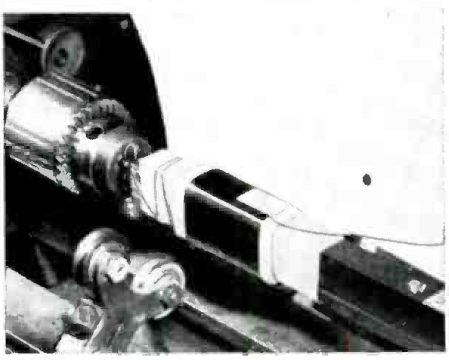
Above, left—First layer wound in place. To start second layer insert glassine paper under wire so that wire is at least one-eighth inch from paper's edge, and roll it on with the next turn of wire. (Photo right.) Paper secures and stiffens ends of windings.



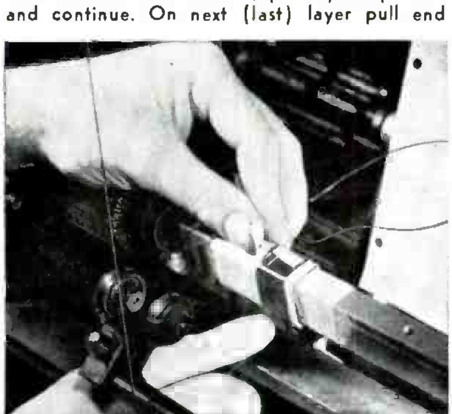
Should an end turn cut through the glassine, lay a strip of paper under it as shown above,



and loop it back, winding other turns over it. Pull the loop up snug after a few turns.



Finishing winding. Place paper loop as shown, wind a few turns over it, pull up loop ends and continue. On next (last) layer pull end



turn through and pull loop ends tight. If winding ends midway, use loop as above, wind a few turns over it and slip end turn through.

from tube to speaker and therefore was a low-impedance affair. My impedance ratio was from a pair of 2A3's to a 16-ohm voice coil and amounted to 5000:16, or 312.5. I knew the turns ratio had to be the square root of that: 17.7 approximately. Plain arithmetic gave me that and it meant there had to be 17.7 primary turns for each secondary turn.

I forget now just what the dimensions of my window were, but I remember deciding that 6,000 turns of No. 28 wire would come very close to filling the bill for the primary. The figure of 6000/17.7 meant 340 on my secondary would get the needed impedance ratio.

My friend had told me to make at least three secondaries. That didn't really mean much so I called him on the phone. "Why, it's simple," he answered. "To get good high-note response you have to have good coupling. So make three secondaries: one next to the core, another between the two halves of the primary, and the third on the outside. That way you get better coupling between the primary and secondary. Just tie all three of the secondaries in parallel."

"But I figured 340 turns for my secondary and . . ."

"That's fine," he said. "Make three of them and tie 'em together. Just use a smaller-size wire so you can accommodate three 340-turn windings."

"But about this high response business," I said. "The books say it's a matter of leakage inductance and . . ."

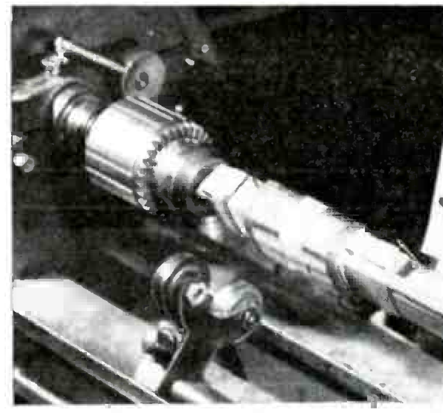
"That's just a measure of the coupling. With low-impedance stuff the coupling is all that limits your high notes. Forget the capacitance."

I sat down again with my wire tables and figured. 3 × 340 meant 1,020 turns had to go into that space and, what with the thickness of the insulation—hmmmm. No 12 wire ought to be about right. A trifle light, but No. 11 would be too big. I drew up my winding sketch. (See diagram.)

Now came the big problem: how to do the actual winding. There were several lathes over at the technical school, and the management said I was welcome to use them if I'd clean up after myself. I promoted a counter that could be attached to the end of the spindle to keep track of the number of turns. I still had the old cardboard winding form and I stripped all the old wire off it. Then I sawed a piece of wood that fitted nicely into the form and bought my wire.

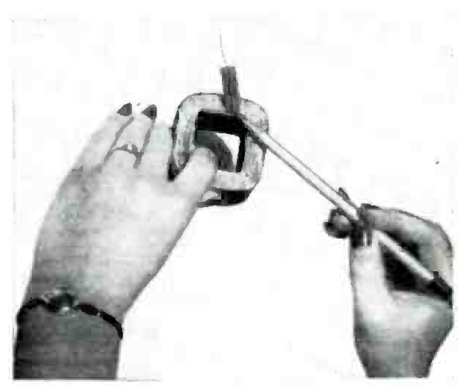
One more visit to my transformer friend showed me how to tape the ends of each winding layer, and then I started. It went much easier than I had expected. Actually it wasn't hard at all. Tedious, but not at all difficult. It took the better part of the day, what with attaching the counter and setting up a roller for the spool of wire to feed from. I wore heavy gloves and fed it by hand. Cutting the insulation carefully with a pair of shears, I taped it as neatly as possible.

The YL and I had a date that night, and we spent it fitting the laminations into and around the winding and then



Winding finished with final paper wrapping and a strip of adhesive to hold it secure.

Putting insulating fiber between windings evens up the surface and provides insulation.



Finished job, showing method of attaching lead wires. These connections are usually

made in the interior, between windings, and are held securely by the windings over them.

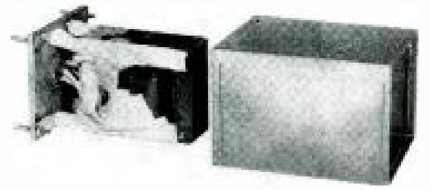
re-potting the transformer. Her mother still resents the fact that we used a saucepan to heat the tar and pour it into the case. We cleaned it, but I guess we didn't get it as clean as she thought we should have. Tar wouldn't hurt her anyhow. We used to chew it when we were kids.

The transformer was still warm when we bolted it onto the chassis and soldered the leads in. We hadn't checked it for shorts or opens or anything, just hitched it up and tried it out. It worked fine. I swore I could hear lows and highs that hadn't been there before. The old 39¢ open-frame job was given to the YL's kid brother who was building a set at that time.

Soldered wire is covered with another piece of insulation, held down with some coil cement.

Adhesive strips make external connections stronger. Whole winding may be taped also.

Last job of all is inserting laminations. This is not hard to do if all the dimensions are correct.



The transformer is now ready for repotting. But don't forget to give it a test run first!

But that transformer had faults. Several of them. The two halves of the primary weren't balanced properly, and the whole unit was too big and clumsy. My finances improved, and the YL became my XYL, and before long I could buy a big, fancy output transformer and build a new audio amplifier. That old wreck was kicked around the house for a couple of years before it was given, traded really, to a chap I knew. I had never run a test on it at all while I had it.

The new owner *did* run a test. I was amazed when he gave me the results. He used it in a class-B 6L6 PA amplifier and ran loads of current through it. The amplifier conked out one time, and he put an audio oscillator into the circuit as a sort of signal-tracer deal. He found the trouble and then idly twisted the dial on the thing. It went right down to 20 cycles on the bottom and (he said) up to 16 kc on the top. I frowned when he told me, so he unshipped the big brute from the chassis and made a bench test. The half-power points on the curve were 11 cycles and 23 kc. Those were where the level dropped 3 db. The efficiency was 87% and there was no sign of distortion at 30 watts, which was as much as he had available. All this too, was without feedback, mind you.

It sounded as though it were better than the transformer I had bought. The curve on that was supposed to be 1 db from 20 cycles to 20 kc but it conked out at 12 kc on the top.

I got a new job around then in a laboratory and was put to running bench tests on a whole series of standard transformers. I found an amazing thing: None of the "high-fidelity" transformers tested would meet their published curves. In fact, most of them didn't come near them. There were only two brands among all those I tested whose transformers *all* came up to their own specifications. Since our work involved Sonar listening gear we had to have the highest possible fidelity in transformers for faithful transmission of submarine sounds. We soon found we could not get enough really good transformers from the busy companies and so we had to wind a lot of our own.

The winding was done much as I had done it. I managed to get those photographs from the U. S. Navy. They show the work done in that laboratory in making up a transformer—and we made a great many of them.

I have since wound up more output transformers for my own outfit and for those of some friends. I use essentially the same technique as with that first hoary old model. I try to find a big old power transformer that someone has burned out and rip the old windings off it. I anneal the laminations and then design a new winding. This is really very simple and takes just a little figuring. You have to remember these things:

1. Fill up the window with copper. Fill it as full as you can. This governs the efficiency.

2. As a rule of thumb, allot half your space to the primary and half to the secondary. It works fine.

3. Have plenty of turns for the primary to get good low-frequency response. I never use wire larger than No. 30 any more. Even with 6L6's the transformer still runs plenty cool. For 2A3's you can use even smaller wire if you wish. Lots of turns.

4. Have several secondaries in parallel for your coupling. At least three. Five is even better. Put them here and there and all over and then just tie them together—but watch your polarity.

5. If it's to be for a push-pull amplifier, wind both your primaries at the same time from two spools of wire. That way you can get a good balance and keep down the intermodulation distortion. Make them in two sections or three, interleaved with the secondaries; but if you wind both primaries together, you'll have a good balance.

6. Lay the turns in closely and don't let any over laps stay in. Go back and remove them.

7. Don't use transparent sticky tape if you live near water. Get thin cambric tape and regular thin paper insulation from your supply house.

As to what kind of power transformer is best—that's up to you. The bigger it is, the easier it is to get enough primary turns for good bass response. Just get yourself a wire table and study the turns-per-inch of the different sizes. Don't squeeze it. A thousandth of an inch too little means a slight loss in your efficiency, but a thousandth too much means you can't get the laminations back together and you'll have your work for nothing. Measure your insulation thickness and plan the whole thing carefully.

You might be arguing to yourself now, "Well, if it's so easy, why don't the companies make transformers that are as good?" I'll tell you why. The economics are agin it. You're worrying about one transformer — your own. They have to think in terms of a thousand or more. Extra wire, extra insulation, and larger cores run up the cost considerably and then they couldn't compete with the others' prices.

You can have any coil-winding firm make you up a special transformer to your own specifications, and it will cost you plenty. Or, if you're a working stiff without much lettuce, you can look around for an old, burned-out 300 ma power transformer and, with a little work, make yourself a really fine output transformer.

It's really easy and, what's more, a lot of fun. Try it.

# Columbus Set For Video

## One city's servicemen prepare to meet the problems of television

By DAVID GNESSIN

Al Ray, ARSD president, Paul Wendell and Bill Hensler, visiting engineers, and Fred Colton, chairman of the Columbus association's educational committee, shown in the usual order.

COLUMBUS, OHIO, does not yet have its own television station. It is a healthy 100 miles to the nearest TV transmitter at Cincinnati. Yet the numerous TV dipoles and reflectors on Columbus rooftops amply testify that Columbusites—their appetites whetted by the occasional fringe reception of television signals from other cities—are anxiously awaiting 1949 when the first of three TV transmitters opens regular schedules in this capital city.

The radio servicemen and dealers in this town, long banded together for mutual gain and public service through the *Associated Radio Service Dealers of Columbus* (ARSD), realizing the imminence of television, took matters into their own hands by organizing study chapters on this subject as a regular feature of their monthly meetings. Fred Colton, the red-haired sparkplug of that organization, spearheaded the effort as chairman of the Education Committee. Using the regular Television Course now available in the *Sams Photofact Series* as text, the group started by reading the lessons at home, then bringing up their questions at the meeting.

The system worked so well they invited guest speakers to handle the advanced questions, which were rapidly reaching the stage where the cooperating member dealers found difficulty in finding satisfactory solutions. Here they were, out of the regular service area of scheduled TV stations, yet besieged by eager buyers thirsting for television and demanding they be supplied, maintained, and serviced.

The first of these really professional seminars in television took place Thursday, August 12, in the large basement of the Buckeye Radio Lab. The guest speakers (see photograph) included Paul Wendell and William Hensler, both of the Howard W. Sams Institute of Indianapolis. These engineers were happy to offer their expert opinions on television as seen by the serviceman. That information was of necessity limited to the bare two years or less that television has been available in any measure to their own Indianapolis.

The speakers were besieged by the service dealers, who were anxious for any practical information on the subject. Prominent in their minds was the worry about the dangerous voltages found in TV sets. It was contended that since C-R tubes require high voltages, these should be recognized as dangerous and care should be taken to insure safety in servicing.

The Columbus servicemen brought up the question of servicing sets with many different stages, any of which might be inoperative and affect the general operation. The speakers made the reassuring reply: "Under most general conditions, the television receiver, by its own C-R pattern, provides its own test instrument, showing the trained serviceman the errant stage, immediately localizing the trouble—making the servicing job considerably simpler than the tiny a.c.-d.c. job with the elusive intermittent which takes hours to locate." This theory is strongly supported by John R. Meagher, of RCA Television Service, who states in the current *RCA Service News*, (see reprint in November issue). "If we learn to recognize these visible symptoms, we can quickly localize the trouble to a particular portion of the set. *In no other type of electronic equipment are the troubles and symptoms so clearly displayed before our eyes!*"

The attending dealers were further cheered to find that their worries about stocking a large pile of expensive C-R tubes for servicing all the different types of TV receivers was groundless. In the first place, the high mortality of C-R tubes in the laboratory assures extremely low loss of picture tubes in the field. Secondly, the visiting engineers could name only four different types of C-R tubes in general use in commercial TV receivers, indicating an extremely high degree of standardization on this relatively high-priced item. Finally, the other tubes in the TV receiver are practically duplicates of the FM numbers already stocked by service shops in general practice.

The engineers made it a point to mention that even at that meeting, as the servicemen were making notes of the replies of the speakers, the guests were making notes of the questions for use in future Photofact service notes, as practical aides in the servicing field. In that regard both the publishers and servicemen pledged each other continued support for their mutual betterment.

The practical demonstration of alignment at the seminar brought out a unique point possibly overlooked in routine servicing. In TV service, merely moving the wiring aside to get at the solder terminals varied the constants enough to affect circuit alignment. So remember, replacing that open condenser isn't quite enough from now on —replace those leads *exactly as you found them*. The radio manufacturers have taken to separating the different circuits to avoid confusion. While simplifying assembly (the prime reason for this separation) the new technique exposes wiring terminals for ready servicing. *It took television to do it—but it was worth it!*

# Coin Radios—A Good Business

## *How one serviceman became his own boss*

**By JAMES McDANIEL**

MANY radiomen have a great desire to go into business for themselves instead of working for someone else. Having the same urge about a year ago, I decided to investigate coin-operated radios.

I began by visiting several banks, with the idea of getting a loan to finance the business. None of the banks had ever heard of coin-operated receivers, but the bankers were enthusiastic and advised me to go ahead immediately.

The next step was a trip to the company making the radios. Here I was shown through the plant and given demonstrations.

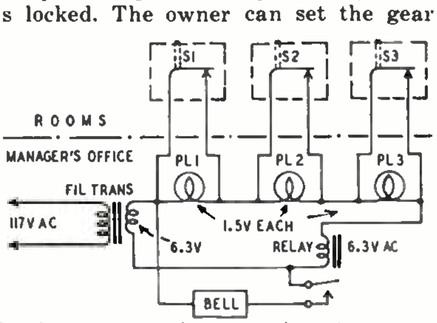
The next day I visited several hotels and signed contracts for installing the sets in guest rooms.

### The receivers

Because I am a radio technician, keeping the sets in good condition has been no problem. The sets are standard a.c.-d.c. jobs with slug tuning. They are very selective and have plenty of volume.

There is a master volume control locked inside the case so that only the serviceman can get at it. This is set so that no matter how high the customer turns his volume control, the people in the next room won't be annoyed.

The timing box, the mechanism which determines how long the radio will play, occupies a separate compartment, which is locked. The owner can set the gear ratios so that the customer will get either one or two hours' playing time for 25c.




Burglar alarm guards any number of receivers.

I chose the one-hour timing, not being quite sure just what the customers would consider fair. If they seemed to think one hour was not enough, I could increase the time to two hours and everyone would be happy. But if I started with two hours and then cut down to one, the users would feel they had lost something and would complain. So far, one hour has worked out nicely.

As much as $3 in quarters can be put into the coin box at one time so that the customer can listen uninterruptedly for more than the basic one- or two-hour period.

The timing mechanism sometimes jammed when the starting plunger was pushed down too soon after the coin was deposited. The result was that the radio would not operate, even though the coin was accepted. The hotel manager made refunds in these cases and I reimbursed him. The problem was much less important after the public became used to operating the sets.

The coin box will hold about $40 worth of quarters, so that collections do not have to be made too often. The coin mechanism can be disconnected in case the owner wants the set to play like any home receiver.

Luncheonette set gives 15 minutes for a dime.

### Other installations

Although I have installed receivers so far only in hotels, several other types of sets are made—for beauty parlors, hospitals, luncheonettes, motels, tourist camps, and so on.

Those for beauty parlors have an earphone attachment so that customers can listen even when they are under hair driers or while they are being worked on. The new "stethoscope" phones are used. They fit under the chin instead of over the head so there is no interference with the beautician's work.

The special model made for hospitals has a white-painted cabinet and provision for attaching a pillow speaker to avoid bothering other patients. The maker probably kept in mind the fact that hospital patients generally have plenty of bills to pay, because the timing mechanism in the radio is geared to play three hours for 25c. In a hospital where these receivers are used, interference from X-ray machines, fluorescent lights, and other medical equipment has been very small, in spite of the fact that the radios have no external antennas. The models made for luncheonettes and other eating places give 15 minutes of listening for a dime.

The white hospital model has pillow speaker.

### Business problems

One of the prime necessities is to protect the radio and the coin box from a few misguided hotel customers. The familiar towel-and-soap stealers need very little encouragement to become radio-and-coin thieves. The sets could be screwed to walls, but most hotel managers don't like this; so I furnish small tables, to which the sets are fastened and which are bolted to the floor.

I have found the burglar alarm shown in the diagram very useful. A normally open microswitch is installed in each receiver in such a way that the back of the case presses the contact lever, making it close. Leads from each switch are brought down to the hotel manager's office, where current from the transformer secondary flows through all switches in series with the normally closed relay. This keeps the relay contacts open.

If a guest tampers with a set, in removing the back he will make the microswitch open. If, for instance, his set is the one in which S1 is installed, S1 will open. The 1.5-volt pilot lamp PL1 is then placed in series with the relay coil and it lights. The added series resistance reduces relay coil current so the contacts close, making the bell ring. The manager, summoned by the bell, sees that PL1 is lit and knows just which guest is tampering with his radio.

This is admittedly a big installation job if there are many sets in the hotel. However, the mischief done by guests can be so costly that it is well worth while.

The arrangements made with the owner of the hotel or other place where the radios are installed will, of course, vary. The average income from each of my sets is about $3 per day. Of that 25% goes to the hotel owner. However, after the purchase price of each receiver has been paid out of the profits, the hotel owner's portion can be increased.

# SCREWDRIVER, VOLTOHMMETER AND BRAINS

By H.A. NICKERSON

ARE you charging $3 an hour for your servicing time? Maybe you should—or maybe you shouldn't.

On vacation in a strange town, I needed a set of tubes tested, so I went to a newly opened service shop. I stated my errand and asked to borrow an ohmmeter. The man behind the counter told me, with a laugh at my ignorance, that all I needed was a continuity tester.

Borrowing the shop copy of the RCA Tube Manual, I was unable to find my tubes listed; the manual was an old edition. Taking pity again on my ignorance, the serviceman made the continuity test and found that the filament of the 35W4 was open. Then we started to talk.

"I noticed your ad," I said. "You didn't state your experience."

"When I opened up," he told me, "There was quite a piece about me in the local paper. As a matter of fact, I have a master's degree in electrical engineering, but I don't believe in bragging about it."

"Well," I replied. "I still don't see how the average person—especially a stranger in town like me—can tell whether he ought to bring work to you. As a matter of fact, I understand most of the local people take their sets to a nearby town where there's a ham with a good reputation."

Said he: "After people learn that I do good work, they'll bring their sets here."

The conversation was friendly enough, but even in resort towns people aren't in business for their health. "How about a new 35W4?" he said with a mental glance at the cash register. My own mental picture revealed shelves of assorted tubes in my own workshop, so I declined. He relaxed again and put his elbows on the counter.

"Do you do much service work?" he asked me.

"No, just occasionally. I'm sort of a radio tinkerer," I told him, "and once in a while I write an article for a radio magazine."

A smile passed across his face and he stabbed a hole in the air with his forefinger. "You know," he said, "we have one of those tinkerers here in town—hit-or-miss boys, I call them. Now, when I was working as a production engineer, I had to inspect and pass on 350 to 450 sets before I could say I'd done a day's work. After you've tested 'em day in and day out you get so you can tell what the trouble is by the sound. For instance," and he poked the air again, "you hear a hum. How do you know what's causing it?"

"Well," I answered, "first you suspect the power-supply filter, then a leaky tube, usually the output tube. You substitute condensers in the filter and put the tube on a leakage test."

"Heck, no," he laughed, "you don't have to go through all that—all you have to do is listen!" He became serious. "Too many radio men are charging the customers for their own lack of knowledge. A radio set has one of two troubles, either an open or a short. All you have to do is find out which it is and fix it. Oh, I know," and he brushed aside my unspoken objection, "it might be an intermittent. But any good man ought to be able to find that in an hour at the most."

He turned to the workbench and I took a look around the shop. I noticed a volt-ohmmeter, apparently one of the vest-pocket models with a maximum range of 1 megohm. There were some resistors and condensers, too, and a collection of tools.

As I stood there, he aligned a five-tube "ack-dack," as he called it, by ear. As he jarred the chassis after putting in a new tube, I heard a scratchy on-and-off effect from the speaker.

"In my ignorance," I volunteered, "that sounds like trouble in the new tube."

He admitted my ignorance. "How could that complete on-off effect come from a tube that draws such a small current? It must be in the i.f. transformer." He hit transformer, tube, and chassis, all with equal effect on the noise. (He hadn't found the answer by the time I left.)

As he worked, he started talking about servicing fees. "The real radiomen in this locality got together," he told me, "and agreed to charge $3 an hour for service, with a flat charge of $1.50 for going to a customer's home."

I posed a question. "What do you do about the fellow with the old set worth $15 that you work on for three hours, digging out old bypasses and replacing them?"

"Oh, I charge list prices for the parts and the hourly rate for the time. But it would never take that long to do the job."

"My system is different," I told him. "If I have to work for four or five hours on some old relic, I don't charge what my time is worth; I base the charge on what the set is worth. Then if someone comes in with a set that takes me only a minute to fix, I make up the previous loss with my charge for the short job."

"Ah!" he said, turning around so I could see the triumphant look on his face. "That's why those surveys found so much to complain about. You're gypping the customer with the small job."

"Well," I argued, "someone has to pay for bookkeeping, answering the phones, and sweeping up the floor—to say nothing of the rent."

Now he was indignant. "You just can't charge that to the small job," he laid down. "It's people like you," and he shook his finger in my face, "who give the radio serviceman a bad name. You should charge for your time, and you should charge everyone the same rate. On those long jobs you're just charging the customer for your inexperience anyway."

I had an answer for that. "If I charged for my time on some jobs, the customer would hate me forever. You take your car to some garage, and someone fools around with it for a long time and you have to pay for that time. But next time you'll take it to a better mechanic. I don't expect to get paid for being slow. I should get paid for being fast; if I can locate trouble in a hurry. I'm a specialist and I can charge more for my time. I've known plenty of good radiomen who spent hours on a set and then found some soldering flux in a pilot-light socket. According to you, they should have found it right away, by just listening to the set."

"If they took three or four hours to find a little thing like that," he said, adamantly, "they were just tinkerers."

Before I left the shop I looked around again, this time more critically. I couldn't find any Rider Manuals or Photofact books or anything similar. There was no signal generator. All I saw was the collection of resistors and condensers, the tools, and the pocket-size volt-ohmmeter. I wish I had had the time to stay longer and see how quickly he could check an elaborate band-switching system or find a shorted turn in an i.f. transformer with only the volt-ohmmeter. But I had to go, and so I said good-bye. "I hope I've convinced you not to overcharge for small jobs," was his parting comment.

As I walked slowly down the street, I didn't notice the bright sunshine or the pleasant shade trees that lined the sidewalks on either side. I was *puzzled!*

Had I just spent a half hour with the biggest faker in radio? Or was he a brilliant and highly skilled practical technician? Should time charges be inflexible? Or was my system the better one?

What do *you* think?

Taxi driver in a now familiar pose.

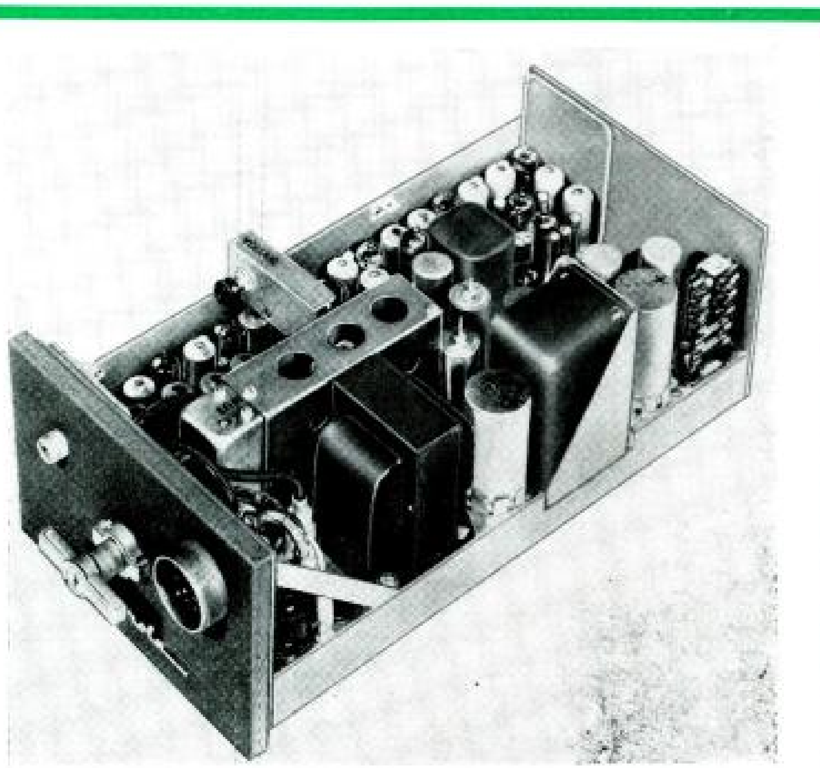
# *Installing* Two-Way Radio In Taxicabs

By SAMUEL FREEDMAN

TAXICABS now have more two-way radio installations than all the other mobile radio services combined. The Federal Communications Commission estimates that there are now about 2,000 taxicab radio systems. A rough estimate based on a number of systems picked at random indicates that there is an average of 21 taxicabs per system. This means that about half of America's 80,000 taxicabs are equipped or licensed for two-way radio. About 150 new systems per month are being licensed.

Equipment for taxis is now available from Bendix, Comco, Doolittle, Federal, General Electric, Harvey, Kaar, Link, Mobile Communications, Motorola, Philco, Raytheon, RCA, Temco, Western Electric, Wilcox Electric, and others. The entire field has developed since the war when the FCC in May, 1945, made available two frequencies in the 152-162-mc band.

Except for a few modified surplus military sets, all taxicab equipment is FM. The operating frequency in the 152-162 megacycle band is reached with several frequency-multiplication stages stepping up the quartz crystal fundamental frequency from 32 to 96 times. Because taxicabs are primarily interested in coverage of their own city or community (usually less than 5 miles maximum distance in any single direction), most sets are of low or medium power. This has permitted the development of compact equipment in which the transmitter and receiver are in the same cabinet. Some manufacturers have designed equipment powered by a vibrator instead of having a separate dynamotor high-voltage supply for the transmitter.



Motorola Dispatcher. Ingenious and sturdy construction fits parts in small space.

The equipment is of three types:

1. *Single unit* with all the transmitting and receiving components mounted on a single chassis. The Bendix 2½-watt and Motorola 5-watt Dispatcher units are typical.

2. *Single housing* with two decks, one for the transmitter and the other for the receiver. The Federal 25-watt equipment is a typical example.

3. *Dual unit* with separate cabinets for the transmitter and the receiver. This requires two mounting plates and additional space. It is common with higher-powered equipment. The highest power used in the mobile units for the 152-162mc band is currently about 30 watts.

In the typical taxicab installation, the following will normally be found:

**In the rear trunk:** The transmitter and receiver as one or two units. Cables here run to the rooftop antenna, to the control unit in the driver's compartment, and to the storage battery, wherever it may be located (usually under the hood).

**In the driver's compartment:** The control unit, microphone, and loudspeaker. A control cable will run back to the transmitter-receiver in the rear trunk.

**Under the hood:** A two-wire power cable will run to the transmitter-receiver in the rear trunk. In some installations only one wire is used and the ground return circuit is through the car body.

**On the roof:** An antenna, either flexible, or rigid with a spring base, capable of withstanding collision with tree branches. For the taxicab frequencies this antenna is approximately 17½ inches long and is always vertical. It connects to the transmitter-receiver *via* a solid-dielectric flexible co-axial cable.

## Installation pointers

Aside from the conditions specific to a particular piece of equipment, the following is considered good practice in installing equipment in taxicabs or similar vehicles.

1. The transmitter and receiver should be made inaccessible to unauthorized persons. This is done best by

locating them in the locked rear trunk.

2. The control unit and microphone should be easy to reach and use by the driver of the taxicab. They are usually located at about the center of the instrument panel.

3. The equipment (transmitter, receiver, and power supply) should be easy to install, service, and remove without sacrificing too much space in the rear trunk.

4. The equipment in the rear trunk should be protected against any rain which might work inside along the seam between the rear trunk door and the car body. It should also be protected against loose tools, tire chains, luggage, or anything else bumping against it.

5. The equipment cabinet or cabinets should be electrically grounded to the car body. If the cabinet is screwed or bolted into the metal deck, this requirement is automatically taken care of. Otherwise a metal braid strap should be connected between the equipment cabinet and some metal part of the car body.

6. The equipment layout and holes should be planned and spotted carefully before they are made.

7. If there is any excess cable length, remember that the equipment may be used in new cars when the old ones are traded in, and the length requirement may be different. A cable that is too long can be still used; one that is too short cannot.

8. The spare tire must be accessible for removal or for checking its air pressure.

9. Every hole through which cable must pass may chafe or cut into the cable. Prevent this by using a rubber grommet, protecting the cable with several layers of insulating tape where it passes through the hole, or by doing both.

10. Every bolt without a lock-washer may be expected to work loose unless it corrodes badly and rusts solid.

11. In drilling bolt holes in the rear trunk to support the transmitter-receiver, make sure that the drill does not penetrate into the gasoline tank or into a heavy car frame member or some inaccessible point where it will not be possible to attach a bolt underneath for tightening.

12. Drill no holes in sheet metal (particularly on the finer exposed finishes of the vehicle) without first using a center punch. Otherwise, the electric drill will crawl and mar a large area.

13. The voltage drop between the storage battery and the equipment in the rear trunk should not exceed 0.5 volt. The battery cable should be kept as short as possible. It is good practice to cut it to the minimum possible length for a particular installation without regard for future installations. Usually the battery end of the cable will need replacement (because of corrosion) by the time the equipment is transferred to another vehicle. A new battery cable for each new installation is entirely reasonable.

14. Do not permit any cable to run outside the vehicle, as underneath the car, where it will be exposed to mud, dust, and jars.

15. Mount equipment in the rear trunk to withstand severe shocks when the vehicle travels over uneven road surfaces at high speeds.

16. Place the microphone where it will not hit the face or body of the driver in the event of a collision.

17. Make the installation such that the value of the car will not be seriously lessened for trade-in because of the holes. The only visible hole should be that in the rooftop for the antenna. The antenna base insulator should be left on the car when it is traded in and a new one used for the next installation.

18. Install equipment so that it can be removed and replaced in the event of faulty behavior or transfer to another vehicle.

All items of equipment should be located for the shortest cable lengths consistent with accessibility for servicing and inspection.

## The taxicab antenna

The single antenna must serve both for reception and transmission. This is made possible by the antenna transfer relay located in the transmitter. When the microphone push-to-talk button is pressed, the relay closes and connects the antenna to the transmitter. When the button is released, the relay opens and connects the antenna to the receiver.

The antennas used for the 152-162-mc band are either flexible, or else rigid with a flexible spring base, as shown in the photograph. The base of the rigid radiator connects through the insulator to the co-axial transmission line leading to the equipment with a flexible braided conductor.

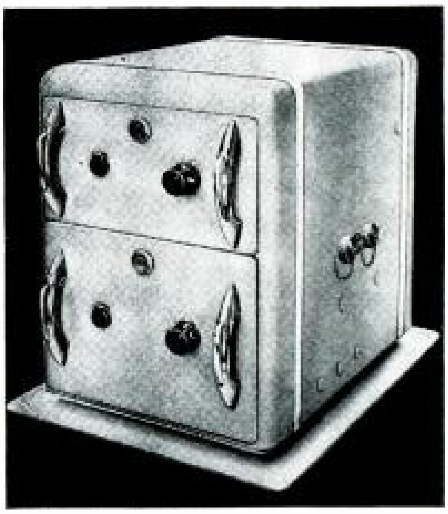
Fig. 1 shows the details of a typical antenna installation. The procedure for such an installation is:

1. Measure the length of antenna cable from the bottom of the antenna base. Determine the location of the cross members near the center of the roof of the car; and, at a spot between members equidistant from each side of the car, drill a $\frac{7}{8}$-inch hole. If a longitudinal channel is encountered and it cannot be penetrated through a hole in the channel, drill a hole through that also. Usually it is not necessary to cut or drop the upholstery. A good location for the antenna base is directly over the center of the back rest of the front seat but clear of the dome light. The hole should be clean, with no burrs. Be careful to prevent the drill from slipping through and damaging the upholstery.

2. Feed the free end of the co-axial cable (without the fitting) from the antenna base through this hole.

3. Route the cable through holes in cross members of the roof. These holes may be located by feeling through the upholstery on the roof of the car. The cable is to be brought out into the trunk compartment near the equipment cabinet. In some cases, removal of the rear seat is helpful in routing the cable and fishing it through. All slack cable should be pulled through into the trunk compartment.

4. Loosen the bracket screw on the antenna base as much as is necessary



Federal units are drawer-mounted in cabinet.

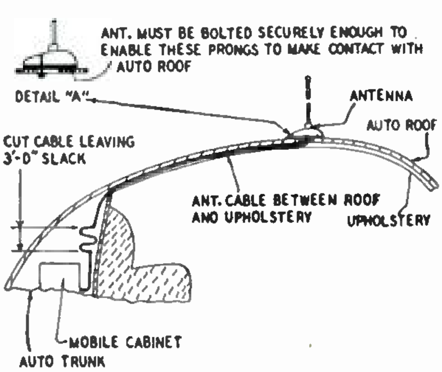
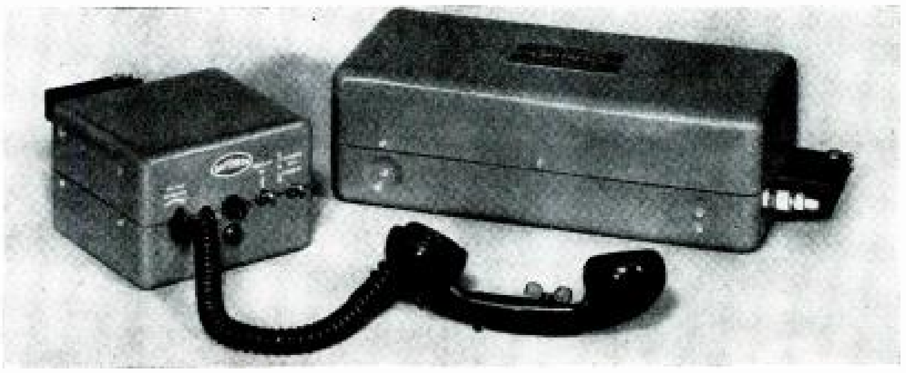



Fig. 1—How antenna is installed in car roof.



Raytheon transmitter-receiver (right) and control box (left) show compactness of equipment.

to slip the bracket through the hole in the roof of the car. A rubber washer must be under the head of the mounting screw. The pointed end of the antenna base should be toward the rear of the car. Tighten the mounting screw, making certain that the semicircular guide on the base fits into the hole and that the two metal grounding points project through the rubber gasket. This will insure proper grounding to the metal frame of the car when the mounting screw is securely tightened. The

Motorola control unit mounts under dashboard.

antenna whip is trimmed to the correct vertical length. For the 152-162-mc band, the correct lengths are:

| Frequency (mc) | Length (inches) |
|---|---|
| 152-155 | 17⅝ |
| 155-159 | 17⅜ |
| 159-162 | 17⅛ |

5. Insert the whip into the base insulator and secure with an Allen wrench. The lock-nut may be covered with Duco or Glyptal so it will not work loose.

6. Cut off any excess cable, allowing 3 feet more than necessary to reach the cabinet. Make a fitting to the cable for attachment to the equipment. Very poor range and signal strength can result if the shield of the co-axial cable floats at either end. The inner conductor must connect to the whip electrically at the rooftop and to the inner conductor of the co-axial fitting at the equipment. The outer conductor or sheath must be grounded at the rooftop and at the equipment cabinet. The writer has seen sets with a working range of less than 5 miles with a co-axial cable floating at one end, compared to a range of 40 miles as soon as this condition was corrected.

If the antenna is not located on the center of the roof, transmission will be directional. The best transmission and reception will take place in the direction in which most of the car metal is between the antenna and the other station. In the case of an antenna mounted on one corner of a vehicle, the difference in signal strength will be approximately 4 to 1 between the best direction and the worst direction for the same distance. One of the great advantages of taxicab radio operating on the 152-162-mc band is the feasibility of using the center of the roof, where this 4-to-1 characteristic has disappeared. Instead, the maximum characteristic is approximately present in every direction rather than only one as in the days of 30-40 mc when bumper antennas were employed.

General experience in the taxicab field has been that low power can be tolerated but a defective antenna system cannot. The maximum airline coverage required in a typical city for taxicab operation seldom exceeds a working range of 5 miles.

To reduce interference to adjacent cities in urban areas, the FCC is currently considering plans to limit the antenna height and transmitter power of the dispatching station, as most of them have an excess coverage.

## Some typical sets

**The Bendix MRT-3A Communication** Unit includes a 2½-watt FM transmitter, a 10-tube superheterodyne FM receiver, and a 6-volt vibrator power supply in one cabinet, which is mounted in the rear trunk. This cabinet measures 16½ x 8 x 3½ inches. The equipment requires a maximum of 16½ amperes from the 6-volt car storage battery during transmission. The entire installation is shown in Fig. 2.

There are three connecting cables. A co-axial cable connects the transmitter-receiver to the antenna. An eight-wire cable goes to the control unit in the driver's compartment. This unit contains an on-off switch and a volume control as well as the hand-set. A two-wire power cable connects to the storage battery. The live side goes through a protective fuse to the live lug of the car starter, making unnecessary a connection to the corrosive lug of the storage battery.

The principal unit is mounted flat across the back of the rear seat, at-

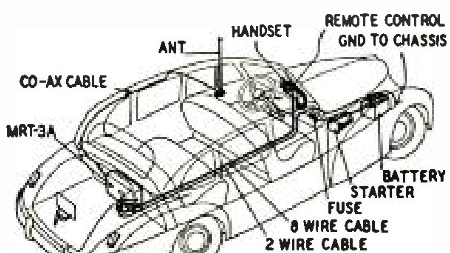



Fig. 2—Installation of components and leads.

tached to a pair of metal braces usually present behind the seat. If these braces are suitably spaced, they can be drilled for four 10-32 bolts on 5 x 12-inch centers to accommodate the predrilled mounting holes in the case. If braces cannot be used, a piece of plywood may be used to support the unit. Screws, nuts, and lock-washers should be used to prevent loosening due to vibration.

**The Motorola Dispatcher** is rated at 7 to 10 watts output. It draws a maximum of 21 amperes at 6 volts during transmission. The entire transmitter, receiver, and dual-vibrator power supply are mounted on a single chassis which mounts in the rear trunk. There are five different ways of mounting the cabinet. The control unit used in the driver's compartment has a volume control with four positions: OFF, LOW, MEDIUM, HIGH. It also has a variable squelch control to adjust sensitivity just above the local noise level. The range may be increased by adjusting the squelch control into the noise region, at a sacrifice in signal quality. A microphone clip on the control unit serves as receptacle for a small microphone. If a handset is used, an additional holder accessory is provided. In the Motorola a single cable connects to the live battery terminal. The return battery circuit is through the grounded car body.

**The Raytheon installation** uses a transmitter-receiver unit and a smaller power supply and control unit with connecting microphone. This equipment is unique in that, by keeping the power supply in the driver's compartment, a shorter power cable may be run to the storage battery.

**The Western Electric Type 238** is another common installation. The maximum load during transmission is 57 amperes. If considerable transmission must take place, it is advisable to equip the vehicle with an oversize generator. This is the same equipment as that designed for the Bell mobile radio service for common-carrier communication. It utilizes separate transmitter and receiver units in the rear trunk. It is also designed to function in connection with a selective dialing and ringing circuit.

**The Federal 25-watt installation uses** a single cabinet housing the transmitter and receiver. Either unit is removable merely by pressing the levers on each drawer handle. The unit may then be inspected, serviced, or exchanged. All connections are automatically made in the rear of the unit when the drawer is locked in position.

## Installation time

The normal time for a complete taxicab installation is approximately half a working day for two men. Some economy in man-hours results when identical equipment is installed in many identical vehicles at the same time. Then more men may be used, with each specializing in certain operations. The vehicles should be placed alongside each other with one man drilling holes, another mounting units in the rear trunk while another works in the driver's compartment. If more men are available, another may be fishing and securing cables. In that manner, installation time may be reduced to about 2 hours, depending on the type of equipment and the type of vehicle which is being equipped.

Typical charge for an installation job is about $20 for labor. Typical charge for servicing is $5 per vehicle per month, under contract, with parts extra. Parts are usually charged for at either list or half-way between list and net. Prices vary greatly, depending on the distance the serviceman must travel, the number of vehicles involved, and to what extent his principal livelihood depends on this work. It also is dependent on the quality and complexity of the equipment and the care which the operating personnel give their equipment. The cost of parts varies from zero to several dollars in any one month, with the possibility of operating several months in a row with no expense whatever.

# HOME-BUILT PHONO USES TWO PICKUPS

Motorboard holds two pickups, one for good discs, one for bad.

By HAROLD J. GOULD

A PHONOGRAPH comparable in results to the more expensive custom-built sets can be built according to the following specifications. The phonograph is equipped with two pickups, and the amplifier has two input stages. A high-quality pickup feeds one input and is used with good records; the other pickup is used for playing old or badly worn discs. The two input stages (see Fig. 1) are identical high-gain pentode amplifiers. The equalizer enclosed in the dashed box is the unit supplied with the Brush PL-20 pickup; the resistors and condensers for this are sealed in a metal can and are connected to terminal lugs. Be sure to use the Brush 3761-B equalizer. It is intended for high-impedance inputs. Others are supplied for low-impedance use.

The input stages are followed by a phase inverter using a triode-connected 6SJ7. This stage gives very little amplification but has low distortion and excellent frequency fidelity. The load resistance for the phase inverter consists of two 47,000-ohm resistors R14 and R15. Splitting the load in this way and grounding the center point supplies the grids of the power tubes with voltages approximately the same in amplitude, but differing in phase by 180 degrees. R14 and R15 should be as nearly equal as possible to obtain equal push-pull signals.

Used in the power amplifier stage are two 6B4-G tubes, biased for class-A operation. Other tubes, such as the 6A3 or 2A3, could be used in this stage; they have similar characteristics, but different heater requirements and bases. Class-A amplification, although not as efficient as the other classes, has much to recommend its use in a high-quality outfit. For one thing, 6B4-G's in class-A push-pull have very low distortion; and what distortion they do have is second harmonic, which cancels out in push-pull. Another advantage of using class-A triodes results from their low plate resistance. This plate resistance is effectively in parallel with the speaker voice coil and serves to damp the speaker. Without adequate damping, a sound impulse fed to the voice coil will not produce an exact replica of the original impulse but may pass through several cycles before it eventually dies out. This is what causes the muddy effect in many amplifiers employing tubes whose plate resistance is too high, especially beam-power tubes.

There is absolutely no advantage in having a superb pickup and amplifier if the output transformer is a cheap, skimpy affair. This component can introduce distortion that will nullify the results of an otherwise high-fidelity system.

A cheap output transformer will handle its rated power all right; but the amount of iron in the core is usually too small for the flux density present, and third-harmonic distortion is introduced into the signal. Also, the transfer of power from the plates of the output tubes takes place less efficiently in a poorly designed transformer. The obvious solution is to use a good transformer, one with plenty of iron and copper in it. The output transformer could well be nearly as large as the power transformer. The writer was unable to obtain a high-quality transformer, but with a little extra work managed to contrive an admirable substitute.

The parts—chokes, transformers, fil-

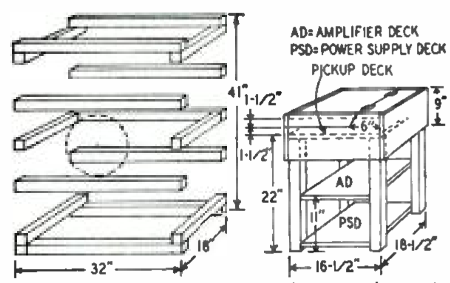
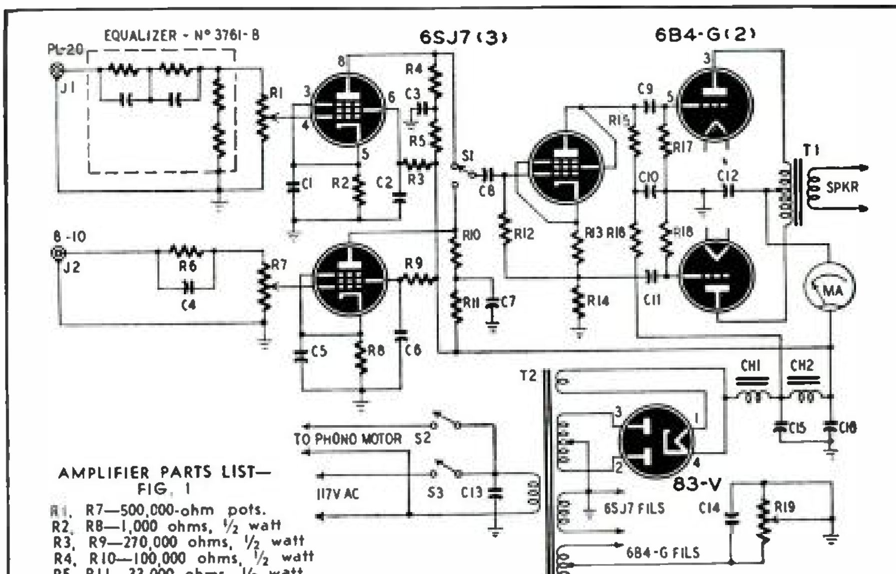



Fig. 2—Details of speaker cabinet and stand.




AMPLIFIER PARTS LIST—
FIG. 1

R1, R7—500,000-ohm pots.
R2, R8—1,000 ohms, 1/2 watt
R3, R9—270,000 ohms, 1/2 watt
R4, R10—100,000 ohms, 1/2 watt
R5, R11—33,000 ohms, 1/2 watt
R6—2.2 megohms, 1/2 watt
R12—1 megohm, 1/2 watt
R13—3,900 ohms, 1 watt
R14, R15—47,000 ohms, 1 watt
R16—22,000 ohms, 1 watt
R17, R18—470,000 ohms, 1/2 watt
R19—400 ohms, 10 watts, adjustable
C1, C5—25-μf, 50-volt elec.
C2, C6, C13—0.1-μf, 400-volt paper
C3, C7, C10, C12—10-μf, 450-volt elec.
C4—250-μμf midget mica
C8, C9, C11—.05-μf, 400-volt paper
C14—40-μf, 50-volt elec.
C15, C16—8-μf, 600-volt, oil-filled
T1—push-pull output transformer, 5,000 ohms to voice coil (see text)
T2—power transformer, 600 volts c.t., 150 ma, 5 volts, 3 amps., 6.3 volts c.t., 3 amps., 6.3 volts, 2 amps.
CH1, CH2—30 h., 150 ma
S1—s.p.d.t. rotary switch
S2, S3—s.p.s.t. toggle switches
J1, J2—single-circuit microphone connectors
M—0-200-ma meter

ter condensers—that were selected for the power supply were on the hefty side, allowing a generous margin for safety and making for trouble-free operation. R19, the 6B4-G biasing resistor, should be adjusted to give a 45-volt drop across it.

(The milliammeter in the power-stage plate circuit was apparently put there to indicate whether or not the stage was functioning. Other constructors might leave it out for economy's sake.—*Editor*)

Fig. 3—Inside of speaker cabinet is padded.

The speaker chosen for the phonograph was a Jensen A12-PM. Although there are many units on the market utilizing woofer-tweeter combinations, this was judged to be the best compromise between quality and economy. Heavy and solidly built, its power-handling ability is high enough. Any good speaker may, of course, be used.

A well-designed enclosure for the speaker is as important as a good speaker. If the enclosure is flimsy or undersized, the sound will lack deep bass and the high notes will sound strident. Also, there will be annoying rattles on loud passages.

The enclosure used satisfies all the requirements for high-quality, life-like reproduction. It consists of a ruggedly constructed wooden box, the dimensions of which are shown in Fig. 2. This size exceeds the requirements of a minimum inside volume of 15.000 cubic inches which is needed for a 12-inch speaker mounted on an infinite-type baffle. By the time the inside reinforcing members and absorbent lining are added, the spare space is used up. For strength and solidity 7/8-inch-thick wood is used in the construction of the box, with cross-members of 2 by 2. To lessen the possibility of boards' working loose in time, wood screws rather than nails are used to fasten the several sections together.

A removable back for the speaker box is constructed of the same heavy wood used for the walls. The 11-inch speaker opening is equipped with a hinged lid which can be lowered to protect the speaker cone against accidental injury. To aid in moving such a large and heavy speaker assembly, casters are fitted to the bottom of the cabinet. (A square of heavy metal screening placed between the speaker and the hole would probably be a better way to protect the cone against injury.—*Editor)*

When the box is completed and the speaker mounted and wired, the enclosure and its back are lined with absorbent material to a thickness of approximately 1½ inches. Kimsul acoustical wadding may be used here. This material was unobtainable, however, and the writer made do with a quantity of cotton batts of the kind used to fill quilts and bedspreads. These served the purpose and were an inexpensive substitute for the regular sound-absorbent material. A glance at the photo will be sufficient to show how this lining is tacked inside the baffle. With the

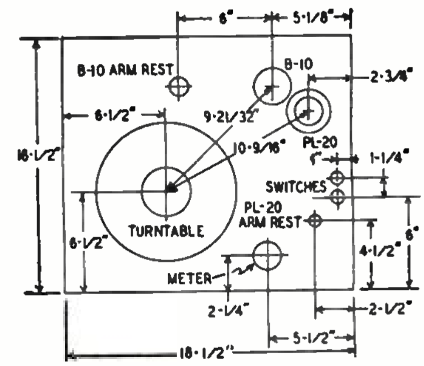



Fig. 4—The drawing shows motorboard layout.

lining in place, the back of the box should be screwed down securely using plenty of heavy wood screws.

Construction of the separate phonograph-amplifier assembly is shown in Figs. 3, 4, and 5.

This is a phonograph that will give its high-priced brother, the custom-built model, a run for its money as far as performance is concerned. And as for appearance, there is no reason why it cannot compete here, too. If the builder has any skill at all in cabinet making, or wishes to have the cabinet made to order by a cabinet maker, he will have a fine piece of furniture. The rough appearance of the model shown in the photographs was due partly to lack of skill at carpentry and partly to impatience with spending any undue time on the "mere appearance" of the equipment.

(Note: While many readers will not be impressed with the idea of using an extra pickup for the purpose of saving the "good" one, the two-pickup scheme could well be used to make the phonograph play the new Microgroove records as well as standard discs. Simply substitute a Microgroove pickup for the inexpensive crystal the author used. Of course, a two-speed turntable will be necessary, too. Both preamplifiers are not necessary—one of those now used may be abandoned by placing S1 ahead of the preamplifier and using it to switch pickups to the input of a single 6SJ7. If the PL-20 gives too much surface noise with poor records, build one of the simple step-type equalizers shown in the PL-20 bulletin, obtainable from the manufacturer.—*Editor*)

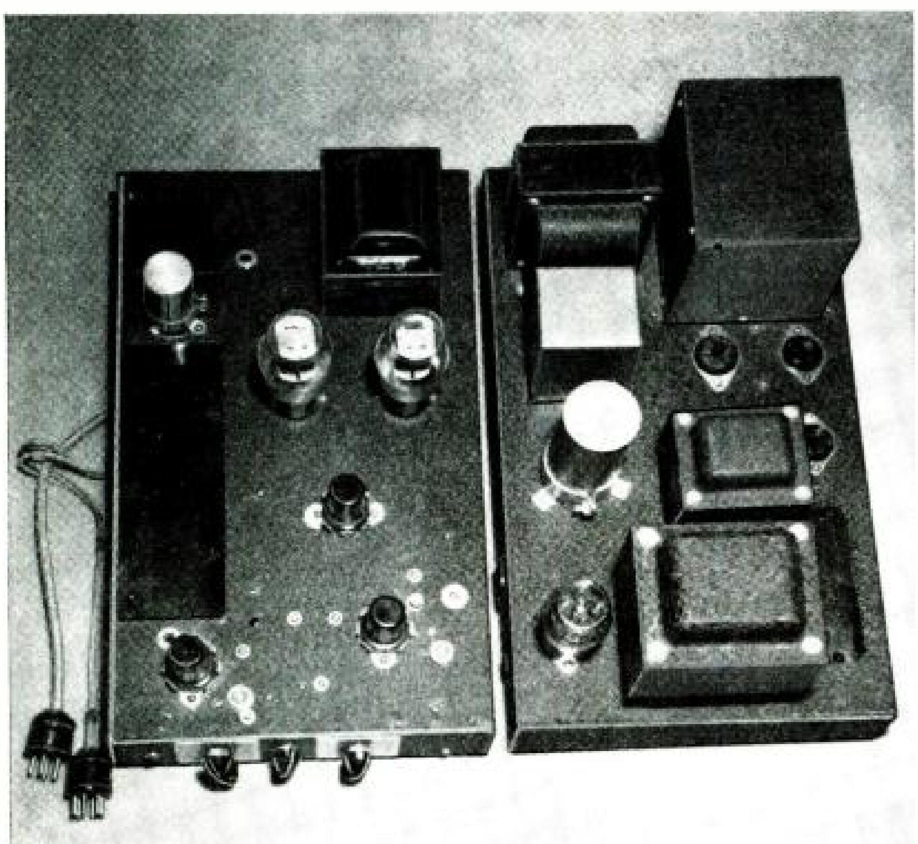


Fig. 5—Use of separate chassis for amplifier and power supply helps to reduce hum pickup.

# Push-Button Generator

Sloping-panel cabinet is conveniently small.

***Receivers can be aligned and tested more speedily and accurately with this crystal signal generator***

By ROBERT E. ALTOMARE

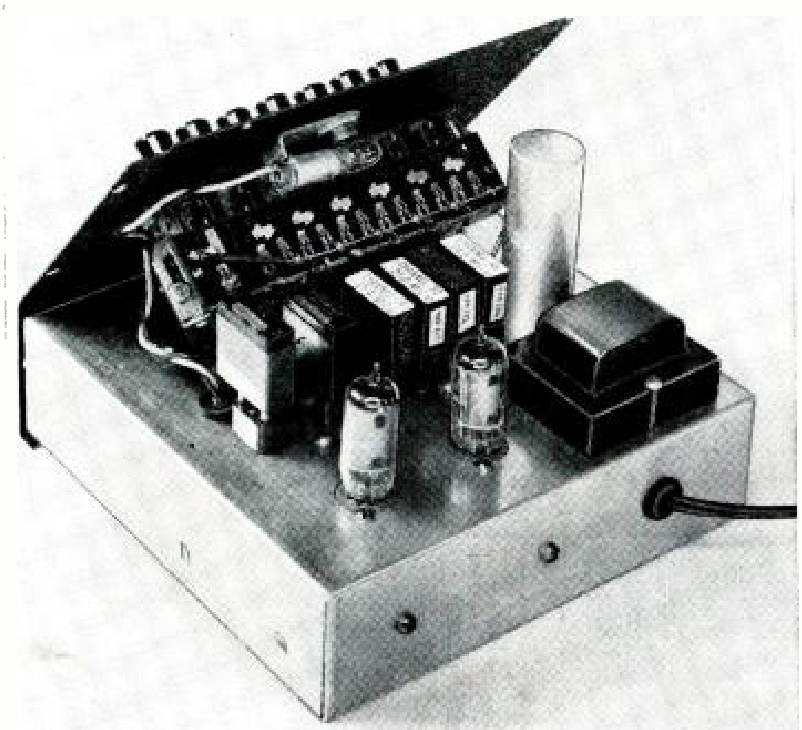
RECEIVERS can be aligned faster and more accurately than usual with the aid of this crystal-controlled, push-button-tuned signal generator. Seven channels are used, but, by employing a switch with more buttons, the constructor can increase the number of available frequencies. By a judicious choice of crystals, harmonics may be used and an instrument developed which covers an extremely wide range with comparatively few channels.

The instrument also has separate audio output with very good wave form. The audio can also be used to modulate the r.f.

A 6AU6 miniature pentode is employed as an electron-coupled Pierce oscillator. The screen grid acts as the oscillator anode. The Pierce circuit was chosen because it is simple and requires no adjustable tuned circuits.

The diagram shows the circuit. The crystals connect directly between the control grid and the screen. With too much r.f. excitation, the crystal may crack. Since r.f. excitation depends on the d.c. anode voltage, this must be kept fairly low. The 56,000-ohm dropping resistor may have to be increased to keep the screen down to about 60 volts. The 100-ohm cathode resistor aids in protecting the crystal in the event of an accidental overload. The 100,000-ohm grid resistor furnishes grid-leak bias. The 33-μμf capacitor determines the amount of feedback applied to the control grid; its value is not too critical.

Since a Pierce oscillator requires a capacitive anode circuit, the anode tank must be tuned to a frequency *below* that of the crystal. While maximum output will be obtained if this tank is tuned just below the crystal frequency, there will be enough output even if the tank is tuned far below it, provided the L-C ratio is high. This is why a tuning capacitor can often be omitted and only stray and coil capacitances utilized in its place. In this instrument the 2.5-mh and 1-mh chokes act as tuned anode circuits. The 5-45-μμf trimmer is inserted simply because various constructors will have their own ideas as to which crystal frequencies are most desirable. It, along with the stray and choke-coil capacitances, will resonate the choke anywhere between approximately 170



Despite small cabinet and chassis size, layout of parts is a very simple matter.

and 800 kc. The 1-mh choke will resonate somewhat below 1 mc (depending on the coil and the stray circuit capacitances). Crystals inserted in positions 5, 6, and 7 can therefore be 1 mc or higher.

Another 6AU6 is used as an audio oscillator; its output can be used to modulate the r.f. oscillator. A phase-shift circuit was chosen because it gives very low distortion, yet is extremely simple and compact, no transformers or inductances being necessary.

The audio gain control also determines the percentage modulation when the r.f. oscillator is being modulated. It actually varies the feedback necessary to sustain audio oscillation. The 82,000-ohm resistor in series with it provides a stopping point. Oscillations just begin when the potentiometer arm is set at the ground end. When it is at the plate end, sufficient audio output goes to the r.f. oscillator to modulate it approximately 100%. The suppressor of

**FREQUENCY TABLE**

| Channel | Xtal freq. | Important harmonics |
|---|---|---|
| 1 | 200 kc | 600, 1,000 and 1,400 kc |
| 2 | 455 kc | none |
| 3 | 460 kc | none |
| 4 | 470 kc | 1,410 kc |
| 5 | 1 mc | multiples of 1 mc |
| 6 | 5 mc | multiples of 5 mc |
| 7 | 10.7 mc | 96.3, 107 mc |

the r.f. oscillator tube is modulated so there is little interaction with the oscillator proper.

## Crystal frequencies

The writer chose the frequencies listed in the table because these are probably the most useful ones for service work. The table shows the range possibilities with harmonics of the crystal frequencies chosen. (Another reason for using a Pierce oscillator was that its output is rich in harmonics.)

Economy is an important factor, too. For this reason, surplus crystals were used. For example, the 455-, 460-, and 470-kc crystals are purchasable on the surplus market at attractively low prices. These crystals were employed in FM channels and, in order to obtain correct final frequencies after multiplication, it was necessary to employ fractional-kilocycle crystals. Thus, the 455-kc crystal actually oscillates at 455.556 kc. It might be thought that this makes for inaccuracy. Actually, the error is only 0.122%, a degree of accuracy normally unobtainable in a tunable signal generator even if it is "on the button" because of operating errors introduced by parallax and the width of the pointer.

This particular crystal is employed not only to align 455-kc i.f. amplifiers, but also for 456-kc i.f.'s. The error here is less than 0.1%.

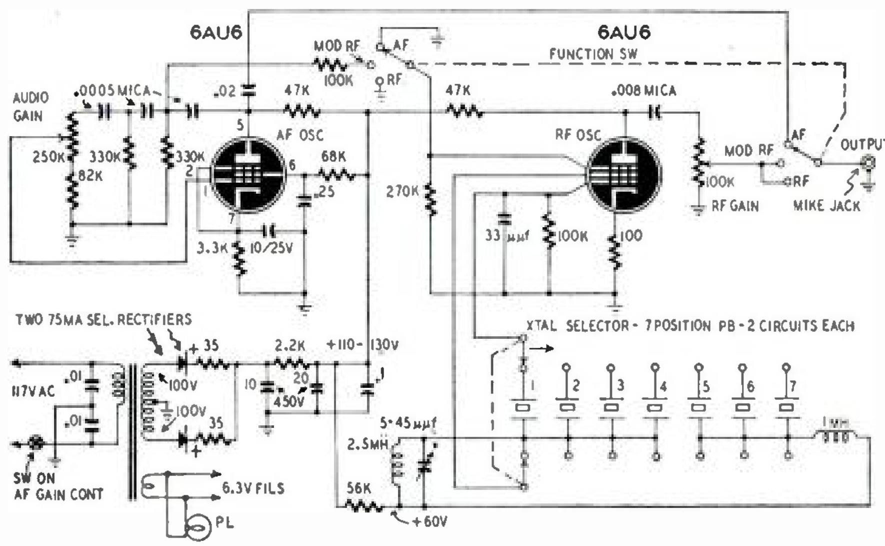
Some other crystals available on the surplus market at reasonable prices include those with frequencies of 200, 1,000, 2,500, 3,500, 5,000, and 10,000 kc.

It might be a good idea to mount one crystal socket on the front panel so that unusual frequencies could be set up without opening the case.

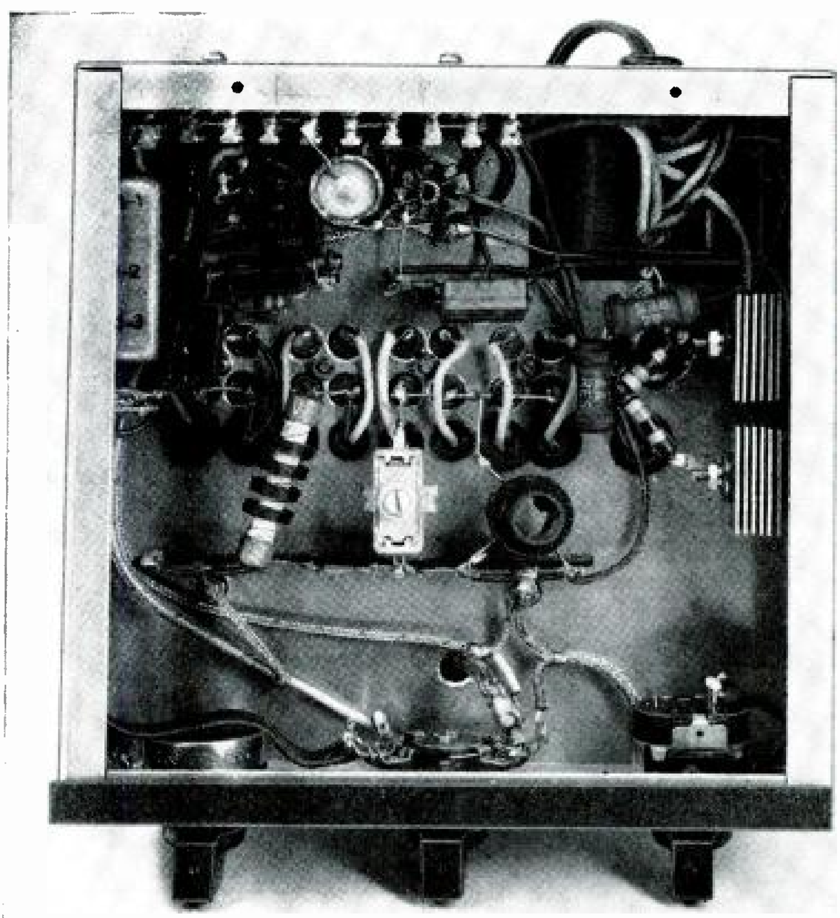
The crystal-controlled signal generator will be most useful in aligning broadcast sets, of course. Harmonics of the 200-kc and 470-kc oscillators, as well as the fundamental of the 1,000-kc crystal, are essential for aligning the r.f. sections of broadcast sets. I.f.'s are taken care of by the 455-, 460-, and 470-kc crystals. And the 10.7-mc channel is suitable for FM i.f.'s.

Servicemen are not the only ones who will find the unit handy. Many amateurs, for instance, have found that building a v.f.o. with the desired stability is not as easy as it sounds. For them, the push-button crystal selection scheme makes a large number of crystal frequencies available, especially if a larger push-button assembly is used.

The variety of harmonics available from the several crystals can be used to spot a large number of frequencies in the short-wave bands, useful for calibrating or band-locating.

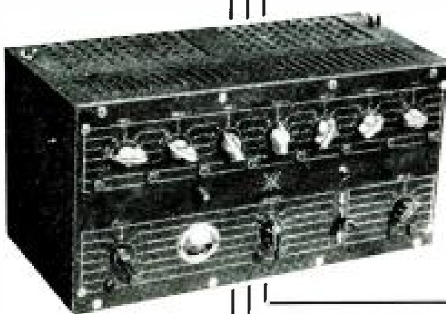



More crystal frequencies can be made available if a larger push-button assembly is employed.



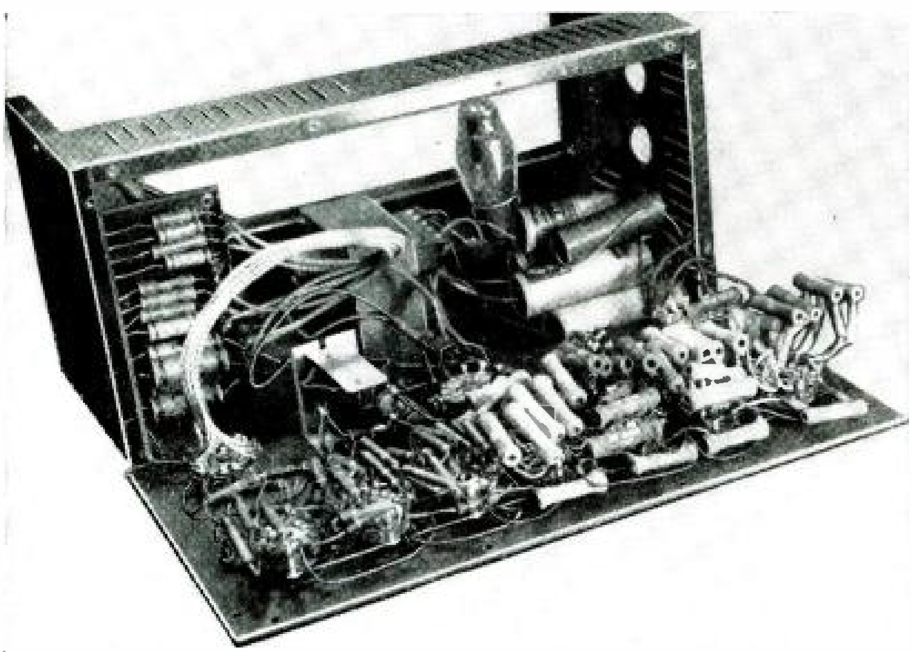
All the parts can be distributed neatly under the chassis leaving plenty of space to spare.

# Substitution Unit—Plus



**A capacitor test up to 800 volts is also supplied by the instrument**

**By G. N. CARTER**



Inside and (above) front view. The resistors are mounted directly on the panel switches.

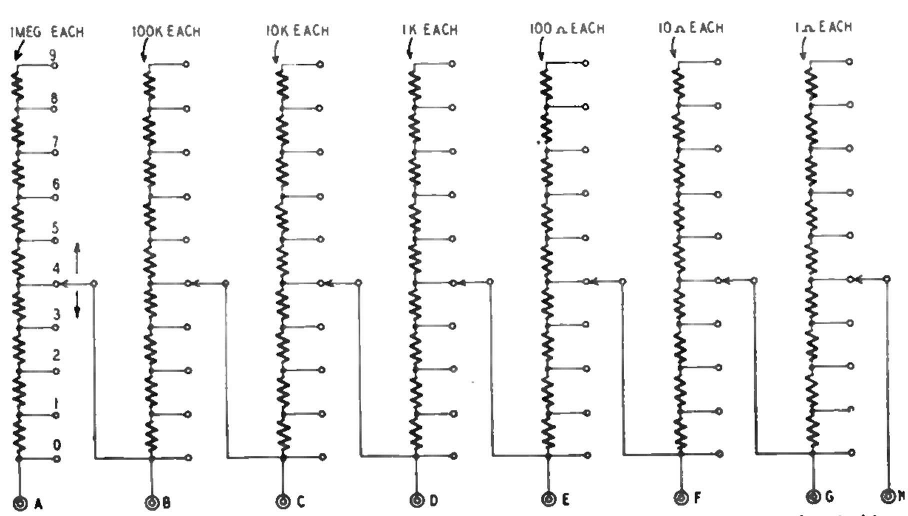



Fig. 1—Any resistance from 1 to 9,999,999 ohms is available with a minimum of switching.

NEXT to the tube tester and the volt-ohmmeter this piece of equipment has been found to be the most useful in the shop. It can be employed on almost every service job because it deals with the two most frequently used components, condensers and resistors.

The unit actually does four separate jobs. First, it provides a resistor substitution unit giving any value between 1 and 9,999,999 ohms. Second, it furnishes a high-voltage test for condensers, with test voltages of 200, 400, 600, and 800. Third, it contains a paper condenser substitution unit with values of .005, .01, .02, .03, .04, .05, 0.1, 0.25, and 0.5 μf. Last, an electrolytic condenser substitution assembly gives values of 4, 8, 12, 16, 20, 30, and 40 μf.

It was built as a substitution unit for service bench use, but a similar instrument made with precision resistors and accurately calibrated capacitors could well be used as a semi-laboratory instrument for comparison tests or in connection with a Wheatstone bridge. In that case, the electrolytic condensers would have to be checked regularly, as they cannot be depended on to maintain their capacitance.

The resistor unit shown in Fig. 1 is a modification of a decade resistor box. Any resistance value between 1 and 9,999,999 ohms may be obtained with the direct-reading scale. Each decade range is individually accessible by plugging into the correct pair of tip jacks. (This feature is especially valuable when employing values between 1 and 9 ohms. Jacks G and H can be used, eliminating the possible resistance of the switch contacts which would be in the circuit if the connections were made to jacks A and H and all switches but the last turned to zero.—*Editor*) Resistors of 5% tolerance were used, giving sufficient accuracy for most replacement work, as well as a saving in cost over those of better accuracy.

Shorting-type switches were used to minimize sparking and burning of the switch contacts when employed in current-carrying circuits. Note that in the zero position of the switches adjacent terminals are shorted, allowing a rapid selection of values without having to move the test leads from one jack to another. Say the test leads were plugged into jacks A and D to find some unknown value. If the 1-megohm resistors were too high in value, then the megohm switch would be turned to zero, effectively cutting out all those from the circuit and leaving the 100,000- and the 10,000-ohm resistors.

The only precaution to observe is that when the decade is across a high-voltage circuit, the switches in use should not all be turned to zero. If they are, the source will be shorted. Zero was purposely omitted from the front panel markings to prevent persons unfamiliar with the circuit from using that position and possibly causing trouble.

In the model, the four lowest ranges employed 10-watt resistors for greater power dissipation in case these ranges were to be used as bleeders or as dummy loads in checking audio power output of amplifiers.

The capacitor-substitution sections are shown in Fig. 2. In the one using paper capacitors (at left) the foil end of each capacitor should be connected to the common bus and to the ground terminal. In the electrolytic section (at right) capacitor polarities should be observed as shown. Although 450-volt electrolytics were used in the model, 600-volt units would be more useful and would be less likely to break down.

## Capacitor tester

This portion of the instrument, diagrammed in Fig. 3, has several features worth noting. The first position of the rotary switch puts a 0.1-μf condenser across the test terminals so that the operator can test the checker for correct operation. The other four positions supply 200, 400, 600, and 800 volts to the test jacks. To reduce shock hazard while using the voltage test, the a.c. switch is spring-returned to OFF, which means that both hands cannot accidentally be across the high voltage. This a.c. switch is ganged to a discharge switch which discharges the condenser under test through the 1-megohm resistor, producing a flash in the neon bulb. A pair of polarized leads with insulated tip plugs on one end and clips with rubber insulators on the other allows the test voltage to be applied to condensers and other components for test purposes. The spring-return switch used for charge-discharge and a.c. is a Centralab 457. (It might be more convenient to use an ordinary toggle for the a.c. on-off switch, retaining the spring-return unit for charge-discharge only. This would eliminate the necessity of waiting for the 83 to warm up each time a test is made when a number of capacitors are to be tested in one session. The safety of the spring-return feature is not too complete, since one hand could be touching the plus terminal while the other brushed against the metal panel while operating the switch. So be just as careful as usual when making capacitor tests.—*Editor)*

To test a condenser, clip the test leads from the test terminals across it, select the desired voltage with the rotary switch, and press the charge-discharge switch to CHARGE. If the condenser has a value of .02 μf or greater, the neon lamp will flash and go out, indicating a nonleaking condenser at that test voltage. When the switch returns to DISCHARGE, the condenser will discharge and flash the neon bulb again, indicating a good condenser and making it safe to handle, particularly if it is of high capacitance and was tested on 800 volts.

To check the operation of the tester, switch to the TEST position. This will put the 0.1-μf capacitor across the test terminals. Operation of the CHARGE-DISCHARGE switch in the usual way will show that the unit is working. If, some day, the test does not flash the lamp, don't start tearing the instrument apart. Try a new 0.1-μf test capacitor first; the old one may have gone bad.

The outer case for the instrument was taken from a discarded PA amplifier, the 9 x 17½-inch front panel being replaced with a piece of black Masonite fastened to the frame with rack-panel-mounting screws. The surface of the Masonite was sanded lightly with fine sandpaper to remove the glaze and permit it to be easily marked with a white crayon pencil. If, just prior to marking, the surface is moistened with glass cleaner, the pencil will write much more easily than if dry and the result will be almost the equal of a pen or a brush job. After the marking was completed, the panel was sprayed lightly with clear lacquer to prevent the white lines from getting smudged. White bar knobs were used for the resistance switches and red for the three lower ones which are for the condenser substitution units and the voltage test.

After giving this job a fair trial, the technician will never go back to the hit-or-miss method of bridging across suspected unit resistors or condensers picked up at random. Probes with alligator clips will reach into difficult places and make sure connections, then several values may be tried almost instantaneously.

This is the workmanshiplike way to substitute components.

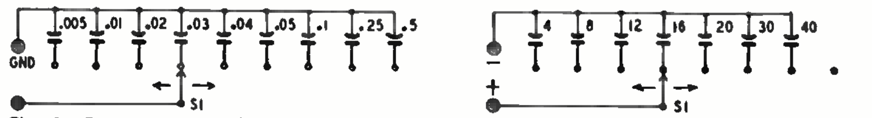



Fig. 2—Two rotary switches make available all values of paper and electrolytic capacitors.

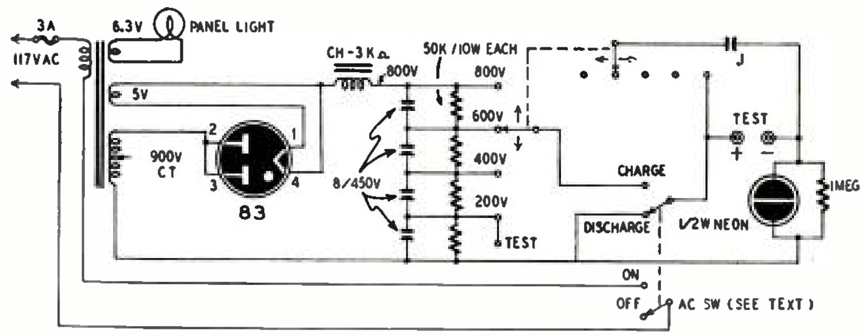
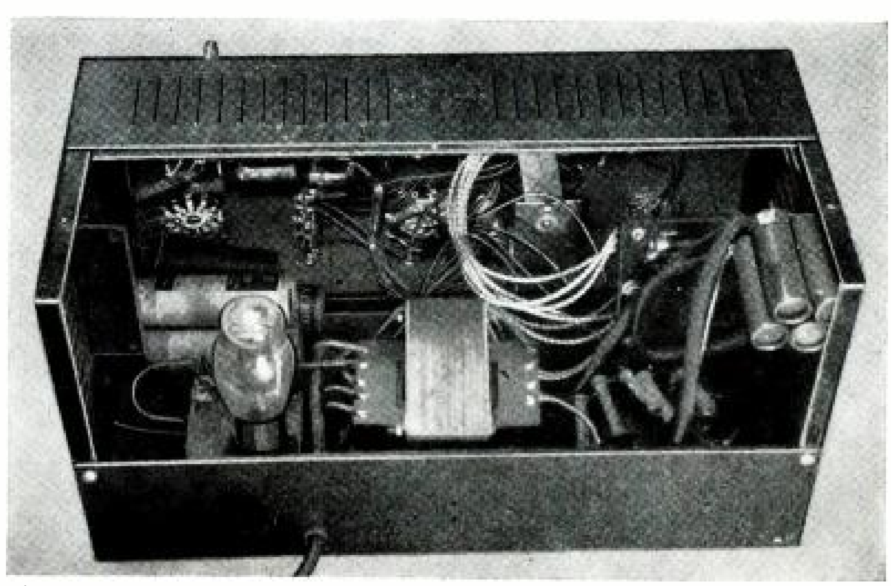



Fig. 3—Voltage supply. An old receiver pack may be adapted, as voltages are not critical.



This rear view of the equipment reveals a few more details of mounting and parts layout.

# European Report

## By Major Ralph W. Hallows

RADIO-ELECTRONICS LONDON CORRESPONDENT

An interesting new series of subminiature tubes has recently been brought out by Mullard Electronics. Designed for use in deaf-aid appliances, these tubes are of three types: DF70 is a pentode amplifier, DL71 and DL72 are output pentodes, intended for use with crystal insert and magnetic earphones respectively. The characteristic curves of DF70 are seen at right. An outstanding feature of these tubes is their minute filament current, which is but 25 milliamperes for all types. The drain on the A-battery of a 3-tube hearing aid is thus only 75 ma. The B-battery load is 1.76 ma with 2 DF70s and 1 DL71, or 2.45 ma when the DL72 is used in the output stage. It is not so many years since the old Audion required 750 ma at 4 volts, or 3 whole watts of A current to heat its filament —and now the DL70 rubs along quite contentedly with one tenth as much filament current at less than one sixth the voltage, consuming no more than 0.0468 watt! I needn't say what a boon these low-current tubes are to users of hearing aids, particularly when their filament current is supplied by the Vidor mercury cell which I described recently. One of these cells will supply the filaments of a 3-tube hearing aid for 30 hours *continuously* without any falling off in performance.

### Hail Columbium!

A remarkable new magnetic alloy, developed here by the Permanent Magnet Association in collaboration with the Electrical and Allied Industries Research Association, has just been announced. In this case the "little something that the others haven't got" is a tiny quantity of the scarce metal which we call Niobium and you Columbium—anyhow it's Element No. 41. The make-up of the alloy is:

| | % |
|---|---|
| Cobalt | 21 |
| Nickel | 11 |
| Aluminum | 8 |
| Copper | 4 |
| Columbium } Iron } | 56 |
| | 100 |

The exact percentage of Columbium has not been divulged, but it is believed to be very small. Queer, by the way, that that table should contain yet another metal for which we have a different name. We call it aluminium, (pronounced "al-you-minnie-um"). You will see that the new alloy is more of an iron than a steel, for it contains no carbon at all. Further, except for the columbium, it is made up of the same ingredients as Alnico, though they are not quite in the same proportions. The new alloy, which doesn't yet appear to have been given a name, is superior to any other now known in its coercivity. In other words, it is much less easily demagnetized. It is the latest addition to the largish family of cobalt-nickel-aluminum-iron alloys and the history of its gradual development goes back quite a few years. Two alloys very like it, but without the Columbium, were produced during the war for use in radar equipment. Then came another, containing vanadium, which was designed not for magnetic purposes but for use in jet propulsion engines. This proved to have unexpected magnetic qualities and gave birth to the idea that even better results might occur if Columbium, which is in the same group as vanadium in the periodic table of the elements, were used instead.

### Birmingham television

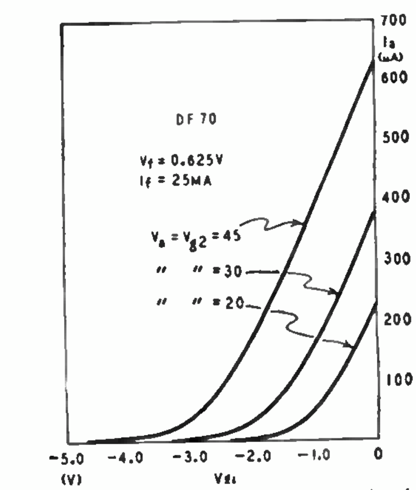
There is considerable disappointment that the official date for the opening of the TV transmitter at Sutton Coldfield, near Birmingham, should be as far ahead as the fall of next year. In fact I wouldn't be surprised if popular clamor led to a speed-up. This station will be a good deal more powerful than the one in London. The exact figures haven't been announced, but I gather that they're something like 50 kw for vision and 10-15 kw for speech. It is to work on 61.75 mc and 58.25 mc for vision and sound respectively. This is just about as far as the band of frequencies allotted to television allows it to be from the London transmissions.

I don't quite know why such a wide separation has been decided on—it can hardly be from fear of mutual interference, since the London frequencies are 45 and 41.5 mc. Certainly it's causing a bit of heart-burning amongst those—and there are quite a few of them—living outside the normal London service area, though well within that of the Birmingham station, who have already invested in televisers. By using "add-on" rf amplifying stages and efficient antennas they have been able to bring in the London transmissions pretty well. But the snag is that their sets won't tune to the frequencies of the new station. It's preset tuning of course in televisers; but it seems to me that the range should be adequate in any mass-produced receiver to allow at least the whole 40-60 mc band to be covered.

### A.c.-d.c. Television

Though the manufacturers don't call them a.c.-d.c. sets, the new Pye B18T televisers which have just appeared here will work quite satisfactorily from 200-240-volt d.c. mains. These sets represent a big step forward, for by doing away with the need for a mains transformer they show how to make a surprising reduction in price.

This Pye set, for instance, with a 7½ x 6 inch image and a 19-tube circuit, sells at the equivalent of about $175 in table model form. Nor is the




Curves of DF70 anode current *vs* grid voltage.

price the only thing that has been reduced: the set weighs only 30 pounds and its size is 17 x 12½ x 12¾ inches overall. The whole thing is a neat affair, incorporating some neat and ingenious ideas. The heaters of the tubes, for instance (including that of the cathode-ray tube) are series connected. Focussing is done by means of a permanent magnet. Not only does it need no current, but as there is no temperature drift, the control becomes one of the pre-sets and doesn't appear on the panel.

V. h. t. ("very high tension," or high voltage for the C-R tube) comes from the fly-back like this: the line-scan time base is a blocking oscillator feeding a pentode, whose output goes by way of a transformer to the deflector coils. The primary is made to form a step-up auto-transformer, which boosts up the fly-back voltage and passes it on *via* a single-diode rectifier to the v. h. t. line. (See "Kickback Power Supply" RADIO-CRAFT, January, 1948).

There are just three visible control knobs on the set: on-off switch, sound

volume and picture brightness. And, once the set has been properly installed, and the pre-sets correctly adjusted, these are the only ones needed.

This is a real pioneer amongst television receivers. I don't think it will be long before the set advertised as an a.c.-d.c. model makes its appearance. That will be progress indeed.

**Better listening**

At the moment the radio industry is conducting a "better listening" propaganda campaign. The object is to convince the owner of an aged receiver that his set is out of date and can't give him what's going from the broadcasting stations. Actually, there must be at least four or five million receivers still in use here which have been working for ten years or even more. During the war almost no new sets were marketed and people became accustomed to making do with their old ones. The habit has stuck and there's no denying that many listeners are putting up with shockingly bad reproduction. Servicemen tell me that they have receivers in for repair in which the only parts not worn out are the knobs.

One very clever advertisement is being run by the Ekco company in the trade papers. The illustration shows an ancient, bearded Dutchman, with eyes fast shut and the headphones of an antediluvian crystal set clamped to his ears. The accompanying slogan is "Winkling out the Rip van listener". I expect the Rip van listener isn't unknown in the U. S. A. either!

One thing that is keeping back sales here is the purchase tax of 33 1/3% on radios. Salesmen have to break down not only sales resistance but tax resistance. I know quite a few folk who could well afford new equipment, but just won't buy it on account of that tax. Come to that, I hope no reader will ask the age of the broadcast receiver in my own home!

**Star radio**

The story of the tracking down of the sources of certain once mysterious radio noises (described in the March, 1948, issue of this magazine) is a fine example of the international cooperation of science. It began in 1933, when K. J. Jansky of the Bell Laboratories determined the source of the noise as the Milky Way. But the Milky Way covers a pretty big amount of space and more exact location was wanted. In 1946 J. S. Hey, working near London, found that radiation came from an active area not more than two degrees in diameter in the constellation Cygnus.

In July of this year J. G. Bolton of the Australian Council for Scientific Research narrowed down the Cygnus area to 8 seconds of arc; and now M. Ryle and F. G. Smith of the Cavendish Laboratory at Cambridge, working on 80 mc and observing the interference between signals from two directional antennas 500 meters apart, have measured the size of the source with still greater accuracy.

They find that the radiation comes in "bursts" of 20 seconds duration. This means that the source has a probable diameter no greater than the distance which radio waves can travel in 20 seconds: 186,000 x 20 = 3,720,000, or say 3¾ million miles. The diameter of the sun is 800,000 miles. There must be in the constellation of Cygnus some great body, of more than four times the sun's diameter, which is continually sending out these pulses of radiation.

Lately, at least six other sources of u.h.f. radio noise have been pinpointed. The work is going forward in many parts of the world and it may well lead to fundamental discoveries about the nature of radiation from our own sun and from other suns far out in space. It's an extraordinary thought that we don't know and never can know what's going on in any star *now*. So far away are those in the Milky Way that some of the "plocks" in the telephone receivers or the "blips" on C. R. T. traces that we hear or see are due to upheavals that actually occurred long before the earliest of our ancestors ceased gibbering in the tree-tops and decided to walk the earth on their two hind legs!

# New Telephone Recorder

A ROBOT telephone secretary which can be adapted to any business or home, made its debut in Switzerland this summer before going into mass production in the United States and Great Britain.

This robot, a combination telephone and phonograph for taking messages in the subscriber's absence, is the creation of Willi Mueller, whose earlier invention of the Ipsophon had already commanded recognition.

That pioneer apparatus is now succeeded by a far more compact and less expensive instrument, the Notaphon. It uses an entirely new recording system which eliminates the use of magnetized wire and the attendant drawback of rewinding for the playback. Recording on the Notaphon is effected by means of a disc similar to a phonograph record; but, unlike the latter, it is not cut but merely magnetized when a recording is made.

The Notaphon may be connected to any standard telephone instrument without altering or interfering with the latter's mechanism.

When a call comes through and the telephone receiver is not removed after three rings—perhaps either because the subscriber is absent or because he wishes to remain undisturbed—the Notaphon automatically goes into action.

It first announces the subscriber's name and address, and then requests the caller to speak. If he does not do so within eight seconds, the request is repeated, if he still does not speak, he hears "Notaphon ringing off."

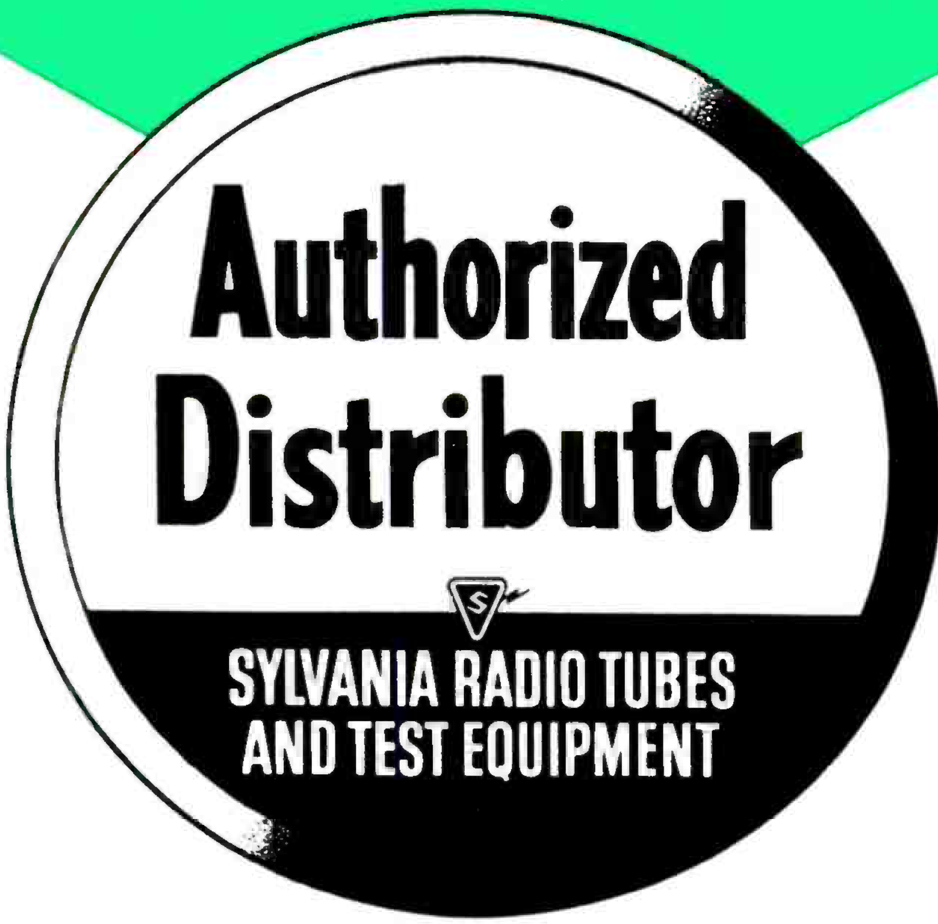

As soon as the caller utters a sound, the recording mechanism starts to function. A silence of eight seconds automatically cuts it out. The whole arrangement is simple and foolproof.

One of several novel features of the Notaphon is a vocal secret code, preset by the subscriber, which enables him alone to play back the messages recorded on the disc. By dialing his own number from any telephone, waiting for the Notaphon's request to speak, and then pronouncing the vowel sounds forming his secret code, he sets the reproduction mechanism into motion. Five thousand possible code variations insure complete secrecy.

When the subscriber, who is perhaps spending the night out of town, has dialed his number, given the code correctly, and been told by the Notaphon that he is now connected, the playback of the day's "bag" starts at once.

On completing the playback, the robot requests its master to erase the recording. This is done by pronouncing another predetermined vowel sound. Deletion is verbally confirmed by the Notaphon, which now regains its full half-hour capacity. If deletion is not desired, the recording of later calls on the disc starts where previous recording stopped. When the instrument's capacity is exhausted, the robot voice informs subsequent callers of the fact.

# Look for the distributor who displays this sign!

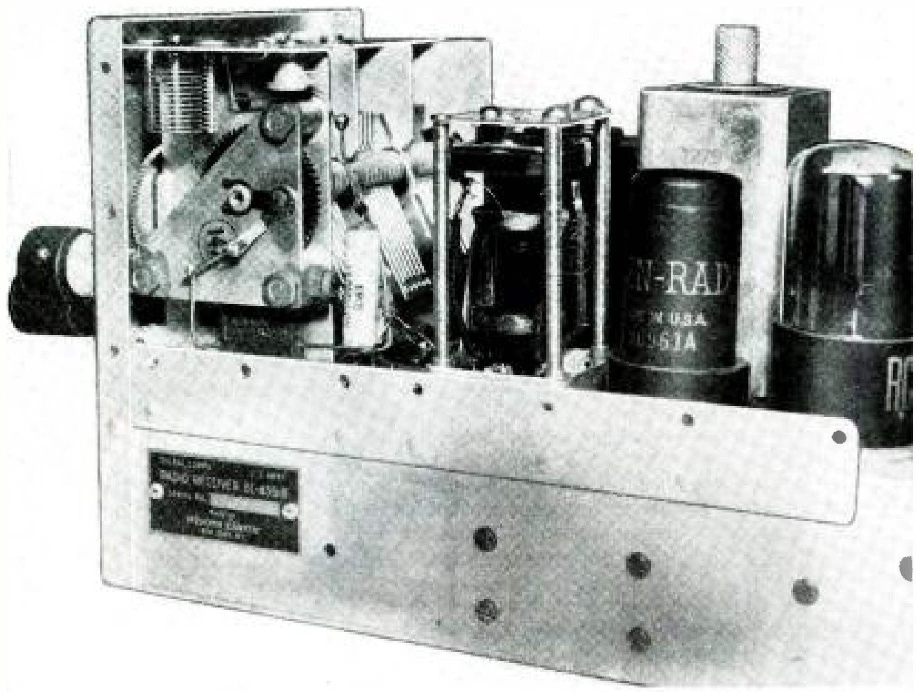



As a part of its 1948 program, Sylvania Electric will supply each of its authorized distributors with this new decal, printed in red, yellow, black and three shades of green. It's worth your while to look for this sign on his windows, doors and trucks — it is your assurance that this distributor will supply you with genuine Sylvania radio tubes and top-quality test equipment — and that you can count on prompt, courteous service as well!

*Sylvania Electric Products Inc., Radio Tube Division, Emporium, Pa.*

**SYLVANIA ELECTRIC**

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


A side-on view of the BC-455-B, which is one of the well-known command group of receivers.

# More Selectivity For the BC-455-B

By E. W. WILLIAMSON

AMONG the slickest radio receivers on the surplus market are those from the command set, the BC-453, 454, and 455. When converted to available current sources, they leave little to be desired.

However, the 455-B, covering the 6-9-mc range, differs from the other receivers in that it employs no i.f. transformers, as such. Instead, each i.f. can contains a single plate tank, condenser-coupled to the following stage, while the coil which would serve as secondary in a conventional i.f. stage is untuned. This second coil merely acts as an r.f. choke in the following grid circuit.

For this reason, and because the i.f. is 2830 kc, the 455-B, while sensitive, tunes too broadly for crowded bands. The inherent selectivity of the set is only 9.8 kc two times down or 24.2 kc ten times down.

Fortunately, this lack of sharpness is easily remedied. The lower the intermediate frequency, the greater the selectivity and gain, up to the point where the image ratio becomes troublesome. All that is necessary to make the 455-B razor-sharp is to substitute conventional 456-kc. intermediate-frequency transformers.

The change-over is simplified by the construction of the i.f. stages already in the set. Each i.f. can contains four metal pillars, one at each corner, attached to the plug-in base. These pillars support a mica plate on which the variable condenser is mounted. The "works" of a standard 456-kc i.f. transformer (in this case a Meissner 16-6658) fit snugly inside these supporting pillars, and can be suspended from a plastic or metal plate attached to the top of the pillars with the original screws. Here are the steps:

Each of the three plug-in i.f. coils is secured to the chassis by two screws. Remove these screws and lift out the cans. Remove the four small screws holding the shield can to the plug-in base, and pull off the can. Remove the four screws holding the mica plate to the supporting pillars. Remove the screw in the center of the plug-in base which holds the coil form to the base. Cut the wires soldered to the plug-in socket terminals. The coil form, mica plate, and condensers may now be lifted out, and the unit is ready for installation of the 456-kc coils.

Remove the coil and condenser assembly from a 456-kc i.f. transformer. Drill and tap holes for 6-32 screws, through the two bosses of the plastic plate supporting the trimmer condensers, and attach the entire unit to the new top plate. Then screw the plate to the four supporting pillars of the plug-in unit and solder the four leads to the proper socket terminals, as shown in the drawing.

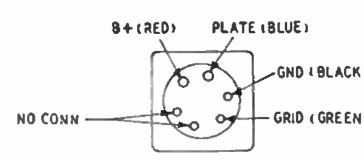
Drill two ¼-inch holes in the top of the shield can to permit tuning the new transformers.

The next step is to line up the new i.f.'s with a signal generator. Clip the generator's output lead to the top grid connection of the 12K8 and adjust the trimmers for peak output. Because the shield cans in the set are somewhat larger than those from which the 456-kc coils were removed, the effective inductance of the coils is altered slightly and it may not be possible to set the coils at 456 kc. The writer found that 498 kc fell in about the middle of the trimmer's range.

The oscillator coil is originally set to track with the antenna coil with a 240-μμf fixed padder shunted across a 40-μμf variable condenser. Changing the i.f. naturally calls for new tracking arrangements. This is not difficult because the antenna and r.f. coils already are tracked to the dial, and it is necessary only to make the oscillator coil track with these circuits.

The plug-in oscillator coil, as supplied with the set, contains 17 turns of wire in ½ inch of space on a form 11/16 inch in diameter. It is tuned by a powdered-iron core, which is preset and anchored in position. Remove the coil from its shield by unscrewing the four small screws which fasten the plug-in unit to the shield can. The coil then drops out, attached to its plug-in base.

Break the seal on the powdered-iron core, and screw the core down as far as it will go. Then either add four turns of wire to the coil, bringing the total to 21 turns, or remove the entire winding and rewind the coil to have a total of 21 turns. The winding is easy, since the coil form is threaded. No. 24 enameled wire makes a nice fit in the threads. Unscrew the core 10½ turns, and replace the coil in its shield.



Bottom of the i.f. unit showing color codes.

Now solder a 500-μμf silvered-mica condenser in shunt with the button-shaped 240-μμf padder next to the 40-μμf variable padder on the frame of the main gang condenser. To do this, it is necessary to remove the aluminum shield enclosing the main condenser.

Fit the 500-μμf condenser snugly in the space below the reduction-gear mechanism, as shown in the photograph, so that it will not be in the way when the shield is replaced.

Feed a 6100-kc modulated signal into the antenna terminal of the set. Set the dial to 6100 kc and adjust the variable padder until the signal is loudest. While doing this, rock the dial a little to find the point of peak response. Since the antenna and r.f. circuits already are tuned to a gnat's eyelash, only a very slight rocking should be necessary.

If it is impossible, by varying the padder condenser, to bring the signal in at exactly 6100 kc on the dial, adjust the iron core in the oscillator coil half a turn at a time until the signal can be brought in precisely.

Now set the dial at 8900 kc and feed an 8900-kc modulated signal into the set. Adjust the oscillator trimmer condenser for peak response. Go back to the low end and readjust the padder, repeating both operations until good tracking is obtained from one end of the dial to the other.

If you find that the trimmer adjustment makes it impossible for the padder to correct the low end or that adjustment of the padder throws the high end beyond the range of the trimmer, you can get the inductance approximately correct by the following method:

Set the dial to 7500 kc and feed a signal of that frequency into the set. Set the padder condenser at about half capacitance, and adjust the oscillator inductance with the iron core until the signal comes in. Next turn to the high end and trim, and then to the low end and pad.

It is best t complete the preliminary tracking befo.e replacing the aluminum shield on the gang condenser because the oscillator section of the gang condenser has two trimmers, only one of which, C-4E, can be adjusted with the shield in place. The other, C-4G, which is near the front of the set and normally is hidden by the shield, is set at maximum capacitance at the factory. It may be necessary to adjust this trimmer, as well as C-4E, to bring the oscillator into line at the high end.

It is convenient, while tracking the receiver, to remove all the coil shield cans from the metal plate to which they are riveted by drilling out the rivets. A ¼-inch hole then may be bored in the center of the oscillator coil shield can, so that a small screw driver or tuning tool can be used to adjust the iron core. Later the cans may be re-attached to their supporting plate with 2-52 screws in the corners.

To complete the conversion, change the frequency of the b.f.o. from 2830 kc to the new i.f. This may be done by adding either inductance or capacitance to the b.f.o. unit until the required frequency is obtained. Or buy a 456-kc beat-frequency oscillator unit and substitute its coils for those in the set.

When the tuning is complete, a strong signal 10 kc away from the dial setting will be inaudible.

# Phase-Modulated Exciter

By RUFUS P. TURNER

Front view of the phase-modulated exciter. The signal of a low-frequency crystal is multiplied eight times to hit 80 meters.

AMATEUR NBFM rigs generally sound good only so long as the carrier is not swung too much by the variations in voice intensity. This is especially true when the receiver is a conventional AM superheterodyne. Some fellows get so enthusiastic describing their new NBFM transmitters that they unintentionally shout into the microphone and knock the carrier all over the place. We decided, therefore, to include some sort of automatic level control in the audio channel of our NBFM exciter. Speech clipping won out over automatic modulation control because the clipper's action is instantaneous; a.m.c. takes a short time to catch up with unwanted voice peaks and does not "let go" immediately.

For a satisfactory design, we borrowed the basic essentials of the phase modulation exciter described some time ago by Sterman[1] and the speech clipper used in the Collins 30K transmitter[2]. Modifications were made in a few portions of each circuit, either to permit use of easily obtained components or to adapt the exciter more efficiently to 75-meter operation from a low-frequency crystal.

The block diagram in Fig. 1 shows the basic arrangement of the radio and audio channels of the exciter. The amount of equivalent frequency modulation obtained by phase modulating a crystal oscillator amounts to only a few hundred cycles. The desired narrow-band swing of 2 or 3 kc must be obtained by frequency multiplication.

A frequency-multiplication factor of 8 usually is satisfactory. To use this factor, it is necessary to operate the crystal oscillator between 481.25 and 487.5 kc in order to obtain output in the 3850-3900-kc NBFM section of the 75-meter phone band. However, it is desirable to keep the carrier at least 3 kc inside of each edge of the NBFM section to prevent out-of-band operation during frequency modulation. This means that the center frequency must be kept within the limits of 3847 and 3897 kc. The crystal frequency, accordingly, must be between 481.625 and 487.125 kc. (See the oscillator block in Fig. 1.)

The oscillator-modulator is followed by a doubler and a quadrupler, which provide the necessary frequency multiplication. The 75-meter output of the exciter may be link-coupled to a high-gain buffer in any conventional 80-meter c.w. transmitter having a plate power input up to 1 kilowatt. In many transmitters, the FM exciter output may be fed directly into the grid circuit of the existing crystal oscillator (without its crystal) either with or without a link-coupled grid tank at the transmitter end.

[1] "Narrow-Band Phase Modulation Exciter," by Sol Sterman; *Radio News*, May, 1947.

[2] "Let's Not Overmodulate . . . ," by Smith & Hale; *QST*, Nov., 1946.

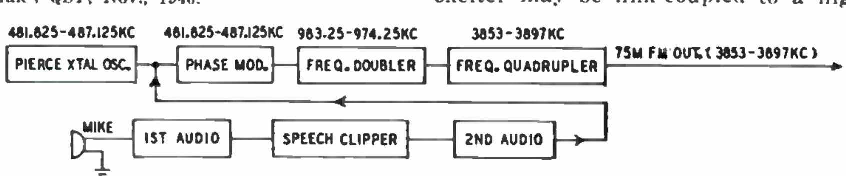



Fig. 1—Block diagram of the exciter. A reactance tube shifts the phase of the oscillator.

The audio channel of the exciter includes a standard speech clipper which effectively knocks the peaks off all audio signals which rise above a level determined by the setting of the clipper control and keeps the carrier swing within controlled limits.

The unit is operated on voltages taken from a small power supply in the main transmitter. However, an individual builder, if he desires, may include the power supply on the exciter chassis for completely packaged construction.

When the exciter was first laid out, we were worried by the possibility of beat-note interference with nearby broadcast reception, since the crystal oscillator is operated on the nearest subharmonics of the broadcast band and the doubler is operated right inside the broadcast band. But tests have shown that no interference is caused in a broadcast receiver in the same house, provided the tank circuits re completely shielded (as shown in the photograph), the power-supply cable and r.f. output cable are shielded and grounded at each end, and the exciter chassis is grounded solidly to earth.

The low-frequency crystal required in this exciter may arouse some curiosity. We took a few "wipes" off a regular 456-kc receiver i.f. crystal to bring it up to 485 kc (exciter output 3880 kc). But crystal grinding is unnecessary, since government surplus crystals for frequencies between 400 and 500 kc may be bought, mounted in standard holders, for about a half dollar each.

## The complete circuit

Fig. 2 is a complete schematic diagram of the exciter.

One triode of the 6SL7-GT acts as a low-frequency Pierce oscillator, while the second triode section is the phase modulator. The tank circuit L1-C5 in the plate circuit of the phase modulator is tuned to the crystal frequency.

The phase modulator is capacitance-coupled to the 6V6-GT/G frequency doubler. The doubler, in turn, is capacitance-coupled to the quadrupler. The quadrupler output tank is link-coupled to the co-axial output jack J1.

The three tank circuits L1-C5, L2-C10, and L3-C15 are shunt-fed. The .01-μf isolating capacitors C6, C11, and

C16 remove all d.c. from the tuning capacitor rotors, permitting these capacitors to be fastened directly to the shield cans without insulating washers. Once set for any crystal within the range, the tank circuits do not require retuning when crystals are changed.

A 0-1 d.c. milliammeter M is employed for tuning. The two-pole, four-position rotary selector switch SW connects this meter, with the proper polarity, across shunt resistors R8, R10, R12, and R14. In position 1, doubler grid current is read (this reading is a sensitive tuning indicator for the preceding tank circuit L1-C5). In position 2, the meter indicates doubler plate current. In position 3, quadrupler grid current is read. And in position 4, the meter shows quadrupler plate current.

With the shunts given, the meter has approximately the following current ranges: (1) 0-11 ma, (2) 0-50 ma, (3)

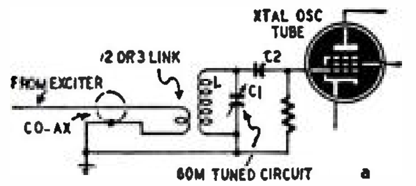



Fig. 3-a—This circuit can cause parasitics.

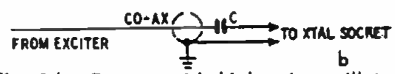



Fig. 3-b—For use with high-gain oscillators.

0-11 ma, (4) 0-50 ma. Note that R10 is so connected that the milliammeter reads only plate current—not the total of plate and screen currents. This may well be done with R14.

The audio channel is a conventional high-gain amplifier with the addition of a speech clipper. The low-pass clipper filter is CH and C22, C23, and C24. R18 sets the clipping level, while R27

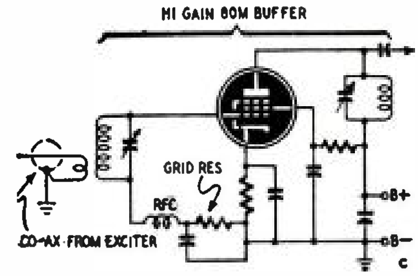



Fig. 3-c—The exciter works into a buffer.

is the gain control. Audio output voltage from the 6SF5 is delivered to the phase-modulator section of the 6SL7-GT through coupling capacitor C27.

Power-supply requirements are 300 volts d.c. at 150 ma, well filtered, and 6.3 volts a.c. at 3 amperes. The B-plus line must be bypassed to chassis with a .005-μf mica capacitor *inside the power-supply unit*, and both sides of the incoming 115-volt power line must be bypassed to the power supply chassis with 0.1-μf capacitors. The power-supply chassis must be grounded solidly to earth.

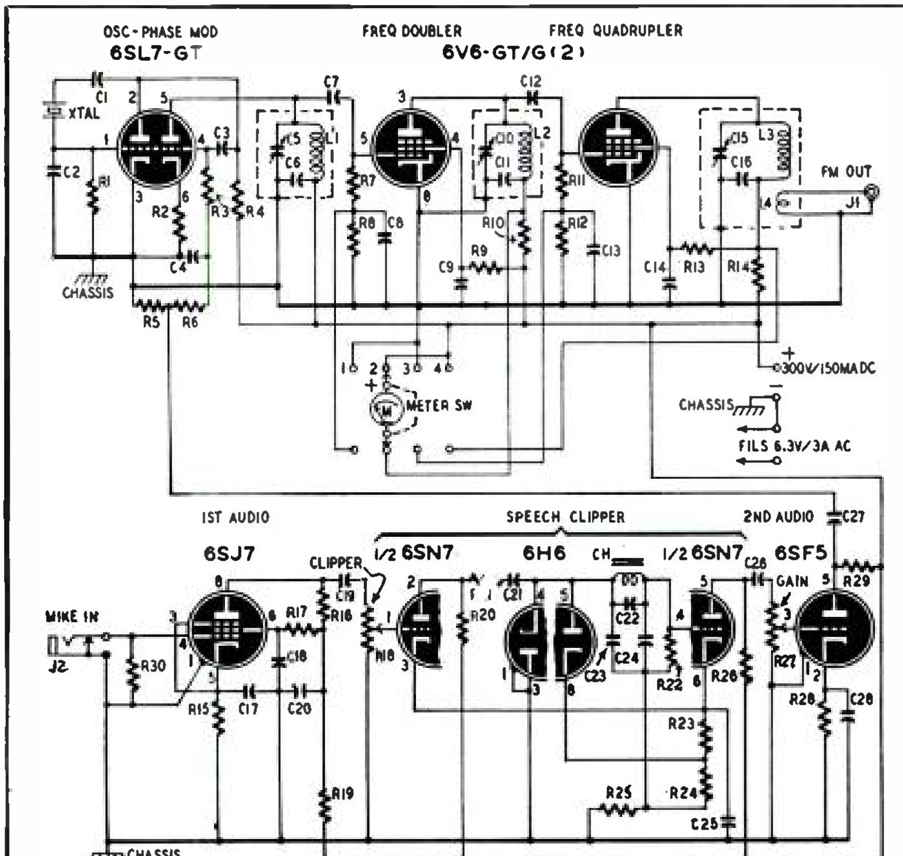



Fig. 2—Diagram of the 80-meter exciter. A low-pass filter follows the speech clipper.

R1, R5, R20, R21, R22, R26, R29—100,000 ohms, ½ watt
R2—33,000 ohms, ½ watt
R3, R4—47,000 ohms, ½ watt
R6, R16—270,000 ohms, ½ watt
R7, R11—100,000 ohms, 1 watt
R8, R12—10 ohms, 1 watt
R9, R13—22,000 ohms, 2 watts
R10, R14—2 ohms, 2 watts
R15—1,500 ohms, ½ watt
R17—1.5 megohms, ½ watt
R18, R27—500,000-ohm potentiometer
R19—10,000 ohms, ½ watt
R23—330 ohms, ½ watt
R24, R25—620 ohms, ½ watt
R28—2,700 ohms, ½ watt
R30—470,000 ohms, ½ watt
C1, C4, C9, C14—.005-μf mica
C2—250-μμf mica
C3, C7—.002-μf mica
C5, C10, C15—100-μμf midget variable (Hammarlund HF-100)
C6, C11, C16, C19, C21, C26, C27—.01-μf mica
C8, C12, C13—100 μμf mica
C17—25-μf, 25-volt electrolytic
C18—0.1-μf, 400-volt paper
C20—8-μf, 450-volt electrolytic
C22—180-μμf mica
C23, C24—200-μμf mica
C25—20-μf, 25-volt electrolytic
C28—10-μf, 25-volt electrolytic
CH—3.5-h, 50-ma choke
J1—female chassis-mounting co-axial receptacle
J2—closed-circuit phone jack
L1—2.5-mh, pie-wound r.f. choke
L2—0.5-mh, lattice-wound r.f. choke
L3—36 turns No. 28 enameled wire, close-wound on 1-inch-diameter polystyrene form
L4—3 turns No. 24 d.c.c. wire, close-wound on same form as L3 and separated ⅛ inch from B-plus end of L3
M—0-1-ma meter (with internal resistance of approx. 100 ohms)
SW—double-pole, 4-position, nonshorting rotary switch
XTAL—481.625- to 487.125 kc crystal (see text)

## Construction

The photograph shows how the 7 x 15 x 3-inch chassis is laid out. Shielding may be completed by slipping an amplifier foundation metal cover over the top of the chassis.

The tank-circuit aluminum shield cans were originally in an old-time broadcast receiver. A hole for the threaded bushing of the tuning capacitor is drilled through the top of each can. This grounds the rotors. The coils are held to the capacitors with stiff bus wire. L1 may be mounted by its own pigtails. The isolating capacitors C6, C11, and C16 are placed inside the shield cans. Leads from the completely wired tank circuits pass (i.f. transformer fashion) through a grommet-lined chassis hole under the center of each shield can.

R27 is mounted through the top of the chassis; and its sawed-off shaft is slotted for screwdriver adjustment, since it ordinarily will not have to be touched after it has been set.

The power-supply cable must be shielded and the shield braid connected to chassis *at both ends*. The r.f. output cable from J1 likewise must be shielded and must be connected to chassis at both exciter and transmitter ends.

All wiring must be short, direct, and as free as possible from movement. Liberal use of insulated terminal strips as circuit tie points is recommended.

If the power supply is built on the exciter chassis, the clipper choke CH must be located and oriented with respect to the power transformer and power-supply filter so that it will not pick up hum.

## Adjustment

After the wiring has been inspected and found correct, the exciter is ready for adjustment. Here are the necessary steps:

(1) Connect the power supply to the exciter, switch on the heater voltage and allow a few minutes for the tubes to reach operating temperature.

(2) Connect two or three feet of insulated wire to J1 to act as a simple antenna.

(3) Set SW to position 1, switch on the d.c. voltage, and tune C5 for maximum meter reading.

(4) Set SW to position 2 and tune C10 for minimum meter reading.

(5) Turn the meter switch to position 3 and readjust C10 for maximum meter swing.

(6) Turn to position 4 and adjust C15 for meter minimum.

(7) Check the exciter's output frequency with a heterodyne frequency meter or other suitable device to make sure the quadrupler output is at 75 meters.

(8) Switch on a nearby receiver or FM monitor and tune to the exciter's output frequency.

(9) Plug a crystal or dynamic microphone into J2.

(10) Advance the clipper control R18 approximately half way and, while whistling into the microphone, adjust R27 until the desired frequency swing is obtained, as observed with the receiver or monitor. Speak into the microphone and note the voice quality. Reduce the setting of R27, if necessary, to improve quality. R27 ordinarily will not need any further adjustment after this setting has been made. Later it will be necessary to adjust only clipper control R18 to fix deviation.

(11) Couple the exciter to the transmitter and readjust C15 with the meter switch set to position 4 (see step 6).

Fig. 3 shows several circuits for coupling the exciter to a transmitter. Fig. 3-c is the best arrangement. Fig. 3-a's arrangement will be satisfactory only if the original oscillator tube is a well screened tetrode or pentode and if the tuned circuit (L-C1) is enclosed in a metal can, otherwise t.p.t.g. oscillations will be set up between the input tuned circuit and the oscillator plate tank. C2 is a 50-μμf mica capacitor. Circuit 3-b is simple and convenient, but will be entirely satisfactory only when the oscillator tube in the transmitter provides considerable gain. C is a 50- to 100-μμf mica capacitor. In extreme cases, it may be necessary to operate the second 6V6-GT/G tube in the exciter as a doubler. The oscillator in the transmitter then will operate also as a doubler.

It is best to do a little experimenting to determine which coupling arrangement will supply normal excitation to your own transmitter.

If you modify the unit for mounting in a cabinet or rack, the crystal socket may be placed on the front panel instead of on the chassis. If you like to QSY rapidly, purchase several crystals between 481.625 kc and 487.125 kc. Wire them so any one can be selected at will with a rotary switch on the panel. Connect the switch between C1 and the top plate of the crystal holders.

Regulated variable supply, top front view.

# Regulated Power Pack Has Variable Voltage

By W. D. HAYES

ONE handy helper in the builder's and experimenter's shop is a variable-voltage regulated power supply, which will provide a well-filtered d.c. output at any voltage within its range and will maintain that voltage, regardless of variations in line voltage or load current. A typical commercial model may supply several hundred milliamperes of output current at voltages up to 400 or so, but for use in the home workshop a small and inexpensive unit is more appropriate.

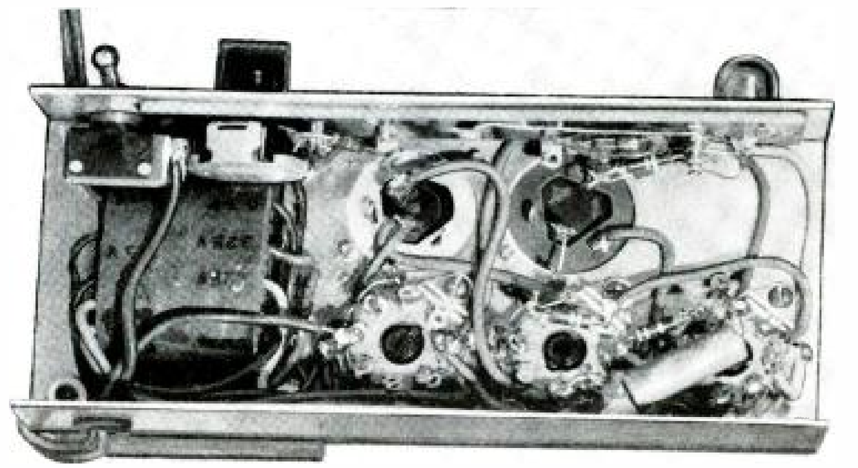
The little supply shown in the photographs provides a variable output voltage from 30 to 250, regulated to within approximately 1% for variations in output current between 0 and 50 ma and for variations in line voltage between 105 and 125. Voltages below 30 and above 250 are also available, but at some sacrifice of regulation. Several amperes of 6.3-volt heater current are also provided in the output. The unit may be built on a small chassis or breadboard. Construction and wiring are not at all critical.

The circuit employs a 6X5-GT as full-wave rectifier and a 6V6-GT as the main control tube. One half of a 6SL7-GT serves as regulator amplifier, while the other half of the same tube is used as a simple diode rectifier for the negative reference voltage. Two type NE12 neon lamps serve as the voltage standard, and one of these also acts as a pilot light, visible at the front of the chassis.

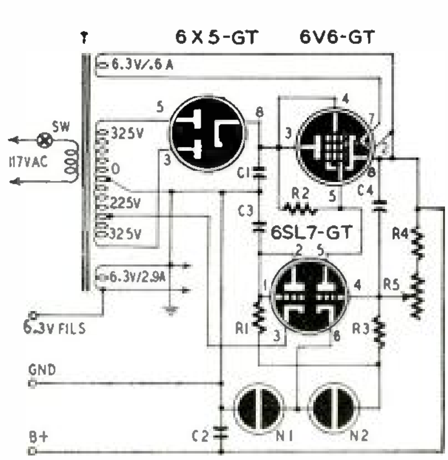
The 6SL7-GT amplifier amplifies differences between the output and the negative reference voltage. Its plate is connected to the grid of the 6V6-GT. The supply's output current flows through the 6V6-GT, and variations in its grid potential change its internal impedance and, consequently the voltage drop across it. Effectively the 6V6-GT is a variable resistor. Its resistance is controlled by the 6SL7-GT amplifier so as to maintain an essentially constant output voltage.

The output voltage is varied by adjusting the amount of voltage applied to the grid of the 6SL7-GT amplifier with R5.

Adequate filtering (C1 and C2), combined with the regulating action itself, assures pure d.c. at whatever voltage you select—and the low internal resistance of the supply means that your decoupling problems will be minimized. Next time you have a job of construction or testing or debugging a small receiver or audio amplifier, put this little power supply to work and see how much easier your job becomes.



Under-chassis view. N2 was added just inside chassis from N1, after the photo was taken.




R1—33,000 ohms, 1/2 watt
R2—470,000 ohms, 1/2 watt
R3—150,000 ohms, 1/2 watt
R4—82,000 ohms, 1/2 watt
R5—500,000-ohm potentiometer
C1, C2, C3—20-μf, 450-volt electrolytic
C4—.01-μf 400-volt paper
N1, N2—type NE-2 neon lamps
T—power transformer, 650 volts, c.t., 50 ma, tap at 225 volts; 6.3 volts, 600 ma; 6.3 volts, 2.9 amps. (Raytheon U-10544)
SW—s.p.s.t. toggle switch

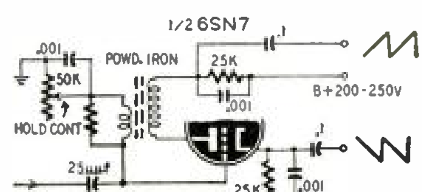
## TELEVISION OSCILLATOR

Since all television picture tubes using electrostatic deflection require push-pull signals, several tubes are usually used. The circuit shown uses only one—a combination blocking oscillator and phase inverter using one half of a 6SN7. The circuit gives about 25 volts output and makes a fine horizontal oscillator for a homemade TV receiver.

The transformer can be any horizontal blocking oscillator unit, or it may be wound at home on a large powdered-iron slug. The grid winding should be about 1,000 turns of No. 36 enameled wire, and the plate coil about 2,000 turns of the same.

The resistor across the grid winding should be varied until a wave with good saw-tooth form is obtained.

ROBERT A. CUNNINGHAM,
*Newport, Ky.*



. . . . MAJESTIC 7YR772

When plugged in on some power lines, the set had a loud hum on local stations. I remedied this by connecting a .01-μf capacitor across the line.

ALBERT BALZUM,
*Ada, Minn.*

. . . . AUTOMATIC RADIO TOM THUMB

Sound was very distorted when the set was operated on a.c. Replacing a discharged A-battery cured the distortion.

ROLAND H. DERY,
*Woonsocket, R. I.*

. . . . MINIATURE TUBES

Some receivers using miniature tubes are noisy because of resistance between the tube pins and the socket lugs. Better contact can be made sometimes by bending the tube pins outward slightly to make a force-fit.

JAMES LETZELTER,
*East Greenbush, N. Y.*

. . . . EMERSON 577 AM-FM

A large amount of frequency drift is caused by the heat of the 25L6, the 25Z6, and the ballast resistor. The holes in the fiber back are too small to allow good circulation of air.

I used a miniature tube-socket punch to make six ⅝-inch holes in the back, after which drift was reduced almost to the vanishing point.

ARNOLD MARGOLIS,
*Bronx, N. Y.*

. . . . AUDIO DISTORTION

An old receiver showed excessive distortion after a five-minute warmup. The voltmeter showed that bias on the output tube started at —15 volts when the set was first turned on, rose to zero, and then started climbing in the positive direction. A new 41 in the output stage cleared up the trouble.

DAVID GNESSIN,
*Columbus, Ohio*

. . . . TUNING EYES

Some receivers with tuning eyes do not have sufficient sensitivity to close the eye unless they are close to the transmitter. In the country, the eye is almost useless. When the eye tube is a 6U5/6G5, replacing it with a 6E5 will often make the eye operate excellently. The 6E5 requires only about one-third the grid voltage of the 6U5 to close the eye.

ALAN SMITH,
*Shaftesbury, Vt.*

. . . . SILVERTONE RECORDERS

Silvertone wire recorders frequently chatter when the wire is rewinding. To stop this, clean any oil or grease from the idler wheels, then hold a pencil eraser against the aluminum idler for a few seconds while it is running. Grease the idler bearings with a very small amount of Marfak No. 3 lubricant.

ALAN McFARLANE,
*Aberdeen, S. D.*



$3.00 FOR CARTOON IDEAS

RADIO-ELECTRONICS prints several radio cartoons every month. Readers are invited to contribute humorous radio ideas which can be used in cartoon form. It is not necessary that you draw a sketch, unless you wish.

IDEAS NOT WANTED

No electrical or radio definitions wanted. Some of these were published in the past, but the subject is about exhausted. All checks are payable on publication.

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25 West Broadway, New York 7, N. Y.



RADIO-ELECTRONICS wants *Technotes* describing common troubles of well-known receivers or telling how rare or difficult problems were solved. A six-month subscription will be awarded for each unillustrated and a one-year subscription for each illustrated *Technote* published.

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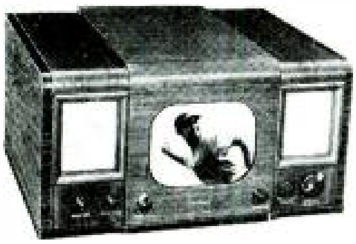

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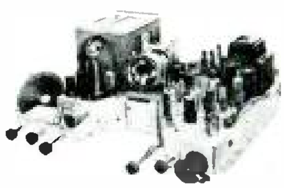

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| 6BA6 | .79 |
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| | EACH |
| .25 - 600V | .12 |
| .5 - 600V | .17 |
| 10 - 50V | .22 |
| 16 - 150V | .18 |
| 20 - 150V | .24 |
| 20/20 - 150V | .26 |
| 30 - 150V | .28 |
| 50/30 - 150V | .44 |
| 4 - 450V | .24 |
| 8 - 450V | .27 |
| 16 - 450V | .36 |
| 16/16 - 450V | .59 |
| 20 - 450V | .39 |
| 30 - 450V | .47 |
| 40 - 450V | .59 |
| 80 - 450V | .97 |
| .005 - 1700V | .13 |
| .008 - 1700V | .15 |
| .01 - 1700V | .17 |
| .02 - 1700V | .19 |
| .05 - 2500V | .58 |
| .1 - 2500V | .64 |
| .25 - 2500V | .86 |
| .05 - 3000V | .69 |
| .003 - 5000V | .57 |
| .005 - 5000V | .62 |
| .01 - 5000V | .74 |
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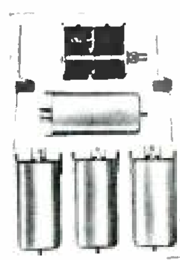

- Variable Condenser
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This Kit contains the vital parts needed to build an FM Tuner or Radio and for modernizing Pre-War FM Sets; all other parts needed are standard.

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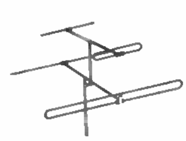
**PHILSON ALL-WAVE TELEVISION ANTENNA**



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## FOUR-HOUR RECORDER

**Amplifier Corp. of America**
**New York, N. Y.**

A long-playing version of the Twin-Trax Magnetape recorder, this unit has a continuous playing time of four hours. Using the same mechanism and two-track feature as the model described

in the October issue of RADIO-ELECTRONICS (page 42), the Model 910-B uses 4,900-foot reels of tape. The reels are mounted parallel to the sides of the cabinet and are coupled to the driving mechanism in such a way that standard 7-inch, 1-hour reels can be used on top of the recorder chassis.

The 55-pound cabinet contains complete amplifier, power supply, and supersonic generation components. A rotary counter is available for locating any selected sections of the recording.

## METAL-CASE SPEAKER

**Tarrytown Metalcraft Corp.**
**Tarrytown, N. Y.**

A 4-inch Utah speaker is inclosed in a heavy cast-aluminum case which will withstand rough handling. The speaker has a 1½-ounce Alnico magnet and a

voice coil of 4 ohms impedance. A 5-ohm volume control is provided. Key slots on the rear of the case permit mounting the unit on a wall.

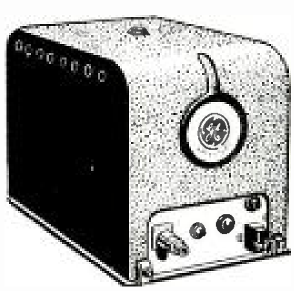
## BUS FM RECEIVER

**General Electric Co.**
**Syracuse, N. Y.**

A new FM receiver, designed specifically for installation in buses, will operate up to eight speakers.

The set incorporates a crystal-controlled local oscillator and a vibrator power pack. Employing 10 tubes, it has double limiters for optimum quieting. The crystal is a new design, operating on the third mechanical mode and requiring a frequency multiplication of only three.

Of metal construction, the receiver can be mounted directly behind the



driver's seat, under a passenger seat, or in any other suitable location. The speakers are in round metal housings mounted on the ceiling at intervals throughout the length of the bus. A matched dipole antenna is used with the set, and can be mounted on the bus in either a crosswise or lengthwise position.

## NOVEL MICROPHONE

**Amperite Co., Inc.**
**New York, N. Y.**

This RB velocity microphone eliminates the usual blasting effects produced by shouting into an ordinary microphone. The abrupt difference in output caused by moving away is also reduced.

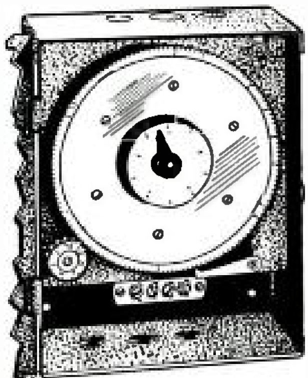
The frequency response is from 50 to 11,000 cycles ± 2 db, and the harmonic distortion is less than 1%. Output level is -62 db. Angular discrimination from 60 to 10,000 cycles is less than 5%.

The microphone is available in high- and low-impedance models. Both come complete with a cable connector and a switch which is hidden to prevent tampering.

## RADIO PROGRAM TIMERS

**Montgomery Manufacturing Co.**
**Chicago, Ill.**

The new line of synchronous program timers is particularly suited for accurate control of public address, radio, chimes, or any other system of wired or direct reproduction. These units can be set exactly for the times programs



are to be switched on and off with any desired interval as low as 2½ minutes. As many as 288 operations per day can be set on the program disc. A calendar switch is provided which can be set to silence the program through as many 12- or 24-hour periods as desired in any week. Thus a single operation or a full week's program which will be continuously repeated until reset can be set up on the timer.

## HIGH-VOLTAGE PROBES

**Precision Apparatus Co., Inc.**
**Elmhurst, N. Y.**

Series TV high-voltage safety test probes are designed for use in conjunction with standard test sets and v.t.v.m.'s. Voltages up to 30,000, such

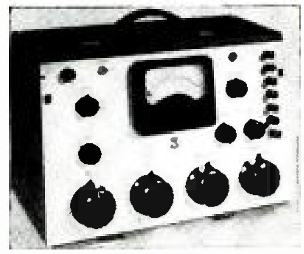
as are used in television receivers, may be measured without danger to the serviceman. Stock tubular multipliers are avaliable for use with the probes, eliminating the necessity for a special instrument. The multipliers are placed within the probe.

Safety provisions include a multi-channeled guard barrier, full handle-length internal arc-back shield which is directly grounded, an external arc-back shield, and a shielded cable. All high-voltage and ground connections within the probe are made with high-compression contact springs. The probe head is made of polystyrene, the remainder of the instrument being constructed of bakelite and lucite.

## REMOTE BROADCAST AMPLIFIER

**Radio Corporation of America**
**Camden, N. J.**

The new BN-2A portable remote amplifier has three input gain controls and



four input channels, the third and fourth being switched to one control. Because of excellent frequency response, low noise level, and low distortion, the maker recommends the amplifier for FM as well as AM.

Though the unit weighs only 29 pounds and is only 14½ inches long, it has a self-contained, 117-volt a.c. power supply, as well as provision for battery operation. Gain of each channel is 92.5 db. High-level mixing is used. Provisions for switching the amplifier output to a PA system as well as the line are included, making the amplifier suitable for almost any remote pickup.

## S.S.S.C. SELECTOR

**General Electric Co.,**
**Syracuse, N. Y.**

The YRS-1 Single-Sideband suppressed carrier Selector selects either sideband at the receiver with simple push-button controls. No tuning need be done. Carrier drift is followed, within limits, by means of a locked oscillator.

Four buttons are provided: one for dual sideband reception with reinforced carrier, one for normal reception, and one for each sideband. The device can be used with any receiver whose i.f. frequency is approximately 455 kc.

## LOW-COST INTERCOMS

**Operadio Manufacturing Co.**
**St. Charles, Ill.**

The Flexifone intercommunication system is designed for applications where a small, low-cost installation is needed. The master station will handle three remote stations. The housing is die-cast metal.

## PORTABLE SERVICE KIT

**Sylvania Electric Products, Inc.**
**Emporium, Pa.**

The new service kit is a 17 x 11¾ x 5½-inch fabric-covered case with tool pockets in the lining of the lid. Looking more like a small suitcase than a tool kit, the case will accommodate over 75 tubes and most of the commonly used tools.

## HIGH-CURRENT RECTIFIERS

**Federal Telephone and Radio Corp.**
**Clifton, N. J.**

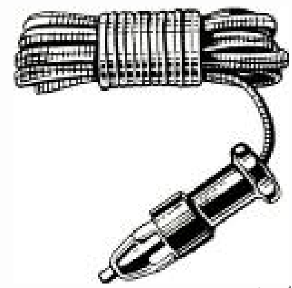
Two new selenium rectifier stacks RS 400 and RS 500 with current ratings of 400 and 500 ma, respectively, have been developed. The rectifiers are similar in appearance to other miniature stacks of this manufacturer. They are intended for use in television receivers, for recti-

fying filament voltage to avoid hum in high-gain tubes, and for other applications where high-current-capacity rectifiers are needed.

## BATTERY CHARGING PLUG

**P. R. Mallory & Co., Inc.**
**Indianapolis, Indiana**

This new cigarette lighter plug is intended to help car owners charge their batteries with a minimum of effort and possibility of soiling clothes.



Made in the same shape as a standard dashboard lighter, the plug is connected to the charger and then inserted in the dash lighter receptacle. Necessity for raising the hood and connecting clips to the battery posts is eliminated, saving both time and cleaning bills.

## DISPLAY TUBE TESTER

**Hickok Electrical Instrument Co.**
**Cleveland, Ohio**

The 533 DM tube tester is designed as a merchandiser to let customers see for themselves the condition of their

tubes. A 9-inch illuminated scale reads REPLACE, DOUBTFUL, and GOOD.

The tester uses the dynamic mutual conductance circuit, and the meter shows ranges of 3,000, 6,000, and 15,000 micromhos as well as the zone markings mentioned.

## POCKET-SIZE TESTER

**Superior Instruments Co.**
**New York, N. Y.**

Model 770 volt-ohm-milliammeter uses a 2%-accurate meter with a 1-ma movement. Voltage is measured at 1,000 ohms per volt, with a.c. full-scale ranges from 15 to 3,000 volts. D.c. voltage ranges are from 7½ to 1,500. Maximum current range is 1½ amperes, and resistances up to 1 megohm are measured in two ranges. The instrument is extremely compact, measuring 3⅛ x 5⅞ x 2¼ inches. It is suitable for carrying on outside calls.

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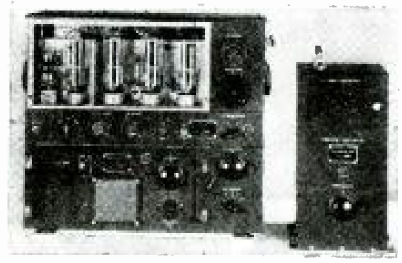
## GENERAL ELECTRIC 150 WATT TRANSMITTER

### Cost the Government $1800.00 ● Cost to You—BRAND NEW—$100.00

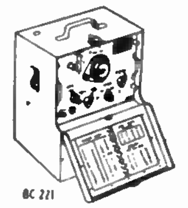


This is the famous transmitter used in U.S. Army bombers and ground stations, during the war. Its design and construction have been proved in service, under all kinds of conditions, all over the world. The entire frequency range is covered by means of plug tuning units which are included. Each tuning has its own oscillator and power amplifier coils and condensers, and antenna tuning circuits, all designed to operate at top efficiency within its particular frequency range. Transmitter and accessories are finished in black crackle, and the milliammeter, voltmeter, and RF ammeter are mounted on the front panel. Here are the specifications: FREQUENCY RANGE, 200 to 500 KC and 1500 to 12,500 KC. (Will operate on 10 and 20 meter band with slight modification for which diagrams are furnished.) OSCILLATOR: Self excited, thermo compensated, and hand calibrated. POWER AMPLIFIER: Neutralized class "C" stage, using 211 tube and equipped with antenna coupling circuit which matches practically any length antenna. MODULATOR: Class "B" uses two 211 tubes. POWER SUPPLY: Supplied complete with dynamotor which furnishes 1000V at 350 MA, from either 12 or 24 volts. Complete instructions are furnished to operate set from 110V AC. SIZE: 21½x23x9¼". Total shipping wgt. 200 lbs., complete with all tubes, dynamotor power supply, seven tuning units, antenna tuning unit and essential plugs. NOTE: Price increases to $100.00 effective Oct. 1, 1948.

## HEAT GUN

Streamlined pistol grip heat gun in vivid red housing, that delivers a powerful 20 Cubic Ft per minute blast of hot air at 160 Fahrenheit. Ordinary blowers have small fan motors, but this has a lifetime-lubricated AC-DC motor of the rugged vacuum cleaner type, that produces a hurricane of either hot or cold air. Perfect for blowing out dirt or dust from radio chassis, drying out ignition systems, warming up carburetors, quick-drying paint, thawing out radiators or water pipes, etc. Warning:—Keep this away from your wife, or she will be using it to dry her hair because it will do it in half the time of her ordinary hair dryer, to say nothing of her using it to dry stockings or clothing, or defrost the refrigerator instantly. Only $12.95. Satisfaction guaranteed or money refunded if returned prepaid within 5 days.

### BRAND NEW BC-221 FREQUENCY METERS




with calibrating Crystal and calibration charts. A precision frequency standard that is useful for innumerable applications for laboratory technician, service man, amateur, and experimenter at the give away price of only $75.00.

## GENERAL ELECTRIC RT-1248 15-TUBE TRANSMITTER-RECEIVER

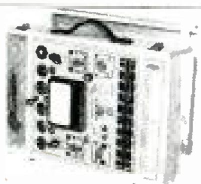
TERRIFIC POWER—(20 watts) on any two instantly selected, easily pre-adjusted frequencies from 435 to 500 Mc. Transmitter uses 5 tubes including Western Electric 316 A as final. Receiver uses 10 tubes including 955's, as first detector and oscillator, and 3—7H7's as IF's with 4 slug-tuned 40 Mc. IF transformers, plus a 7H7, 7E6's and 7F7's. In addition unit contains 8 relays designed to operate any sort of external equipment when actuated by a received signal from a similar set elsewhere. Originally designed for 12 volt operation, power supply is not included, as it is a cinch for any experimenter to connect this unit for 110 AC, using any supply capable of 400 DC at 135 MA. The ideal unit for use in mobile or stationary service in the Citizen's Radio Telephone Band where no license is necessary. Instructions and diagrams supplied for running the RT-1248 transmitter on either code or voice in AM or FM transmission or reception, for use as a mobile public address system, on 80 to 110 Mc, as an FM broadcast receiver, as a Facsimilie transmitter or receiver, as an Amateur Television transmitter or receiver for remote control relay hookups, for Geiger-Mueller counter applications. It sells for only $29.95 or two for $53.90. If desired for marine or mobile use the dynamotor which will work on either 12 or 24V DC and supply all power for the set is only $15.00 additional.

## *RADAGER

### *COMBINATION AUTO RADIO-BATTERY CHARGER

Nationally advertised brand 1949 car radio that will fit practically any car. These car radios have plenty of eye appeal plus a host of other features that no other radio regardless of cost can offer. Built in battery charger that will charge a car battery. The unique circuit of this radio steps up the 6 v input to 110 v, that is available in a convenient outlet, for operation of an electric shaver or similar electrical appliance.

The radio is a powerful 6 tube superheterodyne that has a three gang condenser and a stage of radio frequency amplification for increased sensitivity. The radio complete with built in battery charger and power outlet, is a single compact unit that is easily installed. Sample $39.95; Dealer price, $37.47 each in lots of two or more.



## 1949 MODEL MUTUAL CONDUCTANCE TUBE TESTER

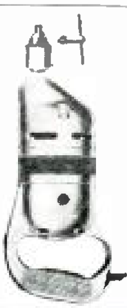
with new 9 pin socket to handle all future tube developments **$49.95**

No possibility of good tubes reading "Bad" or bad tubes reading "Good" as on dynamic conductance testers or other ordinary emission testers. Attractive panel and case equal to any on the market in appearance . . . Large 4½" meter . . . Calibrated microhm scale as well as a Bad Good scale . . . Front panel fuse . . . Individual sockets for all tube base types. Voltages from .75 volts to 117 volts and complete switching flexibility allow all present and future tubes to be tested regardless of location of elements in the tube base . . . Indicates gas content and detects shorts or opens on each individual section of all loctal, octal and miniature tubes including cold cathode, magic eye and voltage regulator tubes as well as all ballast resistors. Name of the nationally known manufacturer withheld because of special price offer.

Model "C"—Sloping front counter case .......... $49.95
Model "P"—Handsome hand-rubbed portable case .......... 54.95

Built in roll chart with either of above $5.00 extra.

## TERRIFIC VALUE— PORTABLE ELECTRIC DRILL



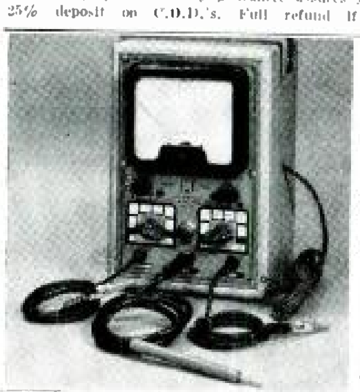
(Sold at less than established factory price so we cannot mention brand name.)
Only $20.95 equipped with ¼" Jacobs Geared Chuck and Key.
Not an intermittent duty drill but a full size rugged tool.
Most convenient type switch, natural grip handle, and balance like a six-shooter.
Precision cut gears—turbine type cooling blower—extra long brushes.
No stalling under heaviest pressure because of powerful 110 Volt AC-DC motor and multiple ball thrust bearing.
Other bearings self-aligning lifetime-lubricating Chrysler Oilite type.
Made for toughest year-in and year-out service in Plant or on construction jobs.
Amazing perpetual factory guarantee assures you of a lifetime of trouble-free use.
25% deposit on C.O.D.'s. Full refund if returned prepaid within five days.

## Sensational Value in AC-DC Pocket Tester

This analyzer, featuring a sensitive repulsion type meter housed in a bakelite case, represents the culmination of 15 years achievement in the instrument field by a large company specializing in electronic test equipment.

Specifications of the AC-DC Model Volt Ohm-Milliammeter:
- AC Volts 0 25, 50, 125, 250
- DC Volts 0 25,50,125,250
- Milliamperes AC 0 to 50
- DC Milliamperes—0 to 50
- Ohms Full Scale 100,000
- Ohms Center Scale—2100
- Capacity—.05 to 15 Mfd.

Total Price, prepaid anywhere in the USA $7.00
Similar DC Meter, lacking the AC operated ranges of above, $5.50 prepaid.



## VACUUM TUBE VOLT-OHM-CAPACITY METER

There are more features engineered into this all purpose instrument than in any other instrument on the market regardless of price. It was designed not only to meet present conditions but to be readily adaptable to future needs. At the sensationally low price of this precision instrument no school, plant, lab or service shop need deprive itself of the "new look" in measuring equipment. Here are a few of the many features of this outstanding meter:

★ 5 inch, easy to read, meter.
★ 6 DC voltage ranges from 0 to 1000 V (Input resistance as high as 1 megohm per volt).
★ 5 AC voltage ranges from 0 to 1000 V (No dry disc rectifier to age and destroy the accuracy of this VACUUM TUBE VOLTMETER).
★ 6 Resistance ranges from 2 10 ohm to 1000 megohms.
★ 4 Capacity ranges from .00025 to 20 MFD.
★ A zero center range for balancing FM discriminators.
★ Isolating resistor built into probe.
★ Sturdy natural finish hard wood case.

**This outstanding development of one of the leading manufacturers of test equipment costs only $39.95 complete with all leads, as illustrated.**

RT—1655—11 tube crystal controlled superheterodyne receiver that covers the FM band. The ultra modern circuit uses the latest types of tubes including 7 miniature 6AK5's. Beautiful chassis and aluminum cabinet. Tubes and schematic supplied $14.95

World renowned 700 page tenth edition of the Radio Handbook in cloth binding and hard cover at the sensational reduced price, for a limited time only. $1.49

RT1711 Brand New 12 Tube, 110 Volt Receiver Indicator Oscilloscope complete with all tubes and power supply. Has telescoping hood over scope tubes, which is equipped with a detachable calibrated screen. Has centering and amplitude controls and two video inputs. A natural for television .......... $39.95

Latest type PM Speaker in a fully-enclosed black crackle finished metal cabinet. This speaker and case match communications receivers and in addition make perfect intercom remote stations. Our price .......... $4.50

## COMPRESSED AIR INSTANTLY, Anywhere!!

Portable Air Compressor and storage tank. Ruggedly built of best materials using lifetime lubricated ball-bearing on connecting rod and oil impregnated main bearing on shaft. Unusual design forever eliminates valve trouble, the most common fault in air compressors. PATENTED unique air intake system increases efficiency tremendously over other compressors so that air output is much greater than that from larger compressors powered by heavier motors. Will deliver approximately 3500 cu. inches of air per minute at maintained pressure of 30 lbs., or will inflate a 60 lb. truck tire in less than one minute. Comes complete with 100 lb. gauge, although finger-tip adjustment allows setting of output pressure at any value, which will automatically be maintained. Works from any ¼ H.P. motor. Useful for spraying paints or lacquers, disinfectants, insecticides, annealing or brazing with natural gas, inflating tires, etc. Price $14.50 postage prepaid anywhere in the U.S. Efficient, completely adjustable syphon type spray gun complete with 12 ft. of 100 lb. tested hose available for only $7.75 with pint container, also prepaid. 25% required on all C.O.D. orders.

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BUFFALO RADIO SUPPLY, 219-221 Genesee St., Dept. RE-12 BUFFALO 3, N. Y.

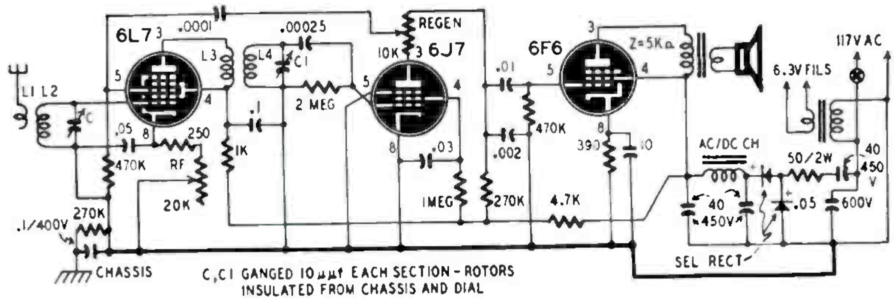
### H-F RECEIVER

*Please design for me a 32-mc receiver using a 6-volt transformer for filament power and a selenium-rectifier B-supply.—C. T. W., Jersey City, N. J.*

**A.** The receiver shown in the diagram has high gain due to the regenerative 6L7 r.f. stage. If operation of the regeneration control does not make the set oscillate, reverse the connections of L3. The 20,000-ohm r.f. control acts as the volume control.

At 32 mc it may or may not be necessary to ground the lower end of the primary L1. Reception may be improved by connecting both ends of it to a doublet antenna.

For 32-mc operation, L2 and L4 consist of 10 turns of No. 14 solid-copper wire on a 1¼-inch-diameter form. The primaries L1 and L3 are five turns of No. 18 enameled wire interwound with the secondaries.



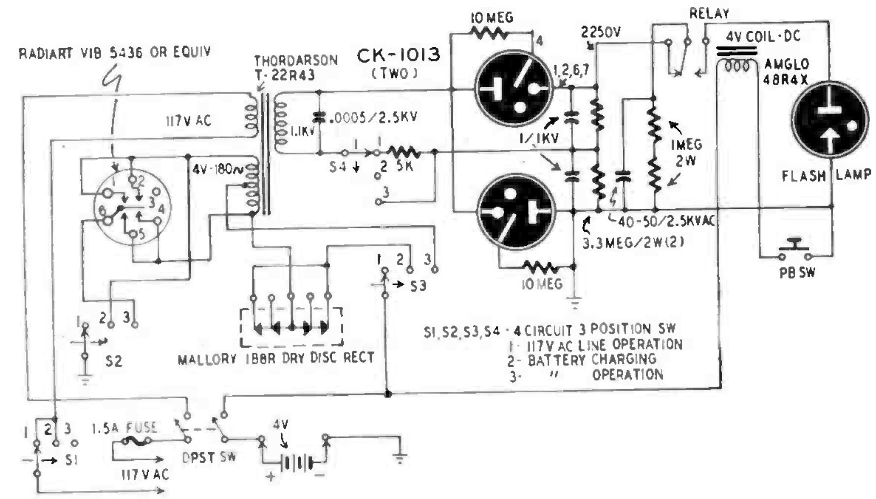

### PHOTOFLASH UNIT

*Please show me how to build an electronic photoflash for photographic work. It should operate on either batteries or 117-volt house current.—R. H. A., Janesville, Wis.*

**A.** The photoflash unit diagrammed operates on 117 volts a.c. or 4 volts d.c. Position 2 of the four-gang selector switch permits charging the batteries from the house current. Two small 2-volt storage cells should be used.

If only battery operation is desired, leave out the gang switch and use a s.p.s.t. on-off switch.

The batteries and power supply can be mounted in an insulated metal carrying case with handle and shoulder strap, and the flash lamp in the conventional-type holder and reflector. A three-wire cable is needed between the flash unit and the power supply. Be sure that the high-voltage lead is insulated for at least 5 kv for safety.




### BC-455 CONVERSION

*I have a surplus BC-455-B receiver which I want to use on 10 meters. Please tell me how to rewind the coils.—S.W.P., Yakima, Wash.*

**A.** First remove all wire from the antenna coil and substitute six turns of No. 18 enameled wire. Space the winding the full length of the form.

Remove all wire except the last layer from the plate coil of the 12SK7 r.f. tube. This should leave about nine turns.

Remove all wire from the 12K8 converter signal grid coil (the one connected to the grid cap of the tube) and rewind with five turns of No. 18 enameled. Space it the full length of the form.

The coil connected to the first grid of the 12K8 is left as is. The coil to which it is coupled should be unwound and replaced with five turns of No. 18 enameled, unspaced.

From each section of the main tuning capacitor remove all rotor plates except two in each line. Leave the two right-hand plates (as viewed from the rear) on each section intact.

# Transmission Lines

**By ROBERT C. PAINE**

A TRANSMISSION line conveys power or communication signals from one point to another. It may be electrically "long" or "short." The "length" depends on the frequency and the wave length. At a power-line frequency of 60 cycles per second a wave length is approximately 300,000,000/60, or 5,000,000 meters long, roughly 3,000 miles. A radio frequency of 100 kc has a wave length of 3,000 meters.

The effects of reflection of waves begin to be barely noticeable on lines .01 wave length long and may become serious as ¼ wave length is approached. So it may be said that a transmission line begins to be "long" when it is over .01 wave length.

At 10 kc a line would have to be over 300 meters long, nearly a quarter of a mile, before reflection effects could be noticed at all. So we see that at audio frequencies a line must be very long indeed to be a "long line." At 10 mc, however, a transmission line starts to be "long" when over 0.3 meter, although serious standing waves would not occur until it approached a length of about 6 meters. At 100 mc, in the middle of the new FM band, .01 wave length is only 3 cm, not much over an inch.

But in the ultra-high region, the merest scrap of wire becomes a "long line." So with greater activity on the higher frequencies, reflection becomes very important.

If the line is not properly terminated, electromagnetic waves are reflected from the distant end. The returning waves meet the waves from the generator in such a way as to add up at some points and subtract at others. This results in fixed points of high and low voltage and high and low current which are known as *standing waves*. (Reflection also occurs on short lines, but there is so little difference in phase between the outgoing and reflected waves that standing waves are negligible.)

Standing waves can be kept low or eliminated by proper line terminations and impedance-matching methods. Standing waves are harmful because they result in power losses due to heavy currents at certain points, which heat the conductors, and high voltages at other points, which increase the losses in the insulation. These standing-wave voltages can become high enough to break down the insulation.

Where standing waves exist, the impedance of the load as seen by the generator at the input end of the line varies with frequency and the length of the line. This interferes with proper loading of the generator. The load impedance should equal that of the generator at all times for greatest power transfer. The impedance of a receiver should match that of the antenna, as seen at the input end of the transmission line, to get the greatest signal.

The conductors of a transmission line actually form a wave guide on which energy exists in the form of a traveling electromagnetic field. The electromagnetic field consists of an electric field between the conductors and a magnetic field encircling them. These fields extend indefinitely out into space; a portion of them is shown in Fig. 1. The solid lines

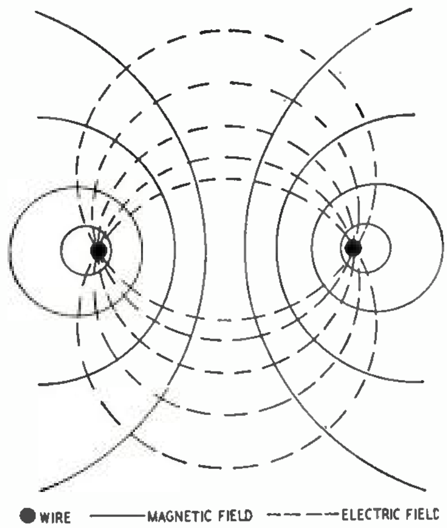



Fig. 1—End view of line and fields around it.

represent the magnetic field and the dashed lines the electric field. The line wires are shown in cross section.

On a line terminated by an *open circuit* the *magnetic* field collapses on reaching the open end of the wires, since the current flow is interrupted at that point. This sudden collapse of the field produces a reflected voltage wave of such polarity as to add to the initial wave, causing a *maximum of voltage* at the end of the line.

On a line terminated by a *short circuit*, the *electric* field collapses on reaching the end, since there can be no voltage across the short circuit. This produces a reflected current wave in such a direction as to add to the initial current, causing a *maximum of current* at the end of the line.

Fig. 2 shows the reflected waves of voltage (solid line) and current (dashed line) on an open-circuited line 13/18 wave length or 260 degrees long (one wave length is 360 electrical degrees). The current is zero at the open end of the line B, but the voltage is maximum there. At a quarter wave length (or 90 degrees) from the open end, the current is maximum and the voltage zero (for a no-loss line). At the generator end of the line, the voltage is relatively low.

The effect of this length of line is to increase the voltage at the output to a much greater value than that at the input end, much as a tuned circuit (coil and condenser) multiplies voltage.

However, on a line with reflections, there may be several points at which maximum voltage appears, such as at A and B in Fig 2.

Fig. 3 shows a short-circuited line of the same length. Here the current is at a maximum and the voltage zero at the shorted end. This line results in an output current much greater than that at the input end. There is only a slight multiplication of the input voltage at the voltage peaks, since the input is connected at a point near a voltage peak. As shown, the input voltage of Fig. 3 is higher than in Fig. 2, yet the voltage peaks are of the same height.

Reflection of waves at the end of the line can be understood more easily by thinking of familiar low-frequency circuits. In the open-circuited line, consider the somewhat similar case of a coil in which current is flowing, with energy stored in the surrounding magnetic field. When the circuit is broken, collapse of the magnetic field causes energy to reappear as a momentarily increased voltage of a polarity which tends to cause current to flow in the same direction as before the circuit was broken, often causing a spark. Automobile ignition coils use this principle.

As a parallel to the example of the short-circuited line, consider the two charged plates of a condenser, in which energy is stored in the electric field. When the charged plates are connected together, the electric field collapses. Its energy reappears in the magnetic field of the current which flows momentarily from the positive to the negative plate. (One type of magnetizer for permanent

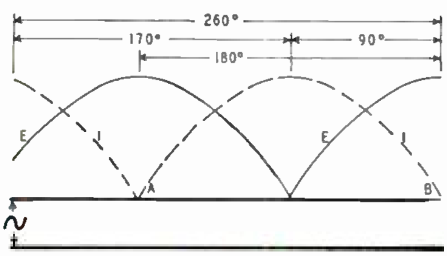



Fig. 2—Voltage and current on an open line.

magnets is based on this principle; it causes a very high current to flow for an instant by the discharge of large condensers.)

When the transmission line is terminated by a load of any kind, the energy of both the electric and magnetic fields traveling toward the load is partially or wholly absorbed and dissipated in the load. The percentage of absorption depends upon the load impedance. On a line terminated by pure capacitive or inductive reactance, no energy can be absorbed by the load; but energy from the electric field can be momentarily stored in a capacitance, and energy from the magnetic field can be momentarily stored in an inductance. Since this energy is almost instantly returned to the line, the wave is completely reflected.

The reflected wave can have any phase relation to the incident generated wave, depending on the type of terminating impedance, with different corresponding patterns of standing waves in which voltage and current maxima may occur at other points than those shown in Figs. 2 and 3.

To understand how standing waves can be eliminated, imagine a uniform transmission line extending to infinity. On such a line outgoing waves would never reach the distant end so there could be no reflection and no standing waves. The input voltage would have a constant ratio to the input current for any particular type of line. This ratio is a measure of input impedance because $Z = E/I$. Should sections be successively cut off the input end, the same impedance would appear at each new input end.

This is because the impedance of a transmission line is controlled by two factors—the inductance of the conductors, and the capacitance between them. Both these increase with increasing line length—but the increasing inductance *increases* the reactance of the line, while the increasing capacitance *decreases* it. So if (for example) the impedance of a 3-mile line were measured in three successive 1-mile sections, then the whole line measured, the four impedances would be the same. The whole line has the same impedance as a part of it. This impedance is known both as the *iterative* (literally "repeating") impedance and also the *characteristic* or *surge* impedance.

Although such an infinite line is impossible, any uniform line can be terminated in a certain load impedance which eliminates standing waves and gives a constant input impedance regardless of line length. The line would appear at its input to be the same as an infinite line, and the impedance seen would be equal to its characteristic.

The characteristic impedance is usually designated $Z_0$. This impedance—for low-loss radio transmission lines—is practically pure resistance, so it is sometimes designated $R_0$. If a line is terminated in its characteristic impedance, the energy of the electromagnetic wave is completely absorbed by the load and no reflection takes place.

The input impedance of any transmission line is determined by the ratio of input voltage to input current. The input voltage shown in Fig. 2 is low and the current high, showing that the

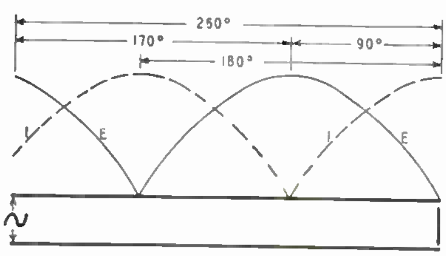



Fig. 3—Voltage and current on shorted line.

input impedance is low. But in Fig. 3 the input voltage is high and the current low, indicating a high input impedance for the same length of line but with a different termination. By selecting lengths between 180 and 270 degrees, the impedance of either the open line of Fig. 2 or the shorted line of Fig. 3 may be made to vary from a very low to a very high value, the impedance of the open line being greatest at 180, and that of the shorted line at 270 (or 90) degrees.

When a transmission line is terminated by any impedance other than its characteristic one, its input impedance varies with the length of the line and the frequency. The formulas are rather complex. So it is generally more convenient to calculate input impedance by means of some of the various charts available*.

The characteristic impedance of air-spaced parallel-wire lines depends on the diameter d of the wires and the center-to-center distance D between them. $Z_0$ in ohms $= 276 \log_{10} 2D/d$. Values of $Z_0$ for various sizes of wire and spacing are shown in Fig. 4. For concentric lines (air-spaced), $Z_0 = 138 \log_{10} D/d$, where d is the diameter of the inner conductor and D is the inner diameter of the outer conductor or sheath. Values for various ratios are shown in Fig. 5.

There are many types of transmission lines. Parallel wires supported by insulators are used where relatively high impedance is desired. A ribbon type consisting of two parallel wires spaced by a flexible dielectric is used for lower impedances. These lines have standardized values such as 75, 150, and 300 ohms. Parallel lines are subject to some extent to interfering external voltages. Co-axial lines are much more completely shielded from interference by the outer conductor. Common impedance values for the solid-dielectric co-axial lines are 52 and 75 ohms.

The conductors of parallel lines are balanced to ground; the conductors of co-axial lines are unbalanced. When co-axial lines are connected to parallel lines or balanced loads, it is necessary to take special measures to maintain balance. In transmission lines where the conductors are separated by a continuous dielectric other than air, the speed of transmitted waves becomes somewhat less than that in air and the wave length is from 5% to 20% less. The correct values are furnished by the various manufacturers.

There are various methods of matching the impedance of the load to the line to eliminate or reduce standing waves. There are also circuits in which standing waves can be useful. These will be discussed in subsequent articles.

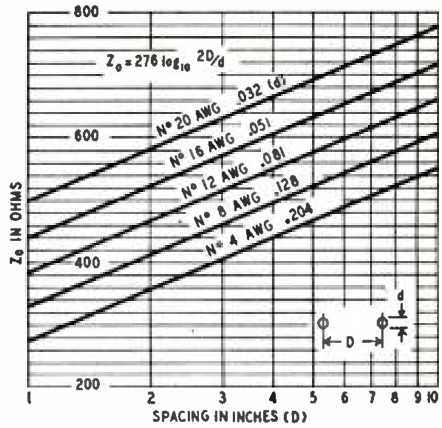



Fig. 4—Impedance values of parallel lines.

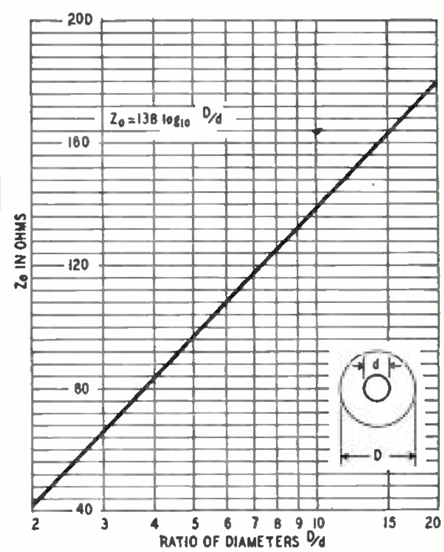
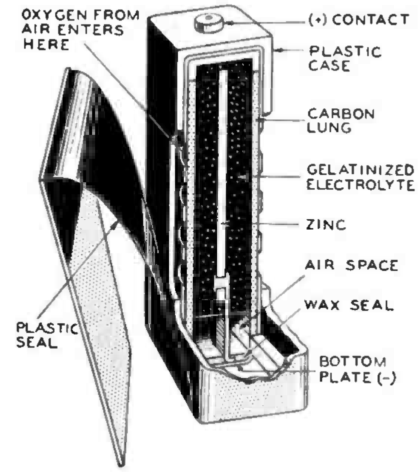



Fig. 5—Impedance chart for concentric lines.

* Robert C. Paine, "Graphical Solution of Voltage and Current Distribution and Impedance of Transmission Lines," *Proceedings I.R.E.*, Nov. 1944, p. 686.

## NEW BATTERY HAS LONG LIFE

A dry battery developed by National Carbon Company for use in hearing aids will give satisfactory service three times as long as a standard cell of the same weight. The new Eveready 1005-E hearing-aid A-cell, like other batteries, needs oxygen to neutralize the hydrogen which would otherwise collect on its carbon electrode. However, the 1005-E,




instead of using oxygen-liberating manganese dioxide—a depolarizer—draws its oxygen from the air. The large space taken in the ordinary cell by the manganese dioxide is thus free in the new unit to hold a larger supply of active chemicals.

What allows the battery to draw its oxygen from the air is its peculiar "inside-out" construction. Most flashlight cells have a zinc casing with a carbon rod up the middle. The 1005-E has, as the diagram shows, a zinc core between two plates of porous carbon. The carbon plates are placed against openings in the sides of the case. In manufacture a strip of adhesive tape covers the windows. Before use, the buyer peels off the tape.

At present the cell is being made only for use as an A-battery in hearing aids. However, other sizes and styles will be marketed when uses are found. An attribute of the cell which may make it especially valuable is the constancy of its voltage during its life.

## TV SET ADS MISLEADING

TV set advertising is sometimes misleading, according to a statement by Raymond B. Willson, operating manager of the National Better Business Bureau in a bulletin issued recently.

The Bureau has received numerous complaints that some sets advertised as "receiving all channels" actually will not receive the high-frequency stations at all, or if they do, reception is poor.

The Bureau recommended that the number of channels which can be received should be clearly stated in all advertising unless the receiver will actually receive all 12. It also said that installation charges should be fully and correctly stated in all advertising material.





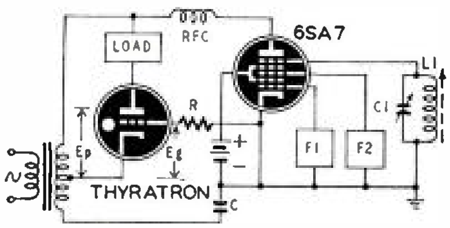
RADIO ELECTRONICS brings you the latest news from all branches of the industry.

## CONTROL OF POWER

Patent No. 2,444,153

Samuel C. Coroniti
(assigned to General Aniline & Film Corp.)

This discloses a means of controlling large amounts of power by a small change of frequency. The power is developed in the plate load of a thyratron. This tube is a.c. operated. Its grid is connected through R (a current limiter) to a point between a resistance (plate resistance of the 6SA7) and a condenser C. The phase of the grid voltage depends upon the relative values of this resistance and the condenser.




The current which flows in the plate circuit of a thyratron is greatest when the plate voltage Ep is in phase with the grid voltage Eg. It is zero when these voltages are out of phase.

Two signals are impressed upon the grids of the 6SA7. One of them "F1" is crystal controlled. The other "F2" is variable and is the controlling factor. It may be generated locally or may be received by radio if remote control is desired. The parallel circuit L1-C1 is tuned near the beat frequency F1—F2. It is designed for high Q for sharp tuning. As F2 is varied over a narrow range the impedance of the tuned circuit varies over a wide range. Therefore the voltage across it also changes and affects the plate resistance of the tube.

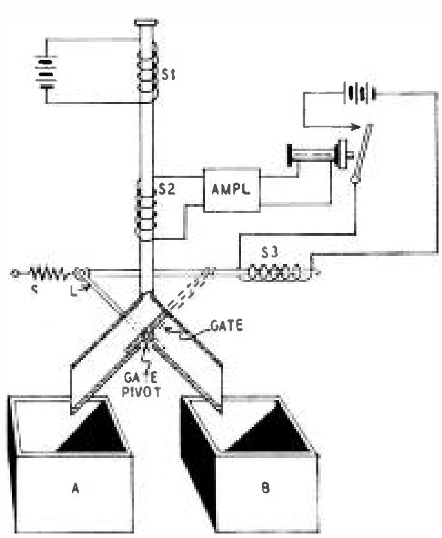
When the 6SA7 plate resistance is very low the grid and plate voltages on the thyratron are almost out of phase. When the resistance is very high, these voltages are almost in phase. Therefore the power in the load depends upon the frequency of F2.

## MAGNETIC SORTER

Patent No. 2,444,751

Kenneth L. Scott, Western Springs, Ill.
(assigned to Western Electric Co., Inc.)

This apparatus sorts material according to magnetic properties. The long nonmagnetic tube divides into two branches at its lower end. Here a pivoted gate is arranged to open one of the passages and to close the other when a magnetized object is dropped into the tube.




The pivoted gate is fixed to a lever L at right angles to it. Normally L is forced to the left by a spring S. This position is shown by full lines in the drawing. When L is forced towards the solenoid S3, the lever and gate take the position shown by dotted lines. Note that in the first case only the passage leading to A, in the second case only that to B, is open.

The vertical tube has two windings. The upper one (S1) is energized from a d.c. source. The other (S2) is connected across an amplifier input circuit. When an object is dropped into the tube it becomes magnetized on passing through S1. If it retains magnetism until it goes through S2 a voltage will be induced in that winding. The voltage change is amplified and energizes the output relay. S3 is magnetized for a short interval. As described previously this opens the passage to B into which the object drops. If the object does not make a good permanent magnet it drops into A.

## FIELD MEASURING TUBE

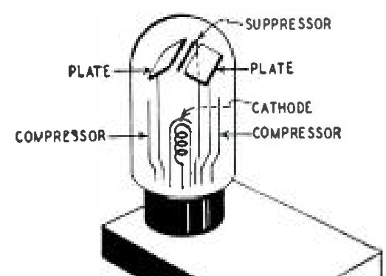
Patent No. 2,437,374

Robert E. Burroughs, Washington, D. C.
(assigned to Eastman Kodak Co.)

Originally designed for electronic gun-sights, this tube has many other practical applications. It is about the size of a walnut and is very sensitive. The tube contains one cathode, two anodes, and a suppressor. In addition there are two "compressors" which focus the electrons into two distinct beams from cathode to anodes.

The plate currents are adjusted to be equal without a magnetic field. Then, if the tube is placed in a field the beams are deflected. Usually one beam is deflected more than the other, and there is an unbalance across the plate loads. This voltage unbalance is indicated on a meter after amplification.

An important use of the tube is to indicate change of position. A tiny magnet is clamped to one object, and the tube is fixed to another. When their distance varies, the change in the field around the tube shows up on the meter. The tube can even be used to detect weak magnetization of a watch. The motion of the magnetized spring creates the changing field.



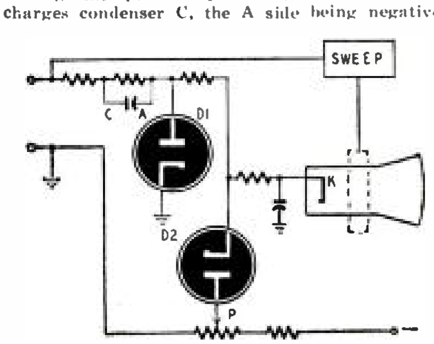

## AUTOMATIC BEAM CONTROL

Patent No. 2,448,299

Arthur Dorne, Mineola, N. Y.
(assigned to United States of America as represented by the Sec'y of the Army)

Automatic control of the maximum beam intensity on the screen of a cathode-ray tube is provided by this patented circuit. This intensity increases as the sweep is reduced, and vice-versa. If the intensity is maintained too high, the screen is damaged.

The sweep is connected to the deflecting plates (or coils) of a cathode-ray tube and also through a network to tube D1. The sweep voltage must go positive during some portion of its cycle. During the positive period, D1 conducts and charges condenser C, the A side being negative.



During the remainder of the cycle, the negative voltage adds to that on the condenser and is applied to cathode K. This increases the beam intensity.

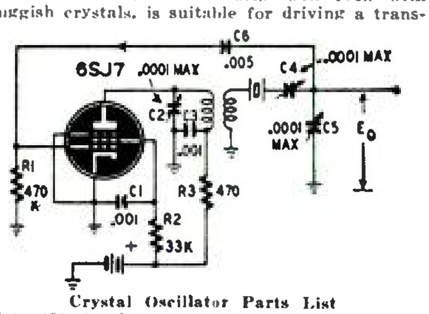
The greater the sweep, the more intense the screen image. A limit is provided by D2 which begins to conduct at some critical value. The P adjustment sets the maximum intensity.

## CRYSTAL OSCILLATOR

Patent No. 2,444,349

Charles W. Harrison, Flushing, N. Y. (assigned to Bell Telephone Labs., Inc.)

This oscillator, which works well even with sluggish crystals, is suitable for driving a transmitter or as a crystal test set. Frequency and amplitude stability are excellent. In addition, the frequency is variable over a limited range. Feedback is adjustable to accommodate different types of crystals.




**Crystal Oscillator Parts List**

| | |
|---|---|
| R1—470,000 ohms | C1, C3—.001 µf |
| R2—33,000 ohms | C2, C4, C5—100 µµf, variable |
| R3—470 ohms | |

The tube may be a 6SJ7. Circuit constants shown are suitable for operation at about 5 mc. The feedback depends upon the ratio of C5 to C4. These condensers also tune the transformer secondary to the crystal frequency. The secondary should have relatively few turns compared to the primary.

The oscillator frequency is tuned over a small range by adjusting the two variable condensers. With more active crystals the feedback may be reduced.

## WATCH TIMER

Patent No. 2,445,916

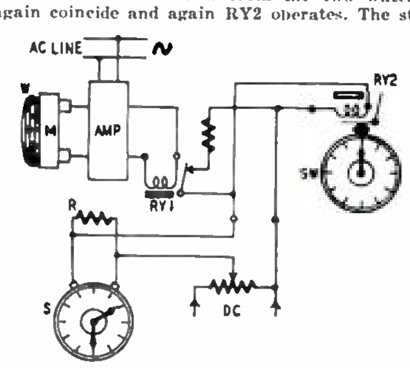
Jean L'Esplattenier, La Chaux de Fonds, Switzerland

With this apparatus any watch may be compared quickly with a standard watch. It indicates whether the tested watch runs too slow or too fast, and how much of either.

The watch being tested is shown as W near a microphone M. The audio output is amplified and connected to a relay RY1. This relay operates at every tick of the watch. The standard watch S has built-in contacts which are closed mechanically at every beat. This watch is adjusted to lose one beat every 30 seconds.

At some instant the beats from W and S will coincide. Resistor R is then shorted out to provide sufficient voltage from the potentiometer to actuate relay RY2. Also relay RY1 operates and removes the shunt across RY2. Operation of RY2 starts the stop watch SW.

Some time later beats from the two watches again coincide and again RY2 operates. The stop




watch then stops and indicates the speed of the test watch. If W runs correctly, this happens exactly 30 seconds later. If it is too slow, it occurs later, and if too fast, the beats coincide earlier. The stop watch indicator travels around once every 30 seconds, and its face is calibrated in seconds per day to show the speed of the watch. W.

## ELECTRONIC VOLTAGE REGULATOR

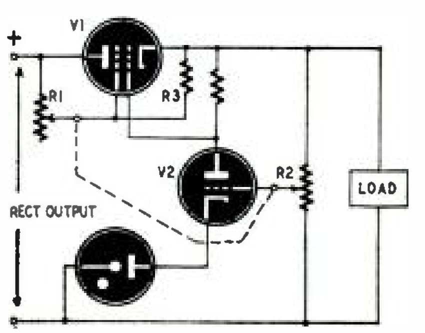
Patent No. 2,445,171

Wm. S. Graff-Baker, Rugby, England (assigned to General Electric Co.)

Offering greater control range than conventional regulators, this circuit uses a screen grid as V1 instead of the usual triode, and there are two additional resistors R1 and R3. Also, R1 and R2 are ganged so that R1 is automatically increased as R3 is adjusted toward the lower terminal. In the usual circuit, control becomes sluggish as V1 nears saturation. The new circuit eliminates this difficulty.

R2 is set near its upper terminal if greater voltage output is desired. This increases V2 plate current and puts a more negative potential on the control grid of V1. V1 does not operate near saturation and its grid has sufficient control. The value of R1 is small, and V1 therefore acts like a triode.

For low voltage across the load, R2 is set near the lower terminal. The control grid of V1 becomes more positive and the tube approaches saturation. Therefore, the grid has much less control than before. With this setting, however, R1 is much greater and V1 acts like a screen-grid tube. The amplification increases, and the grid still controls the regulation.



The great length of the present station list precludes printing a complete account of records made by FM listeners. Greatest distance reported was by Leon H. Hinman of Ithaca, N. Y. He received KTRH-FM of Houston, Texas, on the evening of June 2. Another interesting report is from Earl Cunningham, of Webster, Mass., who sends us a list of 32 stations from Portsmouth, N. H., to Philadelphia, Pa.

Mr. C. R. Bills of South Bend, Indiana, has a list of several stations ranging from 70 to 975 miles (this last one KXYZ-FM, Houston, Texas).

| CITY | CALL | FREQUENCY |
|---|---|---|
| | **ALABAMA** | |
| Anniston | WHMA-FM | 100.5 |
| Birmingham | WAFM | 99.5 |
| Birmingham | WJLD-FM | 104.7 |
| Birmingham | WSGN-FM | 93.7 |
| Gadsden | WJBY-FM | 103.7 |
| Huntsville | WHBS-FM | 95.1 |
| Lanett | WRLD-FM | 102.9 |
| Mobile | WKRG-FM | 99.9 |
| Mobile | WMOB-FM | 97.5 |
| Montgomery | WCOV-FM | 94.5 |
| Montgomery | WMGY-FM | 107.5 |
| Montgomery | WSFA-FM | 103.3 |
| Sylacauga | WSYO | 101.9 |
| | **ARKANSAS** | |
| Blytheville | KLCN-FM | 96.1 |
| Fort Smith | KFPW-FM | 94.9 |
| Fort Smith | KFSA-FM | 107.7 |
| Fort Smith | KRKN-FM | 102.1 |
| Jonesboro | KBTM-FM | 101.9 |
| Siloam Springs | KUOA-FM | 105.7 |
| | **CALIFORNIA** | |
| Alameda | KONG | 104.9 |
| Bakersfield | KERN-FM | 94.1 |
| Chico | KVCI | 101.1 |
| Eureka | KRED | 96.3 |
| Fresno | KARM-FM | 101.9 |
| Fresno | KRFM | 93.7 |
| Hollywood | KNX-FM | 93.1 |
| Los Angeles | KCLI | 105.1 |
| Los Angeles | KECA-FM | 95.5 |
| Los Angeles | KFAC-FM | 104.3 |
| Los Angeles | KFI-FM | 105.9 |
| Los Angeles | KFMV | 94.7 |
| Los Angeles | KHJ-FM | 101.1 |
| Los Angeles | KKLA | 97.1 |
| Los Angeles | KMGM | 99.7 |
| Los Angeles | KMPC-FM | 100.3 |
| Los Angeles | KRKD-FM | 96.3 |
| Los Angeles | KUSC | 91.5 |
| Marysville | KMYC-FM | 99.9 |
| Merced | KVME | 97.5 |
| Modesto | KBEE | 103.3 |
| Oakland | KLX-FM | 101.3 |
| Ontario | KOCS-FM | 93.5 |
| Pasadena | KAGH-FM | 98.3 |
| Redding | KVRE | 103.9 |
| Richmond | KRCC | 104.5 |
| Riverside | KPOR | 97.5 |
| Sacramento | KCRA-FM | 96.1 |
| Sacramento | KFBK-FM | 96.9 |
| Sacramento | KXOA-FM | 107.9 |
| San Bernardino | KBMT | 99.9 |
| San Bernardino | KFXM-FM | 95.1 |
| San Bruno | KSBR | 100.5 |
| San Diego | KFMB-FM | 101.5 |
| San Diego | KFSD-FM | 94.1 |
| San Diego | KSDO | 96.5 |
| San Diego | KWFM | 104.7 |
| San Francisco | KALW | 91.7 |
| San Francisco | KDFC | 102.1 |
| San Francisco | KGO-FM | 106.1 |
| San Francisco | KJBS-FM | 98.9 |
| San Francisco | KNBC-FM | 99.7 |
| San Francisco | KQW-FM | 103.7 |
| San Francisco | KRON-FM | 96.5 |
| San Francisco | KSFH | 94.9 |
| San Francisco | KWBR-FM | 97.3 |
| San Jose | KRPO | 92.3 |
| San Jose | KSJO-FM | 95.3 |
| San Luis Obispo | KVEC-FM | 99.9 |
| Santa Maria | KRJM | 103.1 |
| Santa Monica | KCRW | 89.9 |
| Stockton | KCVN | 91.3 |
| Stockton | KGDM-FM | 92.9 |
| | **COLORADO** | |
| Denver | KFEL-FM | 97.3 |
| Denver | KLZ-FM | 94.1 |
| Denver | KOA-FM | 95.7 |
| | **CONNECTICUT** | |
| Danbury | WLAD-FM | 98.3 |
| Hartford | WDRC-FM | 93.7 |
| Hartford | WTHT-FM | 106.1 |
| Hartford | WTIC-FM | 96.5 |
| Meriden | WMMW-FM | 95.7 |
| New Britain | WKNB-FM | 103.7 |
| New Haven | WBIB | 100.7 |
| New Haven | WAVZ-FM | 95.1 |
| New Haven | WEMI | 107.1 |

| CITY | CALL | FREQUENCY |
|---|---|---|
| New Haven | WNHC-FM | 99.1 |
| New London | WNLC-FM | 99.5 |
| Stamford | WSTC-FM | 96.7 |
| | DELAWARE | |
| Wilmington | WAMS-FM | 96.1 |
| | DISTRICT OF COLUMBIA | |
| Washington | WASH | 97.1 |
| Washington | WINX-FM | 96.3 |
| Washington | WMAL-FM | 107.3 |
| Washington | WOL-FM | 98.7 |
| Washington | WQQW-FM | 103.5 |
| Washington | WRC-FM | 93.9 |
| Washington | WWDC-FM | 101.1 |
| | FLORIDA | |
| Daytona Beach | WNDB-FM | 94.5 |
| Fort Lauderdale | WGOR | 106.5 |
| Gainesville | WRUF-FM | 104.1 |
| Jacksonville | WJHP-FM | 96.9 |
| Jacksonville | WMBR-FM | 96.1 |
| Miami | WGBS-FM | 96.3 |
| Miami | WIOD-FM | 97.3 |
| Miami | WQAM-FM | 94.9 |
| Miami | WTHS | 91.7 |
| Miami | WWPB-FM | 101.5 |
| Miami Beach | WKAT-FM | 93.1 |
| Orlando | WHOO-FM | 96.5 |
| Palm Beach | WWPG-FM | 97.9 |
| Pensacola | WCOA-FM | 98.9 |
| St. Petersburg | WTSP-FM | 102.5 |
| Tallahassee | WTAL-FM | 103.9 |
| Tampa | WDAE-FM | 105.7 |
| Tampa | WFLA-FM | 93.3 |
| West Palm Beach | WJNO-FM | 98.7 |
| | GEORGIA | |
| Atlanta | WAGA-FM | 103.3 |
| Atlanta | WATL-FM | 97.5 |
| Atlanta | WBGE-FM | 95.5 |
| Atlanta | WCON-FM | 98.5 |
| Atlanta | WGST-FM | 94.1 |
| Atlanta | WSB-FM | 104.5 |
| Cedartown | WGAA-FM | 96.1 |
| Columbus | WDAK-FM | 107.9 |
| Columbus | WGBA-FM | 95.1 |
| Columbus | WRBL-FM | 93.3 |
| La Grange | WLAG-FM | 104.1 |
| Macon | WBML-FM | 100.7 |
| Macon | WMAZ-FM | 99.1 |
| Newnan | WCOH-FM | 92.3 |
| Rome | WRGA-FM | 106.5 |
| Savannah | WSAV-FM | 100.3 |
| Savannah | WTOC-FM | 97.3 |
| Toccoa | WLET-FM | 102.9 |
| Valdosta | WGOV-FM | 92.5 |
| | IDAHO | |
| Boise | KIDO-FM | 106.1 |
| Nampa | KFXD-FM | 101.9 |
| Pocatello | KSEI-FM | 96.5 |
| Twin Falls | KTFI-FM | 99.7 |
| | ILLINOIS | |
| Alton | WOKZ-FM | 99.9 |
| Aurora | WBNU | 103.9 |
| Bloomington | WJBC-FM | 101.5 |
| Canton | WBYS-FM | 100.9 |
| Carbondale | WCIL-FM | 100.7 |
| Chicago | WBBM-FM | 97.1 |
| Chicago | WBEZ | 91.5 |
| Chicago | WBIK | 96.3 |
| Chicago | WEFM | 99.5 |
| Chicago | WEHS | 97.9 |
| Chicago | WENR-FM | 94.7 |
| Chicago | WFMF | 100.3 |
| Chicago | WGNB | 98.7 |
| Chicago | WMAQ-FM | 101.1 |
| Chicago | WMBI-FM | 95.5 |
| Chicago | WXRT | 101.9 |
| Decatur | WSOY-FM | 102.1 |
| Elmwood Park | WLEY | 107.1 |
| Evanston | WEAW | 96.7 |
| Freeport | WFJS | 102.5 |
| Harrisburg | WEBQ-FM | 99.9 |
| Herrin | WJPF-FM | 98.5 |
| Jacksonville | WLDS-FM | 100.5 |
| Kankakee | WKIL | 100.7 |
| La Grange | WRGK | 103.1 |
| Mount Vernon | WMIX-FM | 94.1 |
| Oak Park | WOAK | 98.3 |
| Peoria | WMBD-FM | 92.5 |
| Quincy | WQDI | 105.1 |
| Quincy | WTAD-FM | 99.5 |
| Rock Island | WHBF-FM | 98.9 |
| Springfield | WCVS-FM | 102.9 |
| Springfield | WTAX-FM | 103.7 |
| Urbana | WIUC | 91.7 |
| Waukegan | WKRS | 106.7 |
| Woodstock | WILA | 92.1 |
| | INDIANA | |
| Bloomington | WFIU | 90.9 |
| Columbus | WCSI | 93.7 |
| Connersville | WCNB-FM | 100.3 |
| Crawfordsville | WFMU | 102.9 |
| Elkhart | WTRC-FM | 100.7 |
| Evansville | WIKY-FM | 104.1 |
| Evansville | WMLL | 94.5 |
| Ft. Wayne | WFTW-FM | 103.7 |
| Ft. Wayne | WKJG-FM | 106.1 |
| Ft. Wayne | WOWO-FM | 96.1 |
| Hammond | WJIZ | 92.3 |
| Indianapolis | WMHC | 97.1 |
| Indianapolis | WXWL-FM | 94.7 |
| Kokomo | WKMO-FM | 99.9 |
| Lafayette | WFAM | 95.1 |

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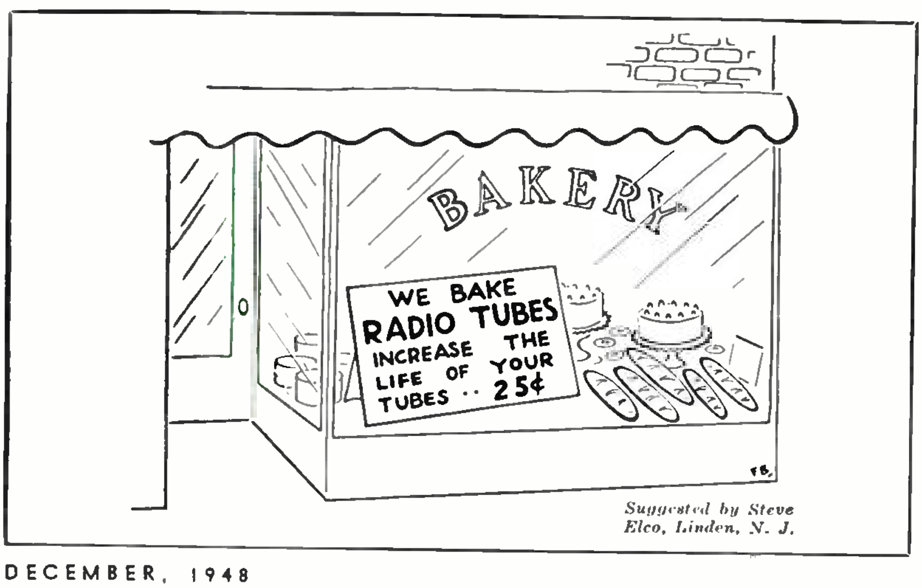
| CITY | CALL | FREQUENCY |
|---|---|---|
| Muncie | WMUN | 104.1 |
| New Castle | WCTW | 103.1 |
| Shelbyville | WSRK | 101.3 |
| South Bend | WSBF | 101.3 |
| Terre Haute | WBOW-FM | 101.1 |
| Washington | WFML | 106.5 |
| Warsaw | WRSW | 107.3 |
| | **IOWA** | |
| Burlington | KBUR-FM | 92.[illegible] |
| Cedar Rapids | KCRK | 96.9 |
| Council Bluffs | KFMX | 96.1 |
| Davenport | WOC-FM | 103.7 |
| Des Moines | KSO-FM | 97.3 |
| Des Moines | KRNT-FM | 104.5 |
| Des Moines | WHO-FM | 100.3 |
| Dubuque | KDTH-FM | 100.5 |
| Dubuque | WDBQ | 103.3 |
| Fort Dodge | KFMY | 102.7 |
| Iowa City | KSUI | 91.7 |
| Keokuk | KOKX-FM | 102.7 |
| Mason City | KGLO-FM | 101.1 |
| Sioux City | KSCJ-FM | 94.9 |
| Waterloo | KXEL-FM | 105.7 |
| | **KANSAS** | |
| Garden City | KGAR-FM | 99.3 |
| Hutchinson | KIMV | 105.7 |
| Hutchinson | KWBW-FM | 93.1 |
| Kansas City | KSBS | 105.9 |
| Topeka | WIBW-FM | 102.5 |
| Topeka | WREN-FM | 94.1 |
| Wichita | KFH-FM | 100.3 |
| | **KENTUCKY** | |
| Bowling Green | WBON | 101.1 |
| Henderson | WSON-FM | 99.5 |
| Hopkinsville | WHOP-FM | 98.7 |
| Lexington | WBKY | 91.3 |
| Louisville | WBOX | 100.7 |
| Louisville | WHAS | 99.7 |
| Louisville | WRXW | 95.1 |
| Owensboro | WVJS-FM | 96.1 |
| Paducah | WKYC | 93.3 |
| Paducah | WPAD-FM | 96.9 |
| | **LOUISIANA** | |
| Alexandria | KALB-FM | 96.9 |
| Alexandria | KPDR-FM | 99.7 |
| Baton Rouge | WAFB-FM | 104.3 |
| Baton Rouge | WBRL | 98.1 |
| Baton Rouge | WLCS-FM | 101.1 |
| Baton Rouge | WLSU | 91.7 |
| Monroe | KMFM | 104.1 |
| New Orleans | WRCM | 97.1 |
| New Orleans | WSMB-FM | 102.7 |
| New Orleans | WTPS-FM | 95.7 |
| New Orleans | WWLH | 100.3 |
| | **MAINE** | |
| Bangor | WGUY-FM | 93.1 |
| Lewiston | WCOU-FM | 93.9 |
| Portland | WGAN-FM | 101.9 |
| | **MARYLAND** | |
| Annapolis | WNAV-FM | 99.1 |
| Baltimore | WCAO-FM | 102.7 |
| Baltimore | WFBR-FM | 101.9 |
| Baltimore | WITH-FM | 104.3 |
| Baltimore | WMAR-FM | 97.9 |
| Baltimore | WMCP | 94.[illegible] |
| Bradbury Hts. | WBUZ | 96.7 |
| Frederick | WFMD-FM | 101.5 |
| Hagerstown | WJEJ-FM | 104.7 |
| Salisbury | WBOC-FM | 97.5 |
| Silver Spring | WGAY-FM | 102.3 |
| | **MASSACHUSETTS** | |
| Boston | WBMS-FM | 104.1 |
| Boston | WBZ-FM | 92.9 |
| Boston | WEEI-FM | 103.3 |
| Boston | WHDH-FM | 94.5 |
| Brockton | WBET-FM | 97.7 |
| Cambridge | WXHR | 96.9 |
| Chicopee | WACE-FM | 100.3 |
| Fall River | WCFR | 93.5 |
| Fall River | WSAR-FM | 103.7 |
| Fitchburg | WEIM-FM | 104.7 |
| Greenfield | WHAI-FM | 98.3 |
| Haverhill | WHAV-FM | 92.5 |
| Holyoke | WHYN-FM | 93.1 |
| Lawrence | WLAW-FM | 93.7 |
| Lynn | WLYN-FM | 105.5 |
| New Bedford | WFMR | 98.1 |
| Pittsfield | WBEC-FM | 94.3 |
| Springfield | WBZA-FM | 97.1 |
| Springfield | WMAS-FM | 94.7 |
| Springfield | WSFL | 101.9 |
| West Yarmouth | WOCB-FM | 94.3 |
| Worcester | WGTR | 99.1 |
| Worcester | WTAG-FM | 96.1 |
| | **MICHIGAN** | |
| Ann Arbor | WPAG-FM | 98.7 |
| Ann Arbor | WUOM | 91.7 |
| Battle Creek | WELL-FM | 102.1 |
| Bay City | WBCM-FM | 96.1 |
| Benton Harbor | WHFB-FM | 99.9 |
| Detroit | WDTR | 90.9 |
| Detroit | WJBK-FM | 93.1 |
| Detroit | WJLB-FM | 97.9 |
| Detroit | WJR-FM | 96.3 |
| Detroit | WWJ-FM | 97.1 |
| Detroit | WXYZ-FM | 101.1 |
| East Lansing | WKAR-FM | 90.5 |
| Flint | WAJL | 107.1 |
| Grand Rapids | WFRS | 92.5 |
| Grand Rapids | WLAV-FM | 96.9 |

| CITY | CALL | FREQUENCY |
|---|---|---|
| Jackson | WIBM-FM | 92.[illegible] |
| Mt. Clemens | WMLN | 106.3 |
| Muskegon | WKBZ-FM | 106.5 |
| Muskegon | WMUS-FM | 100.5 |
| Owosso | WOAP-FM | 103.1 |
| Pontiac | WCAR-FM | 99.5 |
| Port Huron | WTTH-FM | 99.1 |
| Royal Oak | WEXL-FM | 104.3 |
| Saginaw | WSAL | 98.1 |
| Wyandotte | WJJW | 103.1 |
| | MINNESOTA | |
| Duluth | WEBC-FM | 92.3 |
| Mankato | KYSM-FM | 103.5 |
| Minneapolis | KBTR | 98.5 |
| Minneapolis | WTCN-FM | 97.1 |
| Rochester | KROC-FM | 94.7 |
| St. Cloud | KFAM-FM | 104.7 |
| St. Paul | KSTP-FM | 102.1 |
| St. Paul | WMIN-FM | 99.5 |
| Winona | KWNO-FM | 97.5 |
| | MISSISSIPPI | |
| Greenville | WJPR-FM | 101.9 |
| Gulfport | WGCM-FM | 101.5 |
| Jackson | WJDX-FM | 102.9 |
| Meridian | WMOX-FM | 98.5 |
| | MISSOURI | |
| Clayton | KFUO-FM | 104.1 |
| Clayton | KXLW-FM | 101.1 |
| Jefferson City | KWOS-FM | 98.5 |
| Joplin | WMBH-FM | 96.1 |
| Kansas City | KCFM | 94.9 |
| Kansas City | KMBC-FM | 100.5 |
| Kansas City | KOZY | 98.1 |
| Kansas City | WHB-FM | 102.1 |
| Kennett | KBOA | 98.9 |
| Poplar Bluff | KWOC-FM | 94.5 |
| St. Joseph | KFEQ-FM | 92.3 |
| St. Louis | KSD-FM | 96.1 |
| St. Louis | KSLH | 91.5 |
| St. Louis | KWK-FM | 99.1 |
| St. Louis | KXOK-FM | 93.7 |
| St. Louis | WEW-FM | 95.1 |
| St. Louis | WIL-FM | 97.3 |
| Springfield | KTTS-FM | 94.7 |
| | NEBRASKA | |
| Lincoln | KFAB-FM | 97.9 |
| Lincoln | KFOR-FM | 102.9 |
| Omaha | KOAD | 92.9 |
| | NEVADA | |
| Las Vegas | KENO-FM | 103.9 |
| | NEW HAMPSHIRE | |
| Claremont | WTSV-FM | 106.1 |
| Manchester | WKBR-FM | 100.1 |
| Manchester | WMUR-FM | 95.7 |
| Nashua | WOTW-FM | 106.3 |
| Portsmouth | WFMI | 107.3 |
| | NEW JERSEY | |
| Alpine | W2XEA | 92.1 |
| Asbury Park | WCAP-FM | 107.1 |
| Asbury Park | WJLK | 94.3 |
| Atlantic City | WBAB-FM | 100.7 |
| Bridgeton | WSNJ-FM | 98.9 |
| Jersey City | WFMO | 103.1 |
| Newark | WAAT-FM | 94.7 |
| Newark | WBGO | 91.1 |
| New Brunswick | WCTC-FM | 98.3 |
| New Brunswick | WDHN | 93.5 |
| South Orange | WSOU | 89.5 |
| Paterson | WWDX | 107.1 |
| Plainfield | WXNJ | 103.9 |
| | NEW YORK | |
| Albany | WROW-FM | 93.9 |
| Albany | WRWR | 95.5 |
| Binghamton | WNBF-FM | 100.5 |
| Buffalo | WBNY-FM | 92.9 |
| Buffalo | WBEN-FM | 106.5 |
| Buffalo | WEBR-FM | 96.9 |
| Cherry Valley | WVCV | 101.9 |

| CITY | CALL | FREQUENCY |
|---|---|---|
| Corning | WKNP | 106.1 |
| Cortland | WKRT-FM | 99.9 |
| De Ruyter | WVCN | 105.1 |
| Elmira | WENY-FM | 106.9 |
| Endicott | WENE-FM | 101.7 |
| Floral Park | WSHS | 90.3 |
| Hempstead | WHNY | 98.3 |
| Highmarket | WVBN | 107.7 |
| Hornell | WWHG | 105.3 |
| Ithaca | WHCU-FM | 97.3 |
| Ithaca | WVFC | 95.1 |
| Jamestown | WJTN-FM | 93.3 |
| Massena | WMSA-FM | 105.3 |
| New Rochelle | WGNR | 93.5 |
| New York | WABF | 99.5 |
| New York | WCBS-FM | 101.1 |
| New York | WFUV | 90.7 |
| New York | WGHF | 101.9 |
| New York | WGYN | 97.9 |
| New York | WJZ-FM | 95.5 |
| New York | WMGM-FM | 100.3 |
| New York | WNBC-FM | 97.1 |
| New York | WNYC-FM | 93.9 |
| New York | WNYE | 91.5 |
| New York | WOR-FM | 98.7 |
| New York | WQXR-FM | 96.3 |
| Niagara Falls | WHLD-FM | 98.5 |
| Ogdensburg | WSLB-FM | 106.1 |
| Oneonta | WDOS-FM | 99.1 |
| Oswego | WOPT | 104.7 |
| Poughkeepsie | WHVA | 104.7 |
| Rochester | WHEC-FM | 96.5 |
| Rochester | WHFM | 98.9 |
| Rochester | WRNY-FM | 97.9 |
| Schenectady | WBCA | 101.1 |
| Schenectady | WGFM | 99.5 |
| South Bristol | WVBT | 101.9 |
| Syracuse | WAGE-FM | 98.5 |
| Syracuse | WFBL-FM | 93.1 |
| Syracuse | WNDR-FM | 102.5 |
| Syracuse | WSYR-FM | 94.5 |
| Troy | W?VR | 91.3 |
| Troy | W?LY | 92.3 |
| Troy | WTRI | 102.7 |
| Utica | WIBX-FM | 96.9 |
| Utica | WRUN | 105.7 |
| Watertown | WWNY-FM | 100.5 |
| Wethersfield | WFNF | 107.7 |
| White Plains | WFAS-FM | 103.9 |
| | NORTH CAROLINA | |
| Asheville | WISE-FM | 102.5 |
| Asheville | WLOS-FM | 104.3 |
| Burlington | WBBB-FM | 101.1 |
| Burlington | WFNS-FM | 93.9 |
| Charlotte | WAYS-FM | 107.7 |
| Charlotte | WBT-FM | 99.9 |
| Charlotte | WIST | 104.7 |
| Charlotte | WMIT | 106.9 |
| Charlotte | WSOC-FM | 103.5 |
| Durham | WDNC-FM | 105.1 |
| Fayetteville | WFNC-FM | 98.1 |
| Gastonia | WGNC-FM | 101.9 |
| Goldsboro | WGBR-FM | 93.3 |
| Greensboro | WCTP | 98.7 |
| Greensboro | WFMY | 97.3 |
| Greensboro | WGBG-FM | 100.3 |
| Henderson | WHNC-FM | 107.3 |
| Hickory | WHKY-FM | 102.9 |
| High Point | WHPE-FM | 95.5 |
| High Point | WMFR-FM | 99.5 |
| Raleigh | WNAO-FM | 96.1 |
| Raleigh | WRAL-FM | 101.5 |
| Reidsville | WREV | 102.1 |
| Roanoke Rapids | WCBT-FM | 98.5 |
| Rocky Point | WCEC-FM | 100.7 |
| Salisbury | WSTP-FM | 106.5 |
| Shelby | WOHS-FM | 96.1 |
| Statesville | WSIC-FM | 105.7 |
| Wilson | WGTM-FM | 106.7 |
| Winston-Salem | WAIR-FM | 93.1 |
| Winston-Salem | WSJS-FM | 104.1 |




*Suggested by Steve Elco, Linden, N. J.*



## OPPORTUNITY AD-LETS

Advertisements in this section cost 25c a word for each insertion. Name, address and initials must be included at the above rate. Cash should accompany all classified advertisements unless placed by an accredited advertising agency. No advertisement for less than ten words accepted. Ten percent discount six issues, twenty percent for twelve issues. Objectionable or misleading advertisements not accepted. Advertisements for January, 1949 Issue, must reach us not later than November 11, 1948.
**Radio-Electronics, 25 W. Broadway, New York 7, N. Y.**

| CITY | CALL | FREQUENCY |
|---|---|---|
| | NORTH DAKOTA | |
| Fargo | KVNJ-FM | 92.3 |
| | OHIO | |
| Akron | WAKR-FM | 97.5 |
| Alliance | WFAH | 101.7 |
| Ashland | WATG | 101.3 |
| Bellaire | WTRF-FM | 100.5 |
| Canton | WAND-FM | 92.5 |
| Canton | WCMW-FM | 94.9 |
| Canton | WHBC-FM | 94.1 |
| Cincinnati | WCTS | 101.9 |
| Cincinnati | WLWA | 101.1 |
| Cincinnati | WSAI-FM | 102.7 |
| Cleveland | WBOE | 90.3 |
| Cleveland | WEWS-FM | 102.1 |
| Cleveland | WHK | 100.7 |
| Cleveland | WJW-FM | 104.1 |
| Cleveland Hts. | WSRS-FM | 95.3 |
| Columbus | WCOL-FM | 92.3 |
| Columbus | WELD | 97.1 |
| Columbus | WHKB | 98.7 |
| Dayton | WHIO-FM | 99.1 |
| Elyria | WEOL-FM | 107.3 |
| Findlay | WFIN-FM | 100.5 |
| Fostoria | WFOB | 105.5 |
| Fremont | WFRO | 99.3 |
| Hamilton | WMOH-FM | 103.5 |
| Lakewood | WLAL | 104.9 |
| Lima | WIMA-FM | 102.1 |
| Lima | WLOK-FM | 103.3 |
| Newark | WCLT | 100.3 |
| Portsmouth | WPAY-FM | 104.1 |
| Springfield | WJEM | 103.9 |
| Steubenville | WSTV-FM | 103.5 |
| Tiffin | WTFM | 98.3 |
| Toledo | WTDS | 91.3 |
| Toledo | WTRT | 99.9 |
| Toledo | WSPD-FM | 101.5 |
| Wooster | WWST-FM | 104.5 |
| Youngstown | WFMJ-FM | 105.1 |
| Youngstown | WKDN-FM | 98.9 |
| | OKLAHOMA | |
| Ardmore | KVSO-FM | 93.7 |
| Durant | KSEO-FM | 107.3 |
| Enid | KCRC-FM | 102.7 |
| Muskogee | KMUS | 101.5 |
| Muskogee | KBIX-FM | 98.5 |
| Norman | KOKU | 90.9 |
| Oklahoma City | KOCY-FM | 94.7 |
| Oklahoma City | KOKH | 90.1 |
| Oklahoma City | KOMA-FM | 105.9 |
| Oklahoma City | KTOK-FM | 104.3 |
| Oklahoma City | WKY-FM | 98.9 |
| Stillwater | KOAG-FM | 91.7 |
| Stillwater | KSPI-FM | 93.9 |
| Tulsa | KAKC-FM | 95.5 |
| Tulsa | KWGS | 90.5 |
| Tulsa | KTUL-FM | 97.1 |
| | OREGON | |
| Albany | KWIL-FM | 101.7 |
| Eugene | KRVM | 90.1 |
| Eugene | KUGN-FM | 99.1 |
| Grants Pass | KGPO | 96.9 |
| Portland | KGW-FM | 100.3 |
| Portland | KOIN-FM | 101.1 |
| Portland | KPFM | 97.1 |
| Portland | KPOJ-FM | 98.7 |
| Portland | KPRA | 95.5 |
| | PENNSYLVANIA | |
| Allentown | WFMZ | 95.9 |
| Allentown | WKAP-FM | 100.7 |
| Allentown | WSAN-FM | 99.9 |
| Altoona | WFBG-FM | 103.7 |
| Altoona | WAPJ | 96.5 |
| Bethlehem | WEST-FM | 107.9 |
| Bethlehem | WGPA-FM | 95.1 |
| Bradford | WESB-FM | 97.5 |
| Butler | WISR-FM | 97.7 |
| Chambersburg | WCHA-FM | 95.5 |
| DuBois | WCED-FM | 102.1 |
| Easton | WEEX | 98.3 |
| Erie | WERC-FM | 99.9 |
| Erie | WLEU-FM | 97.9 |
| Harrisburg | WABX | 100.9 |
| Harrisburg | WHP-FM | 97.3 |
| Jonnstown | WARD-FM | 105.3 |
| Johnstown | WJAC-FM | 95.5 |
| Lancaster | WGAL-FM | 101.3 |
| Lancaster | WLAN-FM | 96.9 |
| Lebanon | WLAB | 104.1 |
| Lebanon | WLBR-FM | 100.1 |
| Lewistown | WLTN | 97.9 |
| McKeesport | WMCK-FM | 104.9 |
| Meadville | WMGW-FM | 100.3 |
| New Castle | WKST-FM | 101.1 |
| Philadelphia | KYW-FM | 92.5 |
| Philadelphia | WCAU-FM | 98.1 |
| Philadelphia | WFIL-FM | 102.1 |
| Philadelphia | WIBG-FM | 94.1 |
| Philadelphia | WIP-FM | 93.3 |
| Philadelphia | WJUN | 91.7 |
| Philadelphia | WPEN-FM | 102.9 |
| Pittsburgh | KDKA-FM | 92.9 |
| Pittsburgh | KQV-FM | 98.1 |
| Pittsburgh | WCAE-FM | 96.1 |
| Pittsburgh | WJAS-FM | 99.7 |
| Pittsburgh | WKJF | 93.7 |
| Pittsburgh | WMOT | 94.5 |
| Pottsville | WPAM-FM | 95.5 |
| Reading | WEEU-FM | 92.9 |
| Scranton | WARM-FM | 105.7 |
| Sharon | WPIC-FM | 102.9 |
| State College | WEHR | 90.9 |
| Sunbury | WKOK-FM | 94.1 |
| Uniontown | WMBS-FM | 105.7 |
| Uniontown | WNIQ | 106.5 |
| Warren | WNAE-FM | 92.1 |
| West Chester | WWCH | 91.3 |
| Wilkes-Barre | WBRE-FM | 98.5 |
| Wilkes-Barre | WIZZ | 103.3 |
| Williamsport | WRAK-FM | 100.3 |
| York | WRZE | 98.5 |
| York | WSBA-FM | 103.3 |
| | RHODE ISLAND | |
| Providence | WJAR-FM | 95.5 |
| Providence | WLIV | 107.7 |
| Providence | WPJB | 105.1 |
| Providence | WPRO-FM | 92.3 |
| Providence | WPTL | 91.5 |
| | SOUTH CAROLINA | |
| Anderson | WCAC | 101.1 |
| Charleston | WCSC-FM | 96.9 |
| Charleston | WTMA-FM | 95.1 |
| Columbia | WIS-FM | 94.5 |
| Greenville | WESC-FM | 92.5 |
| Greenville | WFBC-FM | 93.7 |
| Greenville | WMRC-FM | 94.9 |
| Greenwood | WCRS-FM | 95.7 |
| Spartanburg | WDXY | 100.5 |
| Spartanburg | WSPA-FM | 98.9 |
| | TENNESSEE | |
| Bristol | WOPI-FM | 96.9 |

| CITY | CALL | FREQUENCY |
|---|---|---|
| Chattanooga | WAPO-FM | 94.7 |
| Chattanooga | WVUM | 98.1 |
| Clarksville | WCLC | 106.7 |
| Jackson | WTJS-FM | 100.7 |
| Johnson City | WJHL-FM | 100.7 |
| Kingsport | WKPT-FM | 98.5 |
| Knoxville | WKPB | 93.3 |
| Knoxville | WROL-FM | 97.3 |
| Memphis | WHHM-FM | 106.9 |
| Memphis | WMCF | 99.7 |
| Nashville | WSIX-FM | 97.5 |
| Nashville | WSM-FM | 103.3 |
| | TEXAS | |
| Abilene | KRBC-FM | 96.9 |
| Amarillo | KGNC-FM | 104.3 |
| Beaumont | KRIC-FM | 99.5 |
| Belton | KMHB | 97.1 |
| Dallas | KIXL-FM | 104.5 |
| Dallas | KRLD-FM | 92.5 |
| Dallas | WFAA-FM | 97.9 |
| Denton | KDNT-FM | 106.1 |
| Edinburg | KURV-FM | 104.9 |
| Harlingen | KGBS-FM | 94.7 |
| Houston | KOPY | 97.9 |
| Houston | KPRC-FM | 102.9 |
| Houston | KTRH-FM | 101.1 |
| Houston | KUHF | 91.7 |
| Houston | KXYZ-FM | 96.5 |
| Lubbock | KFYO-FM | 99.5 |
| Lufkin | KRBA-FM | 95.5 |
| San Angelo | KGKL-FM | 94.5 |
| San Antonio | KISS | 99.5 |
| San Antonio | KONO-FM | 92.9 |
| San Antonio | KTSA-FM | 104.1 |
| San Antonio | KYFM | 101.5 |
| San Antonio | WOAI-FM | 102.5 |
| Texarkana | KCMC-FM | 98.1 |
| Tyler | KGKB-FM | 101.5 |
| Vernon | KVWC-FM | 98.7 |
| Wichita Falls | KTRN | 97.3 |
| Wichita Falls | KWFT-FM | 99.9 |
| | UTAH | |
| Ogden | KOPP-FM | 103.9 |
| Salt Lake City | KDYL-FM | 98.7 |
| Salt Lake City | KSL-FM | 100.3 |
| | VIRGINIA | |
| Arlington | WARL-FM | 105.5 |
| Danville | WBTM-FM | 97.9 |
| Harrisonburg | WSVA-FM | 100.7 |
| Lynchburg | WLVA | 97.5 |
| Lynchburg | WWOD-FM | 107.9 |
| Newport News | WGH-FM | 96.5 |
| Norfolk | WARY | 105.3 |
| Norfolk | WRVC | 102.5 |
| Norfolk | WTAR-FM | 97.3 |
| Portsmouth | WSAP-FM | 99.7 |
| Richmond | WCOD | 98.1 |
| Richmond | WLEE-FM | 102.9 |
| Richmond | WRNL-FM | 102.1 |
| Richmond | WRVB | 94.5 |
| Roanoke | WDBJ-FM | 94.9 |
| Roanoke | WSLS-FM | 99.1 |
| Roanoke | WROV-FM | 103.7 |
| Suffolk | WLPM-FM | 107.7 |
| Winchester | WINC-FM | 92.5 |
| | WASHINGTON | |
| Longview | KWLK-FM | 103.9 |
| Seattle | KING-FM | 94.9 |
| Seattle | KRSC-FM | 98.1 |
| Seattle | KIRO-FM | 100.7 |
| Tacoma | KTNT | 97.3 |
| | WEST VIRGINIA | |
| Beckley | WCFC | 101.3 |
| Beckley | WJLS-FM | 99.5 |
| Bluefield | WHIS-FM | 104.5 |
| Clarksburg | WPDX-FM | 95.1 |
| Huntington | WHTN-FM | 100.5 |
| Huntington | WPLH-FM | 102.5 |
| Logan | WLOG-FM | 103.3 |
| Morgantown | WAJR-FM | 99.3 |
| Oak Hill | WOAY-FM | 94.1 |
| Wheeling | WKWK-FM | 97.3 |
| Wheeling | WWVA-FM | 98.7 |
| | WISCONSIN | |
| Beloit | WBNB | 107.3 |
| Chilton | WHKW | 89.9 |
| Delafield | WHAD | 90.7 |
| Eau Clair | WEAU-FM | 94.1 |
| Green Bay | WJPG-FM | 101.1 |
| Green Bay | WTAQ-FM | 102.5 |
| Greenfield | WWCF | 94.9 |
| Janesville | WCLO-FM | 99.9 |
| LaCrosse | WKBH-FM | 93.1 |
| Madison | WFOW | 104.9 |
| Madison | WHA-FM | 88.7 |
| Madison | WIBA-FM | 101.5 |
| Madison | WISC-FM | 99.9 |
| Marshfield | WDLB-FM | 103.9 |
| Merrill | WLIN | 100.7 |
| Milwaukee | WEMP-FM | 94.1 |
| Milwaukee | WISN-FM | 102.9 |
| Milwaukee | WTMJ-FM | 93.3 |
| Neenah | WNAM-FM | 98.5 |
| Oshkosh | WOSH-FM | 92.9 |
| Racine | WRJN-FM | 100.7 |
| Rice Lake | WJMC-FM | 96.3 |
| Superior | WEBC | 92.3 |
| Waukesha | WAUX-FM | 95.3 |
| Wausau | WHSF | 89.1 |
| Wausau | WSAU-FM | 95.5 |
| Wisconsin Rapids | WFHR-FM | 103.3 |

## SETTING A.F. OSCILLATORS

Many a constructor of audio test generators is confronted with the problem of calibration. For best results another calibrated oscillator should be used.

If the builder is a ham or knows one, he may have access to a surplus BC-221 r.f. frequency meter, which can be used very nicely for the a.f. calibration.

Feed the audio output of the frequency meter into the vertical input of an oscilloscope, and the output of the audio generator into the horizontal input. Let the meter warm up for at least 15 minutes; then switch it to the low band and set it to zero beat with the built-in crystal standard.

Now tune the variable-frequency oscillator in the frequency meter to various frequencies differing from the crystal comparison frequency by amounts from zero to 10 kc. The difference between the crystal check frequency and the v.f.o. frequency will be the audio-frequency tone.

Compare the a.f. generator frequency to that put out by the frequency meter. When they are equal, the scope will show a more or less perfect letter O. The generator scale can be marked at each point of comparison.

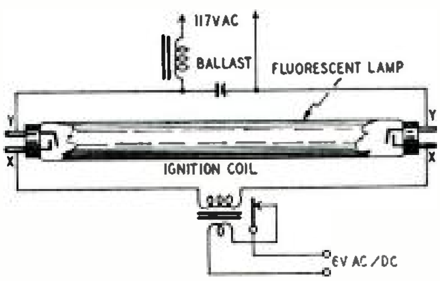
IGINIO CORRENTE,
*Bayonne, N. J.*

## STARTING FLUORESCENTS

Here is a method for starting burned-out fluorescent lamps. Old lamps can be used indefinitely.

The burning out of the lamp means that one or both of the filaments has opened. The filaments heat the gas in the tube so that they will not need a higher starting voltage than is available from the 117-volt lines.

The drawing illustrates the method of starting lamps with open cathodes. An ignition coil and interrupter create a




high-voltage a.c. This ionizes the gas sufficiently to allow the 117-volt line current to keep the tube lit. After the lamp is started, the coil can be removed.

DONALD G. BERLYER,
*Ballarat, Australia*

## CRYSTAL HOLDER

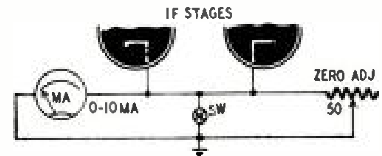
A clip-type fuse holder for 3AG-size fuses makes an excellent holder for the negative terminal of the 1N21 or 1N27 silicon crystals which are available on the surplus market. A tube-pin clip from an octal wafer socket is a good connector for the positive end.

HARRY MANDEL,
*Brooklyn, N. Y.*

## S-METER

I had a 0-10-ma meter which I wanted to use as an S-meter in an ordinary home receiver. The set used two 6K7's as i.f. amplifiers. Both cathodes were connected together and to ground.

I inserted the meter between the cathodes and ground, as the diagram indicates. The 50-ohm rheostat is used



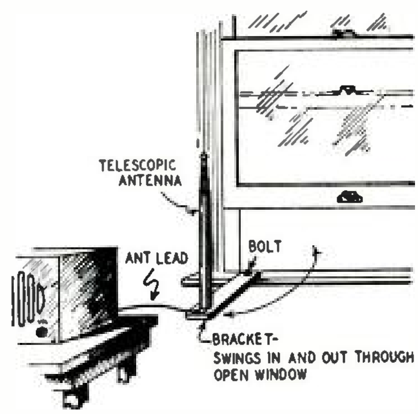

for zero adjustment. The switch bypasses the meter and reconnects the cathodes directly to ground when no meter indication is desired.

If the i.f. tubes in your receiver have cathode-bias resistors, place the meter between their ground ends and ground. Be sure bypass condensers are grounded.

JOHN A. BISHOP,
*Transvaal, South Africa*

## WINDOW ANTENNA

My landlord doesn't allow antennas on the roof of my apartment house (although he had just installed a new television receiver) so I used the scheme shown in the drawing.




The antenna is a 10-foot collapsible rod type, obtained from surplus. It is mounted on a strip of wood. The other end of the strip is bolted to the window sill.

When I am ready to go on the air, I swing the strip around so that the antenna is outside the window. The antenna is then raised.

I am using this antenna on 10 meters with very good results. I see no reason why it couldn't be used as well on 6 and 2 meters.

G. SAMKOFSKY, W2YSF
*Brooklyn, N. Y.*

## CHEMICAL CONTAINERS

Many radio preparations, such as chassis cleaner, come in bottles without applicators. Clean out old liquid shoe polish bottles and put the solutions in them. The applicator furnished for the shoe polish can then be used for the chemicals.

WILLIAM MUESSIG, JR.,
*Aurora, Ore.*

## ALUMINUM DISCS

Every recordist uses some blank discs for making test cuts. Instead of throwing these away after they are used, immerse them in hot water for several minutes, then peel off the recording lacquer. The shiny aluminum disc that emerges will be useful for making small chassis, shields, and separators. The lady of the house will find them useful, too, for serving canapes or for use as coasters for plants and flower-pots.

JOHN ANTHONY TAGLIABUE,
*Union City, N. J.*

## PILOT LAMP FUSE

A shorted first filter condenser in a receiver power supply usually causes the rectifier tube to burn out, necessitating an expensive replacement. To prevent this, I place a pilot lamp in series with the rectifier cathode and the input to the filter.

In normal operation, the lamp will make a very good pilot. If the first filter (or any later component which is across the power supply) shorts, the excessive current drawn by the lamp will burn it out. It thus acts as a fuse, protecting the rectifier tube.

The lamp chosen should be a 6-volt one, with a current rating somewhat higher than the total current drawn by the receiver and filter (as determined with an ammeter placed temporarily where the lamp will go).

JEAN S. BASTIN,
*Roux, Belgium*

## SPEAKER REPLACEMENT

The cone of the electrodynamic speaker in my table-model receiver was damaged beyond repair, and I wanted to use a PM speaker as the replacement.

I removed the field coil (with its core and housing) and output transformer from the old speaker, leaving all leads connected, and fastened the field coil under the chassis with solder.

The new PM was installed, and the old output transformer mounted on it. I connected the new voice coil to the proper transformer terminals.

This avoided the necessity for procuring a new electrodynamic speaker, since the old field coil is still in the circuit, acting as a power-supply choke, just as it did before.

JOHN R. HOOPER,
*Eastport, Me.*

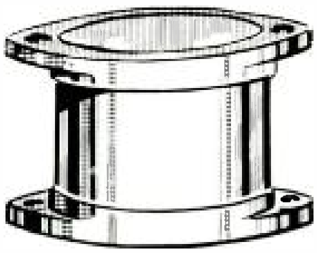
## TRANSFORMER WINDING

When winding a transformer with small wire, it is usually quite a problem to keep the windings in place during the winding process. Masking tape will solve the problem. The tape is wrapped around the form, gummy side up, and each turn sticks to the tape.

Masking tape is also useful where the person winding the coil wants to stop in the middle of the job for any reason. The wire already wound will remain in place until the work is resumed.

JOHN E. KENT,
*Waynesboro, Va.*

# TRANSMITTING Mica CONDENSERS



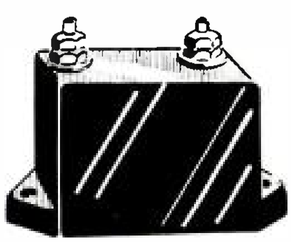
STYLE "A"

## SPECIAL LOW PRICES FOR IMMEDIATE SALE AND DELIVERY

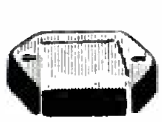
**We have literally hundreds of thousands of these top quality standard type transmitting mica condensers in stock for immediate delivery at a fraction of their original cost. Every condenser is brand new and carries the name of a fine nationally known manufacturer.**

**Despite the unusually low prices, these mica condensers, like all Wells Components, are fully guaranteed. Be sure to order sufficient quantities for your requirements.**

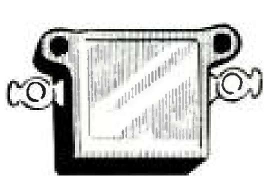
STYLE "AA"



STYLE "B"



STYLE "C"



STYLE "D"

### STYLE "AA" CONDENSERS

| Cap Mfd | Wrkg. Volt. | Price Each |
|---|---|---|
| .04 | 1000 | $3.50 |
| .02 | 3000 | 4.50 |
| .002 | 35000 | 15.00 |

### STYLE "A" CONDENSERS

| Cap Mfd | Wrkg. Volt. | Price Each |
|---|---|---|
| 25 MMFD | 10,000 | $1.65 |

### STYLE "B" CONDENSERS

| Cap Mfd | Wrkg. Volt. | Price Each |
|---|---|---|
| .0000425 | 5000 | $0.80 |
| .00005 | 3000 | .75 |
| .00007 | 1140 | .70 |
| .00003 | 3000 | .75 |
| .00004 | 3000 | .75 |
| .00009 | 3000 | .75 |
| .000091 | 3000 | .80 |
| .000107 | 3500 | .85 |
| .0001 | 3000 | .85 |
| .00015 | 6000 | 1.15 |
| .00015 | 5000 | 1.05 |
| .0001 | 5000 | .85 |
| .000175 | 3000 | 1.05 |
| .0002 | 1430 AC | 1.00 |
| .0002 | 5000 | 1.05 |
| .00022 | 5000 | 1.05 |
| .00025 | 5000 | 1.10 |
| .0003 | 3000 | .95 |
| .00036 | 5000 | 1.10 |
| .0004 | 3000 | .95 |
| .0004 | 5000 | 1.10 |
| .00047 | 3000 | 1.00 |
| .0005 | 3000 | 1.00 |
| .0005 | 5000 | 1.15 |
| .00055 | 5000 | 1.15 |
| .00056 | 3000 | 1.00 |
| .00056 | 5000 | 1.15 |
| .000625 | 3000 | 1.05 |
| .0007 | 3000 | 1.05 |
| .00075 | 5000 | 1.15 |
| .0008 | 5000 | 1.15 |
| .0008 | 3000 | 1.00 |
| .00095 | 5000 | 1.15 |
| .001 | 4500 | 1.25 |
| .001 | 3000 | 1.15 |
| .001 | 5000 | 1.30 |
| .00125 | 2000 | 1.10 |
| .0011 | 5000 | 1.35 |
| .0015 | 3000 | 1.10 |
| .0015 | 5000 | 1.40 |
| .0018 | 2000 | 1.10 |
| .002 | 3000 | 1.10 |
| .002 | 5000 | 1.40 |
| .002 | 6000 | 1.75 |
| .0024 | 3000 | 1.15 |
| .0024 | 5000 | 1.50 |
| .003 | 3000 | 1.60 |
| .003 | 5000 | 1.70 |
| .004 | 3000 | 1.50 |
| .005 | 2500 | 1.40 |
| .005 | 5000 | 1.70 |
| .0056 | 3000 | 1.30 |
| .006 | 3500 | 1.45 |
| .0068 | 3000 | 1.40 |
| .008 | 3000 | 1.45 |
| .01 | 2500 | 1.60 |
| .01 | 5000 | 1.95 |
| .0125 | 6000 | 2.00 |
| .02 | 3000 | 1.70 |
| .025 | 2500 | 1.60 |
| .047 | 2500 | 1.75 |

### STYLE "C" CONDENSERS

| Cap Mfd | Wrkg. Volt. | Price Each |
|---|---|---|
| .000005 | 2500 | $0.40 |
| .00005 | 2500 | .40 |
| .0001 | 2500 | .40 |
| .0001 | 1250 | .35 |
| .0001 | 600 | .25 |
| .00015 | 2500 | .40 |
| .00015 | 1250 | .35 |
| .000175 | 2500 | .40 |
| .000175 | 1500 | .35 |
| .0002 | 2500 | .40 |
| .0002 | 1500 | .35 |
| .0002 | 600 | .25 |
| .00022 | 2500 | .45 |
| .00022 | 1250 | .35 |
| .00024 | 2500 | .45 |
| .00025 | 2500 | .45 |
| .00025 | 1200 | .35 |
| .0003 | 2500 | .45 |
| .00039 | 2500 | .50 |
| .0004 | 2500 | .45 |
| .0004 | 1200 | .35 |
| .0005 | 2500 | .45 |
| .00051 | 2500 | .55 |
| .00056 | 2500 | .55 |
| .000575 | 1500 | .60 |
| .0006 | 1250 | .45 |
| .0007 | 1250 | .45 |
| .0008 | 1250 | .45 |
| .0008 | 1000 | .35 |
| .00085 | 1200 | .40 |
| .001 | 2500 | .55 |
| .001 | 1200 | .40 |
| .001 | 600 | .35 |
| .0011 | 2500 | .55 |
| .0012 | 1250 | .50 |
| .00125 | 1200 | .45 |
| .0015 | 1200 | .45 |
| .0018 | 1200 | .50 |
| .002 | 1200 | .45 |
| .002 | 2500 | .55 |
| .0022 | 2500 | .60 |
| .0022 | 1200 | .45 |
| .0024 | 1200 | .50 |
| .0025 | 1250 | .50 |
| .0027 | 1250 | .55 |
| .00275 | 1200 | .60 |
| .003 | 1200 | .55 |
| .0035 | 2500 | .60 |
| .00375 | 2500 | .65 |
| .00375 | 1000 | .45 |
| .0039 | 1250 | .55 |
| .004 | 2500 | .60 |
| .004 | 1250 | .45 |
| .0043 | 2500 | .65 |
| .0045 | 1000 | .45 |
| .0047 | 1250 | .55 |
| .0046 | 500 | .45 |
| .005 | 2500 | .60 |
| .005 | 1250 | .45 |
| .005 | 600 | .35 |
| .0051 | 2500 | .65 |
| .0051 | 1200 | .45 |
| .0056 | 2500 | .65 |
| .0056 | 1200 | .45 |
| .006 | 2500 | .65 |
| .006 | 1200 | .45 |
| .0068 | 1200 | .55 |
| .007 | 500 | .35 |
| .008 | 1200 | .45 |
| .009 | 600 | .50 |
| .01 | 2500 | .60 |
| .01 | 1250 | .45 |
| .01 | 600 | .40 |
| .015 | 1250 | .55 |
| .015 | 600 | .35 |
| .0175 | 1200 | .55 |
| .02 | 2500 | .65 |
| .02 | 1250 | .45 |
| .02 | 600 | .35 |
| .025 | 1250 | .55 |
| .03 | 1200 | .50 |
| .04 | 1200 | .55 |
| .04 | 1000 | .45 |
| .04 | 600 | .35 |
| .047 | 1200 | .50 |
| .047 | 600 | .40 |
| .056 | 1000 | .55 |
| .06 | 1000 | .50 |
| .073 | 500 | .40 |
| .09 | 1000 | .55 |
| .09 | 600 | .45 |
| .1 | 1000 | .60 |
| .1 | 600 | .45 |

### STYLE "D" CONDENSERS

| Cap Mfd | Wrkg. Volt. | Price Each |
|---|---|---|
| .00004 | 600 | $0.20 |
| .0001 | 1250 | .25 |
| .0001 | 600 | .20 |
| .00015 | 1200 | .25 |
| .00015 | 600 | .20 |
| .000175 | 1000 | .30 |
| .0002 | 1200 | .25 |
| .0002 | 600 | .20 |
| .00025 | 2500 | .35 |
| .00025 | 1200 | .25 |
| .00025 | 600 | .20 |
| .0004 | 2500 | .35 |
| .0004 | 1200 | .25 |
| .0005 | 2500 | .35 |
| .0005 | 1200 | .30 |
| .0005 | 600 | .20 |
| .00051 | 2500 | .35 |
| .00052 | 2000 | .35 |
| .00055 | 2500 | .40 |
| .00056 | 1200 | .35 |
| .0006 | 2500 | .35 |
| .0006 | 1200 | .25 |
| .0006 | 600 | .20 |
| .00065 | 600 | .25 |
| .0007 | 600 | .25 |
| .0008 | 1000 | .35 |
| .00085 | 1200 | .35 |
| .001 | 2500 | .40 |
| .001 | 1250 | .35 |
| .001 | 600 | .25 |
| .0012 | 600 | .30 |
| .0015 | 1200 | .35 |
| .0018 | 1200 | .35 |
| .002 | 2500 | .40 |
| .002 | 1200 | .35 |
| .002 | 600 | .25 |
| .0022 | 2500 | .40 |
| .0022 | 1200 | .30 |
| .0022 | 600 | .25 |
| .0024 | 1200 | .25 |
| .0025 | 2500 | .40 |
| .0025 | 1200 | .30 |
| .0027 | 1200 | .30 |
| .003 | 1200 | .30 |
| .003 | 2000 | .40 |
| .00375 | 1000 | .40 |
| .0039 | 1200 | .40 |
| .004 | 2500 | .45 |
| .004 | 1200 | .35 |
| .004 | 600 | .25 |
| .0044 | 600 | .25 |
| .0043 | 1200 | .35 |
| .0045 | 600 | .30 |
| .0047 | 2500 | .40 |
| .0047 | 1200 | .30 |
| .005 | 2500 | .40 |
| .005 | 1250 | .30 |
| .005 | 600 | .25 |
| .0051 | 1200 | .35 |
| .0051 | 600 | .30 |
| .0056 | 1200 | .35 |
| .0056 | 600 | .30 |
| .006 | 1200 | .35 |
| .006 | 600 | .25 |
| .0068 | 1200 | .35 |
| .007 | 600 | .30 |
| .008 | 1200 | .35 |
| .008 | 600 | .30 |
| .009 | 600 | .30 |
| .01 | 1250 | .40 |
| .01 | 600 | .30 |
| .01 | 2500 | .50 |
| .015 | 1250 | .40 |
| .015 | 600 | .30 |
| .014 | 600 | .35 |
| .0175 | 600 | .40 |
| .02 | 2500 | .50 |
| .02 | 1200 | .35 |
| .02 | 600 | .25 |
| .022 | 1200 | .35 |
| .025 | 1200 | .35 |
| .025 | 600 | .25 |
| .03 | 1200 | .35 |
| .033 | 1200 | .35 |
| .04 | 1000 | .35 |
| .04 | 600 | .30 |
| .047 | 1200 | .40 |
| .047 | 600 | .30 |
| .056 | 1000 | .35 |
| .06 | 1000 | .40 |
| .073 | 500 | .30 |
| .09 | 1000 | .45 |
| .09 | 600 | .35 |
| .1 | 1000 | .50 |
| .1 | 600 | .35 |

**This is only a partial listing. Write or wire for information on types not shown and for receiving set micas and silver micas.**

**We advise distributors to order immediately from this ad. Our standard jobber arrangement applies.**

***Manufacturers and Distributors: Write for our complete Mica Condenser Listing No. 103A.***

**WELLS SALES, INC.**

**320 N. LA SALLE ST. DEPT. Y, CHICAGO 10 ILL.**

## ALUMINUM DISCS

Every recordist uses some blank discs for making test cuts. Instead of throwing these away after they are used, immerse them in hot water for several minutes, then peel off the recording lacquer. The shiny aluminum disc that emerges will be useful for making small chassis, shields, and separators. The lady of the house will find them useful, too, for serving canapes or for use as coasters for plants and flower-pots.

JOHN ANTHONY TAGLIABUE,
*Union City, N. J.*

## PILOT LAMP FUSE

A shorted first filter condenser in a receiver power supply usually causes the rectifier tube to burn out, necessitating an expensive replacement. To prevent this, I place a pilot lamp in series with the rectifier cathode and the input to the filter.

In normal operation, the lamp will make a very good pilot. If the first filter (or any later component which is across the power supply) shorts, the excessive current drawn by the lamp will burn it out. It thus acts as a fuse, protecting the rectifier tube.

The lamp chosen should be a 6-volt one, with a current rating somewhat higher than the total current drawn by the receiver and filter (as determined with an ammeter placed temporarily where the lamp will go).

JEAN S. BASTIN,
*Roux, Belgium*

## SPEAKER REPLACEMENT

The cone of the electrodynamic speaker in my table-model receiver was damaged beyond repair, and I wanted to use a PM speaker as the replacement.

I removed the field coil (with its core and housing) and output transformer from the old speaker, leaving all leads connected, and fastened the field coil under the chassis with solder.

The new PM was installed, and the old output transformer mounted on it. I connected the new voice coil to the proper transformer terminals.

This avoided the necessity for procuring a new electrodynamic speaker, since the old field coil is still in the circuit, acting as a power-supply choke, just as it did before.

JOHN R. HOOPER,
*Eastport, Me.*

## TRANSFORMER WINDING

When winding a transformer with small wire, it is usually quite a problem to keep the windings in place during the winding process. Masking tape will solve the problem. The tape is wrapped around the form, gummy side up, and each turn sticks to the tape.

Masking tape is also useful where the person winding the coil wants to stop in the middle of the job for any reason. The wire already wound will remain in place until the work is resumed.

JOHN E. KENT,
*Waynesboro, Va.*

## "NEW LOOK" COMMENTS

*Dear Editor:*

We really enjoy your new format and the more frequent television articles. Glad to see that your gang is waking up to the fact that television will be the giant of the electronics field in short order.

STAR RADIO,
*Perth Amboy, N. J.*

*Dear Editor:*

I am really glad it is now possible to read RADIO-ELECTRONICS without turning pages to hunt for the continuation of the article.

FELIX HUTTRER,
*Plymouth, England*

*Dear Editor:*

Congratulations on the new RADIO-ELECTRONICS! It's a beauty, from front index and color right down to the slick-paper noncontinuation articles.

DAVID GNESSIN,
*Columbus, Ohio*

*Dear Editor:*

Congratulations on the new setup for RADIO-ELECTRONICS. My chief interest is that it keep its technical excellence, but I particularly welcome the departmentalization. I also like the color emphasis, as in "Eclipse of the Vacuum Tube" (September issue). There is never a dull moment with RADIO-ELECTRONICS!

H. F. LESLIE,
*Somerset, England*

## FM NOISE NO PROBLEM

*Dear Editor:*

In your August issue you printed a letter concerning ignition noise in FM receivers. I think the writer was using a poor receiver. I base this on my personal experience with a Zenith model 7H822 which is on my desk. I am on the second floor, on the street side of the building, and there is a continuous procession of automobiles and trucks going by all day long. I have yet to hear any ignition noise when the set is tuned to a station.

I think Mr. Zarattaro was using a receiver with poor noise-reducing properties or one that was defective, as my location is certainly a severe one.

K. E. HASSEL,
*Assistant Vice President,*
*Zenith Radio Corp.*

## FAVORS RATIO DETECTOR

*Dear Editor:*

In the letter which pointed out that ignition often ruins FM radio reception, Mr. Zarattaro is quite correct.

However, the problem may be solved very easily by converting the discriminator to a ratio detector or by adding a limiter stage to the existing ratio detector.

I have a Meissner FM tuner which gives me very good reception.

THOMAS W. ATHALEY,
*New Bedford, Mass.*

## TUNE FM SETS CORRECTLY

*Dear Editor:*

I think part of Mr. Zarattaro's trouble is in not having the station tuned in properly. If I don't have my FM receiver tuned right, automobile interference will break through; but correctly retuning the set cuts out interference. I am located right on a main highway where there is plenty of traffic.

I listen for the between-station hiss when I tune my set. When the hiss is gone, I figure the station is tuned in properly. I tune in a station, not for the loudest, but for the clearest sound.

FRANK C. PIERCE,
*New Bedford, Mass.*

(Perfect discriminator *alignment*, as well as perfect tuning, is necessary for exclusion of interference. This may explain some of the apparently contradictory results obtained by readers with similar equipment and in similar situations.—*Editor)*

## WANTS CODE-STATION LIST

*Dear Editor:*

The September issue of RADIO-CRAFT wins our approval for design and editorial content. We have been reading your magazines since the days of *Modern Electrics*. Many things have happened in radio since the time the *Electrical Experimenter* and Duck's catalogue, but without Gernsback's leadership and foresight many of us old-timers (I have been in radio and electricity since 1908) in all probability would have been lost in the confusion.

I still copy code and would like to see a table of call letters of low-frequency commercial stations published in the magazine. What say?

HOWARD'S RADIO HOSPITAL,
*Cleveland, Ohio.*

(Any other readers interested in a list of commercial c.w. stations for code-practice purposes?—*Editor)*

## FM SERVICE INADEQUATE

*Dear Editor:*

As a long-time FM listener, I am certainly disappointed in the type of service FM is giving. Too many stations in this area are giving forth with low fidelity, operating with low interim power, or making no attempt to get on the air at all. As for high fidelity, only two stations out of about 25 I can receive even approach the 15,000-cycle standard.

FM receivers, too, lack high standards. I have tried many; most lack sensitivity and drift too much.

At present I am using a Meissner AM-FM tuner and a Hallicrafters SX-42. The antenna is a rotatable Vee-Dx on a 20-foot mast on the roof. Best dx I have gotten was about 250 miles. I find that dx is best from 10 pm on when the sky is overcast and the humidity low.

I prefer having FM stations listed by frequency instead of by call letters.

THOMAS A. IREY,
*Boyertown, Pa.*

# RADIO SCHOOL DIRECTORY

## 6N6-G IS AVAILABLE

*Dear Editor:*

On page 58 of your August, 1948, issue, we note a squib on substituting the 6K6 for the 6N6. The statement is made that the 6N6 is "no longer available."

You may be interested to know that Hytron is manufacturing the 6N6-G for the industry — and has for several months been supplying the tube through its Hytron jobbers.

HARRY G. BURNETT,
*Hytron Radio and Electronics Corp.*
*Salem, Mass.*

(Fine! When are we going to hear about renewed production of the 6A5-G? There has been a tremendous popular demand for that tube during the past year.—*Editor*)

**STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946**

Of Radio-Electronics, published monthly at Philadelphia, Pa. for October 1st, 1948.
State of New York } ss.
County of New York }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Hugo Gernsback, who, having been duly sworn according to law, deposes and says that he is the editor of the Radio-Electronics, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily, weekly, semiweekly or triweekly newspaper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the act of August 24, 1912, as amended by the acts of March 3, 1933, and July 2, 1946 (section 537, Postal Laws and Regulations), printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Radcraft Publications, Inc., 25 West Broadway, New York 7, N. Y.; Editor, Hugo Gernsback, 25 West Broadway, New York 7, N. Y.; Managing Editor, Fred Shunaman, 25 West Broadway, New York 7, N. Y. Business Manager, none.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.) Radcraft Publications, Inc., 25 West Broadway, New York 7, N. Y.; H. Gernsback, 25 West Broadway, New York 7, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed through the mails or otherwise, to paid subscribers during the twelve months preceding the date shown above is ..............................
(This information is required from daily, weekly, semiweekly, and triweekly newspapers only.)
(Signature of editor, publisher, business manager, or owner) H. Gernsback.

Sworn to and subscribed before me this 1st day of October, 1948. May Parisi, Notary Public.
[Seal]
(My commission expires, March 30, 1949)

# Index to Advertisers



RADIO SCHOOL DIRECTORY
(page 94-95)

# Book Reviews

**UNDERSTANDING TELEVISION, by Orrin E. Dunlap, Jr. Published by Greenberg, New York, N. Y. 5½ x 8 inches, 128 pages. Price $2.50.**

Written to explain television to the layman, this book begins with a brief historical survey, then tells the reader in general terms "what you see by television."

Containing a large number of excellently reproduced pictures of equipment and of telecast scenes, the volume consists mostly of an easy-to-read discussion summarizing, in effect, the popular-type articles and news stories which have appeared in recent years concerning television's entertainment value and future. Included, too, are brief stories of behind-the-scenes operations, a glossary of technical terms, and a bibliography, as well as a chapter on "What Performers Should Know About Television."—*R. H. D.*

**RADIO STATION MANAGEMENT, by J. Leonard Reinsch. Published by Harper & Brothers. 177 pages. 5½ x 8½ inches. Price $3.50.**

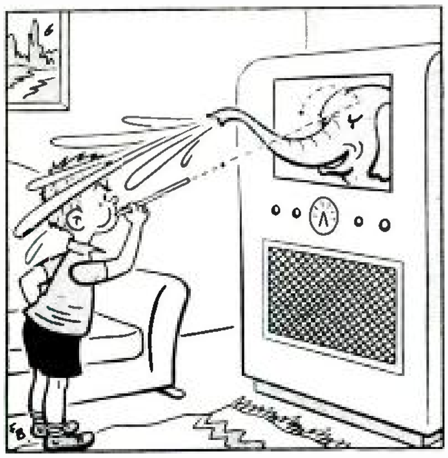
Standard practices of the broadcasting industry are set forth in this book. Though the material is reasonably complete, it is difficult to see how anyone unfamiliar with broadcasting could get from the text more than a sketchy idea of operating a station; those with broadcasting experience are already familiar with almost all of the material presented.

No technical information is included, but brief listings of the duties of chief engineer and operators are given, together with sample forms for program and transmitter logs, trouble reports, preventive maintenance, and the like.—*R. H. D.*

**ELECTRONIC INSTRUMENTS. (Volume 21 of the M.I.T. Radiation Laboratory Series) edited by Ivan A. Greenwood, Jr., J. Vance Holdam, Jr. and Duncan Macrae, Jr. Published by McGraw-Hill Book Company, 6½ x 9¼ inches. 721 pages. Price. $9.00.**

The electronic instruments discussed are those of most importance in radar and allied electronic applications. The instruments are divided into four classes: electronic computers, servomechanisms, voltage and current regulators, and pulse test equipment.

The material is illustrated with formulas, mathematical examples, charts, and schematic and block diagrams. A number of the schematics cover existing equipment and are complete with parts values.



*Suggested by Carlton Phillips, Corning, N. Y.*

This book is of major interest to design engineers and engineering students. Much of it is also worth-while reading for experimenters and persons working with specialized electronic equipment. —*R.F.S.*

**ELEMENTS OF ACOUSTICAL ENGINEERING, by Harry F. Olson. Second Edition. Published by D. Van Nostrand Company. 539 pages, 6 x 9 inches. Price $7.50.**

This standard work needs little comment, except to report that it has been revised and modernized throughout. The second edition is 195 pages longer than the first. This increase appears throughout the book, each chapter containing more subject matter than its first-edition counterpart.

Two new chapters, "Underwater Sound" and "Supersonics and Ultrasonics," have been added. Supersonic in this case refers to any sound of very great intensity.

The illustrations have also been revised and increased in number. Out of the 342 illustrations in the second edition, 145 are new ones.

**TELEVISION SIMPLY EXPLAINED, by Maj. Ralph W. Hallows. Published by Chapman and Hall, Ltd., London. 5 x 8 inches, 198 pages. Price 9 shillings sixpence.**

Major Hallows' genial style of writing and his facility for lucid explanation are familiar to RADIO-ELECTRONICS readers. Both are apparent in this elementary television book. Much of the geniality has been sacrificed, however, to compactness, since a complete explanation of the workings of television has been compressed into less than 200 pages.

Not a manual for technicians, the book was written to answer the layman's questions about picture transmission. Though the impression sometimes exists that laymen cannot understand any phase of electronics without long study, it is hard to see how a clearer, more readable explanation could be written. The author begins with a chapter entitled "Sound and the Ear—Light and the Eye" and carries the reader in logical sequence through every principal phase of television.

Perhaps it is the plentiful use of analogies that makes things so clear. Undoubtedly, large contribution was made by the author's self-discipline; though obviously thoroughly schooled in the subject, he allowed himself no assumptions of knowledge on the reader's part, but followed his theme from beginning to end without an unfilled gap, reciting in a few places some of the simplest facts known to radiomen but which are not known to non-technical readers.

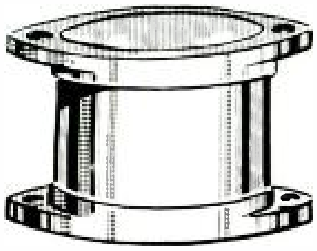
As a result, a reading of this book (a one- or two-evening project) will prove to be an excellent antidote for the feeling of wonderment existing in the minds of many members of the viewing public. And technical men who have not previously worked with television will do well to begin their studies with this volume, using it to obtain a preliminary eagle's-eye view before settling down to more specialized study of the subject. —*R.H.D.*





Printed in the U.S.A.

# TRANSMITTING *Mica* CONDENSERS



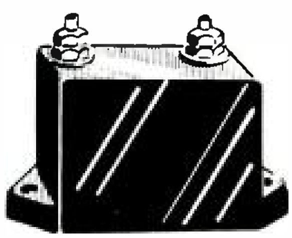
STYLE "A"

## SPECIAL LOW PRICES FOR IMMEDIATE SALE AND DELIVERY

**We have literally hundreds of thousands of these top quality standard type transmitting mica condensers in stock for immediate delivery at a fraction of their original cost. Every condenser is brand new and carries the name of a fine nationally known manufacturer.**

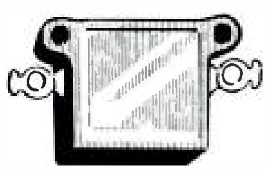
**Despite the unusually low prices, these mica condensers, like all Wells Components, are fully guaranteed. Be sure to order sufficient quantities for your requirements.**

STYLE "AA"



STYLE "B"

STYLE "C"



STYLE "D"

| Cap Mfd | Wrkg. Volt. | Price Each |
|---|---|---|
| **STYLE "AA" CONDENSERS** | | |
| .04 | 1000 | $3.50 |
| .02 | 3000 | 4.50 |
| .002 | 35000 | 15.00 |
| **STYLE "A" CONDENSERS** | | |
| 25 MMFD | 10,000 | $1.65 |
| **STYLE "B" CONDENSERS** | | |
| .0000425 | 5000 | $0.80 |
| .00005 | 3000 | .75 |
| .00007 | 1140 | .70 |
| .00003 | 3000 | .75 |
| .00004 | 3000 | .75 |
| .00009 | 3000 | .75 |
| .000091 | 3000 | .80 |
| .000107 | 3500 | .85 |
| .0001 | 3000 | .85 |
| .00015 | 6000 | 1.15 |
| .00015 | 5000 | 1.05 |
| .0001 | 5000 | .85 |
| .000175 | 3000 | 1.05 |
| .0002 | 1430 AC | 1.00 |
| .0002 | 5000 | 1.05 |
| .00022 | 5000 | 1.05 |
| .00025 | 5000 | 1.10 |
| .0003 | 3000 | .95 |
| .00036 | 5000 | 1.10 |
| .0004 | 3000 | .95 |
| .0004 | 5000 | 1.10 |
| .00047 | 3000 | 1.00 |
| .0005 | 3000 | 1.00 |
| .0005 | 5000 | 1.15 |
| .00055 | 5000 | 1.15 |
| .00056 | 3000 | 1.00 |
| .00056 | 5000 | 1.15 |
| .000625 | 3000 | 1.05 |
| .0007 | 3000 | 1.05 |
| .00075 | 5000 | 1.15 |
| .0008 | 5000 | 1.15 |
| .0008 | 3000 | 1.00 |
| .00095 | 5000 | 1.15 |
| .001 | 4500 | 1.25 |
| .001 | 3000 | 1.15 |
| .001 | 5000 | 1.30 |
| .00125 | 2000 | 1.10 |
| .0011 | 5000 | 1.35 |
| .0015 | 3000 | 1.10 |
| .0015 | 5000 | 1.40 |
| .0018 | 2000 | 1.10 |
| .002 | 3000 | 1.10 |
| .002 | 5000 | 1.40 |
| .002 | 6000 | 1.75 |
| .0024 | 3000 | 1.15 |
| .0024 | 5000 | 1.50 |
| .003 | 3000 | 1.60 |
| .003 | 5000 | 1.70 |
| .004 | 3000 | 1.50 |
| .005 | 2500 | 1.40 |
| .005 | 5000 | 1.70 |
| .0056 | 3000 | 1.30 |
| .006 | 3500 | 1.45 |
| .0068 | 3000 | 1.40 |
| .008 | 3000 | 1.45 |

| Cap Mfd | Wrkg. Volt. | Price Each |
|---|---|---|
| .01 | 2500 | 1.60 |
| .01 | 5000 | 1.95 |
| .0125 | 6000 | 2.00 |
| .02 | 3000 | 1.70 |
| .025 | 2500 | 1.60 |
| .047 | 2500 | 1.75 |
| **STYLE "C" CONDENSERS** | | |
| .000005 | 2500 | $0.40 |
| .00005 | 2500 | .40 |
| .0001 | 2500 | .40 |
| .0001 | 1250 | .35 |
| .0001 | 600 | .25 |
| .00015 | 2500 | .40 |
| .00015 | 1250 | .35 |
| .000175 | 2500 | .40 |
| .000175 | 1500 | .35 |
| .0002 | 2500 | .40 |
| .0002 | 1500 | .35 |
| .0002 | 600 | .25 |
| .00022 | 2500 | .45 |
| .00022 | 1250 | .35 |
| .00024 | 2500 | .45 |
| .00025 | 2500 | .45 |
| .00025 | 1200 | .35 |
| .0003 | 2500 | .45 |
| .00039 | 2500 | .50 |
| .0004 | 2500 | .45 |
| .0004 | 1200 | .35 |
| .0005 | 2500 | .45 |
| .00051 | 2500 | .55 |
| .00056 | 2500 | .55 |
| .000575 | 1500 | .60 |
| .0006 | 1250 | .45 |
| .0007 | 1250 | .45 |
| .0008 | 1250 | .45 |
| .0008 | 1000 | .35 |
| .00085 | 1200 | .40 |
| .001 | 2500 | .55 |
| .001 | 1200 | .40 |
| .001 | 600 | .35 |
| .0011 | 2500 | .55 |
| .0012 | 1250 | .50 |
| .00125 | 1200 | .45 |
| .0015 | 1200 | .45 |
| .0018 | 1200 | .50 |
| .002 | 1200 | .45 |
| .002 | 2500 | .55 |
| .0022 | 2500 | .60 |
| .0022 | 1200 | .45 |
| .0024 | 1200 | .50 |
| .0025 | 1250 | .50 |
| .0027 | 1250 | .55 |
| .00275 | 1200 | .60 |
| .003 | 1200 | .55 |
| .0035 | 2500 | .60 |
| .00375 | 2500 | .65 |
| .00375 | 1000 | .45 |
| .0039 | 1250 | .55 |
| .004 | 2500 | .60 |
| .004 | 1250 | .45 |
| .0043 | 2500 | .65 |
| .0045 | 1000 | .45 |
| .0047 | 1250 | .55 |
| .0046 | 500 | .45 |
| .005 | 2500 | .60 |

| Cap Mfd | Wrkg. Volt. | Price Each |
|---|---|---|
| .005 | 1250 | .45 |
| .005 | 600 | .35 |
| .0051 | 2500 | .65 |
| .0051 | 1200 | .45 |
| .0056 | 2500 | .65 |
| .0056 | 1200 | .45 |
| .006 | 2500 | .65 |
| .006 | 1200 | .45 |
| .0068 | 1200 | .55 |
| .007 | 500 | .35 |
| .008 | 1200 | .45 |
| .009 | 600 | .50 |
| .01 | 2500 | .60 |
| .01 | 1250 | .45 |
| .01 | 600 | .40 |
| .015 | 1250 | .55 |
| .015 | 600 | .35 |
| .0175 | 1200 | .55 |
| .02 | 2500 | .65 |
| .02 | 1250 | .45 |
| .02 | 600 | .35 |
| .025 | 1250 | .55 |
| .03 | 1200 | .50 |
| .04 | 1200 | .55 |
| .04 | 1000 | .45 |
| .04 | 600 | .35 |
| .047 | 1200 | .50 |
| .047 | 600 | .40 |
| .056 | 1000 | .55 |
| .06 | 1000 | .50 |
| .073 | 500 | .40 |
| .09 | 1000 | .55 |
| .09 | 600 | .45 |
| .1 | 1000 | .60 |
| .1 | 600 | .45 |
| **STYLE "D" CONDENSERS** | | |
| .00004 | 600 | $0.20 |
| .0001 | 1250 | .25 |
| .0001 | 600 | .20 |
| .00015 | 1200 | .25 |
| .00015 | 600 | .20 |
| .000175 | 1000 | .30 |
| .0002 | 1200 | .25 |
| .0002 | 600 | .20 |
| .00025 | 2500 | .35 |
| .00025 | 1200 | .25 |
| .00025 | 600 | .20 |
| .0004 | 2500 | .35 |
| .0004 | 1200 | .25 |
| .0005 | 2500 | .35 |
| .0005 | 1200 | .30 |
| .0005 | 600 | .20 |
| .00051 | 2500 | .35 |
| .00052 | 2000 | .35 |
| .00055 | 2500 | .40 |
| .00056 | 1200 | .35 |
| .0006 | 2500 | .35 |
| .0006 | 1200 | .25 |
| .0006 | 600 | .20 |
| .00065 | 600 | .25 |
| .0007 | 600 | .25 |
| .0008 | 1000 | .35 |
| .00085 | 1200 | .35 |
| .001 | 2500 | .40 |
| .001 | 1250 | .35 |

| Cap Mfd | Wrkg. Volt. | Price Each |
|---|---|---|
| .001 | 600 | .25 |
| .0012 | 600 | .30 |
| .0015 | 1200 | .35 |
| .0018 | 1200 | .35 |
| .002 | 2500 | .40 |
| .002 | 1200 | .35 |
| .002 | 600 | .25 |
| .0022 | 2500 | .40 |
| .0022 | 1200 | .30 |
| .0022 | 600 | .25 |
| .0024 | 1200 | .25 |
| .0025 | 2500 | .40 |
| .0025 | 1200 | .30 |
| .0027 | 1200 | .30 |
| .003 | 1200 | .30 |
| .003 | 2000 | .40 |
| .00375 | 1000 | .40 |
| .0039 | 1200 | .40 |
| .004 | 2500 | .45 |
| .004 | 1200 | .35 |
| .004 | 600 | .25 |
| .0044 | 600 | .25 |
| .0043 | 1200 | .35 |
| .0045 | 600 | .30 |
| .0047 | 2500 | .40 |
| .0047 | 1200 | .30 |
| .005 | 2500 | .40 |
| .005 | 1250 | .30 |
| .005 | 600 | .25 |
| .0051 | 1200 | .35 |
| .0051 | 600 | .30 |
| .0056 | 1200 | .35 |
| .0056 | 600 | .30 |
| .006 | 1200 | .35 |
| .006 | 600 | .25 |
| .0068 | 1200 | .35 |
| .007 | 600 | .30 |
| .008 | 1200 | .35 |
| .008 | 600 | .30 |
| .009 | 600 | .30 |
| .01 | 1250 | .40 |
| .01 | 600 | .30 |
| .01 | 2500 | .50 |
| .015 | 1250 | .40 |
| .015 | 600 | .30 |
| .014 | 600 | .35 |
| .0175 | 600 | .40 |
| .02 | 2500 | .50 |
| .02 | 1200 | .35 |
| .02 | 600 | .25 |
| .022 | 1200 | .35 |
| .025 | 1200 | .35 |
| .025 | 600 | .25 |
| .03 | 1200 | .35 |
| .033 | 1200 | .35 |
| .04 | 1000 | .35 |
| .04 | 600 | .30 |
| .047 | 1200 | .40 |
| .047 | 600 | .30 |
| .056 | 1000 | .35 |
| .06 | 1000 | .40 |
| .073 | 500 | .30 |
| .09 | 1000 | .45 |
| .09 | 600 | .35 |
| .1 | 1000 | .50 |
| .1 | 600 | .35 |

**This is only a partial listing. Write or wire for information on types not shown and for receiving set micas and silver micas.**

**We advise distributors to order immediately from this ad. Our standard jobber arrangement applies.**

***Manufacturers and Distributors: Write for our complete Mica Condenser Listing No. 103A.***

**WELLS SALES, INC.**

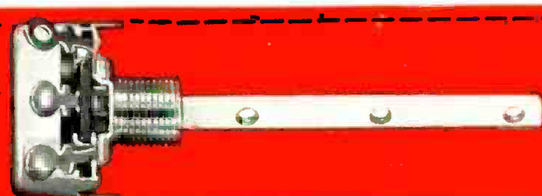
**320 N. LA SALLE ST. DEPT. Y, CHICAGO 10 ILL.**

# Get Acquainted with the Little Fellow with the BIG Advantages

*The All New*

## Mallory Midgetrol

ACTUAL SIZE 15/16"



## Offers These BIG Advantages . . .

**BIGGER MARKET** — The small size of the Mallory Midgetrol lets you service portables, auto radios and small AC-DC receivers which require 15/16" controls.

**SIMPLER INSTALLATION** — The unique shaft design of the Mallory Midgetrol saves installation time with *all* types of knobs.

**SIMPLER STOCKING** — Electrical characteristics let you use the Mallory Midgetrol to replace 1⅛" as well as 15/16" controls. Stocks are further reduced because no special shafts are needed.

Both mechanically and electrically, the Mallory Midgetrol is amazingly quiet. Tests prove it *stays* quiet! And the Mallory Midgetrol offers nine *all new* features.

*It's the NEW Standard in Carbon Controls.* See your Mallory distributor.

- NEW SIZE
- NEW DESIGN
- NEW SHAFT
- NEW EXTENSION
- NEW SWITCH
- NEW ELEMENT
- NEW CONTACT
- NEW TERMINAL
- NEW TWO-POINT SUSPENSION

P. R. MALLORY & CO. Inc.

**MALLORY**

CAPACITORS . . . CONTROLS . . . VIBRATORS . . . SWITCHES . . . RESISTORS . . . RECTIFIERS . . . VIBRAPACK* POWER SUPPLIES . . . FILTERS

*Reg. U. S. Pat. Off.

**APPROVED PRECISION PRODUCTS**

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