RADIO CRAFT

HUGO GERNSBACK, Editor

In this issue—

Advertising for Servicemen

Signal Tracer-Oscillator

A Four-Tube FM Receiver

RADAR TRAPS
AUTO SPEEDERS
SEE PAGE 22

NOV
1947

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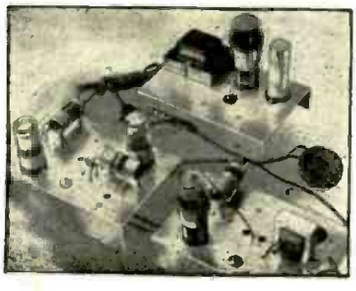

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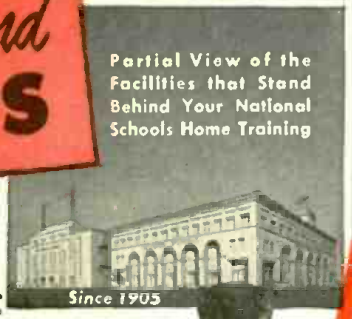
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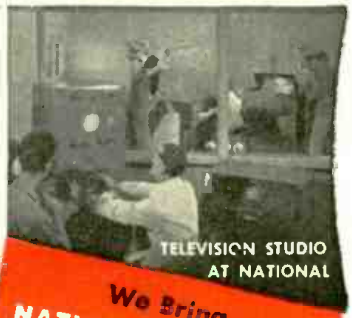
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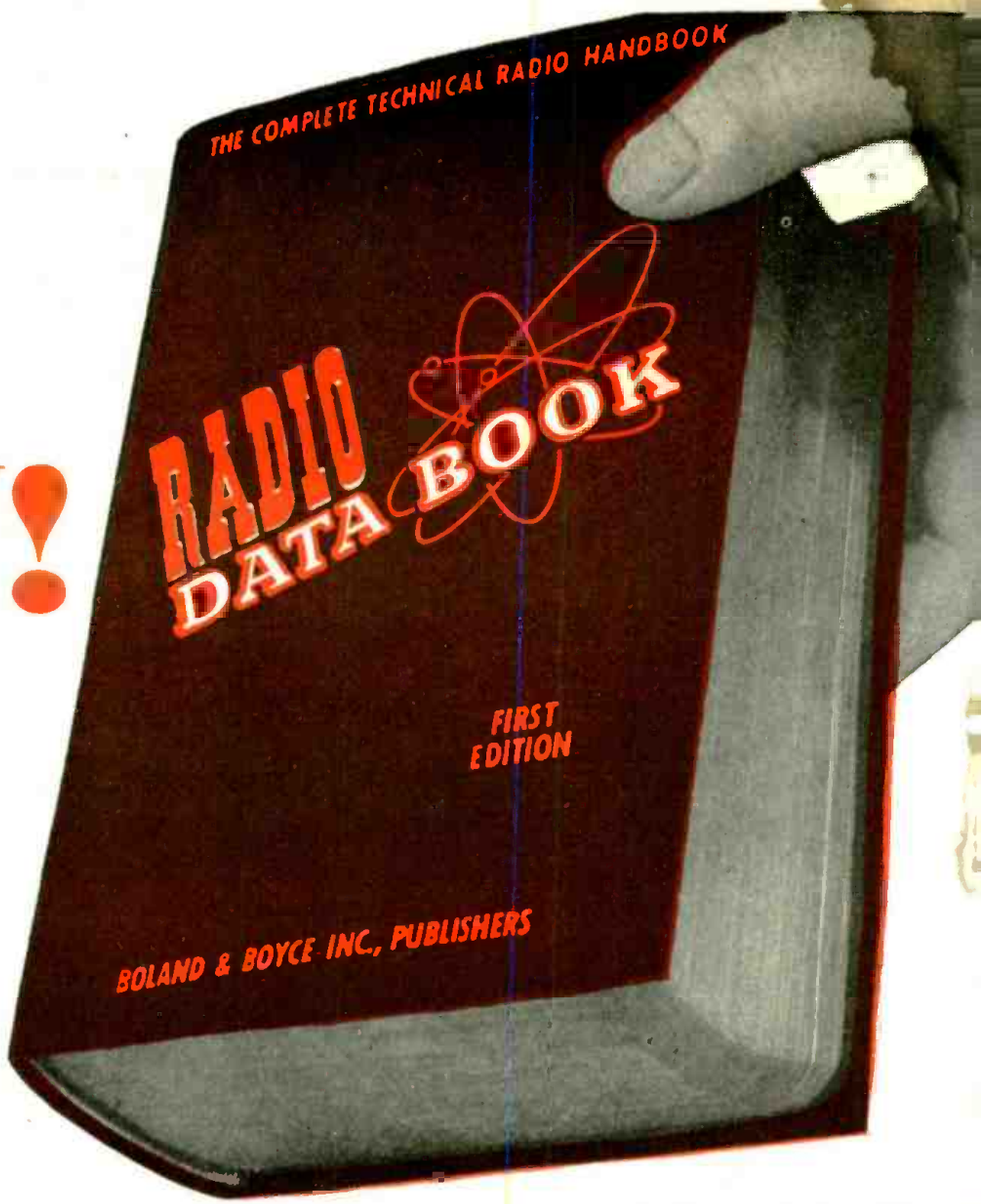

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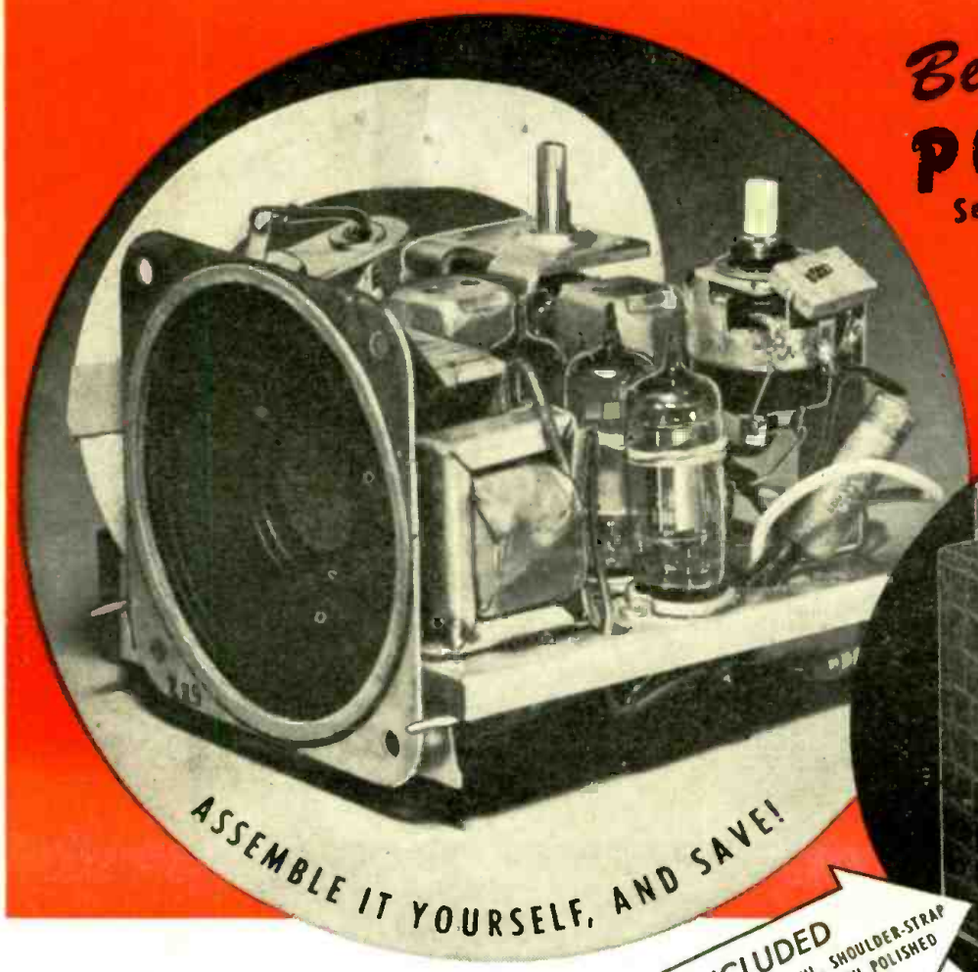

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In An Early Issue

FOUR-TUBE FM RECEIVER
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On the Cover:

The radar speed metering system used by Connecticut State Police to study highway speed conditions.

Chromatone by Alex Schomburg from photo by Warren Z. Illes.

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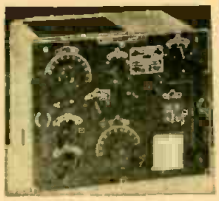

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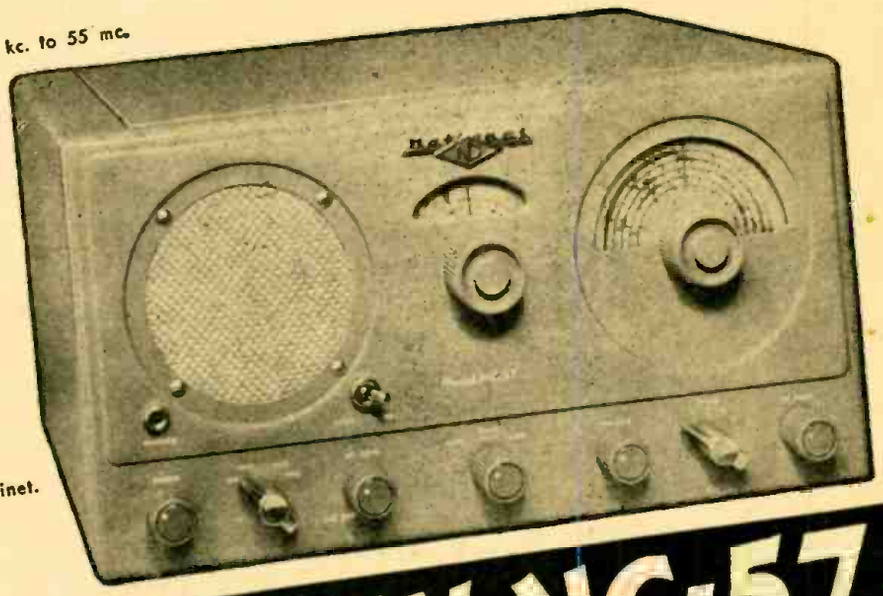

HERE IT IS—THE NEW NC-57

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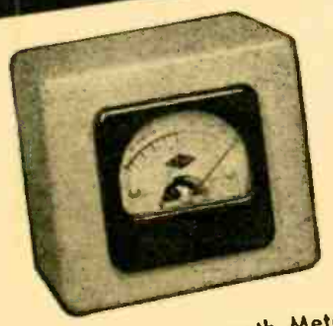

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FOR SALE—Radio business in booming oil and cattle country; cleared $3,800 in 1946. Will sell less some testers for $2,800—4 testers included. Write if interested, W. G. Eslick, 124 E. 5th St., Casper, Wyo.

WANTED—Antenna tuning unit BC-306-B in good condition. Instruction manuals BC-375E and BC-348 also plugs types PL-61 and PL-59. A. Bursey, Nippers Hr., Green Bay, Newfoundland.

FOR SALE — Practically new Meissner analyst, $87.50; Hickok mutual conductance tube checker, $95; DuMont scope $90; Silver Vomax VT checker $48; Solar condenser checker $35; 9-14 Rider Manuals; Sam's folders 1-19. R. F. Lawrence, 2516 Colby, Everett, Washington.

FOR SALE—Midland radio and television schools radio course complete $35. W. F. Kelly, 521 N. Highland Ave., N.E. Atlanta 6, Ga.

WANTED—Audax Pro-5 pickup head shell, less pickup arm and cartridge works, any condition if mechanically okay. H. J. Tannenbaum, 660 N. Dearborn St., Chicago 10, Ill.

FOR SALE—Complete radio service including furnished home on main highway; excellent location, approximately 2500 tubes, lots of transformers, speakers, 93 surplus transmitters, 35 receivers, etc. $6800 cash, one year lease, possibly more. Coats Radio, 660 W. "A" St., Ontario, Calif.

WANTED—Experienced radio service men for growing business in progressive town. Good pay for right men. Write giving full particulars to Mendel's Radio Laboratory, 71 S. Main St., Barre, Vermont.

FOR SALE—Power transformer. 115 V, 60 cycle, Primary, 1560-1250-1560, secondary at 300 ma. two 2 mfd. 2000 V. condensers, heavy duty choke—makes fine 1500 V power supply. Also "Stancor 8002" modulation transformer—takes two-TZ20's. Want 6000 V. Scope transformer. George S. F. Orsten, Barker, N. Y.

FOR SALE—RCP 704 signal generator; RCP 447 multitester; CA 11 signal tracer; 100 assorted uninsulated resistors and 100 assorted insulated; also 50 assorted condensers, etc. Write for list. Willie L. Smith, P. O. Box 164, Sansom, Ala.

WANTED—Either Triplett 675 or Simpson 283 d-c milliamperes 0-1000 ma in 8 ranges. A-1 condition. Donald Murphy, 622 N. 16th St., Allentown, Pa.

FOR SALE—National 110 receiver with all coils and tubes; large South Wind gasoline heater; 836A Hallicrafters, ¼ h.p. motor; HT9 transmitter with all coils; 80 meter VFO; 6 tube signal tracer, car radio; ¾ H.P. Briggs & Straton complete set furnace controls. All like new. C. Schecter, Scenic Drive, R. No. 2, Muskegon, Mich.

FOR SALE—Webber 50-tube tester in good condition, changed to test Loktals $15 with charts. George V. Hanold, RT No. 1, Wonewoc, Wisc.

FOR SALE OR TRADE—Atwater Kent 876 console radio, 550-18000 kc, vernier drive, 88-1. Excellent condition $50 or trade for BC312 or 348 in good condition. Steve Wolff, 41 Linden Ave., Rutledge, Pa.

FOR SALE — RCA frequency modulator TMV-128-A; an auxiliary unit for the study of FR and IF wave forms on the cathode ray oscillograph. Used very little. John Unida, 791 Atlantic St., Stamford, Conn.

WANTED—Rider Manuals 6 to 10 and 13; also Precision E-200 signal generator; Solar analyzers, CF-1-60 or CBB. State condition and price. Richard Clark, 157 Grand Ave., N.E., Grand Rapids, Mich.

FOR SALE—Hallicrafters SX28A with 12" speaker; National NC240D with matching 10" speaker. Both used only 3 months, in new condition. J. D. Berry, 407 Ann St., West Reading, Pa.

FOR SALE—NRI vacuum tube voltmeter, multimeter and signal tracer—a-c 0-500 v in 4 ranges, d-c 0-450 v in 4 ranges, 20,000 ohms per volt. Current 0 to 45 milliamperes in 2 ranges; resistance 0 to 100 megs. Output measurements in 4 ranges. Complete with test cords and phone $35. M. J. McDonald, 7236 S. Artesian Ave., Chicago 29, Ill.

SELL OR TRADE—Supreme 546 3" oscilloscope in A-1 condition, used very little. Want S-40A Hallicrafters or National of equal value. oscilloscope $70. A. B. Moore, New Madrid, Mo.

WANTED—Service manual for BC-348-R Signal Corps communications type receiver made by Belmont. Alex N. MacLeod, 127 Cedar St., Sudbury, Ontario, Canada.

FOR SALE—Microphone, Shure Cardioid unidyne 55A with 12" adjustable table stand, 10' mic. cord $25. F. G. Sealy, Gen. Del., Vacaville, Calif.

WILL TRADE—Rider manual 1 worth $14.50 prepared for N.R.I. includes am-fm, television, amplifiers, changers, circuit diagrams and aligning procedures. Want tube tester in good condition. Ben Marconi, 120 Gatling Place, Brooklyn 9, N. Y.

FOR SALE—I.R.C. Precision meter multipliers and shunts, all units double. 41.66 ohms (double unit 83.32 total) 1%; 500 ohms (1000 double) 1/3%, 1,000 ohms (2000 double) ½%, 10,000 ohms (20,000 double) ¼%, 6,000 (12,000) ¼%, mod. WW4 wire wound. 50c ea. or 3 units $1.25 postpaid in U.S.A., Robert J. Fogg, 1125 Lafayette, S.E., Grand Rapids 7, Mich.

FOR SALE—G-E TC-3P tube checker $48 plus $2 delivery, in A-1 condition and Triumph 400 tube checker $12 in good condition. $13 delivered. National Radio Service, 70B59, 379 Merritts Ave., N.E., Atlanta 5, Ga.

FOR SALE—Booster amplifier RCA 50 watts, good operating condition. $45 with 2 12" speakers in outdoor baffles $65; also Riders manuals 1-5, 6, 7, 8, 9, 10, 11, 12, 13 and 14. All complete and perfect $125 for set. H. C. Miles, 204 Sherman Ave., New York 34, N. Y.

FOR SALE—HQ120x less speaker, perfect condition $100; 50 watt 6V6—807 transmitter complete with power supply on 10" x 12" chassis, coils and crystal for 20 meters—$35. All inquiries answered. Don Edwards, 332 West Hall, Lubbock, Texas.

FOR SALE—Complete construction data, including recording playback amplifier plan. $1.50. Catalog 25c. Modern Design, East Rockaway, N. Y.

SELL OR TRADE—3,000v @ 350 ma. c.t.; 7½H @ 500 ma, both oil filled, die cast; set of cables for SCR-543, few large undrilled chassis (removable taps) and many other items. Want photograph equipment. Donald J. Waryinski, 1321 Sycamore St., Pittsburgh 11, Pa.

WANTED—Used signal generator in good condition with operating data. M. Springhetti, 317 Grove St., Brockton 2, Mass.

FOR SALE—1/6 and ¼ h.p. a-c motors in good condition $14 and $15; new solar CE condenser analyzer $55; Motorola universal auto radio $35. Paul Capito, 637 W. 21st St., Erie, Pa.

URGENTLY NEEDED — Thordarson CHT #15A74 input transformer, can be used but must be in A-1 condition. Write stating price. All replies answered. Stanley J. Lucas, Box 458A, Morris Plains, N. J.

FOR SALE—Excellent condition, National receiver NC-200 chassis slightly cut to fit compartment, no cabinet $175; also Pincor rotary converter, type 12 K-30, input 12v d-c, 42 amps, output 110v, 60 cycle, 2.73 amps, $70. Edward D. Untermyer, P.O. Box 1313, Stamford, Conn.

FOR SALE—Radio service sales and appliance store; building, test equipment and stock. Sacrifice $3,000. Must sell because of ill health. L. H. Harry, Pinehurst, Idaho.

WANTED—Jensen bass reflex cabinet for 12" speaker. State price. Edmond D. Gonzales, 134 West St., Milford, Mass.

SELL OR TRADE—New plate transformer, pri, 115v—sec. 1470v ea side center tap at 1.2 amps. for wire recorder mechanism and data, or what have you? Dudley Hardy, 26 Gillis St., Nashua, N. H.

FOR SALE OR TRADE—NC100ASD receiver with speaker, accurately calibrated in good condition; also 2 stage 100 watt, final TB-35-10 meters only. Write for details. Lenny D'Airo, 2289 Coney Island Ave., Brooklyn 23, N. Y.

WILL TRADE—6 tube ac-dc portable radio and phono combination with automatic changer. Want typewriter in good condition. Harley Burris, R-4, Center, Texas.

FOR SALE—Complete 35 watt p-a system with mike, speaker and automatic record changer $100; also VTVM ac-dc volts; 2 billion ohm, 7" meter carrying case, $40 f.o.b. Marvin Radio, 14 E. 208th St., Bronx 67, N. Y.

FOR SALE—Midwest QE-12 tube table radio, 110v a-c, 5 bands, 2 long and 3 short; 6 thumb pressure keys for automatic tuning. In walnut cabinet with record player and recording unit as well as crystal microphone for converting to amplifier. Worth $400, will sell $250. P. DeSota, Pa. Dr.—P.O. Box 223 Sagua La Grande, L.V. Cuba.

WANTED—Variable condenser, 4 gang, 365 mmfd, with trimmers, up to 6½". State dimensions. J. F. Tremitiere, 42 Cherokee Ave., Allendale, N. J.

FOR SALE—Hickok 288X signal generator, covers am and fm bands, crystal controlled. $145. Walters Radio Service, 1252 Pulaski Ave., Shamokin, Pa.

FOR SALE—Exact replacement parts for Stewart-Warner, R-100-A, Stark Clarion, Kolster, Majestic, etc., 6-tube Zenith 8331052 chassis containing tuning condenser, sockets, i.f. transformers, coils—$2 and 100 watt Vasco soldering iron. Bill Benner, 145 S. Maple, Webster Groves 19, Mo.

WANTED—Two 12B8 tubes and 1—1D8 tube. State prices. Rockville Radio Co., 273 Sunrise Highway, Rockville Center, New York.

YOUR OWN AD RUN HERE FREE

The Sprague Trading Post is a free advertising service for the benefit of our radio friends. Providing only that it fits in with the spirit of this service, we'll gladly run your own ad in the first available issue of one of the six radio magazines in which this feature appears. Write CAREFULLY or print. Hold it to 40 words or less. Confine it to radio subjects. Make sure your meaning is clear. No commercial advertising or the offering of merchandise to the highest bidder is acceptable. Sprague, of course, assumes no responsibility in connection with merchandise bought or sold through these columns or for the resulting transactions.

DEPT. RC-117 SPRAGUE PRODUCTS COMPANY
North Adams, Mass.
(Jobbing distributing organization for products of the Sprague Electric Company)

MICROTUBES

A New Milestone in Electronic Developments

By HUGO GERNSBACK

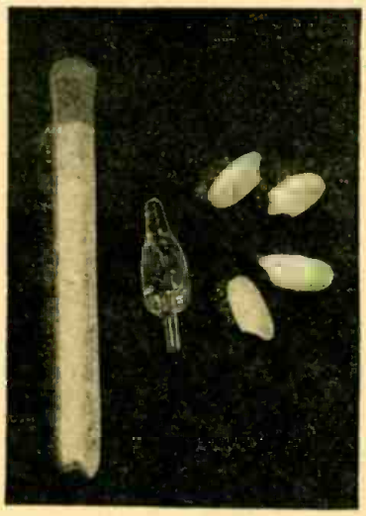
THE Tube Laboratory of the National Bureau of Standards has just announced a new "rice-grain" radio tube—now known as the *microtube*. This new subminiature radio tube is only slightly larger than a rice grain and only a bit wider than a book match, illustrated on this page.

This constitutes possibly one of the greatest electronic developments in a decade. It certainly is a milestone in radio from every point of view. The development is so revolutionary that at this time it is impossible to foresee just how far it may lead us into further radio progress.

Complete technical details of the new tube cannot be given at this time because the new microtube has important military applications that cannot be revealed at present.

One of the important contributions which the National Bureau of Standards has made is in the reduction of microphonic noises and internal tube noises. As every radio technician knows, microphonics has been one of the great irritants in radio work and the Tube Division of the National Bureau of Standards is to be congratulated on this accomplishment, which ranks in importance with the reduction of tube size itself.

The Bureau mentions that these tubes will create profound effects in industrial and commercial fields, such as, for instance, in electronic computing machines. Present-day models of such machines use as many as 18,000 tubes in a single machine and some of the newer present models as well as others now being projected require as many as 2,000 radio tubes. It can be seen that by using microtubes a tremendous amount of space will be saved. This is true also in every type of radio where saving of space is an important factor.



The above illustration is a considerably enlarged view of the National Bureau of Standard's new Microtube. At the right are rice grains, at the left a book-match for comparative size.

Incidentally, the new tubes have an expected life of 15,000 to 20,000 hours.

While at this time of writing the tubes are not available commercially, they are now being developed by a large tube manufacturer who is working under a development contract.

Other important future projections of the new microtube can be readily made now that the new subminiature tube is a reality.

General David Sarnoff in 1921 predicted the eventual use of a wrist-watch size radio. General Sarnoff was serious when he made his prognostication, which now moves into the status of a distinct possibility. Indeed, a 5- or more tube superheterodyne watch size radio receiver now can be built with these new microtubes. There is no problem today as to the rest of the components which can easily go into a space the size of a man's wrist watch. The only thing that might baffle a constructor would be the batteries. However, this need not worry us too much either, because we can immediately think of a battery substitute.

Remember, these tubes do not use much current; therefore, we can imagine a miniature electric generator, powered by a watch-spring motor, using the recently perfected, most powerful Alnico V magnet. Such a subminiature generator becomes a distinct possibility. You merely wind the watch in the ordinary manner and the generator will keep running for a short period. It then can be rewound for more power. Thus, we will have a self-contained radio receiver compressed into the size of an ordinary watch. The face that normally is the crystal now becomes the loudspeaker diaphragm or cone, then by holding the wrist radio to the ear we should have clear and sufficiently loud reproduction to enjoy whatever program we wish to listen to.

Much smaller radios than these can be envisaged also for military purposes, such as subminiature radars, proximity fuses, handie-talkies, and a host of others. It has been said that World War II was won chiefly through the instrumentality of radio and electronics. The submarine war could not have been won if it had not been for our superiority in radar and associated other electronic techniques. Instant communication was a most important factor in winning the war. Radar for tracking down enemy aircraft was THE reason that made possible the aerial victory in the Battle of Britain. Without it there would not have been enough airplanes at the right spot at the right time, and the Battle of Britain certainly would have been lost.

If another war should come, we may rest assured that again radio and electronics will be *the* outstanding factor. Controlled missiles, in the so-called push-button war, could not be possible without radio-electronics.

The guided missiles now being perfected to protect our shores and to intercept other missiles will all contain the new microtubes. Indeed, the guided missile that can be followed from *(Continued on page 91)*

RADIO-ELECTRONICS

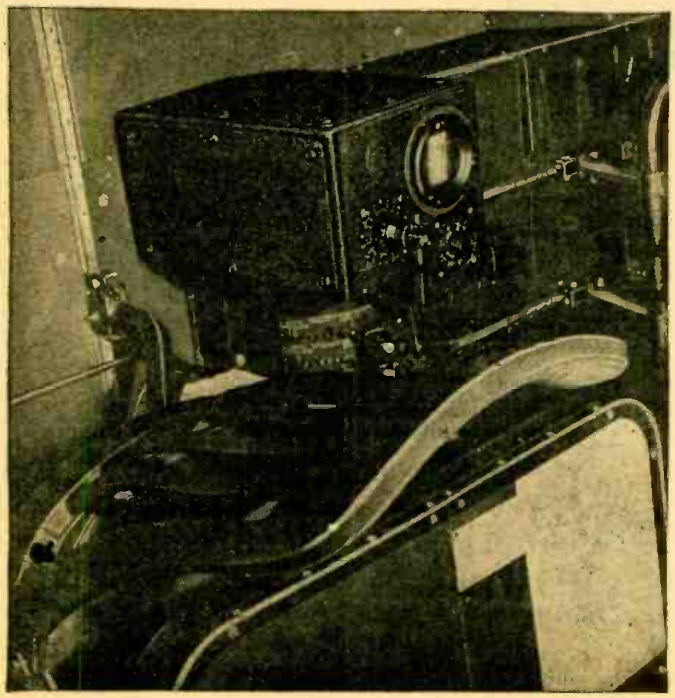
RECEIVING LICENSES were a subject of civil dispute in a remote Canadian area last month. Residents of Atikokan and Steep Rock Lake in Northern Ontario were aroused because 50 persons were fined $10 each for operating radio receivers without a license. The contention of residents is that the Canadian Broadcasting Co.—whose expenses the licenses are supposed to pay—gives no service to the area, and therefore has no moral right to collect from radio users. Listeners of the region have to depend on American and independent Canadian broadcasters for their radio entertainment.

Canadians have always had to pay for broadcasting licenses, but when the Canadian Broadcasting Company was formed the license fees were increased to help pay its program expenses.

AIRCRAFT ENGINE troubles now can be located and identified during flight with an *electronic engine analyzer* announced last month by the Sperry Gyroscope Co.

According to Sperry, the instrument provides continuous visual analysis of the complete aircraft power plant during flight. The flight engineer can view on its cathode-ray-tube screen at any time patterns which show engine vibration, ignition system performance, and synchronization between magnetos and engines. Malfunctions and imminent failures are not only detected but located and identified.

Simply stated, the equipment consists of vibration pickups screwed into the cylinders and generators which produce a voltage proportional to engine speed, a 13-tube amplifier and sweep circuit and the cathode-ray indicator. Two switches, condition selector and cylinder selector, permit localizing malfunction to various cylinders or identifying it as due to given conditions. A 3-inch cathode-ray tube is used.



The new Sperry analyzer which spots engine troubles in flight.

A CAMERA SHUTTER operating with electrically polarized light and having no moving parts can make exposures of .00000004 (four hundred-millionths) second. Devised for photographic studies of electrical discharges, it was described to the American Institute of Electrical Engineers last month.

The device uses an all-electrical shutter, the heart of which is a Kerr cell. The polarized light used cannot pass through the cell except when it is supplied with an electric field. The speed of operating, therefore, depends upon the rapidity with which a required voltage can be applied to the cell electrodes.

The ordinary Kerr cell is composed of 2 flat plates or electrodes immersed in a fluid which becomes doubly refractive upon the application of an electric field. Many fluids may be used, but scientists have found that nitrobenzene seems to have the highest Kerr constant.

When this cell is placed between polarizers crossed for minimum transmission of light, the arrangement becomes an optical shutter. In the Kerr optical shutter, a voltage applied to the electrodes alters the state of polarization of light and permits transmission through the second polarizer.

ULTRASONICS proved its worth as a laundering means in a demonstration at Pennsylvania State College last month. Results of the test show that these high-frequency vibrations can provide the mechanical force of a standard washing machine.

In the demonstration, a dirty cloth in a bucket of soapy water was given an ultrasonic wave treatment. Areas of the cloth which had been exposed to the waves came out clean.

Work on ultrasonic laundering has been started here under the direction of Dr. Pauline Beery Mack, director of the Ellen H. Richards Institute, and Dr. Harold K. Schilling, director of the Acoustics Laboratory.

Research on ultrasonic waves for washing clothes is also being carried on in Great Britain. One theory is that dirt is held to clothes by electrical attraction, and that sound waves will help shake the dirt loose.

MAGNETISM can be used to reveal simply and cheaply whether a metal rod containing iron is identical with a standard specimen, it was stated last month by D. E. Bovey of the General Electric Company.

The instrument which applies magnetism to metal analysis is called a *metals comparator*. It consists of a balanced circuit and a solenoid. The other leg is a variable resistance that can be changed until the circuits from the 2 legs are in balance.

In use, the standard specimen is inserted in the solenoid first and a balance obtained. Then the rod of unknown properties is inserted in the coil. If the balance holds, it is identical with the specimen in composition and characteristics. In searching the stockpile for an identical metal, one rod after another is tested until one is found that holds the balance. Rods can be tested as fast as they can be inserted in the solenoid.

The instrument has been used to differentiate between annealed and unannealed steel bars. It has been used also to sort finished metal parts, including plated parts, on the basis of composition or heat treatment.

A GIANT WURZBURG radar is being erected by the Bureau of Standards, under the direction of Dr. Grote Reber, it was announced last month. The installation will be used to detect solar and cosmic radiation that penetrate the earth's atmosphere.

(The Giant Wurzburg was the acme of Nazi radars. It has a parabolic reflector 25 feet across, and operates on frequencies between 550 and 600 mc. It was described and pictured in RADIO-CRAFT of December, 1945.)

Much has been learned about radiations "from the outside" with the help of new efficient shortwave antennas, and it is hoped that the Wurzburg parabola may pick up yet undetected waves.

A 3-DAY CONVENTION of the Hudson Division of the American Radio Relay League at Asbury Park, N. J., Sept. 26 to 28, was attended by 1,400 hams, YL'S, XYL's and guests. Featured were contests, discussions of amateur topics and door prizes; the first was a complete $1,026.00 ham station including a Temco transmitter and a Collins receiver. Special items for the YL's included a fashion show, dancing exhibition and a Bendix washer door prize.

MONTHLY REVIEW

SUPERSONICS as a detector of flaws in metal castings may be much more effective through new methods of application. The improved method was described last month to the San Diego meeting of the Institute of Electrical Engineers by Donald C. Erdman of Burbank, California.

In the method described by Mr. Erdman, a small quartz crystal is used as a transducer, a device to convert electrical energy into pressure waves, or returned pressure waves into electrical energy. Extremely short blocks of radio-frequency power are fed to the transducer, with intervals between the blocks to permit the receipt of returned waves if there are any. The method is similar to the echo techniques used in radar, in which electric impulses are reflected by obstacles back to the antenna from which sent. When high-frequency sound waves are sent through metal, waves that hit a hidden flaw within it are reflected back.

In inspecting small metal objects, the quartz crystal and casting are separated but both are placed under water. This permits the supersonic beam to be directed into fillets and curved surfaces, he said. When large objects are being inspected, their surfaces are usually flat enough to allow the quartz crystal to be placed directly against the part being tested.

ARTIFICIAL CRYSTALS are now being used to replace hard-to-get quartz as frequency controls in many long-distance telephone carrier circuits, the Bell Telephone Laboratories revealed last month.

The new crystals, ethylene diamine tartrate, are familiarly known as EDT. Although these crystals differ markedly from quartz in chemical composition, both are piezo-electric in character; that is, they can convert mechanical energy to electrical energy, or they can reverse the process.

In commercial production the artificially grown crystals weigh about 1 pound and are about 6 inches in length and 2 x 3 inches in cross section.

The first seeds of crystal from which subsequent crops are harvested are only 1/3 inch across. They are obtained by evaporating a saturated solution of the chemical in a dish, just as sea water can be evaporated to obtain salt.

These are then swished slowly back and forth in a solution of the chemical which is kept supersaturated. Slowly, more crystal is added to these seeds—that is, they grow. The entire growing process must be very precisely controlled. Temperature variations, for example, must be kept within 1/10 degree.

A crop of crystals can be harvested every 3 months, and the seeds cut off from the new growth and replanted in the solution to start another crop.

In the search for a quartz substitute, Bell chemists and physicists investigated more than 100 crystals before they selected EDT.

In a few years, the artificial crystals are expected to replace as much as 90 per cent of the natural quartz used in long-distance telephone systems—and do as good a job as its scarce, natural brother. Some New York to St. Louis circuits are already operating with synthetic crystal units.

TO OUR READERS

SINCE 1929—for over 18 years—RADIO-CRAFT has sold at 25c per copy. For several years now almost all important magazines in the U. S. have found it necessary to increase their prices due to ever-increasing costs of paper, printing, and wages.

The Publishers of RADIO-CRAFT had hoped that it would not be necessary to increase the price of your magazine, but continuous advances in operating costs—some as high as 200% above pre-war costs—finally forced the adoption of a new price schedule, a move which is sincerely deplored.

Beginning with this issue the price on U. S. newsstands goes to 30c, Canada to 35c. Proportionate increases in subscription prices have also been effected.

As soon as economic conditions permit it, price reductions to the former level will be made.

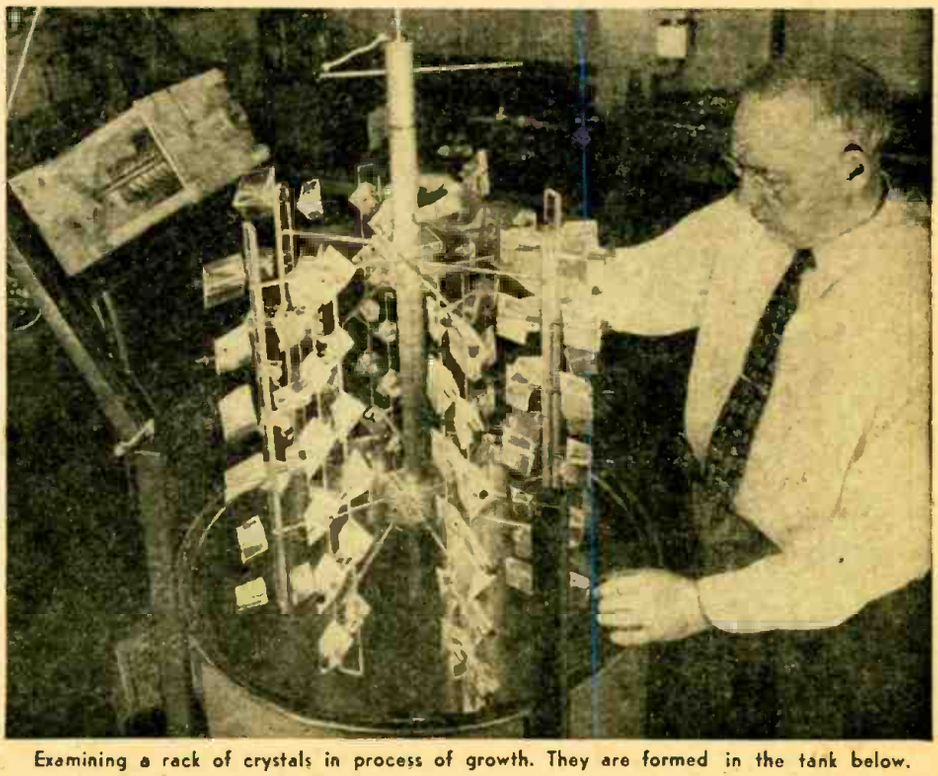
THE PUBLISHERS.

FM LIGHT-BEAM signal transmission is described in U.S. patent 2,423,254, issued last month to Michael Rettinger of Encino, California, and assigned to the Radio Corporation of America.

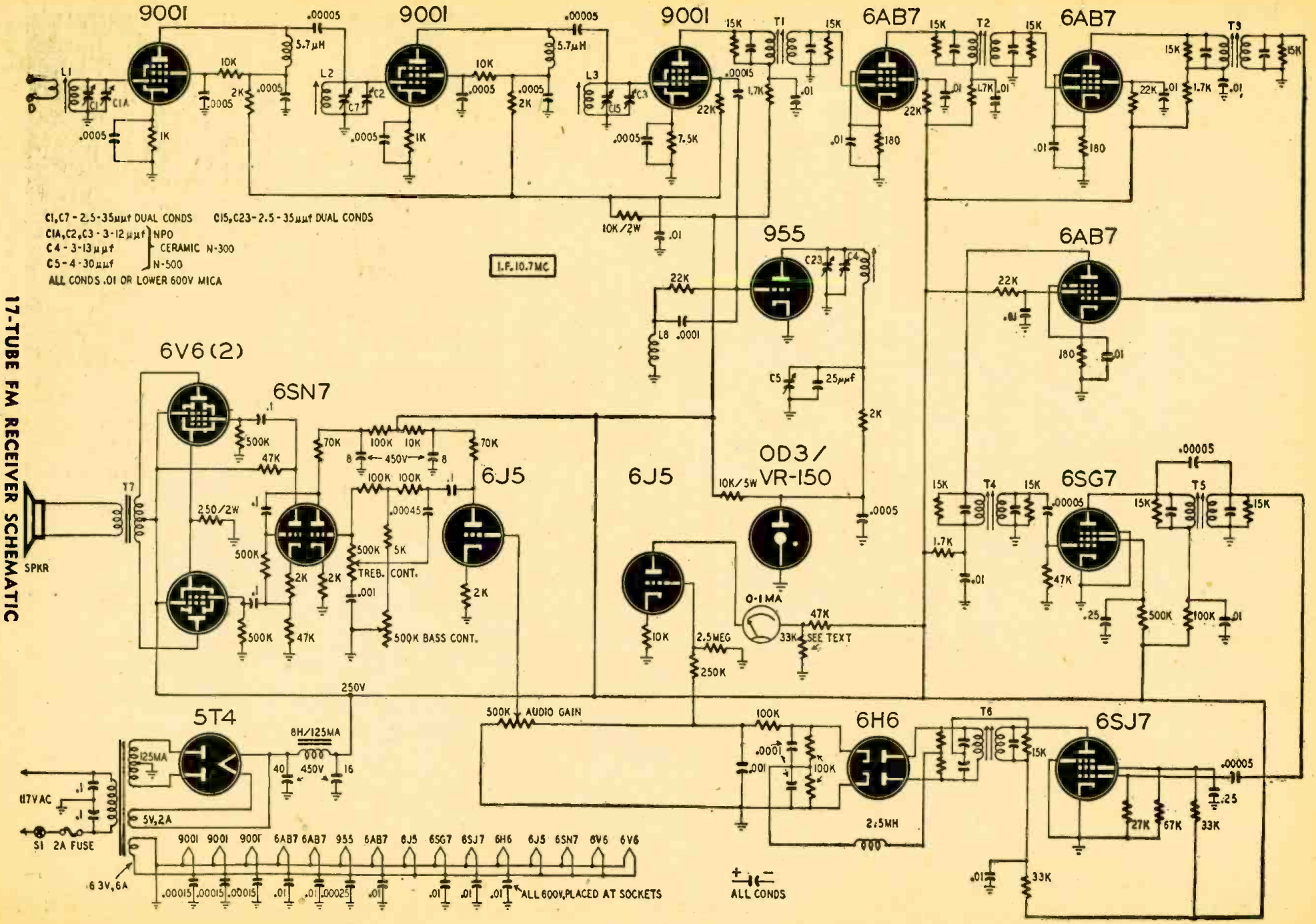
Central feature of the invention is a prism through which white light is projected, coming out in the familiar rainbow spectrum. A photocell most sensitive at the red end of the spectrum and least sensitive to violet light is used as the receiver. The rainbow beam is projected so that the central part of it falls on the photocell.

The prism is so connected in a magnetic circuit that modulation causes it to pivot, shifting the spectrum projected onto the photocell at audio frequency and causing a proportional upward fluctuation of the photocell current as the beam moves toward the red and a downward fluctuation as it moves toward the violet.

Since the amplitude of the light beam is held constant, the analogy with radio FM is exact. In each case, the frequency of the waves is changed, and the greater the deviation from normal carrier frequency, the stronger the signal.



Examining a rack of crystals in process of growth. They are formed in the tank below.

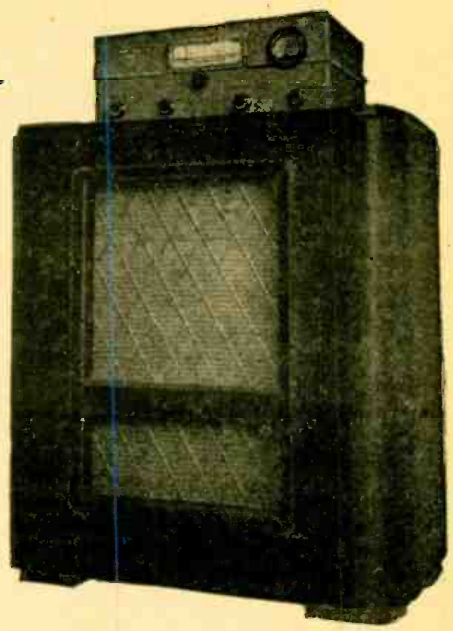


17-TUBE FM RECEIVER SCHEMATIC

We are happy to present this instead of the 4-tube set mentioned on the cover. It will come next month

How to Construct a 17-Tube FM Receiver

By FRANK SANTANGELO



Completed receiver on its bass-reflex cabinet.

THE advantages of FM in fidelity and in noise reduction are so well known as to require little discussion. Only an efficiently designed receiver will obtain the most sensitivity without sacrificing the stability or the signal-to-noise ratio of the receiver. The equipment described here resulted from an attempt to design a receiver that would operate with maximum efficiency on the new 88-108-mc FM band.

A number of things which are unimportant at lower frequencies have a significant effect on the stability of a high-frequency receiver and must be considered when constructing one.

The 17 x 9 x 2-inch chassis on which you build such a receiver should be of a heavy-gauge material to assure mechanical stability.

The components and their placement must be chosen with extreme care. Improper layout of parts can be the cause of spurious oscillation. Poor grounds may cause instability, especially in high-frequency circuits. By using ground clamps on metal tubes, any interaction which might exist between their shields due to poor grounding may be eliminated. These are just a few of the numerous things which have a decided effect on both the mechanical and electrical stability of a receiver.

Two stages of radio-frequency amplification are used to give the desired gain. The r.f. circuits are located in the grid of each tube, and the plates are capacity-coupled to the grid of the following tube.

The oscillator is of the tuned-plate grid-feedback type. Its output is injected into the screen of the mixer. A stable high-frequency oscillator circuit with temperature compensation and voltage regulation helps to assure the utmost in frequency stability.

Because the new band has a total band width of 20 mc, an intermediate frequency of at least 10 megacycles must be used to have signal images fall outside the band.

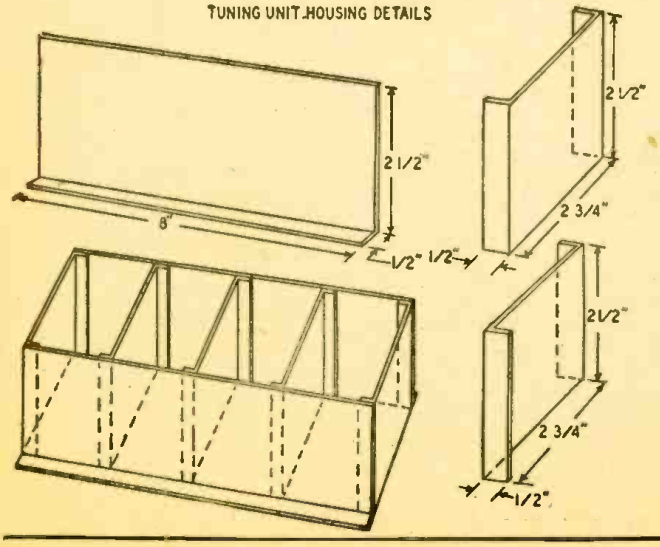
The new National 10.7-mc i.f. transformers were decided on. Three stages were used to obtain the gain required for good limiter saturation on weak signals. These transformers are designed so that the user may resistance-load them to suit his particular application. It was necessary to load the windings of each transformer with a 15,000-ohm resistor to obtain the proper band width.

Automatic volume control was tried and found to offer no advantage; rather it tends to prevent saturation of the limiter on weak signals. Series limiting is used with transformer coupling between the limiters. A shield is placed under the limiter coupling transformer to prevent any possible feedback between this and the first i.f. stage.

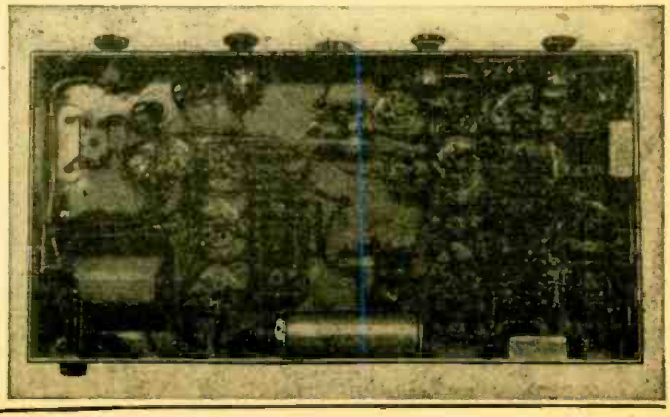
The first limiter has a time constant of 2.35 microseconds and the second a time constant of 1.35 microseconds. These time constants seem to give effective limiting for auto ignition, which is extremely severe in this locality (Somerville, Mass.). The Travis discriminator uses a National-type IFL discriminator transformer.

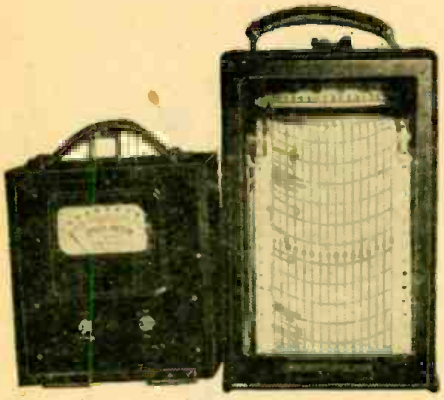
The output of this discriminator has a de-emphasis circuit whose time constant is 100 microseconds, which is necessary for proper high-frequency de-emphasis. The discriminator meter amplifier is a 6J5 with high-impedance input connected to the output of the discriminator. The meter in the plate circuit of the tube is adjusted to give a half-scale reading on background noise (off-station hiss) by varying the 33,000-ohm, meter-to-ground resistor. When this is done, a zero center is auto-

(Continued on page 76)



Left, Fig. 1—Construction details of housing for tuning unit. Below—An under-chassis view of the receiver, a very well-engineered job.





The indicator-amplifier and recorder units.

Highway Radar

Connecticut system makes absolutely accurate records of automobile speeds

CONNECTICUT speedsters protesting that "they were doing only forty" will soon find themselves arguing with radar. So says Captain Ralph Buckley, traffic division head of the Connecticut State Police. Inconspicuous radar speed meters are already being operated alongside Connecticut highways in a series of tests which will probably result in the adoption of radar speed control throughout the state.

The radar device is known as the Electro-Matic Speed Meter, and is a local Connecticut product, being manufactured by Eastern Industries Ltd. of Norwalk. It is a small, portable device composed of 3 units. Largest of these is the transmitter-receiver, the radar set proper. The dipole antenna is enclosed in the set, behind the bakelite front panel on which the words "Electro-Matic Speed Meter" appear. A second unit is the indicator-amplifier, and the equipment is completed by a 6- or 120-volt power supply.

The radar transmitter-receiver is on the car's trunk compartment.

The instrument operates on the Doppler effect. When a series of waves is sent toward an object moving toward the transmitter, the length of the reflected waves is shorter than the wavelength as measured at the transmitter itself. This is because the moving object has moved part of a wavelength toward the transmitter in the interval between each wave. The greater the speed of the object, the greater the difference between the frequency of the transmitted and received wavelengths.

(The same effect can be noted if the source of signals is itself moving toward or away from the receiver, or if the transmitter is stationary and the receiver moves. It is especially noticeable in sound, and many listeners have noticed that the pitch of a fast-approaching train's whistle is higher than the same whistle when the train is moving away from the listener.)

The direct signal from the transmitter and the received signal are mixed in the receiver, and the difference frequency (which tells the speed of the moving object) is fed to the indicator-amplifier, where it is read on a meter calibrated directly in miles per hour or registered on a graphic recorder.

If the car is moving at a steady speed, the indicator will swing up as it comes into the field covered by the instrument, remain there a short instant, and then drop as the car passes by. During this short period of approach at constant speed the reading is taken. By varying the angle the transmitter-receiver makes with the road this action may be adjusted to give the most positive reading. If a graphic recorder is used, a slight flattening of the top of the curve produced by each car indicates the point at which the steady speed is read.

Range depends to a great extent on the height of the instrument. On the ground, it is from 75 to 100 feet. At a height of 3 feet, this range increases to 150 feet, and at 30 feet the zone extends to 350 feet. For practical use, a range of 150 feet has given the best results, and the speed meter is mounted preferably at a height which will give approximately that range.

Turning the transmitter-receiver unit slightly away from the traffic also produces more positive results by limiting the field and decreasing sensitivity for cars on the far side of the roadway. The device should be mounted as near the roadside as convenient, though

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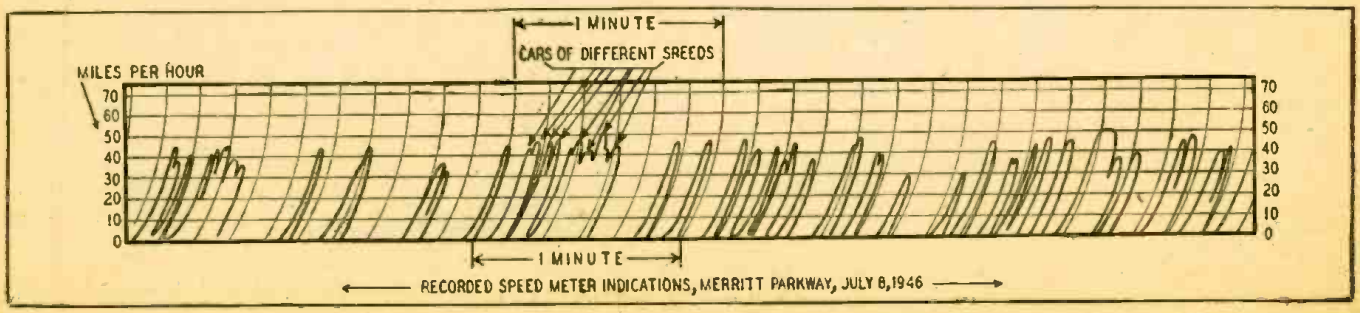

SIGNAL TRACER—SIGNAL GENERATOR

The r.f. probe is based on a tube adapter.

Two of the most useful service functions combined in a single instrument

By FRED WHALEN

A COMBINATION signal tracer and signal generator such as this one can develop into an almost indispensable instrument for the serviceman or experimenter. It is constructed from standard parts, many of which can be found in the junkbox. It is used for r.f. and a.f. signal tracing, and its oscillator generates signals in the i.f. range as well as over the broadcast band.

The circuit, Fig. 1, uses 5 tubes. Of these, four are on the chassis and 1 is in an r.f. probe.

For r.f. signal tracing, the probe picks up a signal from a set under test, rectifies and feeds it to the grid of the 6Q7 a.f. amplifier stage through the 500,000-ohm input gain control. The 6Q7 is resistance-coupled to a 25L6 power amplifier.

For a.f. tracing, use a probe made from a piece of low-capacitance microphone cable fitted with pin tips for plugging into the a.f. input jacks. The audio level is controlled by the 500,000-ohm control in the grid circuit of the 6Q7. Leads from the voice-coil winding of the output transformer are connected to pin jacks on the panel so that an external speaker may be used or tested with the tracer. The external speaker may be used in parallel with the built-in speaker or may be used alone by opening the speaker switch below the pin jacks. High-impedance output is available through a pin jack coupled to the plate of the 25L6 through a .05 μf blocking condenser.

The a.f. amplifier can be made to oscillate by throwing the oscillator switch to modulator position. No transformers are required in this system. Feedback between the plate of the 25L6 and the grid of the 6Q7 develops oscillations at a frequency determined partially by the setting of the input gain control.

The 6K7 r.f. signal-generator tube is connected in a conventional electron-coupled oscillator circuit. A tapped broadcast oscillator coil, designed for use with 175-kc i.f.'s, is tuned with a 365-μμf variable condenser shunted with a small trimmer to tune to the low end of the band. The i.f. range is covered by switching in a .0006-μf fixed trimmer. To modulate the oscillator with a constant tone, throw the oscillator switch to the modulator position. The r.f gain control is coupled to the plate of the 6Q7 through a .02-μf condenser. The voltage developed across the gain control modulates the suppressor of the r.f. oscillator. If external modulation is desired, a phono pickup is connected to the a.f. input jack and the oscillator switch turned to the external position.

The tracer has a built-in, fixed-tuned circuit consisting of a standard antenna coil and a 450-μμf trimmer that is adjusted to tune in a local broadcast station. The tip of the r.f. probe is inserted in the r.f. input jack. The 6SF5 detects the signal and passes it to the 6Q7 where it is amplified and modulates the r.f. oscillator or goes to the 25L6.

The r.f. probe is made from a tube adapter with an octal socket in one end and a banana plug in the other. A phone-tip adapter slips over the banana plug and matches it to the tip jack in the panel. This also provides a sharp point for signal tracing. Three-wire cable and a plug made from a discarded 6H6 complete the circuits between the probe and the tracer. One of the wires is a common ground connection. The others carry plate and heater voltages to the 6SF5 probe tube. Power supply is normal. It

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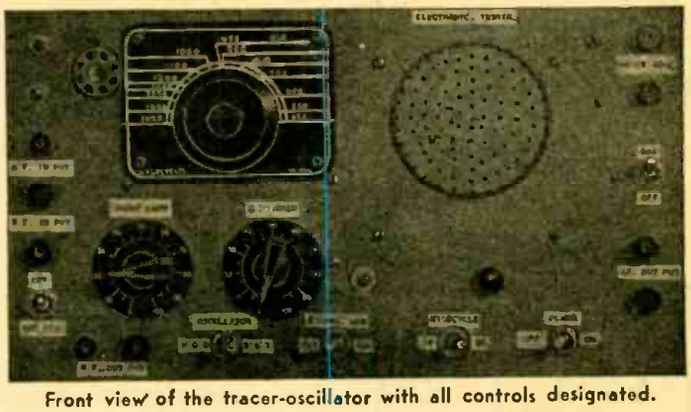


Front view of the tracer-oscillator with all controls designated.

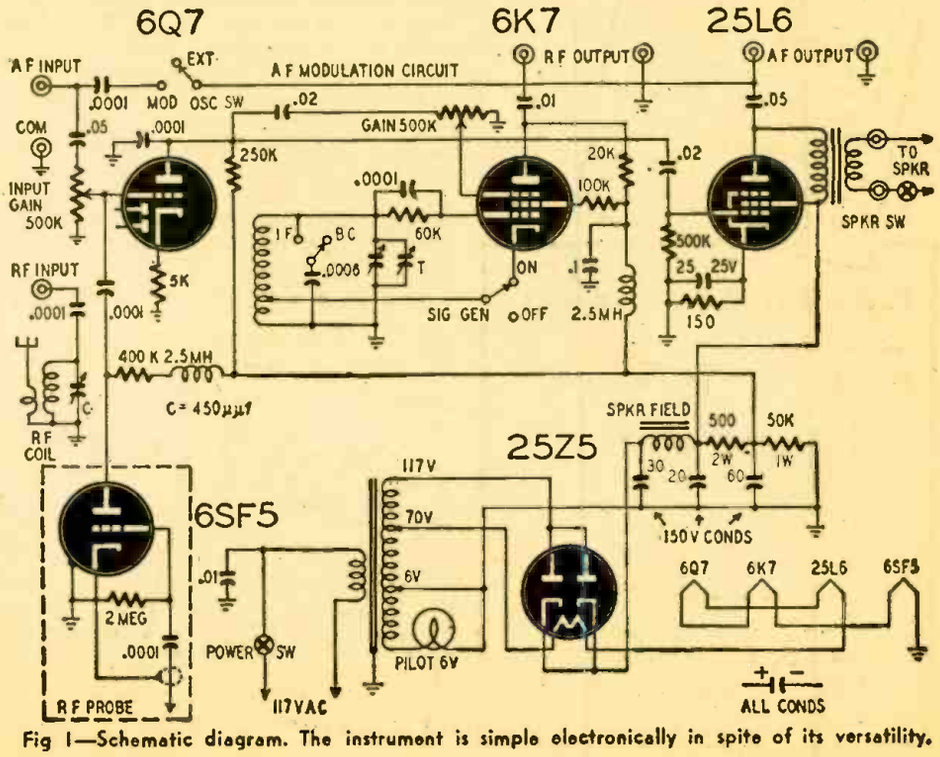
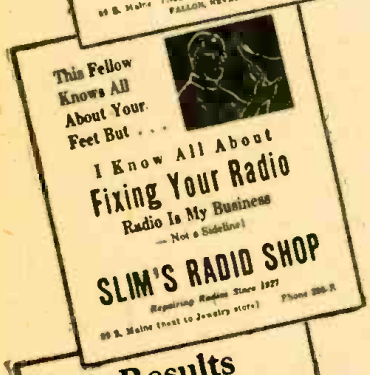
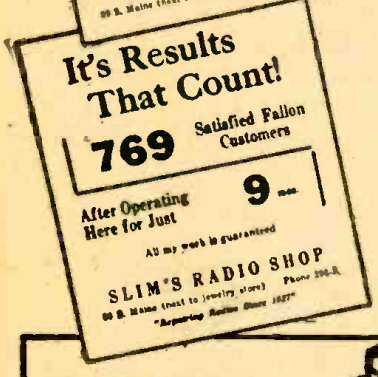


Fig 1—Schematic diagram. The instrument is simple electronically in spite of its versatility.

Advertising for the RADIO repairman

By PAUL W. STREETER





"WHAT has he got that I haven't got?" is a question many radio repairmen ask themselves when they look at the success their competitor seems to be enjoying. The answer usually is a combination of skillful advertising and technical ability. Technical ability can be acquired only by study and actual practice. Advertising that "clicks" can be written after study and actual practice, too.

Every organization which specializes in maintenance and repair work depends on some form of advertising to create new business. The major automobile and oil companies have spent many millions of dollars on advertising to persuade the public to have their dealers take care of automotive repairs. This policy has paid off. Radio repair shops can also use advertising to create new business.

Advertising does not mean just a single-column, 1-inch ad in the local paper. The term covers a vast territory, of which newspaper ads are only a small, although in some cases, an important part. Many different types of advertising may be used. Their relative merits will be discussed in this article.

Newspaper advertising is probably used (or MIS-used) by radio repair shops to a larger extent than any other medium. Newspaper ads *can* be effective if ads with outstanding appeal are prepared. Most radios brought in by newspaper advertising are those that have failed completely, although there is a much larger market for radio repairs among owners whose radios are functioning, but erratically. Advertising properly slanted toward these potential customers will increase the number of repair jobs enough to more than pay the entire advertising cost.

Keep it short!

Newspaper ads generally try to say too much. It is much better to write a simple ad, with a cut to illustrate the point, than to try to get a complicated story across. Most newspaper readers buy the paper for everything except the ads. A majority of readers do not *consciously* read them. A simple ad with short, concise copy and a cut will bring in business that the complicated ad will miss. Cuts are very helpful, and should be used liberally. A great many papers have them available, and they can be used without charge. They may or may not pertain to radio. One of the most effective ads this writer has used stresses proper timing, and carries a cut of a hockey player.

White space makes an ad stand out. White space should be used with medium-sized type, however, as large type crowds it. This writer has had the unfortunate experience of having some ads set with white space specified, but imperceptible because the typesetter used too large type. But by constantly hounding the newspaper, satisfactory results will be obtained.

The best place for any newspaper ad is the bottom of the front page. Many of the smaller papers do run ads in that spot. An ad generally decreases in effectiveness the farther it is from the front page. One exception has been that radio repair ads appearing on the same page with the theater programs are unusually effective. If newspaper advertising is carried on a monthly contract basis,

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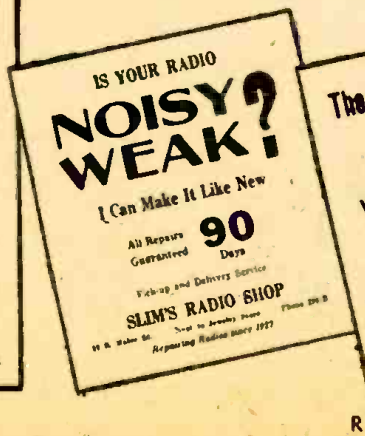

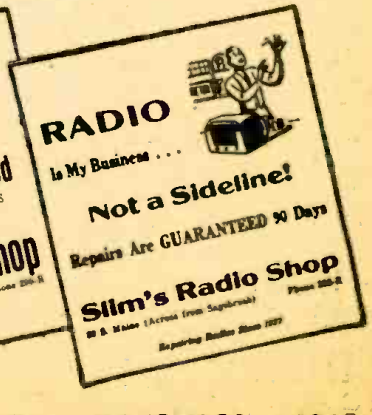

Adventure in High Fidelity

By JAMES R. LANGHAM

"I yanked those beam bottles out of there and put in triodes."

IT WAS some time before the war when we first became really conscious of that term. I say "we" but actually the XYL didn't cotton too much to the idea. We had a vintage phonograph amplifier with 2A3's, a creaky old interstage xformer, and a mess of 56's; and it sounded pretty good. That's what she said.

"Oh, it's not bad for what it is," I argued. "But there's a lot of distortion in it—my ear is pretty keen, you know—"

"Ha!"

"Look at this circuit," I urged. "Beam power tubes and 15 db of feedback. Distortion less than 1% and . . . "

"How much would it cost?" The XYL is always practical, which is at times a little discouraging.

"Not too much. We can use the same interstage and drive it with a 6C5. Of course it'll mean a new output xformer to handle those mils, and this old power supply is on its last legs, and I thought I might as well get a new chassis. . . . "

"How much?"

"Around 8 or 9 bucks."

That was O.K., and the XYL even punched socket holes and wired up the filaments and grounds. I went in for *engineering* then, and so the feedback resistors were all calculated. We took pains with the wiring too—no kinks in the leads, all corners squared up, and the whole thing laced up with sail twine. I was proud of it.

I don't know why it is but people always drop in to call just as I finish a job, and, since I was younger then and full of confidence, I tried it out anyhow.

"Excuse me," I interrupted. "But do you mind if I hitch this up and try it out? You see I've just finished wiring it and . . . "

Oh, that was fine. Sure, they said, go ahead. They'd like to hear some nice music. The XYL had been shaking her head at me but then she shrugged with that "Go ahead, you dope!" expression.

I plugged in the a.c. lead and tied in the speaker and pickup leads and flipped the switch. I was just selecting a record when the damndest squeal I ever heard started coming out of that speaker. It built up to a very high pitch and a very, very high intensity. You know, the sort

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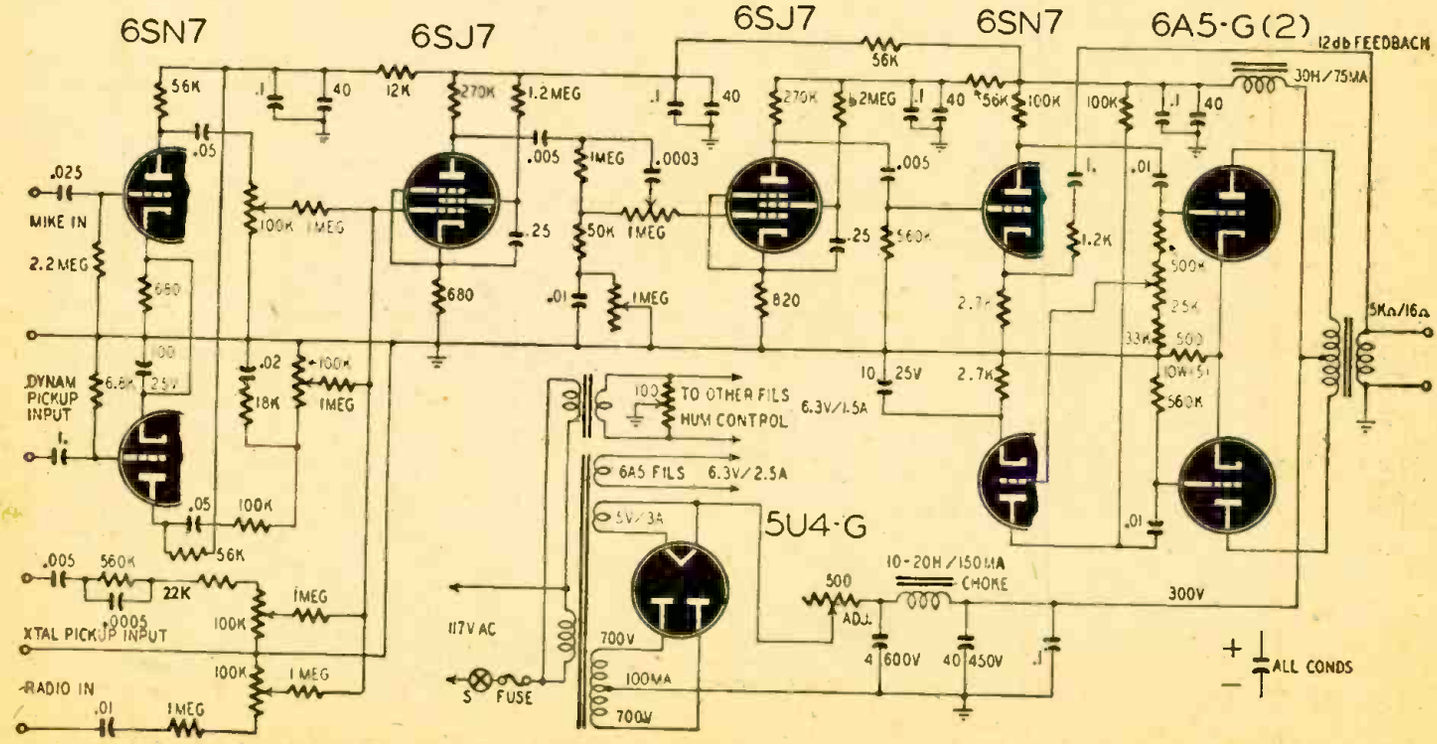


The final high-fidelity amplifier circuit, as it looked at the end of the series of experiments which are described in this article.

Speaker and pilot appear on receiver panel.

Carrier Radiophone

PART II—Receiver and modulator unit

By BOB WHITE

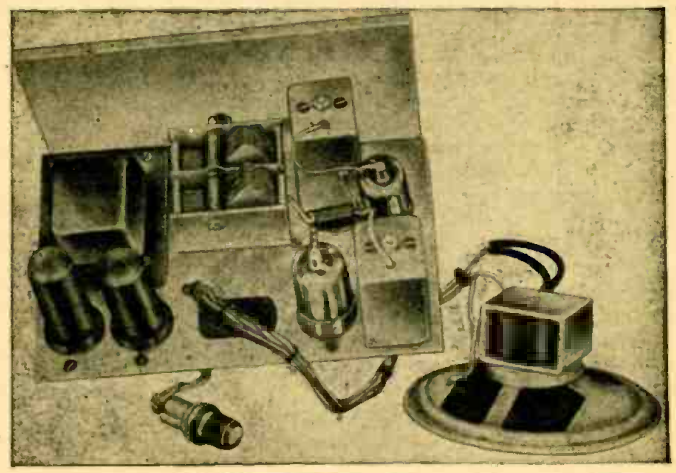
THE power that can be used in carrier-current transmitters without causing interference is very low. (The FCC has recently closed down a number of "carrier" systems as operating illegally and causing interference to other services.) Therefore it is necessary to use an extremely sensitive receiver. Many war surplus low-frequency, a.c.-operated receivers are perfect for this purpose. The only change that need be made for reception of carrier-current signals is to substitute an electric power line for the regular aerial. The antenna post of the receiver is connected to one side of the power line through a 0.01-μf, 600-volt paper condenser, and the ground post or chassis to the other side of the line through a similar condenser. It would be best so to arrange the circuit that the condensers would be across the line only when the receiver is turned on. Also, the equipment should be protected by a small fuse.

For those who would rather gain experience through the construction of their own carrier-current receiver, the details of a simple 4-tube tuned radio frequency receiver are given below.

The receiver (Fig. 1), is of standard design. The only change necessary for the reception of low-frequency airplane radio beacons is the use of a regular aerial instead of the electric power line aerial. The 5Z4 tube is used as a full-wave rectifier in the power supply, the 6F6 pentode power amplifier operates a 5-inch dynamic speaker, the 6J7-GT is a grid-leak-type regenerative detector, and the 6K7-GT supercontrol tube is used as a tuned r.f. amplifier.

The receiver can be constructed on a metal chassis 8 x 5 x 1½ inches. Plan the arrangement of parts and then proceed to drill holes and mount parts.

I.f. transformers T1 and T2 should be for about 370 kilocycles. An i.f. transformer of a little higher frequency can be used if sufficient turns are added to each secondary to make it tune the correct range. A transformer of lower frequency can be altered and made to work by removing an equal number of turns from both the primary and secondary of both transformers. The internal wiring of the i.f. transformers will have to be modified for use as r.f. transformers. The transformers each have a trimmer condenser connected across both the primary and secondary windings. Disconnect the trimmer from the primary, and connect it in parallel with the other secondary trimmer (C8, C9, C13, C14). The primaries of the i.f. transformers T1 and T2 are windings L4 and L2, respectively, and the secondaries are L3 and L1 respectively. The leads from the windings can usually be determined by the colored wires used. Red is connected to B+ in T1 and to the chassis in T2, blue is connected to the plate of the 6K7-GT in T1 and to the 0.05 "antenna" condenser in T2, green is connected to the grid leak in T1 and to the control grid (cap) of the 6K7-GT, and black is connected to the chassis in both transformers. The i.f. transformers are modified so that they may be tuned over a range of frequencies with the 2-gang 500 μμf per section condenser C10-C15.



Chassis view of receiver. Pilot lamp and speaker are on cables.

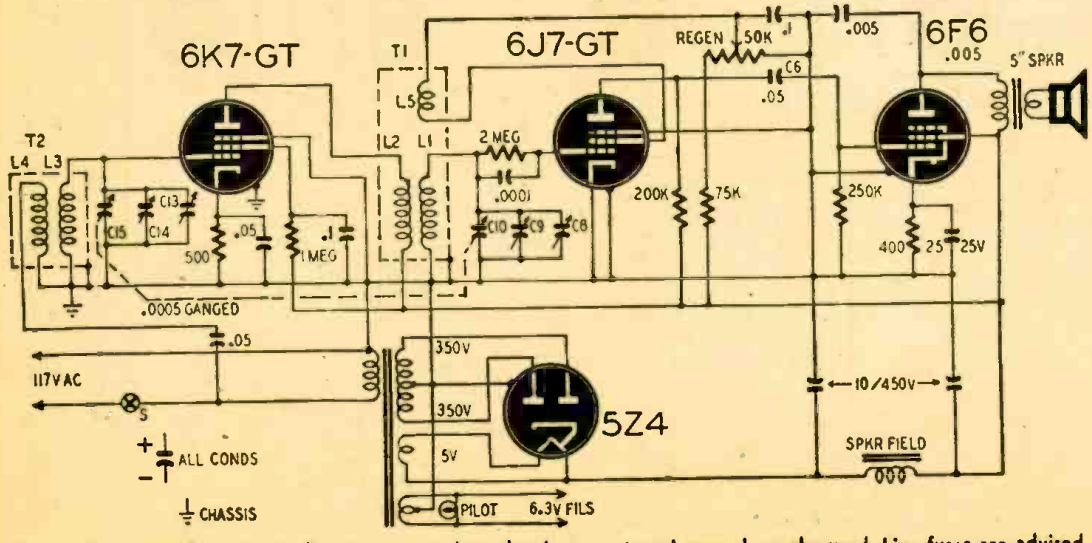
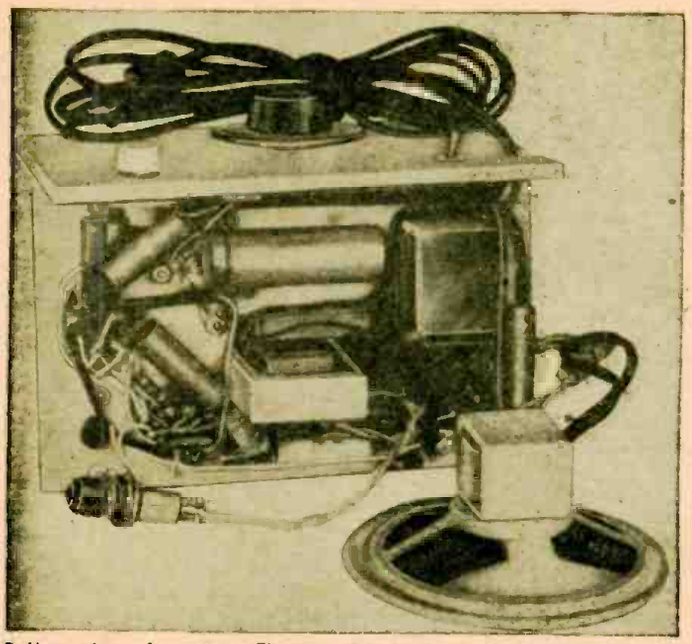
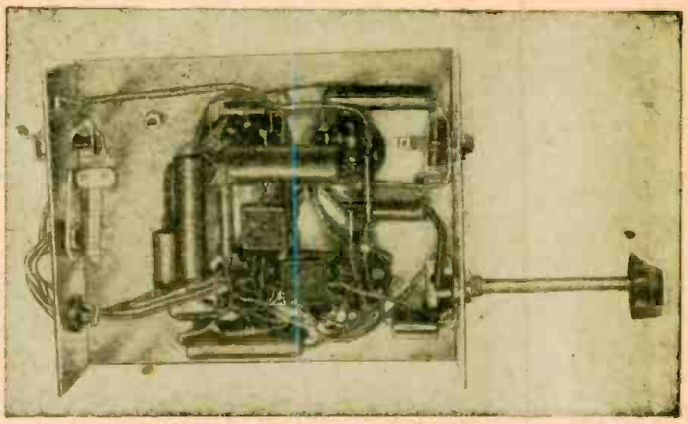


Fig. 1—Receiver schematic. As line is connected to chassis, no external ground may be used. Line fuses are advised.

The regeneration coil L5 is wound on the opposite side of the secondary L1 from



Bottom view of receiver. The top view is shown on preceding page.



Under-chassis view of the 10-watt modulator shown on page 70.

the primary L2 in transformer T1. The actual number of turns will depend upon the type of transformer used, but approximately 100 turns should be satisfactory. This winding may be jumble-wound with No. 34 insulated wire.

The wiring is very simple. A thorough check of all your work is very vital. Don't omit grounding all the shield pins of the tubes.

The chassis is mounted in a wooden case 9 x 9 x 7 inches. The case resembles a speaker cabinet with the speaker and pilot lamp mounted in front and the controls hidden in the back.

To operate the receiver, advance the regeneration control until the thud of oscillation is heard. Tune across the band and so regulate the regeneration that the receiver is kept in the sensitive condition constantly. If the receiver should fail to regenerate, reverse the leads going to winding L5 of the i.f. transformer T1. Failure of the receiver to regenerate across the entire band is remedied by adding more turns to L5.

Turn on your carrier-current transmitter and tune the signal in on the receiver. Reduce the antenna coupling control of the transmitter so that the signal is made as weak as possible. Adjust the trimmer condenser in transformer T1 so that the signal is maximum; then, adjust the trimmer in T2 for maximum signal. Repeat this process several times to align the receiver perfectly. Although tuning by ear is satisfactory for this adjustment, some form of output indicator is preferred.

To receive c.w. signals, keep the receiver regenerating so that the incoming signal and oscillation of the detector will combine to produce an audible tone. Phone stations are received with the regeneration control set just out of oscillation. When the transmitter is not distant from the receiver, 2 signal peaks may be noticed. This problem can be solved by reducing the antenna coupling control on the transmitter.

Phone communication

The desire to talk back and forth over the power lines finally made it necessary to construct a modulator for the carrier-current transmitter. The amplifier described here and shown in Fig. 2 has very good fidelity. It could be used in almost any low-power transmitter, and with the substitution of a suitable output transformer for the modulation transformer could also be used in a small public address system.

The modulator is constructed on a metal chassis 5½ x 7 x 2 inches. Use thorough shielding at the input stages. A grid-cap shield for the metal 6J7 tube must be included to prevent oscillation through the two 6V6-GT push-pull tubes. The 6SN7-GT tube serves as phase-inverter amplifier stage and input 1 amplifier stage. Input 1 is for a phono pick-up or any other sound source with a fairly large output voltage. Input 2 is intended for use with a dynamic or crystal microphone. The high-gain amplifier stage allows pickup of sounds many feet away. The center-tapped volume control is connected so that the center position is neutral. Toward position P the phono amplifier is heard, and toward position M the high-gain microphone stage is heard.

The secondary winding of the modulation transformer T1 is connected in series with the B+ supply to the 807 r.f. amplifier stage. One lead from the secondary of the modulation transformer is connected to the P.A. B+ output post of the power supply; the other lead is connected to the P.A. B+ jack of the transmitter. The value of the impedance of the secondary is found by dividing the operating voltage of the r.f. ampli-

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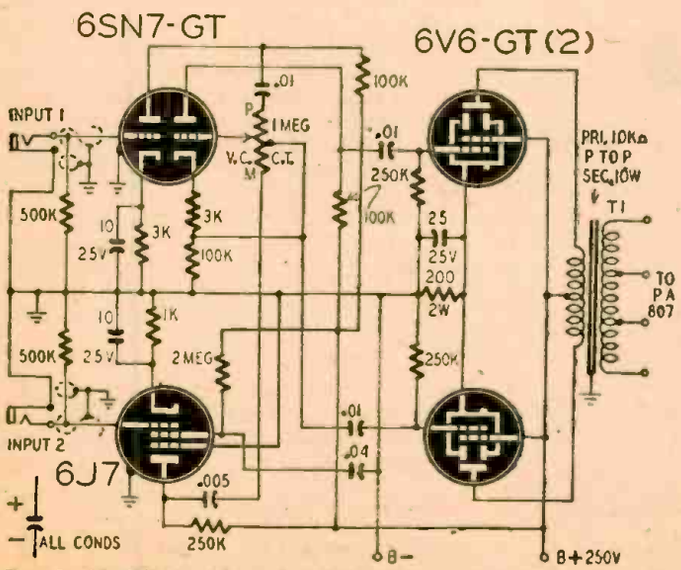
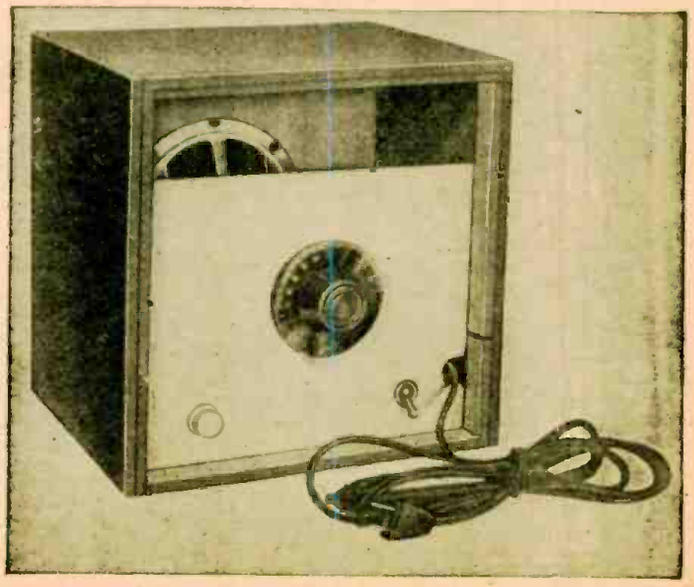
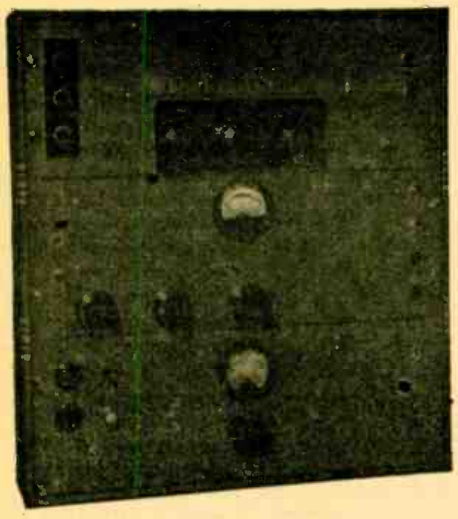


Fig. 2—Modulator schematic. Output is approximately 10 watts.



Tuning controls of the carrier-current receiver are at the rear.



PORTABLE P. A. AMPLIFIER

Here is a 50-pound, three-section unit with a conservatively rated output of 15 watts at low distortion levels

By J. C. HOADLEY

THIS amplifier is equally well adapted to portable recording, remote preamplifier service for feeding a telephone line, or for public address systems. Its characteristics are strictly high fidelity from a frequency-response and distortion standpoint, and it has a particularly versatile response compensation system. It has a gain of approximately 115 db with negligible hum and distortion, yet weighs less than 50 pounds.

The amplifier unit features:

1. Three low-impedance input channels, one of which may be switched to high impedance.

2. A preamplifier unit which may be used separately as such, and which will provide an output impedance of from 50 to 500 ohms for line work.

3. A power amplifier which delivers 14.5 watts at 2.5% distortion to either a 500-ohm line or to various voice-coil impedances, with 4 output jacks, an output level indicator for monitoring and recording use, and a switch for use with dual recording turntables. A separate low-gain input is provided for operation from crystal pickups.

4. Self-contained, husky, well-filtered power supply with plate-current metering of the 2A3 output tubes and bias controls for balancing them.

5. Several 115-volt outlets for convenient connection of a lamp, turntable, motor, or other devices which are controlled by the power switch.

The unit is mounted in a portable carrying case (see photo) 19 x 20½ x 5½ inches which was originally made to house a professional recording turntable. The amplifier was broken into 3 units and mounted on three 6¾ x 18 x ⅛-inch aluminum panels which were sprayed with dull gray lacquer.

The top deck houses the preamplifier and mixer stages and consists of a complete 3-channel remote line amplifier with individual gain control for each channel.

Three 6J7 preamplifier stages with miniature high-fidelity input transformers allow input impedances from 50 to 500 ohms. See Fig. 1.

An impedance of 50 ohms was chosen for use with dynamic microphones. This value has several advantages. Dynamic microphones are extremely rugged and are insensitive to vibration, temperature, and humidity. They have a smooth, wide-range frequency characteristic, which can be varied by changing the sound's angle of incidence upon the microphone diaphragm. The 50-ohm impedance allows microphone lines up to 400 or 500 feet without serious frequency discrimination. One preamplifier may be switched from low impedance to high impedance to accommodate crystal microphones or low-level crystal pickups.

The 6J7 stages are followed by 6C5 stages which control gain and plate circuit mixing individually. Notice the series isolation resistors which eliminate shunting of one tube by its neighbors and the attendant distortion. As a triode cannot work into a resistance lower than its plate resistance, distortion would be serious in a 3-channel mixer.

The mixed output is fed to an output voltage amplifier. This 6C5 stage has a switch which allows its plate circuit to be shunt-fed to a plate-to-line output transformer or switched directly to the grid of the power amplifier which is located on the middle deck.

The preamplifier, when switched to the miniature high-fidelity transformer 500-ohm output, will supply 5 volts across 500 ohms, which is +8 db (based on a zero of .006 watt across 500 ohms). For negligible distortion, it should be run at an average level of not over +2 db (2.2 volts).

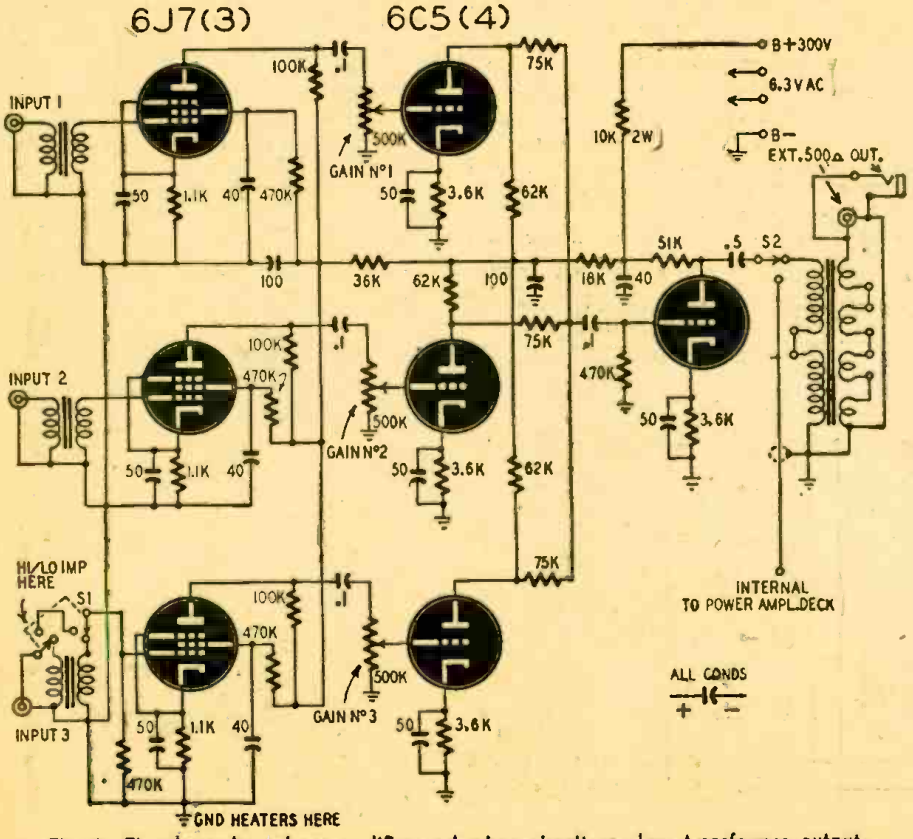


Fig. 1—The three-channel preamplifier and mixer circuit employs transformer output.

The main amplifier

The preamplifier output is first introduced into a gain control which is

the master gain control for the preamplifier section. It becomes a volume control for an external input when S-3 is switched to the external position (see Fig. 2). Following this control are 2 triode stages with a 6SN7 tube. Around this amplifier section is a variable negative feedback network. A 5-position switch enables the operator to select any of 4 preset response characteristics. The fifth position provides variable high- and low-frequency compensation.

Position 1 is the flat position and the amplifier is flat plus or minus ½ db from 30 to 15,000 cycles.

Position 2 provides an NAB standard recording characteristic (high-frequency increase starting at 1,000 and rising 15 db at 10,000 cycles).

Position 3 is the variable one, with a variable bass control allowing a 12-db boost at 60 cycles and a high boost control allowing a 15-db boost at 8,000 cycles.

Position 4 is a flat position with a low-frequency rise starting at 100 cycles and up 8 db at 20 cycles.

Position 5 has an inductive 50-cycle boost of 20 db to compensate for the low-frequency attenuation introduced in modified constant - velocity recording when playing back with a magnetic pickup. These different characteristics which can be selected at will provide an enormous amount of versatility.

The second voltage amplifier stage is shunt-fed by a high-fidelity driver transformer to the grids of the push-pull 2A3 output amplifier tubes. The grid returns are brought out separately so that the fixed bias on each tube may be adjusted to make the plate currents of the output tubes equal.

This is essential in a high-quality output stage, especially when a high-fidelity output transformer is used. More than a few mils unbalance in the output transformer primary winding will result in a loss of low frequencies, due to d.c. saturation of the core material, and an increase in distortion, due to imperfect cancellation of second-harmonic distortion which would result from a push-pull connection.

The output transformer contains 2 output windings and is of the high-fidelity type with an advertised response flat from 30 to 20,000 cps. The first winding has a selection of voice-coil impedances, from 1 to 20 ohms. The second winding allows various line impedances, from 50 to 500 ohms. The impedance selected was 7.5 ohms for the voice coil output which was brought out to a jack on the panel for connection to a speaker. The 500-ohm line output was brought out to a second jack on the right side of the power amplifier panel.

As it was desired to use Brush RC-20 crystal cutters, an output was coupled directly to the 2A3 plates through 0.5-microfarad condensers, and connected through a telephone-type switch to 2 Jones output plugs.

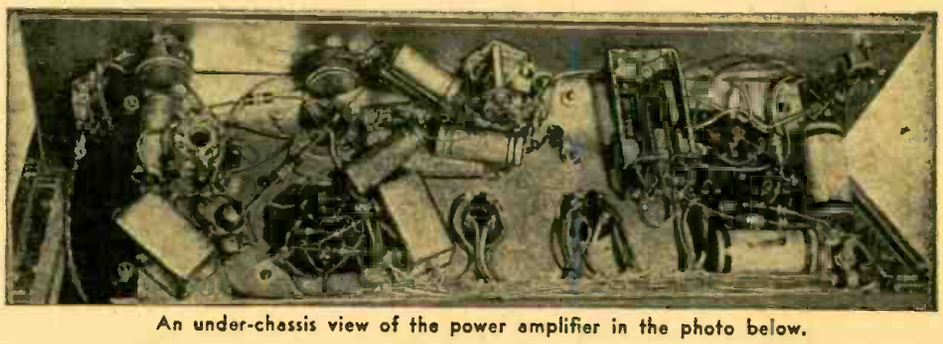
Metering and monitoring

This switch has 3 positions. In the normal position, it connects the 7.5-ohm winding directly to the output plug. In the right and left positions, it connects the 2A3's output to cutter plugs 1 and 2, respectively, and simultaneously introduces a 100-ohm resistor in series with the 7.5-ohm output. This allows the speaker to be used for monitoring when recording, without feedback to microphones. It reduces the speaker output to a comfortable level when recording. If headphone monitoring is preferred, the phones may be plugged into the 500-ohm output jack.

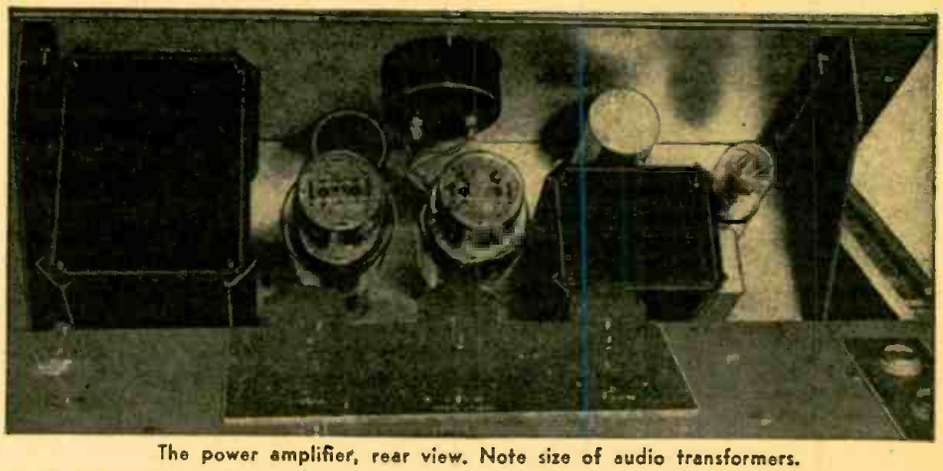
The output-level meter is connected across the 7.5-ohm winding and includes a 0-1 milliammeter and a 1N34 germanium crystal diode. The meter is calibrated in terms of the proper voltage for recording with crystal cutters. It reads 6 volts full scale. This indicator was connected to the 7.5-ohm winding because it causes negligible loading on this low impedance, whereas a more sensitive meter would have to be used across the 500-ohm winding or the high-impedance cutter lines. In case low-impedance or 500-ohm cutters are used, the 15-ohm or 500-ohm winding may be connected to the switch in a similar manner.

(Continued on page 66)

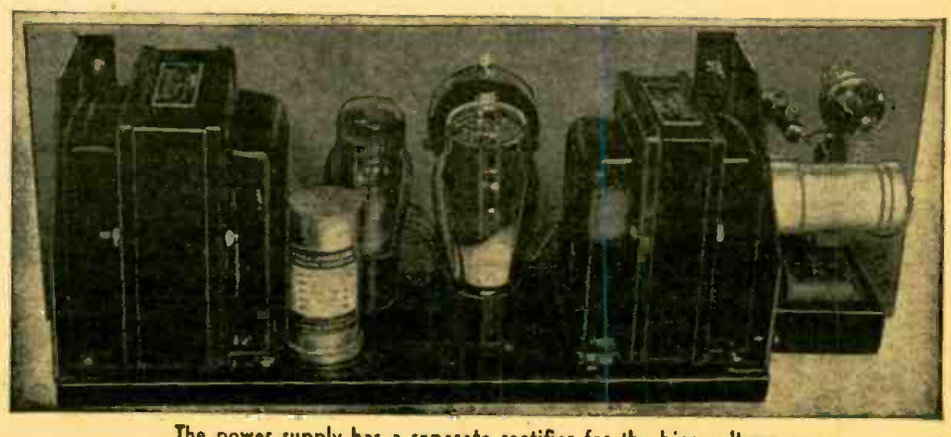
Rear view of preamplifier. There is plenty of decoupling capacity.



An under-chassis view of the power amplifier in the photo below.



The power amplifier, rear view. Note size of audio transformers.



The power supply has a separate rectifier for the bias voltages.

Magnetism -

Part II - Elements of tape recording

By A. C. SHANEY*

Fig. 1.

WHEN Sir Humphrey Davy in 1820 magnetized a bit of soft iron by running a current of electricity around it, he started Michael Faraday thinking of the possibility of converting magnetism back into electricity. Faraday logically reasoned that if electricity magnetizes, magnetism should electrify.

It took him nearly 11 years to discover that magnetism could produce electricity only if *motion* (work) was involved.

Faraday's discovery (simple as it may seem) made obsolete the Voltaic piles—then the major source of electricity—and opened a whole new electrical era of dynamos, generators, and, incidentally, magnetic recording!

Sixty-seven years later, in 1898, Valdemar Poulsen patented the first magnetic recording instrument, which he named the "Telegraphone." In its original form the Telegraphone was crude, inefficient, and somewhat impractical. It appeared that magnetic recording would never compete with older and comparatively better developed recording processes. As a result, it received very little attention — virtually none from American engineers.

During the last war, investigation of captured enemy equipment disclosed that the Germans had brought the art of magnetic tape recording up to a usable level. Subsequently, stepped-up American war research brought the process out of the laboratories and made it commercially available not only as an excellent recording medium, but one which offers highly desirable and unique advantages over disc recording processes. Fig. 1 illustrates such a typical magnetic tape recording and playback unit.

Basic principles

Sound waves are converted into corresponding electrical energy by a microphone and then intensified through an amplifier. This electrical energy is then fed to a recording head which converts electrical energy into magnetic fields of varying intensity. A magnetically coated tape is brought into close proximity to the recording head which magnetizes sections of tape with a magnetic pattern similar to the original sound wave. During playback, the magnetized tape is passed close to a pickup head (identical to the recording head which is usually employed for both functions). The magnetic flux on the tape passes through the pickup head and induces minute electrical energy into its coil structure. This electrical energy is then again amplified (by the recording amplifier if desired) and fed into a loudspeaker where electrical energy is converted back into sound waves similar to those originally picked up by the microphone. (This oversimplified explanation is technically correct, but not complete in detail.)

Fundamental elements

The important elements which enter into magnetic tape recording and playback processes include the following:

1. Recording amplifier,
2. Supersonic biasing oscillator and isolation amplifier,
3. Recording head (magnetic modulator),
4. Recording tape (magnetic carrier),
5. Playback head (magnetic detector),
6. Playback amplifier,
7. Erasing head (magnetic obliterator),
8. Supersonic erasing oscillator and amplifier,
9. Tape handling mechanism,
10. Combination switching circuits.

The interrelation of these elements in the recording, playback, erasing, and tape handling processes have been initially indicated, for simplicity's sake, by block diagrams. Fig. 2 shows both the fundamental and auxiliary elements in a typical magnetic recording process.

The following auxiliary recording elements are included:

1. Preamplifier (for amplification of microphone output),
2. Pre-equalization (to equalize the response of the recording amplifier to match the overload response characteristics of the recording tape),
3. Mixing network (to mix the supersonic bias voltage with the audio signal without causing detrimental interaction),
4. Power supply.

Fig. 3 indicates the fundamental and

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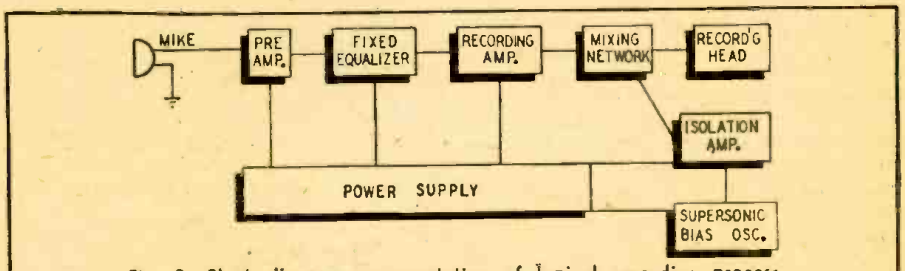


Fig. 2—Block diagram representation of typical recording process.

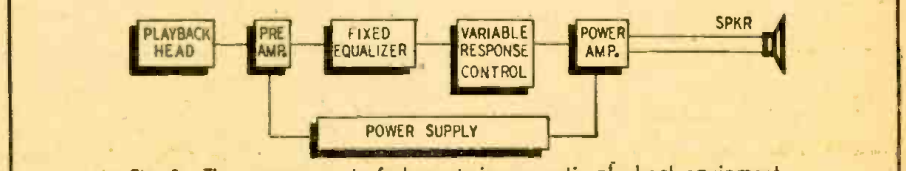


Fig. 3—The arrangement of elements in magnetic playback equipment.

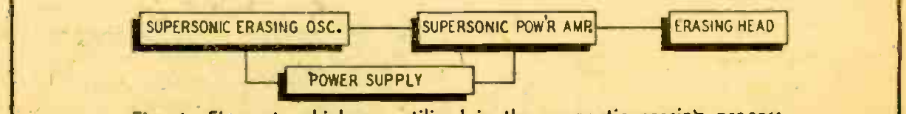
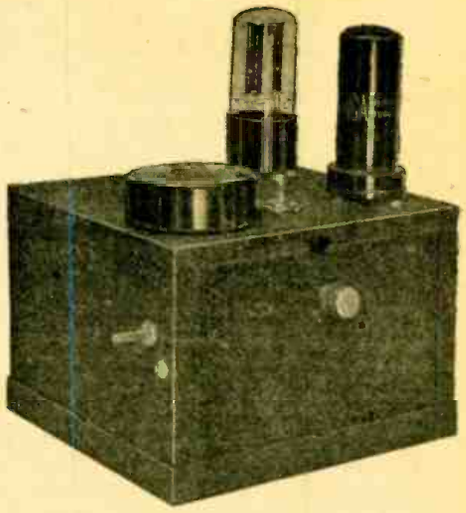


Fig. 4—Elements which are utilized in the magnetic erasing process.

*Chief Engineer, Amplifier Corp. of America.

Signal Calibrator

A 2-frequency crystal oscillator



By I. QUEEN, W2OUX

THIS handy signal calibrator can be used to good advantage by servicemen, amateurs, and experimenters. The entire calibrator is built complete with power supply, 5¼ x 5 x 3⅝-inches, within a metal box, although a box about half the size will accommodate it. Photographs and a schematic are shown.

A 117Z6 voltage doubler provides plate and screen voltages for the oscillator tube, and a small 6.3-volt transformer supplies 6F6 heater. Connect the metal box to B-minus through a condenser and not directly, to avoid possibility of a short when connecting it to a grounded circuit.

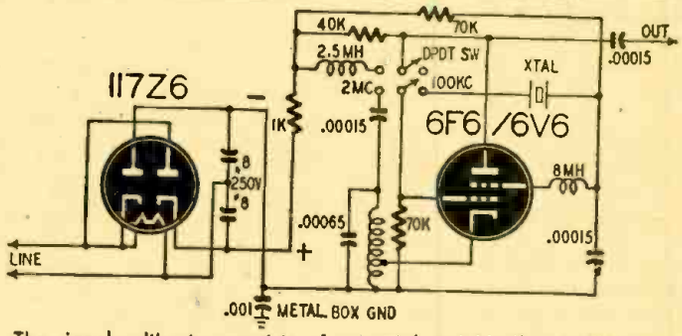
Two frequencies are available: 100 kc and 2 mc, determined by the toggle switch at the top of the box. Surplus 100-kc crystals are now on the market at very low prices. Generally the frequency is slightly on the high side of 100 kc, and it can be tuned exactly by a parallel condenser of about 35-μμf maximum capacitance. This is done by listening to harmonics of the crystal on a short-wave receiver. The 100th harmonic will fall near the 10-mc signal of WWV. The parallel condenser is then adjusted until the 2 signals zero-beat in the receiver. (The crystal used here was found to be so nearly exact that a condenser was not necessary.)

A Hartley circuit is used for the 2-mc signal. The coil is close-wound with 60 turns of No. 28 enameled wire on a ⅝-inch form. The cathode tap is at 20 turns from the cold end. This coil is slug-tuned. A 650-μμf ceramic condenser is connected across it for better stability of the harmonics in the ultra-high range. Final tuning to 2 mc is by adjusting the slug which extends through the metal box. It is done by zero-beating the 5th harmonic with the 10-mc signal from WWV. The 8-millihenry choke coil shown in the schematic is not necessary when the Hartley circuit is used. Since it is necessary when the crystal oscillator is used, however, it is left in the circuit at all times.

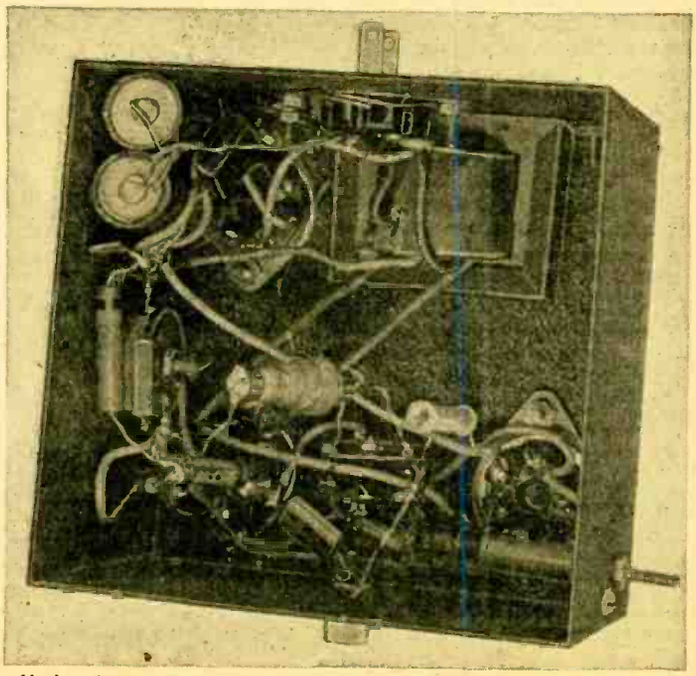
The power supply is only partly filtered, leaving sufficient modulation to produce a low hum for listening on a receiver which does not have a beat oscillator.

This calibrator has many uses. A broadcast receiver can be lined up and the dial calibrations checked at multiples of 100 kc, 600, 700, 800, etc. A piece of shielded wire can be connected between the antenna post of the receiver and the output terminal of the calibrator, or the small aerial fixed to most small sets can be used. Amateur variable-frequency oscillator rigs and monitors can be calibrated accurately at 100-kc intervals. High-frequency sets can be aligned or calibrated by listening to the harmonics from both fundamental signals.

To determine the frequency of a signal, the nearest harmonic of 2 mc should be tuned in first. Because of their wide separation, there should be little trouble in determining which harmonic it is. Then, for closer work, the 100-kc oscillator is turned on and the intervals are counted until the unknown frequency is reached.



The signal calibrator consists of a crystal and Hartley oscillator.



Under-chassis view. The Hartley coil is at the lower right corner.

FM and Television Design

Part I—Tubes and circuits as used in high-frequency r.f. amplifiers

By MILTON S. KIVER

THE current swing is toward the high and ultra-high frequencies for commercial broadcasting. The new FM band extends from 88 to 108 mc; television starts at 44 and reaches up to 216 mc. These ranges include only those frequencies which now have commercial broadcasting. Naturally, other commercial work is being done on frequencies much higher than 216 mc. Color television is but one instance.

When we examine the circuits of receivers designed for these higher frequencies, we encounter many design features which differ from the conventional design of the low-frequency, standard AM receiver. The experimenter who desires to construct high-frequency receivers and the serviceman who is going to repair high-frequency sets must understand why certain circuits assume the form they do. In this article we will analyze the more common modifications to determine their advantages over their low-frequency counterparts.

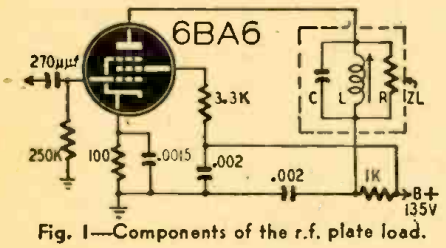


Fig. 1—Components of the r.f. plate load.

Miniature tubes

The miniature tube is a familiar sight these days. Its advantages are compact size, lower interelectrode capacitances, and higher mutual conductances. The connecting leads within the tube are short, reducing internal losses. Finally, most of the miniature tubes have no formal base, with its attendant leakage losses. This is especially significant as we increase the signal frequency. In television circuits, band widths extend for 4 to 6 mc. The higher mutual conductance and lower interelectrode capacitances of the miniature tube improve amplification. To see how both these quantities tend toward improved response, remember that the gain of an amplifier is equal to the product of the mutual conductance of the tube and the load impedance. Mathematically, this is expressed as: Gain$=g_m Z_L$. A high value of g_m results in a high stage gain. In a wide band r.f. or i.f. amplifier, Z_L is the impedance formed by the tuned circuit and its loading resistor. (See Fig. 1.) To get a wide-band characteristic, loading of the tuned circuit is necessary, for as we load such a circuit, we flatten its response. A uniform 6-mc response requires loading resistors from 2,000 to 10,000 ohms. Since the tuned elements themselves, without the shunting resistor, have an impedance considerably greater than the resistor, placing the two in parallel will result in an over-all value which does not differ much from the value of the resistor. The value of shunting resistor, therefore, should be as high as possible to maintain high circuit impedance. It is not so obvious that the value of R for any desired band width is governed directly by the shunting capacitance of the circuit.

In any amplifier, the total capacitance across the circuit (whether it be a plain load resistor or a coil) is the sum of any inserted capacitances, plus the wiring capacitance and interelectrode capacitance of the tube. In low-frequency circuits it is possible to disregard the tube interelectrode and wiring capacitances and consider only the physically inserted capacitor. At the high frequencies, however, there is little or no inserted capacitance and we rely solely upon the tube and distributed wiring capacitance to resonate the coil.

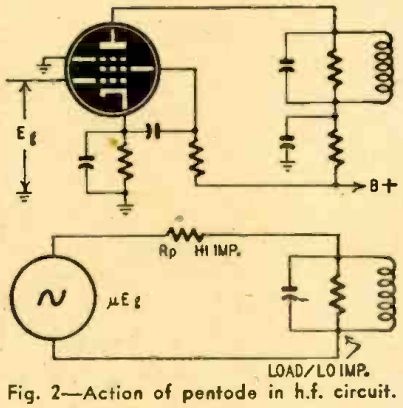


Fig. 2—Action of pentode in h.f. circuit.

Amplifier gain, as we have seen, is dependent upon tube g_m and load impedance Z_L. Load impedance is determined mainly by the shunting resistor, the resistor which is needed to broaden the circuit response. The value of the load resistor (for any given band width) is, in turn, determined by the L to C ratio of the tuned circuit. Consequently, the smaller the tube interelectrode capacitance, the greater the L to C ratio, the higher the shunting resistance and, as a final consequence, the higher the stage gain. Thus, through the very fact that at the higher frequencies the tube interelectrode capacitance assumes greater importance, we find that it must be given more attention as a circuit element. The miniature tubes, because of their smaller element size, have less interelectrode capacitance. Use of a smaller tube also results in shorter leads from the elements to the circuit. This is often just as beneficial as reduced internal capacitance.

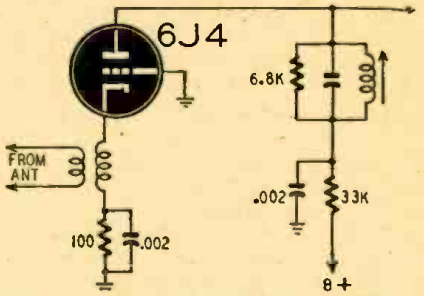


Fig. 3-a—An r.f. grounded-grid amplifier.

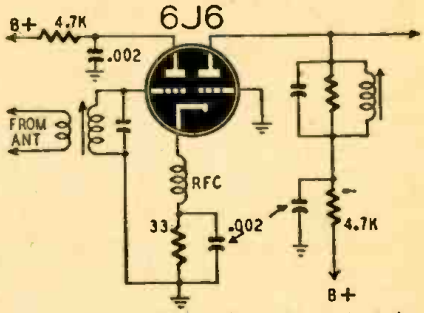


Fig. 3-b—Cathode coupling with dual triodes.

The resurgent triode

Several years ago the triode was regarded as passé so far as the modern superheterodyne receiver was concerned. Yet today we find triodes used extensively in the high-frequency sets coming off the assembly line. In the RCA Model 630TS 10-inch television receiver, 3 double triode tubes (6J6's) are employed in the r.f. section. In the Philco FM receiver, a double triode (7F8) is used as a high-frequency oscillator and mixer. The triode, far from being obsolete, is coming back stronger than ever. Many ask, "Why?"

The reasons are these: In a sensitive receiver, tube and circuit noise are most important in the r.f. amplifier and

mixer stages. Every tube and resistor in a circuit generates a certain amount of noise due to the random motion of electrons within them. In a resistor this is known as *thermal noise* or *thermal agitation;* in a tube it is known as the shot effect. The amount of noise voltage produced is not very large, generally less than 15 microvolts. This voltage is important in the r.f. end of the receiver because many signals entering the system may be of the same order of magnitude as the noise voltages or not much greater. The noise voltages, then, must be kept as small as possible and the signal be given maximum amplification.

The tube generating the smallest amount of internal noise is to be preferred. The noise generated in a tube varies in direct proportion to the number of grids in that tube. Thus, the noise energy produced by a pentode is about 3 to 5 times as great as that by a triode. The ratio between the noise voltages of pentagrid converters and triodes is even greater. Another important fact is that the noise output of a tube operated as a converter (or mixer) is always greater than the corresponding noise output when the tube is used as a straight class-A amplifier. Thus, if we use an r.f. amplifier with a low noise factor and high amplification, we can boost most incoming signals to the point where they override easily the more bothersome converter or mixer noise.

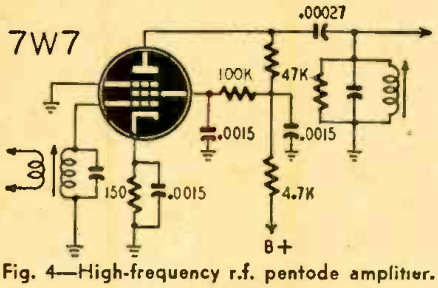


Fig. 4—High-frequency r.f. pentode amplifier.

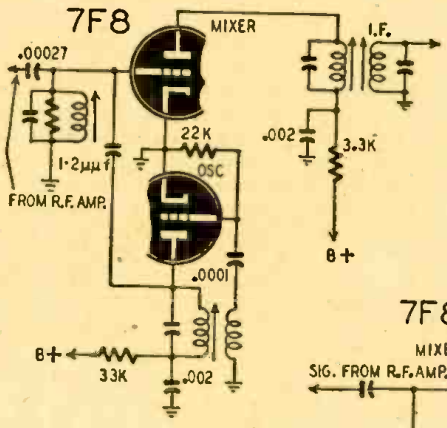
Pentodes have always been considered superior to triodes as amplifiers. This, of course, in standard AM receiver circuits. In receivers designed for television, the situation is slightly different. First, the newer types of triodes designed for high-frequency operation have a greatly reduced grid-to-plate capacitance. This makes them less likely to oscillate. Second, the gain of a triode in television circuits is comparable to that of a pentode. This behavior is explained when we examine the conditions that exist in wide-band amplifiers. At broadcast frequencies the impedance of the resonant circuit (in the output of a stage) is high since it is sharply tuned and not loaded down by any external resistors. In a television circuit the loading resistors (to produce the desired band spread) reduce the impedance of the tuning circuit to a value somewhere between 2,000 and 10,000 ohms.

Fig. 2 shows what happens if we use a pentode tube with a circuit of this type. The actual circuit is shown in Fig. 2-a and the equivalent circuit in Fig. 2-b. The amplified signal divides between the plate resistance of the pentode and the tuned output circuit. Since the pentode's internal resistance is considerably greater than the impedance of the tuned circuit, most of the amplifier signal is lost in the tube. Consequently, the over-all gain is low. It thus becomes possible to get approximately the same gain from a triode as a pentode. Also, the triode generates less noise than a pentode. In areas where the received signal strength is low, this is an important factor.

In FM receivers the tuned circuits have fairly high impedances. A pentode as an amplifier in the r.f. stage is capable of providing more gain than a single triode. However, with the new double triodes such as the 7F8 or 6J6, we can achieve as much gain as a pentode with approximately the same number of components. In addition, we must not forget the low noise factor of the triode.

R.F. amplifier circuits

In using triodes as r.f. amplifiers, several circuit arrangements are possible. In Fig. 3-a, the tube is connected as a grounded-grid amplifier. The grid is grounded and the input signal is fed into the cathode. In an arrangement of this type the grid remains at ground potential, and the cathode potential fluctuates in accordance with the input signal. Since the plate current of a triode is determined by the potential difference between the cathode and grid, it makes little difference which electrode is kept fixed and which fluctuates. There is an added advantage in grounding the grid since it acts as a shield between the input and output circuits and prevents the tube from oscillating.



Figs. 5-a, 5-b — Converter circuits with dual triodes. Both grid and cathode injection are employed.

In Fig. 3-b, a dual triode (either a 6J6 or a 7F8) is functioning as a cathode-coupled amplifier. (If a 7F8 tube is used, tie both cathodes together.) The input signal is fed into the grid of the first triode. The varying current passing through the un-bypassed inductance causes the cathode voltage to vary with respect to ground. Since this cathode is common to the second triode, the plate current of this tube will vary. Note that this second tube is connected as a grounded-grid amplifier. The gain of this combination is as good as a single pentode. The double triode, however, has the advantage of having a high input impedance and of isolating the following oscillator, thus preventing any of its voltage from feeding back to the antenna and radiating to nearby receivers.

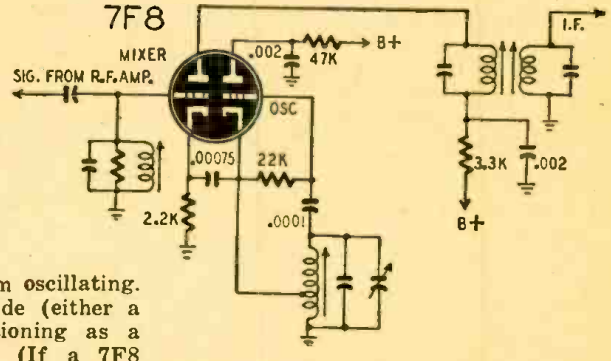
In such amplifiers, the antenna circuit is well isolated from the mixer and the amount of oscillator signal radiated to nearby receivers is negligible. With a single intervening pentode, the isolation is not quite as effective and radiation may occur. This can be particularly troublesome to nearby television receivers.

A pentode r.f. amplifier is illustrated in Fig. 4.

Converter or mixer circuits

A common combination is the use of a double-triode for mixing and generating the oscillator voltage. Typical diagrams are shown in Figs. 5-a and 5-b. The oscillator voltage can be injected either at the mixer grid or the mixer cathode. The incoming signal is applied, as usual, to the mixer grid. Still a third variation of the circuit of Fig. 5 is the cathode-coupled mixer shown in Fig. 6. The incoming signal from an r.f. amplifier is coupled into the grid of one of the triodes of a 6J6 tube. Due to the impedance of the coil in its cathode circuit, the cathode potential varies with respect to ground. The second triode of the 6J6 is the oscillator with the grid coil coupled to the inductance in the cathode circuit. The intermediate frequency appears in the plate circuit of the first triode, from which point it may be passed on to the i.f. system.

In many FM receivers and all television sets, the oscillator frequency is above that of the signal. The difference between the two is of course equal to the i.f. Inserted capacitance is reduced to an absolute minimum and in most instances forms only a small portion of the total capacitance across the resonated coil. The remainder of the capacitance is that of the tube and wiring. Note that this reduction in inserted capacitance is necessitated by the high frequency and the desire to obtain as high an L/C ratio as possible to increase the output. As the set warms up, especially the oscillator circuit, the interelectrode capacitance changes enough to cause an appreciable drift in oscillator frequency. There are 2 ways to minimize this drift: First, we can in-



(Continued on page 86)

250-Watt FM-AM Transmitter

PART V—The modulator, modulation indicator and power supply

By HARRY D. HOOTON, W3KPX

The power supply and modulator are mounted in one chassis unit.

THE modulation percentage indicator is a dual-diode type similar to the circuits which have been described in amateur publications from time to time. The circuit consists of a 6H6 rectifier tube, and 0-1 d.c. milliammeter, a tuned circuit, and a few resistors and capacitors, as shown in Fig. 1. Operation of the modulation indicator is very simple: The pickup loop, a single turn of insulated wire, is placed against the transmitter cabinet side 8 to 10 inches away from the final amplifier tank coil. The transmission line from the pickup loop to the modulation indicator tuned circuit *must* be shielded to prevent r.f. pickup from the buffer stages; *if r.f. from the buffer finds its way into the unit, false modulation percentage readings will be indicated.* With the switch thrown to the right, the 0-1 d.c. milliammeter will indicate the carrier level. Adjust the variable resistor until the milliammeter indicates exactly 1 ma. Once set, the adjustment will remain unless the coupling loop in the final amplifier compartment is moved (if operation on several bands is contemplated, the necessary r.f. pickup may be obtained by wrapping 3 or 4 turns of *well-insulated* wire around 1 of the feeders to the antenna instead of using the loop). Now, throw the switch to the right; the meter should return to zero with the carrier on. If the meter does not return to zero with the carrier on, this indicates noise or modulation, possibly hum, on the carrier. With the meter at zero, modulation will be indicated by a lift of the needle; modulation at the 100% level is indicated when the needle swings from zero to 1 ma during speech operation. If the needle swings past 1 ma, overmodulation is indicated. With the compression in effect, the needle will rise rapidly to 0.7-0.8 ma but will become "stiff" for the remainder of the scale. As a further check on the modulation percentage, the class-B, TZ-40 modulator plate current milliammeter is shunted to indicate approximate percentage of modulation; this feature will be discussed later.

The class-B, TZ-40 modulator stage (Fig. 2) is very simple. The driver transformer is mounted on the speech amplifier chassis. Connections between the driver transformer secondary and the TZ-40 grids are made with twin-conductor shielded cable and plugs. The shield serves as a common conductor. As the two chassis are mounted in the rack one directly above the other, the twin-conductor cable is only about 8 inches in length. The modulation transformer is a 500-watt unit designed to match the TZ-40 plates to a variety of r.f. load values. Any good modulation transformer with the proper impedance values and rated 175 watts or higher will be suitable.

The modulator chassis also includes the modulator power supply. The power unit consists of a power transformer rated at 2,320 volts a.c., center-tapped, at 300 ma, a pair of 866 Jr. rectifiers, 2 filter chokes, two 4-μf filter capacitors, and the necessary filament transformers. The d.c. voltage output from the power supply unit is 1,000 volts at 300 ma.

The modulation meter

As mentioned above, the TZ-40 plate-current milliammeter is shunted to indicate approximate modulation percentage. To make the shunt, connect in the TZ-40 plate-current line a d.c. milliammeter with a full-scale rating of 250 ma. Using an oscilloscope for measurement purposes, note the modulator plate current at 100% *voice* modulation of the carrier. With 250 watts input to the final r.f. amplifier, the modulator plate current will kick up to about 150 ma at 100% modulation, the exact value depending upon the compression control setting. Now, remove the 250-ma meter from the modulator plate-current line and connect in series with the 250-ma unit a variable resistor of about 10,000 ohms, 10 watts, and another d.c. milliammeter of 100-ma, full-scale rating which has been *heavily shunted* by a length of shunt wire. It is best to have the insulation removed from the shunt

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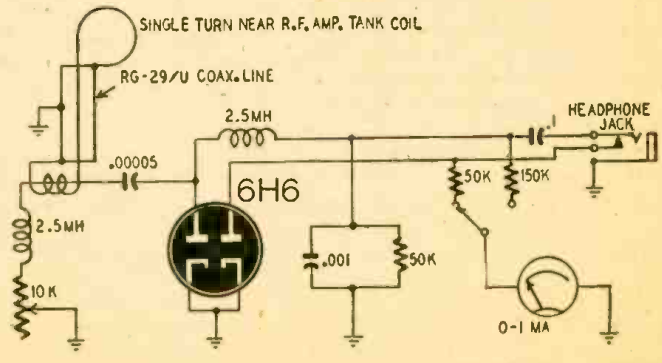
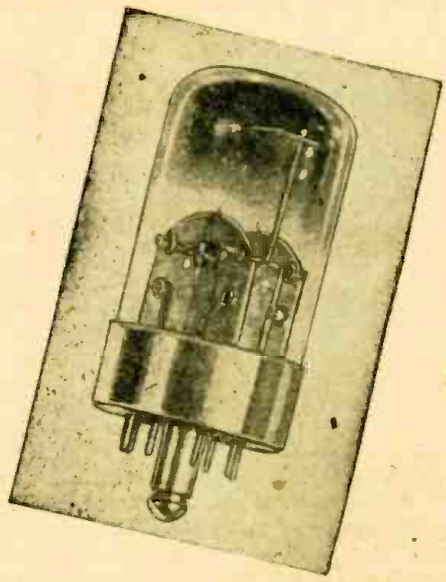
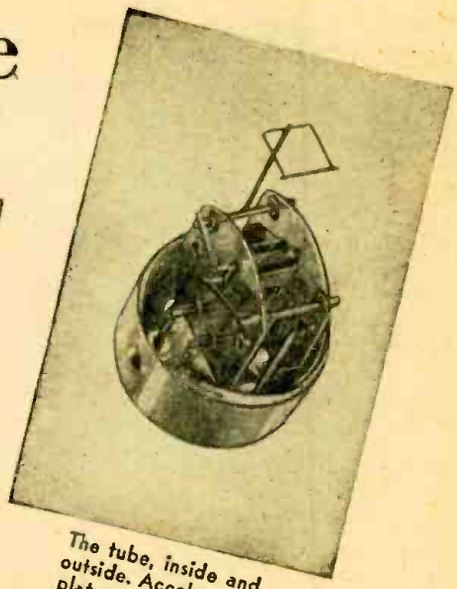


Fig. 1 — The modulation percentage indicator is also usable to monitor the transmitter and adjust compression.

Acceleration Pickup Tube

By S. R. WINTERS





The tube, inside and outside. Acceleration plates are inside the large baffle plates.

A NOVEL electronic tube for determining precisely the swiftly changing accelerations of an airplane (or various points on a plane) in flight has been designed by Dr. Walter Ramberg of the National Bureau of Standards. This brand-new addition to the audion family bears the label *vacuum-tube acceleration pickup.* It has already been applied in measuring accelerations of flesh-and-blood pilots, as well as dummies, when they are subject to violent changes in speed during crash landings or when thrown from pilot seats in speedy jet-propelled aircraft.

This new electronic tube, 6 years in the making, is a double diode which has a surface resemblance to the garden variety of radio tubes. In design it represents a material departure. This tube utilizes the effect of accelerations on the relative position of the electrodes in the diode; in conventional designs this tendency is restrained because it would cause electrical noise or "microphonics." The new addition to the tube family has a fixed, indirectly heated cathode with 2 plates, one on either side. These plates are mounted, so to speak, like rubber bands in that they "deflect in response to acceleration normal to the plane of the plates." This reduces the plate resistance of one diode and increases that of the other, producing a change in the plate current in proportion to the acceleration. The ratio of the 2 currents is registered on a conventional oscillograph.

The above-mentioned elastic mounting of the plates is intended to afford a fundamental mechanical vibration frequency of 800 cycles a second—assurance that this electronic tube will record accelerations with frequencies up to 200 cycles per second. Practical trials at the Bureau of Standards have shown that this latest tube (of which not quite a hundred have been constructed) has the desired natural frequency with an output in proportion to acceleration normal to the plates. For instance, the output for an acceleration of the order of 10 gravities is of adequate magnitude to register directly on a conventional oscillograph, without requiring an auxiliary amplifier.

Calibration procedure

Tubes were calibrated up to accelerations of well over 20 gravities on a spinning table. A very interesting method was used to calibrate it at 2 gravities. The tube was simply placed on its side with the plates in a horizontal position, then turned through 180 degrees, so that the top plate was on the bottom. In the first position the top plate P1 is bent toward the cathode with the force of gravity and P2 bent away from it with the same force. Thus the current through P1 is greater, and through P2 less, than with the tube in an unaccelerated position, such as it would be if upright and stationary. With the tube turned so that P1 is the bottom plate and P2 the top one, the condition is reversed. The ratio of currents through the 2 sections of the tube, as measured in the Wheatstone bridge circuit of Fig. 1, corresponds to an acceleration of 2 gravities.

The fundamental frequency was fixed through trial-and-error procedure by connecting the Wheatstone bridge output to a cathode-ray oscilloscope, gently tapping the pickup with pencil or finger, and then matching the output on the oscilloscope with the output of known frequency of an audio-oscillator.

In common with characteristics of other vacuum tubes, the new tubes had certain inherent drawbacks. The zero or reference point, for example, of most of the tubes tested, displayed a tendency to drift gradually with time. Furthermore, a 15-minute warming up period was necessary to attain equilibrium. However, we are told that these drawbacks should not be significant in registering swiftly changing accelerations over a brief period of time.

Use of this novel electronic tube is suggested in services in which advantages of high output, high capacity, and linearity outweighs such drawbacks as zero-point drift, warm-up time, relatively large power consumption of 7 watts for the tube and Wheatstone bridge, and the necessity of filtering to displace natural frequency response.

The high output, as well as the high natural vibration frequency, of this tube renders it feasible to record swiftly without an amplifier. This is obviously a desirable factor in flight testing of small aircraft, where space and weight are rationed. Likewise it makes for less complicated laboratory tests when amplifying channels are not readily accessible.

The high capacity of the tube is desirable for registering accelerations over a broad range and in avoiding damage from abrupt high accelerations. The linear values of this pickup are such as to allow the filtering out of high-frequency response, irrespective of amplitude, and afford a record proportional to acceleration.

To summarize, the vacuum-tube pickup is another electronic research tool. It

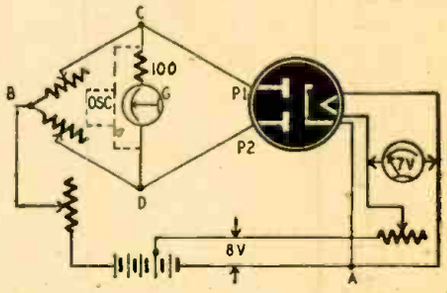


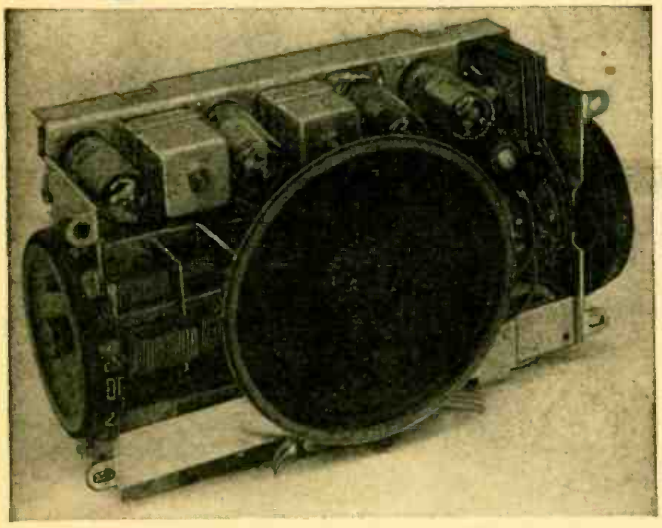
Fig. 1—How the pickup tube is hooked up.

is a convenient means for measuring accelerations from 5 to 40 gravities. It combines high sensitivity with high natural frequency, making it possible to record rapidly varying accelerations directly without the complication of an intermediate amplifier. Its disadvantages are that it is more subject to zero drift; requires a warming-up period of about 15 minutes before reaching equilibrium, and requires a filter to remove response at its natural frequency.

The development of this important electronic tube is credited largely to the Bureau of Standards, although Sylvania Electric Products, Inc,. and the Army and Navy were co-operative agencies when a "birth certificate" for the tube was sought in 1941.

Radio Set and Service Review

Sentinel Treasure Chest Model 286 PR

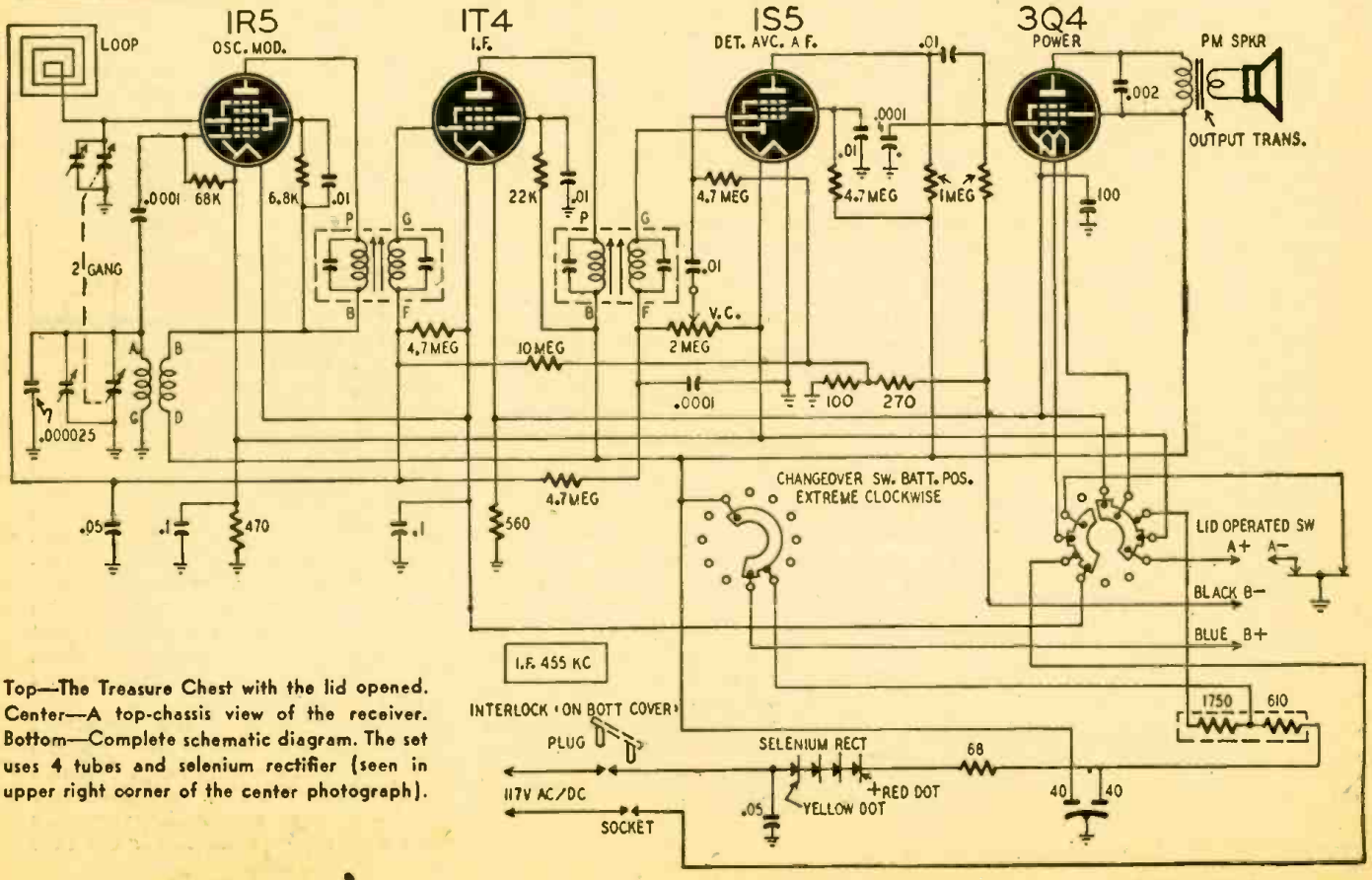


THE Sentinel Treasure Chest—probably so-called because its 2-tone plastic cabinet resembles milady's jewel box—is a 4-tube, a.c.d.c.-battery portable broadcast receiver. It is installed in a maroon case with a gold-plated speaker grill, the color combination harmonizing well with the glossy black hinged lid and back cover.

The case is 8¼ inches long, 4½ inches high, and 5 inches deep. It weighs only 5½ pounds complete with batteries. When it was first placed on the market, it was announced as the "tiniest" 3-way portable yet offered to the public. Its size, little larger than the smallest battery portables, makes it very convenient to carry on long trips.

Two edge-mounted controls are a special feature of the set. The slow-motion dial at the right of the set simplifies tuning. Volume control and power selection switch are at the left, mounted on concentric shafts. The large thumb-operated control discs operate easily with fingertip pressure.

The Treasure Chest brings in local and distant stations with good volume and selectivity, though no preselection is used. This—combined with the slow-motion action of the tuning dial—makes tuning easy *(Continued on page 82)*

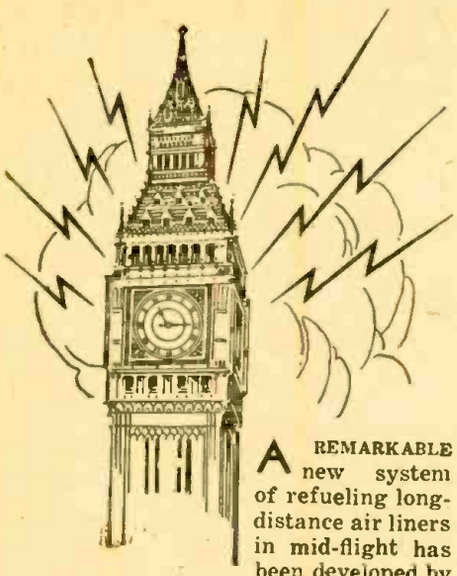


Top—The Treasure Chest with the lid opened. Center—A top-chassis view of the receiver. Bottom—Complete schematic diagram. The set uses 4 tubes and selenium rectifier (seen in upper right corner of the center photograph).

Transatlantic News

By Major Ralph W. Hallows

RADIO-CRAFT EUROPEAN CORRESPONDENT



A REMARKABLE new system of refueling long-distance air liners in mid-flight has been developed by British South American Airways. Successful test flights have been made every week during this summer on the South Atlantic route, and it is intended to employ the new method on the North Atlantic route next year. Bound for Bermuda, the air liner has been leaving London carrying 7 tons less gasoline than needed for the nonstop trip. The 7 tons saved leave room for an extra 7 tons of profitable freight. The basis of the whole system is an entirely novel application of radar aids. Here is how it is done.

You remember that highly successful wartime radar setup known as Rebecca-Eureka? Eureka was a radar beacon dropped with parachute troops and installed by them at the point required. It contained a transmitter, which emitted pulse-trains when triggered off by impulses sent out by Rebecca. In the war Rebecca was airborne and served to enable the aircraft carrying it to "home" on Eureka. In the refueling system now being developed, a modified form of Eureka is also airborne, being carried both by the air liner and by the *flying tanker* from which it is refueled.

On leaving the London Airport, the air liner sets a course for the Azores, using the *Gee* radar navigational system for the first 300 miles and *Consol* or *Loran* after that, if weather conditions make position-fixing by direct methods impossible. The flying tanker is based on Santa Maria in the Azores. The course of the liner having been plotted by radio and radar, a *rendezvous* (38° 30′ N, 29° 0′ W, southwest of Fayal, is typical) is decided upon and radioed to the liner, the expected time of meeting being also given. Each aircraft carries both Rebecca and Eureka. An hour before the predicted foregathering, each switches on Rebecca. They thus "home" on each other and always know each other's position, regardless of cloud or fog. In due time visual contact is made and the refueling begins. The first contact is always made with a weighted line trailed by the tanker, which must be a good conductor of electricity. Thus any potential difference between the two aircraft is wiped out, and there is no fire risk from sparks during the refueling.

Thanks to radio and radar, refueling in the air has been accomplished without the slightest hitch on every trip. The system has enormous possibilities and may well be applied to much longer flights. There is, for example, no reason why a passenger liner or a freighter should not be refueled two or even three times in the course of a long, nonstop journey. A much smaller amount of gasoline would then be carried on starting, and the take-off weight of the aircraft could be made up of a smaller proportion of unprofitable fuel and a larger proportion of highly profitable passengers and goods. Once again the thermionic tube offers to mankind an inestimable benefit!

V. h. f. police radio

Some months ago I described a v.h.f. diversity-transmission, diversity-reception system which had been devised to enable police automobiles to keep in constant touch with their headquarters. The system was originally developed by technicians employed by the British Home Office. It has proved completely successful and is now being installed over the greater part of this country. So big is the demand from police headquarters all over the country that the Marconi Company has found it worthwhile to design and market a special range of transmitting and receiving equipment for use both at police centers and in patrol automobiles. The automobile set, operated from the car battery, is so compact that both transmitter and receiver are easily stowed in the rear luggage compartment. The microphone, receiver, and controls are on the dashboard. The working carrier frequencies are between 75 and 100 mc. The carrier frequency of the stationary set at headquarters is crystal-controlled. The crystal frequency is low, but a succession of tube circuits select and amplify the 18th harmonic, which becomes the carrier frequency, delivered with a power output of 50 watts to the antenna. Both transmitter and receiver use the same antenna and are placed close to it to minimize feeder length. Remote control may be used up to 3 miles over ordinary telephone lines. This facilitates diversity-transmission and reception. The automobile part of the equipment includes a loudspeaker for traffic control purposes. This can be connected to the microphone and the a.f. amplifier with a switch on the dashboard. The mobile transmitter is also crystal-controlled and has a power output of 10 watts.

Radio taxicabs

The university town (a place in England is not as a rule called a city unless it is the site of a cathedral) of Cambridge has a large population and extends over a considerable area. Some of the colleges are a mile from one another, and most of them are the best part of that distance from the railroad depot. The biggest fleet of taxicabs in Cambridge is owned by a lady, who used

(Continued on page 81).

PN-TYPE CRYSTAL PICKUP ▶

The new Brush Model BR-903 pickup cartridge has several outstanding features. It uses a crystal of the PN type (ammonium dihydrogen phosphate) which, unlike rochelle salt, is very rugged. It withstands humidity of 90% and temperatures of about 160° F continuously without harm. In fact, PN crystals can be immersed in boiling water for 10 minutes without damage.

The new cartridge operates with a needle pressure of only ⅓ ounce and has low needle talk. Its sapphire stylus is replaceable.

A load of 5 megohms is recommended. The total cable capacitance between cartridge and load should be kept low, for example 100 μμf. This will allow about 2 feet of shielded cable. Under these conditions approximately 1 volt will be obtained across the load at 300 cycles.

A Remote Microphone

INTERESTING new features, mechanical as well as electrical, are found in the *Ultramike* illustrated here. A *wireless* microphone, sending out a signal on the broadcast band, the unit is entirely self-contained in a case no larger than the ordinary mike stand. The stand contains the 1½-volt filament and 45-volt B-battery as well as the 1-tube oscillator. Another feature is that no screws are used in construction, everything being put together with rivets and tabs.

The circuit is electron-coupled, the screen, cathode, and grid forming a Hartley oscillator. The tapped oscillator coil is tuned to any desired frequency between 1250 and 1650 kc with a variable slug. A plate loading coil is self-tuned roughly near the center of this range. Power is supplied by the plate to an aerial of several feet of wire.

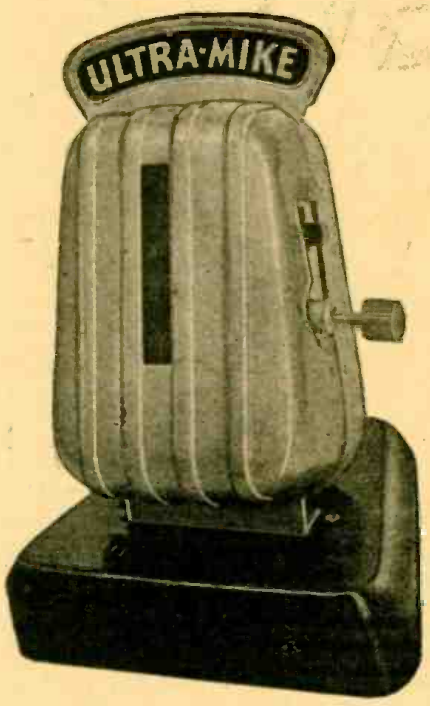
The grid leak, instead of returning to ground, goes to the high end of the 45-volt B-battery through a 100,000-ohm resistor. This is claimed to give more positive oscillation, as current is high when the set is turned on. When oscillation begins, the negative voltage built up on the grid produces normal bias on the grid.

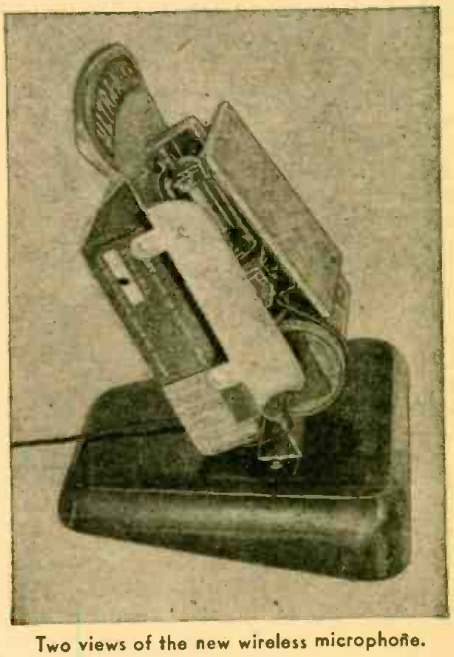
The microphone is a special condenser type, and is connected directly between grid and ground. There is also a grid condenser of .0004 μf in series with the oscillator coil.

A very interesting feature is that the device is intended to be used as carrier-current device. The user is instructed to attach the antenna clip to any convenient radiator, water pipe, electrical conduit or other "ground." Loud signals then will be received on all radio equipment connected to or situated near the same "ground" system, while very little energy is radiated directly through space. Thus the useful range is increased while danger of interference to radios outside the building is actually reduced.

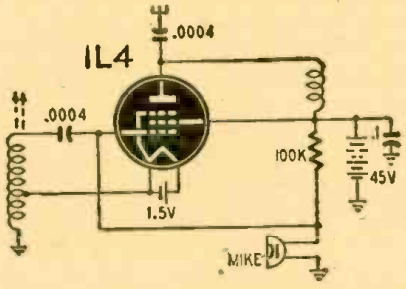
The Editor obtained the following results in his home:

Three different radio sets in 3 different rooms in the apartment were tuned to 1200 kc. Then the Ultramike was adjusted with the tuning knob. With the mouth close to the mike and speaking in a rather low voice, the voice came out very well on all 3 different radio sets, although separated by walls (some of steel wire lath).





Two views of the new wireless microphone.



SENSATIONAL VALUE

...announcing for the first time

The New Model 247

TUBE TESTER

Tests yesterday's tubes, today's tubes and tomorrow's tubes. The Model 247 features a newly designed *element switching system* designed to accommodate all future tubes as they are announced.

Features: It is impossible to insert the tube in the wrong socket when using the new Model 247. Eight separate sockets are used, one for each type of tube base made. If the tube fits in the socket it can be tested.

The Model 247 incorporates a newly designed element selector switch system which reduces the possibility of obsolesence to an absolute minimum. Any pin may be used as a filament pin and the voltage applied between that pin and any other pin, or even the "top-cap". Please note this is not a variation of the commonly used "floating-filament" arrangement but instead represents a real advance in design, inasmuch as it provides a true "free-point" system. Tubes having tapped filaments and tubes with filaments terminating in more than 1 pin are truly tested with the Model 247 as any of the pins may be placed in neutral position when necessary.

The new free-point system described above permits the Model 247 to overcome the difficulties encountered with other emission type tube testers when checking, Diode, Triode and Pentode sections of multi-purpose tubes, because sections can be tested individually when using the new model 247. The special isolating circuit allows each section to be tested as if it were in a separate envelope.

The Model 247 provides a super sensitive method of checking for shorts and leakages up to 5 Megohms between any and all of the terminals. Continuity between various sections is individually indicated. This is important, especially in the case of an element terminating at more than one pin. In such cases the element or internal connection often completes a circuit.

One of the most important improvements, we believe, is the fact that the 4 position fast-action snap switches are all numbered in exact accordance with the standard R.M.A. numbering system. Thus, if the element terminating in pin No. 7 of a tube is under test, button No. 7 is used for that test. This feature will be appreciated especially by servicemen who, when using other tube testers, have been compelled to first try various positions to locate the correct element and then have had to look up charts in order to learn which pin is used for that particular element.

Model 247 comes complete with new speed-read chart. Comes housed in handsome hand-rubbed oak cabinet sloped for bench use. A slip-on portable hinged cover is included for outside use. Size: 10¼"x8¼"x5¼".

ONLY

$29.90

20% deposit required on all C.O.D. orders.

MOSS ELECTRONIC DISTRIBUTING CO.

DEPT. RC-11, 229 FULTON STREET, NEW YORK 7, N. Y.

WORLD-WIDE STATION LIST

Edited by ELMER R. FULLER

A LARGE part of our observers' time seems to have been spent on the 10- and 20-meter amateur bands during the past few weeks. Conditions on these frequencies have been very good at times during the fall and show signs of very good dx during the winter months. Reports this month have been received from Bill Duggan of Goshen, New York; Orville F. Gardiner of the Veterans Hospital in Palo Alto, California; Charles C. Fox of Evansville, Indiana; Charles O. Luckett of Roselle, New Jersey; Marvin Blasser, W5NFZ, of ??? (I'd like to answer your letter, but no address is given, and I did not find your call in the summer issue of the *Amateur Call Book)*; John A. Shanks of Russellville, Tennessee; John Winkler of Big Rapids, Michigan; Dwight Thomas of Waco, Texas; Donald G. Thompson and Carl Slutter of Scranton, Pennsylvania; Central Telegraph Office in Athens, Greece; and the Australian Radio Services.

Australia is now being heard by North American listeners on VLB on 9.54 mc from 0700 to 0815 and at the same times over VLC7 on 11.84 mc. VLA7 on 17.800 mc from 1900 to 2015 and to the west coast over VLA8 and VLC6 on 11.76 and 9.615 mc from 1000 to 1100; and over VLA5 on 15.32 mc; VLB8 on 21.60 mc; and VLG6 on 15.24 mc from 2245 to 2345.

Among the hams heard are TG9RV in Guatemala; KX6USN on Bikini Atoll in the Marshall Islands; VR6AA on Pitcairn Island; KP6AB on Palmyra Island; XADT in Leghorn, Italy; CN8BA in French Morocco; F8MY in Paris; J9CRP in Kwajalein, Marshall Islands; VK9NK in New Guinea.

A transmitter in Burma has been heard in eastern United States on 9.540 mc at 0845 EST and ZIK2 in the British Honduras on 10.600 mc at 1330. An Italian transmitter has been heard on 15.120 mcs at 0730 hours. OTC in Belgian Congo from 2100 to 2300 hours on 9.745 megacycles. A station thought to be in Moscow has been reported to us on about 15.200 megacycles at about 2300 to 2430 hours, when they were still on. A man and a woman were heard speaking at frequent intervals.

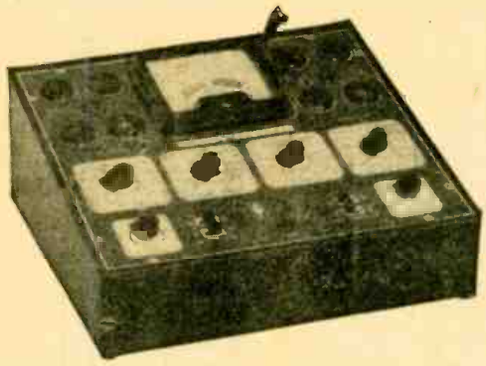
For the benefit of new readers and to answer dozens of letters received each month, *please read this carefully.* If you desire to become one of our short wave observers please send to me your name and address with a description of your receiving equipment and a report of what you have received during the past month. We cannot make appointments on just your name and address. Tell us as much about your reception as you can in your *first* letter. One thing that makes us want to say "no" to your application is the requesting of a listening post certificate to "hang on the wall of your den" and "it would look swell over my receiver." These certificates are issued to observers in return for the service which they have given as such, not as decorations. Your record as an observer is considered before a certificate is issued to you. Please send your reports and applications to Elmer R. Fuller, Short Wave Editor, c/o RADIO-CRAFT, 25 West Broadway, New York City 7. Best of luck, lots of fb dx, om and yl and of course, to all of you, xyl's!

All schedules are Eastern Standard Time.

Freq.	Station	Location and Schedule
2.390		QUARRY HEIGHTS, CANAL ZONE; 0530 to 0700; 1000 to 2305
2.500	WWV	WASHINGTON, D.C.; U. S. Bureau of Standards; 1960 to 0900
3.075		TOKYO, JAPAN; 0400 to 0900
3.310	YVIRO	TRUJILLO, VENEZUELA; 1700 to 2130
3.340	VUD3	DELHI, INDIA; 1200 to 1245
3.370	YVIRT	MARACAIBO, VENEZUELA; 1730 to 2230
3.380	YV5RY	CARACAS, VENEZUELA; 0930 to 2230
3.390	YV4RK	MARACAY, VENEZUELA; 1800 to 2230
3.390		COLOMBO, CEYLON; 0600 to 1200
3.400	YV5RW	CARACAS, VENEZUELA; 0530 to 2230
3.420	YV2RC	MERIDA, VENEZUELA; 1800 to 2130
3.440	YVIRU	MARACAIBO, VENEZUELA; 1900 to 2130
3.460	YV4RP	VALENCIA, VENEZUELA; 1730 to 2130
3.480	YV4RQ	PUERTA CABALLO, VENEZUELA; 1700 to 2130
3.490	YV3RS	BARQUISIMETO, VENEZUELA; 1630 to 2130
3.500	YV5RX	CARACAS, VENEZUELA; 0930 to 1400; 1530 to 2230
3.510	YV6RC	BARQUISIMETO, VENEZUELA; 1800 to 2130
3.530	YV5RS	CARACAS, VENEZUELA; 0530 to 2230
3.910	ZQP	LUSAKA, SOUTHERN RHODESIA; 2230 to 1300
3.930	HC5EH	CIUDAD CUENCA, ECUADOR; 1800 to 2230
4.040		PONTA DEL GADA, AZORES; 1700 to 1900
4.100	HCJB	QUITO, ECUADOR; 1800 to 2330
4.700	ZQI	KINGSTON, JAMAICA; 1630 to 1830
4.750	YVIRV	MARACAIBO, VENEZUELA; 0530 to 2130
4.770	YVIRY	CORO, VENEZUELA; 1600 to 2130
4.780		SINGAPORE, MALAYA; 1730 to 2230; 2330 to 0130
4.780	YV4RO	VALENCIA, VENEZUELA; 1630 to 2130
4.780	HJAB	BARRANQUILLA, COLOMBIA; 1700 to 2255
4.790		BANDOENG, NETHERLAND INDIES; 0730 to 0800
4.810	YVIRL	MARACAIBO, VENEZUELA; 0530 to 2230
4.810	HJBB	CUCUTA, COLOMBIA; 1700 to 2200
4.820	XEJG	GUADALAJARA, MEXICO; 2200 to 2400
4.820	HJED	CALI, COLOMBIA; 1900 to 2300
4.830	YV2RN	SAN CHRISTOBAL, VENEZUELA; 1100 to 2130
4.840	YVIRZ	VOLERA, VENEZUELA; 1630 to 2145
4.850	HJCA	BOGOTA, COLOMBIA; 1900 to 2200
4.860	PRC5	BELEM, BRAZIL; 0600 to 1100; 1530 to 2000
4.880	HJFH	ARMENIA, COLOMBIA; 0600 to 2200
4.890	HJCH	BOGOTA, COLOMBIA; 1800 to 2200
4.920	CR7BO	LOURENCO MARQUES, MOZAMBIQUE; 1330 to 1500; Sundays, 1000 to 1400
4.920	YV5RN	CARACAS, VENEZUELA; 0600 to 2230
4.920	HJAP	CARTAGENA, COLOMBIA; 0600 to 1300; 1700 to 2200
4.940	HJCW	BOGOTA, COLOMBIA; 0645 to 1115; 1600 to 2315
4.950	VQ7LO	NAIROBI, KENYA; 1100 to 1400
4.950	HJCQ	BOGOTA, COLOMBIA; 1000 to 1400; 1700 to 2300
4.960	HJAE	CARTAGENA, COLOMBIA; 1600 to 2230
4.970	YV5RM	CARACAS, VENEZUELA; 0530 to 2230
4.990	YV3RN	BARQUISIMETO, VENEZUELA; 1630 to 2230
5.000	WWV	WASHINGTON, D. C.; U. S. Bureau of Standards; continuously day and night
5.300	DTYC	MUNICH, GERMANY; 0900 to 0930
5.530	OAX1B	PUIRA, PERU; 1800 to 2330

(Continued on page 44)

MONEY BACK GUARANTEE — We believe units offered for sale by mail order should be sold only on a "Money-Back-If-Not-Satisfied" basis. We carefully check the design calibration and value of all items advertised by us and unhesitatingly offer all merchandise subject to a return for credit or refund. You, the customer, are the sole judge as to value of the item or items you have purchased.



The New Model 60-T TUBE and SET TESTER

A COMPLETE TUBE TESTER

Tests all tubes including the new post-war miniature loctals such as the 12AT6, 12AU6, 35W4, 50B5, 117Z3, etc. • Tests by the well-established emission method for tube quality, directly read on the scale of the meter • Tests shorts and leakages up to 3 Megohms in all tubes • Tests leakages and shorts of any one element against all elements in all tubes • Tests both plates in rectifiers • Tests individual sections such as diodes, triodes, pentodes, etc., in multi-purpose tubes.

$49.85 NET PRICE

Model 60-T operates on 90-120 Volts 60 Cycles A.C. Housed in sloping leatherette covered cabinet. Comes complete with test leads, tube charts and detailed operating instructions.

A COMPLETE MULTI-METER

- 6 D.C. Voltage Ranges: 0 to 7.5/15/75/150/750/1,500 Volts
- 6 A.C. Voltage Ranges: 0 to 15/30/150/300/1,500/3000 Volts
- 4 D.C. Current Ranges: 0 to 1.5/15/150 Ma. 0 to 1.5 Amps.
- Low Resistance Ranges: 0 to 2,000 Ohms (1st division is 1/10th of an ohm.)
- 2 Medium Resistance Ranges: 0 to 20,000/200,000 Ohms
- High Resistance Range: 0 to 20 Megohms
- 3 Decibel Ranges: —10 to +38, +10 to +38, +30 to +58 DB.

EXTRA: WE CAN NOW SUPPLY THE MODEL 60 HOUSED IN A BEAUTIFUL HAND-RUBBED OAK CABINET. COMPLETE WITH PORTABLE COVER MAKING IT SUITABLE FOR EITHER BENCH OR OUTSIDE USE. ONLY $2.75 ADDITIONAL. SPECIFY MODEL 60-C

The New Model 650-A *A. C. Operated* SIGNAL GENERATOR

- Operates on 110-120 Volts 50 to 60 Cycles A.C.
- R.F. Frequencies from 100 Kc. to 35 Mc. on Fundamentals in 5 bands by front panel switch manipulation. One additional band provides Harmonics from 30 to 105 Mc.
- Audio Modulating Frequency —400 Cycles Pure Sine Wave. Distortion less than 3%.
- Attenuation: Features a newly designed 3-step ladder type of attenuator (T pad). The first step provides lowest output and can be multiplied by 10 and by 100 by turning the multiplier switch.
- Hartley Excited Oscillator Electron coupled to a Buffer Amplifier. Frequency stability is assured by modulating the amplifier stage.

Complete with coaxial cable, test leads and instructions. Heavy gauge grey crystalline cabinet with beautiful two tone etched front panel. Size 9½" x 10" x 6".

$39.95 NET

The New Model 670 SUPER METER

A Combination Volt-Ohm-milliammeter plus Capacity Reactance, Inductance and Decibel Measurements

D.C. VOLTS: 0 to 7.5/15/75/150/750/1500/7500.
A.C. VOLTS: 0 to 15/30/150/300/1500/3000 Volts.
OUTPUT VOLTS: 0 to 15/30/150/300/1500/3000.
D.C. CURRENT: 0 to 1.5/15/150 Ma.; 0 to 1.5 Amps.
RESISTANCE: 0 to 500/100,000 ohms 0 to 10 Megohms.
CAPACITY: .001 to .2 Mfd. .1 to 4 Mfd. (Quality test for electrolytics).
REACTANCE: 700 to 27,000 Ohms; 13,000 Ohms to 3 Megohms.
INDUCTANCE: 1.75 to 70 Henries; 35 to 8,000 Henries.
DECIBELS: —10 to +18, +10 to +38, +30 to +58. The Model 670 comes housed in a rugged, crackle-finished steel cabinet complete with test leads and operating instructions. Size 5½" x 7½" x 3".

$28.40 NET

The New Model CA-11 SIGNAL TRACER

Simple to operate . . . because signal intensity readings are indicated *directly on the meter!*

- ★ SIMPLE TO OPERATE —only 1 connecting cable —NO TUNING CONTROLS.
- ★ HIGHLY SENSITIVE— uses an improved Vacuum Tube Voltmeter circuit.
- ★ Tube and resistor-capacity network are built into the Detector Probe.
- ★ COMPLETELY PORTABLE — weighs 5 lbs. and measures 5"x6"x7".
- ★ Comparative Signal Intensity readings are indicated directly on the meter as the Detector Probe is moved to follow the Signal from Antenna to Speaker.

★ Provision is made for insertion of phones. The Model CA-11 comes housed in a beautiful hand-rubbed wooden cabinet. Complete with Probe, test leads and instructions.

$18.75 NET

The New Model 450 TUBE TESTER

Speedy operation — assured by the newly designed rotary selector switch which replaces the usual snap, toggle, or lever action switches.

SPECIFICATIONS

• Tests all tubes up to 117 volts. • Tests shorts and leakages up to 3 Megohms in all tubes. • Tests both plates in rectifiers. • New type line voltage adjuster. • Tests individual sections such as diodes, triodes, pentodes, etc., in multi-purpose tubes. • Noise Test-detects microphonic tubes or noise due to faulty elements and loose internal connections. • Uses a 4½" square rugged meter. • Works on 90 to 125 volts 60 cycles A.C.

EXTRA SERVICE—May be used as an extremely sensitive condenser Leakage Checker. A relaxation type oscillator incorporated in this model will detect leakages even when the frequency is one per minute.

$39.50 NET

GENERAL ELECTRONIC DISTRIBUTING CO.

DEPT. RC-11, 98 PARK PLACE, NEW YORK 7, N. Y.

250-WATT FM-AM TRANSMITTER

(Continued from page 34)

wire so the final shunt value can be determined accurately. Place the series circuit, consisting of the 2 meters and the 10,000-ohm resistor, across a low d.c. voltage source, say a 45-volt B-battery; and adjust the series resistor until the 250-ma meter reads the same as the 100% modulation TZ-40 plate-current value. The shunt across the 100-ma meter is now adjusted for full-scale deflection on the 100-ma unit. *Caution: Always disconnect the d.c. voltage source when making adjustments on the shunt;* otherwise the 100-ma meter will burn out. Once the correct shunt value has been determined, the shunt wire can be wound in the form of a small coil and connected permanently across the milliammeter terminals. The shunted 100-ma unit is now connected in the TZ-40 plate-current line to indicate modulator plate current and approximate percentage of modulation. In that portion of the scale between 75 and 100 milliamperes, the meter indication coincides almost exactly with modulation percentage, thus affording a quick visible check.

The compression control

The compression control is the 500,000-ohm potentiometer in the grid circuit of the 6SQ7 (see last month's schematic). Adjustment of the compression control is not critical, but it must be made carefully. Turn the gain control to normal operating position and advance the compression control until a definite flattening of the voice peaks is noticed. Now, reduce the compression control slowly and, at the same time, readjust the gain control slowly up or down, as the case may be, until the compression just "takes hold" at 85 to 90% modulation. If an oscilloscope is available, the correct adjustment can be carried out very easily as a definite flattening of the wave form will be visible long before the average listener's ear notices any distortion.

If the aural method of adjustment must be used, monitor the transmitted wave with a pair of headphones plugged into the monitoring jack on the front panel, or by short circuiting the antenna and ground terminals of the communications receiver and tuning in the emitted signal. Adjust the compression to a point just below where distortion of the audio component of the signal is heard.

It is essential to become familiar with the compression control by the record player test, as described in last month's article, before the transmitter is placed on the air. Incorporating the monitor circuit in the speech amplifier permits accurate adjustments of the compression control.

The compression effect may be removed from the signal by turning the compression control to its OFF position.

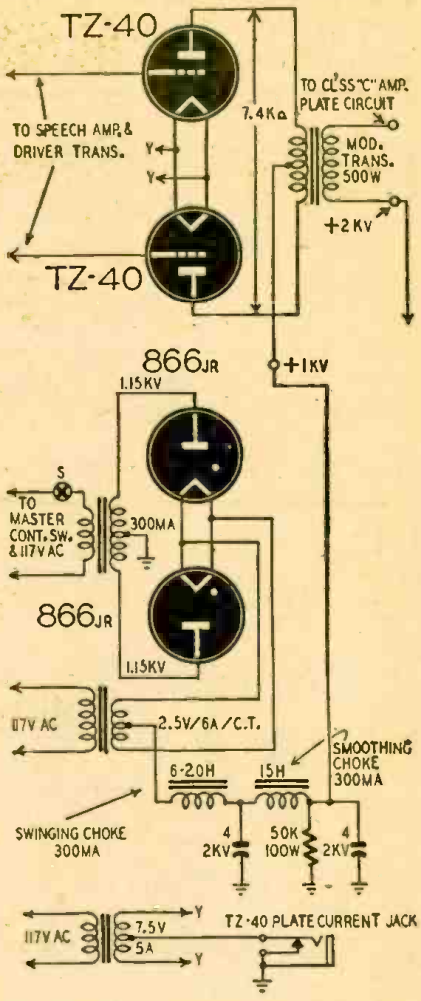
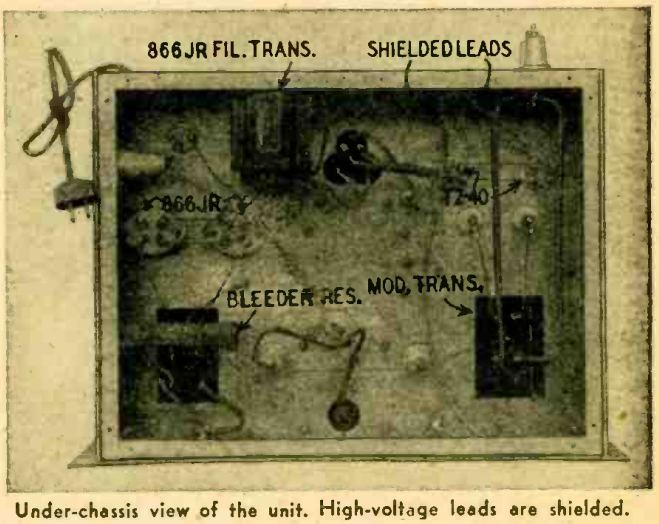


Fig. 2—The power supply and modulator unit.



Under-chassis view of the unit. High-voltage leads are shielded.

WORLD-WIDE STATION LIST

(Continued from page 40)

5.810		MOSCOW, U.S.S.R.; schedule unknown
5.840	PZH5	PARAMARIBO, SURINAM; 1800 to 2045
5.870	HRN	TEGUCIGALPA, HONDURAS; 1800 to 1000; 1300 to 1500; 1800 to 2300
5.880	ZRK	CAPETOWN, SOUTH AFRICA; 2345 to 0130; 1030 to 1600
5.890		MOSCOW, U.S.S.R.; 0800 to 1645
5.890	OAX4Z	LIMA, PERU; 1630 to 2330
5.910	OZX4V	LIMA, PERU; 1800 to 2400
5.959	HH2S	PORT-AU-PRINCE, HAITI; 0600 to 0815; 1100 to 1300; 1730 to 2130
5.960	RV19	MOSCOW, U.S.S.R.; 1700 to 2000
5.970	HVJ	VATICAN CITY; 0900 to 0930; 1000 to 1100; 1300 to 1330
5.970	VONH	ST. JOHNS, NEWFOUNDLAND; 0000 to 1400; 1500 to 2200
5.980	LRSI	BUENOS AIRES, ARGENTINA; 1800 to 2300
5.980		ANDORRA; 0500 to 1900
5.990	FG8AH	POINT-AU-PITRE, GUADELOUPE; 1700 to 1900
6.000	ZFY	GEORGETOWN, BRITISH GUIANA; 0545 to 0745; 0945 to 1145; 1415 to 1945
6.000	CFCX	MONTREAL, CANADA
6.000	HP5K	COLON, PANAMA; 07[illegible] to 1300; 1900 to 2300
6.010	ZRH	JOHANNESBURG, SOUTH AFRICA; 2345 to 0130; 0900 to 1100
6.010	CJCX	SYDNEY, NOVA SCOTIA; 053[illegible] to 2200
6.020	HJCX	BOGOTA, COLOMBIA; 0700 to 0800; 1400 to 2315
6.020	XEUW	VERA CRUZ, MEXICO; 0700 to 0100
6.0[illegible]	FZI	BRAZZAVILLE, FRENCH EQUATORIAL AFRICA; 1600 to 1845; 0000 to 0130
6.[illegible]20	PCJ	HUIZEN, NETHERLANDS; 1400 to 1930; 1745 to 1815; 2000 to 2200
[illegible].030		MOSCOW, U.S.S.R.; schedule unknown
[illegible].030	CFYP	CALGARY, CANADA; 0730 to 0100
[illegible].030	HP5B	PANAMA CITY, PANAMA; 1800 to 2300
6.040		ALGIERS, ALGERIA; 1230 to 1800
[illegible].040		RANGOON, BURMA; 0030 to 0230; 0615 to 0830; 2100 to 2145
6.[illegible]40	COBF	HAVANA, CUBA; 0800 to 2300
6.[illegible]40	XETW	TAMPICO, MEXICO; 0745 to 0045
6.0[illegible]		TETUAN, SPANISH MOROCCO; 0230 to 0300; 1330 to 1830
6.070	GRR	LONDON, ENGLAND; 2300 to 0030
6.070	CFRX	TORONTO, CANADA; 0600 to 2345
6.070		BERLIN, GERMANY; 0000 to 0345
6.070		COLOMBO, CEYLON; 1930 to 0545; 0715 to 1200
6.080	WLWK	CINCINNATI, OHIO; 1830 to 0100
6.080	CKFX	VANCOUVER, CANADA; 0930 to 0300
6.090	LRYI	BUENOS AIRES, ARGENTINA; 0545 to 0715; 1800 to 2100
6.090		LUXEMBOURG; 1430 to 1700
6.090	CBFW	MONTREAL, CANADA; 0730 to 1945; 2000 to 2400
6.090	ZYB7	SAO PAULO, BRAZIL; 1600 to 1950
6.100	VUD10	DELHI, INDIA; 0830 to 0915; 2030 to 2200
6.100		WARSAW, POLAND; 1330 to 2100
6.100	PRE9	FORTALEZA, BRAZIL; 1530 to 2100
6.110	GSL	LONDON, ENGLAND; 1500 to 1745; 1900 to 0030
6.120	HP5H	PANAMA CITY, PANAMA; 0700 to 2300
6.130	XEUZ	MEXICO CITY, MEXICO; 1500 to 0030
6.130	CHNX	HALIFAX, NOVA SCOTIA; 0700 to 2300
6.130	COCD	HAVANA, CUBA; 0700 to 2400
6.140	HJDE	MEDELLIN, COLOMBIA; 1100 to 2300
6.150	GRW	LONDON, ENGLAND; 1445 to 1500; 1900 to 2215; 2330 to 2345
6.150	CKRO	WINNIPEG, CANADA; 2200 to 0300
6.150		BELGRADE, YUGOSLAVIA; 1130 to 1800
6.150	EQB	TEHERAN, IRAN; 1000 to 1415; 2230 to 2400
6.150	TIRH	SAN JOSE, COSTA RICA; 2130 to 2400
6.150	CSWD	LISBON, PORTUGAL; 1430 to 1900
6.160	HJCD	BOGOTA, COLOMBIA; 0700 to 0800
6.160	CBRX	VANCOUVER, CANADA; 0900 to 0200
6.160	HHCM	PORT-AU-PRINCE, HAITI; 0500 to 0830; 1100 to 1400; 1700 to 2145
6.160	HER3	BERNE, SWITZERLAND; 0020 to 0120; 0245 to 0700; 1200 to 1700.
6.230	HRD2	LA CEIBA, HONDURAS; 1200 to 1400; 1900 to 2300
6.240	HJCF	BOGOTA, COLOMBIA; 1700 to 2300
6.240	HI1N	CIUDAD TRUJILLO, DOMINICAN REPUBLIC; 1600 to 2230
6.280	HCJB	QUITO, ECUADOR; 1800 to 2200
6.190	HI1A	SANTIAGO, DOMINICAN REPUBLIC; 1600 to 1800
6.200	HJCT	BOGOTA, COLOMBIA; 1000 to 1400; 1800 to 2315
6.200	YV6RD	CIUDAD BOLIVAR, VENEZUELA; 1700 to 2315
6.200	FK8AA	NOUMEA, NEW CALEDONIA; 0200 to 0400; 1900 to 2000
6.310	HI1Z	CIUDAD TRUJILLO, DOMINICAN REPUBLIC; 1600 to 2255
6.330	COCW	HAVANA, CUBA; 0600 to 2400
6.340	HEI2	BERNE, SWITZERLAND
6.360	HRPI	SAN PEDRO SULA, HONDURAS; 1100 to 1415; 1800 to 2255
6.370	CSX	LISBON, PORTUGAL; 1330 to 1900
6.450	COHI	SANTA CLARA, CUBA; 0700 to 2345
6.480	HI2T	MONSIGNOR NOUEL, DOMINICAN REPUBLIC; 1600 to 2400
6.510	CP40	COCHAHAMBA, BOLIVIA; 1930 to 2200
6.530	TGWB	GUATEMALA CITY, GUATEMALA; 0800 to 1200; 1830 to 0100
6.620	TG2	GUATEMALA CITY, GUATEMALA; 1800 to 2300
6.710	ZLT7	WELLINGTON, NEW ZEALAND; 0415 to 0450
6.720	PMA	BANDOENG, NETHERLAND INDIES
6.750	JVT	TOKYO, JAPAN
6.760	YNDS	MANAGUA, NICARAGUA; 0800 to 1000; 1700 to 2330
6.770	CP49	LA PAZ, BOLIVIA; 0700 to 0900; 1100 to 1200; 1930 to 2100
6.770		SINGAPORE, MALAYA; 0345 to 0935
6.850	YNQW	MANAGUA, NICARAGUA; 0800 to 2400
6.910	YNQW	MANAGUA, NICARAGUA; 1300 to 2300
6.980		MOSCOW, U.S.S.R.; 1600 to 1745; 2315 to 2345
6.980	FO8AA	PAPEETE, TAHITI; Tuesdays and Fridays, 2200 to 2400
7.010	XPSA	KWEIYANG, CHINA; 2330 to 0030; 0430 to 0900
7.100		BISSAU, PORTUGUESE GUINEA; 1600 to 1730
7.120	GRM	LONDON, ENGLAND; 1145 to 1215; 1445 to 1515
7.130		HARGEISHA, BRITISH SOMALILAND; 0800 to 1030; 1200 to 1300
7.150	XGOY	CHUNGKING, CHINA; 0630 to 1130
7.160		VIENNA, AUSTRIA; 0000 to 0200; 0600 to 0800; 1000 to 2030
7.190	JCPA	CAIRO, EGYPT; 0200 to 0300; 1500 to 1[illegible]; 2230 to 2400.
7.210	FGY	DAKAR, FRENCH WEST AFRICA
7.210	VLQ2	BRISBANE, AUSTRALIA; 0230 to 0830
7.220	JCKW	JERUSALEM, PALESTINE; 2330 to 0130
7.220		SINGAPORE, MALAYA; 2330 to 0130

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RADIO SERVICE EDITION

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Now! For little more than you would pay for a smaller instrument, you can obtain a big beautiful, 7-inch Oscilloscope that's the last word for servicing. Excellent for audio circuit analysis, transmitter checking, filter circuit and hum analysis.

CHARACTERISTICS AND SPECIAL FEATURES

Large 7-inch cathode ray tube provides "*Jumbo*" patterns.

A new push-pull deflection circuit provides clearer patterns, less distortion and more gain.

Observation of a wider variety of phenomena is made possible by the addition of a Z axis input for intensity modulation. This feature is useful in studying pulses and portions of cycles, and leads to many applications in industry.

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Subdued red-jeweled panel lamp assembly with removable cap for easy replacement of lamp.

Extra-long, heavy-duty line cord.

Externally accessible line fuse at rear of cabinet.

Power Supply: 105-125 volts, 50-60 cycle, 35 watts.

Accelerating potential 1400 volts.

Horizontal Sweep: Left to right with frequency from 15 to 30,000 cycles. Synchronizing signal sources: internal (vertical), external, *line frequency*.

Deflection Factor at 1000 cycles

AMPLIFIERS: Vertical .21 volt rms per inch peak to peak deflection.
Horizontal .25 volt rms per inch peak to peak deflection.

DIRECT: Vertical 15 volts rms per inch peak to peak deflection.
Horizontal 18 volts rms per inch peak to peak deflection.

Amplifier frequency response is flat to within 3 db. from 7 cycles to 140 kc. at full gain.

Input Impedance

AMPLIFIERS:	Vertical	.5 megohm; 26 mmfd.
	Horizontal	.5 megohm; 33 mmfd.
DIRECT:	Vertical and Horizontal	3.9 megohms; 20 mmfd.
INTENSITY MODULATION:		.5 megohm; 30 mmfd.

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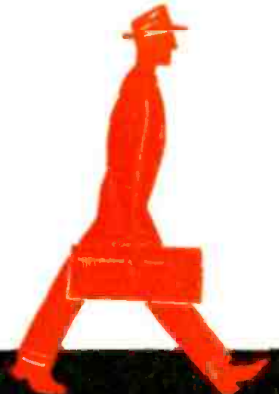

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TECHNOTES

. . . . MODULATION HUM

Modulation hum, especially noticeable on weak carriers, is commonly encountered in a.c.-d.c. sets with B-minus returns isolated from the chassis through a condenser. Check this condenser and those in the a.v.c. circuit for leakage. If resistance is 20 megohms or less, replace these with high-quality units. The same type of defect can be caused by an open control-grid resistor in the r.f. or first detector stages.

JOHN R. SIMPSON,
Gainsville, Fla.

. . . . AUTO RADIOS

If you have an auto radio with loctal tubes, that is noisy or refuses to play, check the construction of the sockets. Often these sets have molded loctal sockets of flimsy construction and the contacts break loose and do not make contact with the tube pins. Use well-built, high-quality sockets as replacements.

WILLIAM PORTER,
Indianapolis, Ind.

. . . . STROMBERG-CARLSON 1121 FM-AM

If the converter is suspected of giving trouble and trouble is not in the tube, try replacing the 5,200-ohm, 4-watt section of the Candohm that supplies screen voltage to the 6SB7. The correct replacement is part No. 149,002. Failure of this part seems to be a common occurrence in this model.

WILBUR J. HANTZ,
Cleveland, Ohio

. . . . RCA 811

Complaint: Intermittent distortion that sounds like an open filter condenser or incorrect bias voltages. This condition develops after the set has warmed up, and may therefore be missed in a check-over.

Check the screen voltage on the 6K7 i.f. amplifier. The voltage should be 80 volts or higher. If it is not, replace the 82,000-ohm screen grid resistor with a 1-watt unit.

C. H. MITCHELL,
Chicago, Ill.

. . . . ZENITH 6R687R (Chassis 6B06)

Noise and drift, particularly on the low-frequency end of the dial, is often caused by small particles of rust on the variable condenser plates. Replace with part No. 22-1241.

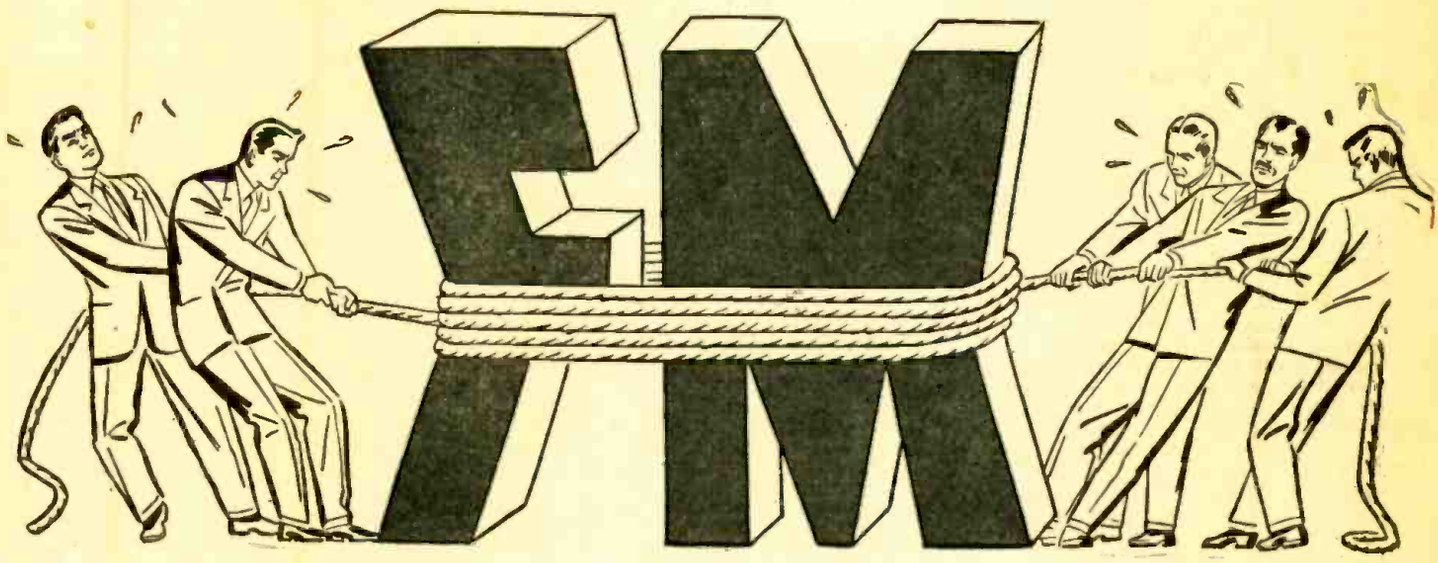
B. BUEHRLE, JR.,
Ferguson, Mo.

. . . . PHILCO 46-1201

When feedback develops at high volume, on phonograph operation only, check the condition of the two rubber grommets on the pickup arm where it connects to the support post. If the rubber in these grommets has hardened, they will transmit audio vibrations from the cabinet and motor plate to the crystal cartridge where they are picked up and fed back into the audio system.

(Continued on page 52)

Don't Murder



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TECHNOTES

(Continued from page 50)

Replace the grommets with units made of live rubber.

HARRY L. ASHBY,
Gary, Indiana

. . . . OSCILLATIONS

Oscillations and birdies in a.c.-d.c. sets often can be traced to filter condensers, although they may measure up to their rated capacity. These condensers develop a high r.f. resistance. This is a common fault that can be cured with new condensers.

D. E. COLVIN,
Churchville, N. Y.

. . . . SPEAKER REPLACEMENTS

I have noticed a large number of speaker replacements and complaints of poor tone on new sets using 4-, 5- and 6-inch PM speakers. In most cases, the complaints and replacements were completely justifiable.

When the set is assembled at the factory, the chassis usually is inserted in the cabinet so that the speaker presses against the front of the cabinet. When the chassis screws are tightened, this occasionally increases the pressure on the speaker frame at one or more points, distorting its shape. This is especially true of sets which have a dial partially supported by the speaker frame. Stresses in shipping and contraction and expansion during the first few hours of operation will distort the speaker sufficiently to affect its tone, and in some cases cause contact between the voice coil and the pole piece.

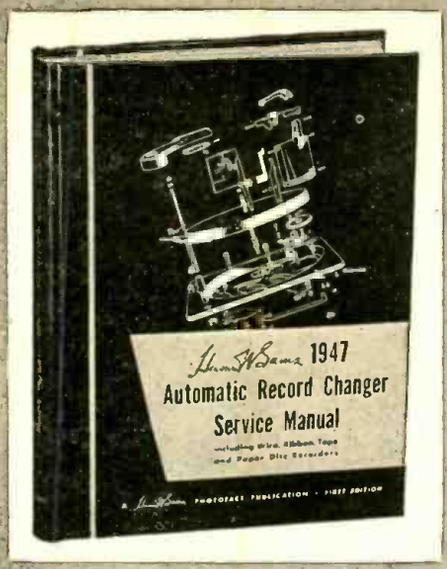
As a cure, tune in a station as perfectly as possible and adjust the set for medium or low volume. Use long-nose pliers or diagonal cutters, whichever is best in the particular situation, and bend one or two *adjoining* speaker frame supports slightly one way or the other for best tone adjustment. The correct amount of bend is easily discernible as the tone is checked. This method provides a permanent cure if care is used in reinserting the chassis of the cabinet. Do not force the chassis hard against the front of the cabinet with the chassis screws. There is usually a large tolerance in the mounting holes in the cabinet and it should not be necessary to drill new ones.

J. D. RIDGWAY,
Milledgeville, Ill.

. . . . SELENIUM RECTIFIERS

When replacing the rectifier tube in a.c.-d.c.-battery portables with a selenium rectifier, check the circuit to see if filament voltage for the battery-type tube is obtained from the B-supply. If so, a suitable dropping resistor should be inserted in series with the filaments, because selenium rectifiers deliver a higher output than the usual rectifier tubes. The output voltage is approximately 5½ volts higher than a 35Z5.

JOHN W. COOK,
Williamsburg, Va.



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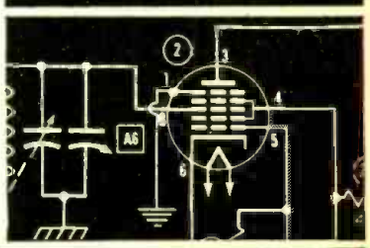

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NEW RADIO-ELECTRONIC DEVICES

SOUND-POWERED TELEPHONE

United States Instrument Corp.
Summit, N. J.

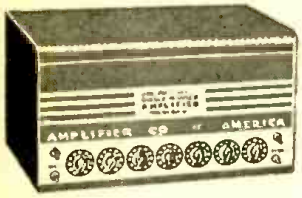
The new sound-powered telephone hand set does not require batteries. It is particularly useful to television antenna installation crews. When the

antenna is being tuned and adjusted for directivity; the man at the set is able to talk to the man making the adjustments. Hand sets may be connected to the transmission line or to a separate line as desired. The units may be used between points up to 30 miles apart.—RADIO-CRAFT.

D.C. AMPLIFIER

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

The Model ACA-100GE direct-coupled amplifier is designed for use with the G-E variable reluctance pickup. It includes a special built-in preamplifier and preequalizer. Regulated d.c. is used on the filaments of the input tubes.



The amplifier develops 23 watts with less than 1% total harmonic distortion. At 12 watts, the distortion is less than ½ of 1%. Frequency response is ± 1 db from 20 to 20,000 cycles, and overall gain is 117 db.

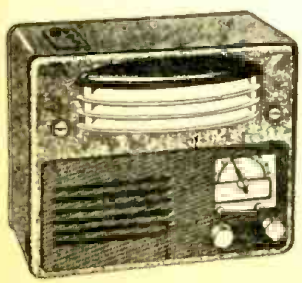
A standard 500,000-ohm input is provided in addition to the special preamplifier. The amplifier has balanced output terminals for 8, 16, 20, and 500 ohms. In-between terminals provide additional output impedances of 2, 4, 5, 10, 80, 125, 160, and 175 ohms. A non-discriminating scratch suppressor and push-pull expander are included in the circuit.

The unit consumes 150 watts, weighs 40 pounds, and its over-all dimensions are 17½x10x10 inches.—RADIO-CRAFT.

RESTAURANT RADIO

Music Menu, Inc.
Los Angeles, Calif.

The Music Menu is a coin-operated radio designed for use in cafes, grills, snack bars, and other public places where patrons may wish to tune in their favorite radio program during meal times.



The sets use a standard 6-tube superhet circuit, tuning from 540 to 1700 kc and operating from 117-volt 50- or 60-cycle lines. There is a built-in master volume control and external volume and tuning controls. A timing motor times the operation from 1 minute to 2 hours depending on whether the unit is set to accept pennies, nickels, dimes or quarters. Up to 24 coins may be inserted at one time.—RADIO-CRAFT.

65-WATT TETRODE

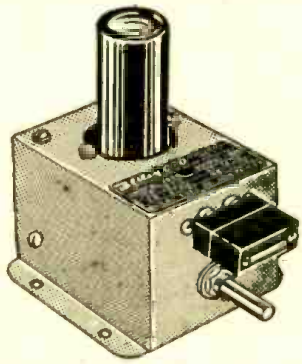
Eitel-McCullough, Inc.
San Bruno, Calif.

The new Eimac 4-65A is a small, instant-heating, transmitting-type tetrode with a 6-volt filament making it suitable for mobile applications. Its metal plate has a 65-watt dissipation rating. The plate voltage range is 400 to 3,000 volts. With 40 watts input (400 volts at 100 ma) for class-C c.w. or FM phone applications, less than 2 watts of grid drive will develop 28 watts plate output. In the same applications, the tube will deliver 200 watts output with 2,000 volts on its plate.—RADIO-CRAFT.

V.H.F. CRYSTAL CONTROL

Bliley Electric Co.
Erie, Penna.

The Model 2A crystal-controlled oscillator uses a 6AG7 tube with direct output on 6, 10, and 11 meters and sufficient power to drive a 2-meter tripler stage. It is mounted on a small chassis that may be added to existing equipment or may be included in the design of new apparatus. A single crystal socket, band switch, and tuning control are readily accessible. Power and



output terminals are on the rear of chassis. Crystals in the 13.5- to 15-mc range are used for 27- to 30-mc coverage, and 24- to 27-mc crystals for from 48 to 54 mc.—RADIO-CRAFT.

'SCOPE PROJECTION LENS

Allen B. DuMont Laboratories, Inc.
Passaic, N. J.

The Type 2088 projection lens is for projecting oscillograms on a large screen for lectures and demonstrations. It is designed for use with oscillographs using 5RP-A cathode-ray tubes with extra-brilliant images.

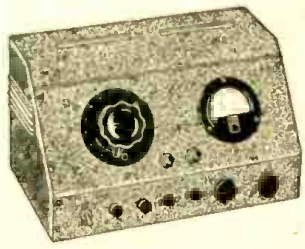
The lens is a 2-element, symmetrical objective lens with a 7.7-inch focal length and a relative aperture of f:3.3. It projects a pattern of an area up to 3 inches square to distances beyond 8 feet, resulting in a screen image up to about 12 feet square.

The telescopic lens barrel has a mounting flange with 4 holes aligned with holes in the front panel of DuMont oscillographs designed or adapted for the 5RP-A tube.—RADIO-CRAFT

VARIABLE A.C. SUPPLY

Electronic Apparatus, Inc.
New York, N. Y.

The Model AC-1135 delivers variable a.c. voltages between 0 and 135 volts



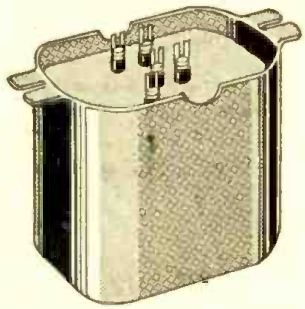
at a maximum of 7.5 amperes with 115-volt, 50- to 60-cycle input. An output voltmeter is provided to meter the 2 output circuits. Each circuit has an individual on-off switch and a closed-circuit ammeter jack.—RADIO-CRAFT.

FLASH TRANSFORMER

United Transformer Corp.
New York, N. Y.

Three new transformers have been developed for photo-flash applications. The type PF-1 has a 117-volt primary, a secondary delivering up to 2,200 volts d.c. after rectification, and a filament winding for a 2x2 rectifier tube. This unit is designed to work into condenser banks of 30 to 100 μf.

The PF-2 has a primary for use with 4- or 6-volt batteries and a full-wave vibrator. The rectifier filament is heated by the battery. The secondary is rated at 2,200 volts.



The PF-3 is a trigger transformer which delivers a 15-kv peak used to control the firing of a flash tube.—RADIO-CRAFT.

TEST INSTRUMENT

General Test Equipment Co.
Buffalo, N. Y.

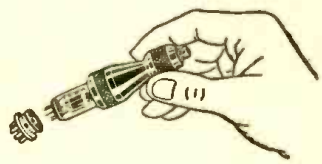
The Pen-Oscil-Lite is a self-contained r.f. and a.f. signal generator no larger than a fountain pen. It emits a high-pitched note that begins in the audio range and can be picked up through the radio-frequency spectrum up to 56 mc or higher. This wide range makes the device useful for signal tracing in PA as well as radio equipment.

It consists of a small vibrator, powered by a penlite cell in the case, which radiates a highly directional signal from the instrument's probelike tip. A signal can thus be injected into a desired circuit without coupling to adjacent circuits. The drain on the cell is approximately 20 ma.—RADIO-CRAFT

MINIATURE-TUBE PULLER

Oliveri Tool Co.
Chicago, Ill.

The Amo miniature-tube puller inserts or extracts miniature tubes from sockets



that may be located in hard-to-reach places. It helps to prevent tube breakage, loss of time, and burned fingers. It has a heat-resistant rubber cap, an aluminum body, and a thumb-operated plunger release.

To insert a tube, press the Amo down on the tube and lift up. Eject the tube with the release button. Reverse the procedure to insert tubes. — RADIO-CRAFT.

IMPEDANCE VECTOR-GRAPH

Sound Apparatus Co.
New York, N. Y.

The vectorgraph is designed to record automatically impedance components as functions of frequency. It can be used to measure the input impedance of loudspeakers, microphones, recording heads, circuit elements, transmission lines, transformers, networks, and other circuits and components. It is used also for measuring attenuation and propagation constants of filters, lines and networks, and the admittance of high-impedance circuits.

The impedance range is 80, 160, 400, 800 and 1,600 ohms, and the admittance range is 8, 16, 40, 60 and 400 micromhos. The frequency accuracy is ± 2%.

The unit consists of a 20 to 20,000-cycle oscillator, a recorder, and a link unit. The recorder and oscillator may be used for plotting frequency-response curves. The recorder may be used alone as an a.c. recorder with flat response from 20 to 20,000 cycles. — RADIO-CRAFT.

AUDIO OSCILLATOR

Barker & Williamson, Inc.
Upper Darby, Penna.

The Model 200 audio oscillator uses a modified Wien bridge R-C oscillator, a 2-stage feedback amplifier, and a

built-in power supply. It is designed for distortion or frequency measurements and other applications where frequencies between 30 and 30,000 cycles are required. Coverage is in 3 ranges: 30 to 300 cycles; 300 to 3,000 cycles; and 3,000 to 30,000 cycles. Voltage output is 11 volts on 500-ohm load.

Frequency response is better than ± 1 db on full range, stability better than 1%, and calibration is ± 2.5%. The unit operates from 117-volt, 60-cycle lines. It weighs 12 pounds and is housed in a steel cabinet 11¾x7¼x9½ inches. —RADIO-CRAFT.

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Question Box queries will be answered by mail and those of general interest will be printed in the magazine. A fee of 50c will be charged for simple questions requiring no schematics. Write for estimate on questions that may require diagrams or considerable research. Six to 8 weeks is required to draw up answers involving large schematics.

? SIMPLE OSCILLOSCOPE

Please print a diagram of an oscilloscope using a 5BPI with single 6J7's as deflection amplifiers and a gas triode as sweep generator.—R.R., Philadelphia, Pa.

A. The oscilloscope circuit below is simple yet it has many features of more complex circuits.

The power transformers should be placed beneath the chassis, well removed from the 5BPI. Don't forget that voltages on the cathode-ray tube and its control circuits can be DANGEROUS!

? METER DATA

I have a 1-ma d.c. meter with a scale calibrated from 1 to 10 and an internal resistance of 50 ohms. What size shunt should be used to increase its range to 100 ma? What size multiplier is needed to use it as a 10-volt voltmeter?—F.E.M., Chicago, Ill.

A. The required shunting resistance for the meter is found by dividing the meter resistance by N minus 1 where N is the factor by which the meter range is to be increased. The internal resistance of this meter is 50 ohms, and you desire to increase its range 100 times. The shunt resistance is: 50/N-1 = 50/99 or 0.505 ohm.

The meter draws 1 ma at full scale. There is a drop of .050 volt across its resistance. For a 10-volt scale, it is necessary to drop 9.95 volts across the multiplier resistance. From Ohm's law: R = E/I; the resistance therefore is 9.95/.001 or 9,950 ohms.

? TUBE CHARACTERISTICS

In a certain vacuum tube, a change of 4 volts grid bias or 14 volts on the plate will produce a change of 2 ma in the plate circuit. What is the mu of the tube? What is its plate impedance and mutual conductance?—F.E.M., Chicago, Ill.

A. The mu of a tube is the ratio of a change in plate voltage to a change in grid voltage, in the opposite direction, to keep the plate current constant. The mu equals change in plate voltage divided by the change in grid voltage; or in this case, 14/4 = 3.5.

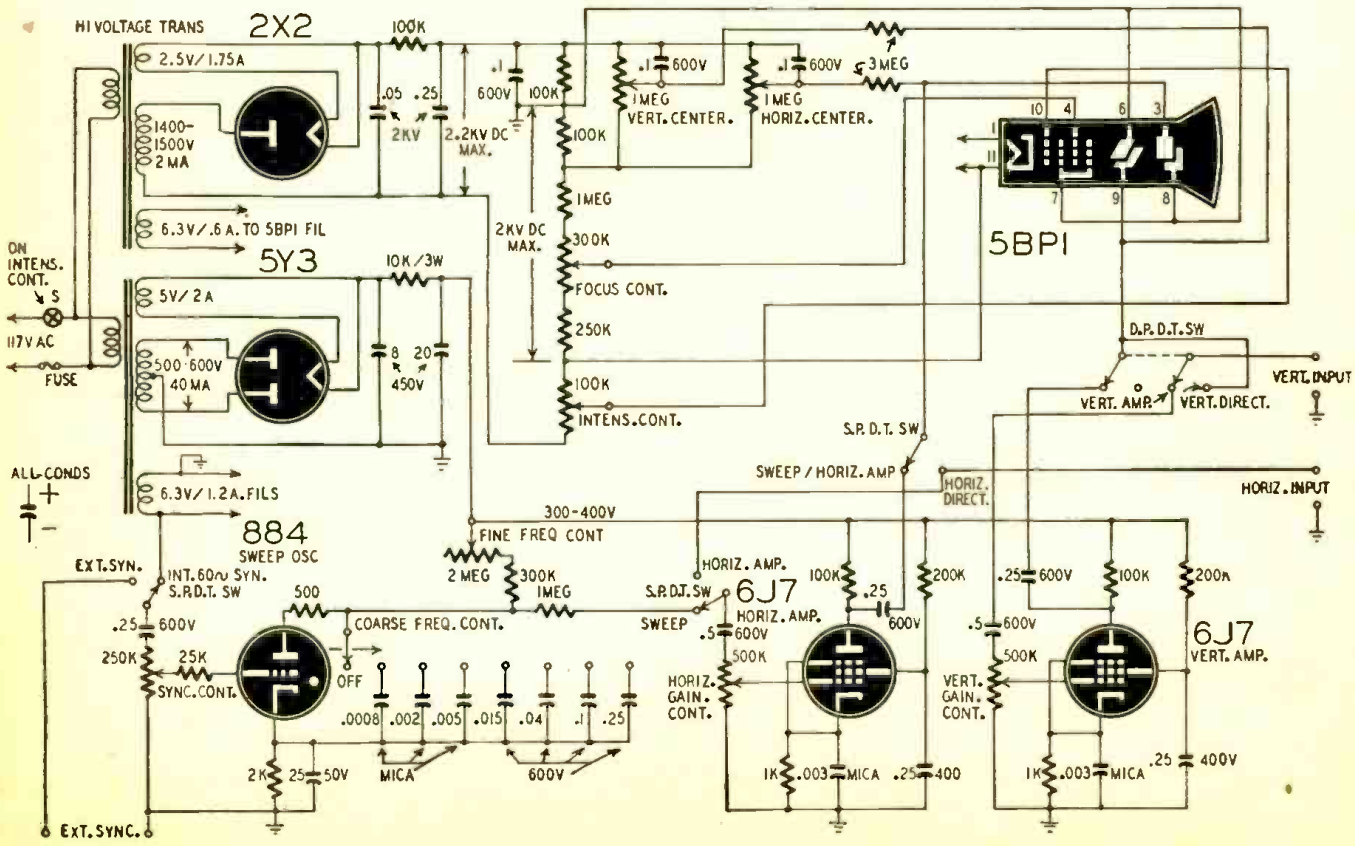
The plate resistance of a tube is the result of dividing a small change in plate voltage by the corresponding change in plate current. The quotient is expressed in ohms. In your problem, the plate resistance is 14/.002 or 7,000 ohms. The current change is in amperes.

The mutual conductance or transconductance of a tube is the change in plate current (in amperes) divided by the change in grid voltage causing it, when all other electrode voltages are constant. The mutual conductance is: .002 amper/4 volts = .0005 mhos or 500 micromhos.

? WIRELESS INTERCOM

I would like to have a diagram of an a.c.-d.c. intercom using no more than 4 tubes if this is practical. The unit is to be used to communicate between floors in my home.—A.M., North Bergen, N. J.

(Continued on page 58)



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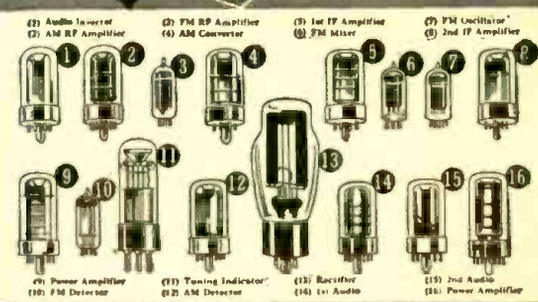

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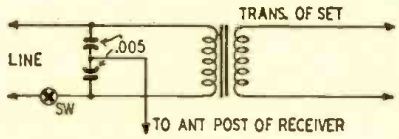
A. The simple unit described here should meet your needs. When transmitting, the speaker serves as a microphone working into the grid of the 12SK7 speech amplifier. The plate current of the 12SA7 is plate-modulated by means of the large choke in the plate circuit of the 50L6. When receiving, the 12SA7 is a regenerative detector with the 12SK7 and 50L6 as a.f. amplifiers. The speaker is capacitance-coupled to the plate of the 50L6. The values of the fixed and variable condensers C1 and C2 between L1 and the line should be adjusted for best performance. Total capacitance between 0.0001 and 0.002 μf should work well. The oscillator coil L2 is a 132-kc b.f.o. coil. L1 consists of 20 to 50 turns of No. 28 d.s.c. wound around the center of L2.

THE QUESTION BOX

(Continued from page 56)

POWER LINE ANTENNA

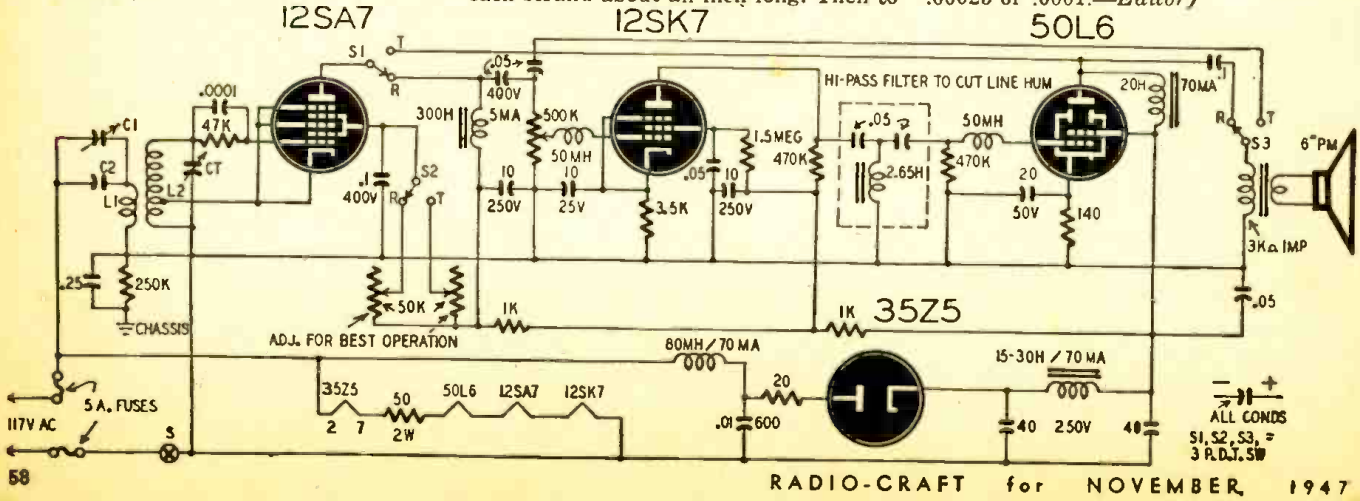
Here is an antenna system that can be placed inside the chassis of the receiver, with no visible outside wire:



Locate the 117-volt line cord running to the power transformer. Untwist a part of this cord and bare a spot in each strand about an inch long. Then to each bared spot solder one terminal of a 0.0005 condenser. Connect the two remaining condenser terminals together with a short jumper wire and insulate all joints. Solder a short piece of wire from the jumper and connect to the antenna post of the receiver. In this way your electric light lines are used for the antenna system.

STEWART HENRY,
Dalhousie, New Brunswick

(In most cases, a single condenser connected to one side of the line cord will give better results. Try the plug both ways in the wall receptacle to determine which way gives best reception. If more selectivity is required, try reducing the size of the condenser to .00025 or .0001.—*Editor*)



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30 MC IF TRANSFORMER

29¢

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89¢

KEY IN HIGH FREQ. BUZZER

SCOPE TRANS.

$3.95

110V Pri: 60 cy, Sec: 4000 V at 10MA. Size 6 x 4 x 3½

DYNAMOTOR UNIT - PE-101-C

Duo output Dynamotor input voltage 12 to 24V., output voltage 400V. at 135 ma, 800V. at 20 ma, and 9V. at 1.1 amp. $2.95

BC-654 TRANS. & RECEIVER

LESS TUBES AND CRYSTALS USED - IN GOOD CONDITION $7.50

The frequency range of both transmitter and receiver is continuous from 3700 to 5800 kilocycles; all stages gang tuned by anti-back lash worm gear dial mechanisms.

The BC-654-A is 18" wide, 14" high, and 9½" deep. Weight 44¼ pounds. Power required for Receiver—1.5,45, and 90 volts D.C. Power required for Transmitter—1½, 6, 51, 84 volts D.C. and 500 volts D.C. at 160 Ma. Operates from Dynamotor PE-103-A. Complete with carrying case.

TRANSMITTER TUNING UNIT-BC375 only $1.95

Approximately 65 MMFD cond., coils, RF chokes, dials, assorted mica condensers, 2500 WVDC. Over $50.00 in parts!

BN IFF TRANSMITTER & RECEIVER $9.95

Widely used on 144MC and now also successfully used as a television receiver, this being made possible by the wide band 30 MC I.F. channel and video amplifier: being sold at this exceptionally low price for the encouragement of television. Original diagram furnished. Less tubes and power transformer, wt. 100 lbs.

PYRANOL CAPACITATOR $2.95

General Elect. 1 MFD, 5,000 VDC, 4" x 4½" x 3¾".

NEW BC-223AX TRANSMITTER $12.50

Complete with tubes and tuning unit covering 80 meter Ham band, including frequencies charts, less Xtals.

BUTTERFLY CONDENSERS

Oscillator assembly 76 to 300 MC with acorn tube socket mounted on condenser $1.95

Type B—frequency range 300 to 1000 megacycles. 95¢

BC4 antenna condenser. 105-330 MC. $1.95

Oscillator 105-330 MC. $1.95

SPRAGUE Condenser .1 MFD 7000V.

$1.95

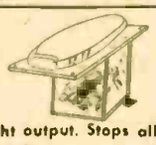
Condensers

Cap. MFD	Working Volt	Your Cost
1	1000 oil	44c
8	600 oil	95c
2	600 oil	49c

POWER TRANS. $1.29

110V, 60 Cy. Pri. Sec: 255V ea. side of center at 80 Ma, 5V at 4 Amps, 6.3V at 3.8 Amps. Hermatically sealed case.

HIGH SPEED PHOTO FLASH TUBE $8.95



12,000,000 lumens light output. Stops all action. Ignition coil included on back of bulb. 10,000 flashes. Diagrams furnished.

POWER TRANSFORMER $1.95

110V, 60 Cy. Sec: 300V ea. side of center at 125MA, 6.3V at 2.1 Amps, 5V at 3 Amps., Hermatically sealed, size 6" x 3½" x 4¼".

POWER TRANSFORMER $1.95

110V, 60 Cy. Sec #1: 4V at 16 Amps, Sec #2: 2½V at 1.75 Amps; Ideal for 2X2 and 826 tubes. Hermatically sealed, size 6" x 3½" x 4¼".

POWER TRANSFORMER $1.95

primary 110V, 60 Cy., Sec: 700V each side of center at 80 MA, 6.3V at 1.2 Amps, 5V at 3 Amps. Hermatically sealed size 6" x 3½" x 3"

Filament TRANS.

110-V, 60 cy. Pri. sec.—5V—3A Shelled Case. $1.49

110-V, 60 cy. Sec.: 2.5V at 5.25 amps. Shelled Case. $2.45

110-V, 60 cy.: Sec.: 1, 5V at 10 amps.; Sec.:2, 5V at 10 amps.; Connected in series will give 10V at 10 amps. Shelled Case. $3.95

RCA Trans. & Rec.

RCA TRANSMITTER MODEL AVT 112-A

OPER. ON 6-12 OR 24V. FREQ. RANGE, 2.5-6.5 MC 5⅜ x 6¼ x 4⅞ - WT. 6 LBS.

CORONA BALLS

10¢ ea. - $1.00 DOZ.

IF TRANS. 95¢

mounted in aluminum shield can, 1500 KC, with air trimmer, impedance coupled type.

RCA-AVR 20A RECEIVER

OPERATES ON 6 OR 12 V. FREQ. RANGE 2500-6500 KC 4 TUBE SUPERHETRODYNE CIR.

TUBES USED 6S7-6K8-6F7-6B8

THIS RECEIVER IS BUILT TO OPERATE WITH THE AVT-112A

$12.95 EA. $25.00 PR.

GENERAL ELECTRIC METER $3.95

type D041, 0-1 MA, meter scale graduation 0-5 D.C. Kilo V and 0-10 MA D.C.

MICA CAPACITATOR 49¢

.002MFD. 3000 VDC

General Electric 25 MFD Photoflash pyranol capacitator 2000 VDC—INT. $14.95

SPST Relay 24V. 528 ohm. coil contact rating 5 amp. Packed 2 to a carton ..... 2 for 49c

Coxail Solid Copper tubing, 30 foot $2.95

30-20 MFD Solar condenser 150 V tubular 49c

Assorted tubular oil-filled condensers up to 5 MFD. 15 for $1.00

BRAND NEW BC375 Transmitter, GE, 150 watt less dynamotor and cables .. $49.95

3 lbs. ossorted hardware $1.00

Westinghouse oil 1 MFD 6000V.—WVDC $7.95

Westinghouse oil 1 MFD—10,000V. WVDC $12.95

144 MC radar osc. uses 15E with variable coupling. Complete less tubes $3.95

Assorted high frequency chokes—25 for $1.00

Thordarsen 300 MA power transformer, 110 or 220V. 60 cy. input secondary 500/ct/100 tapped at 400/400 extra bias winding 200/ct/100 at 50 MA. 18 lbs. $4.95

BC 191E less tubes and tuning unit $14.95

5V. filament transformer, 60 amps. 22 lbs. $5.95

Assorted resistors ½ watt fully insulated in popular ohmages. 100 for $1.49

Thordarsen T48003. 2H-7H 550 MA swing choke. Size: 4½ x 3½ x 5½". Square black crackle case $5.95

Assorted mica condensers. Per 100 ..... $1.95

Wafer sockets—4, 5, 6, 7 and 8 prong—per 100 ..... $2.95

12" Utah PM speaker Alinco No. 5 with 6F6 output transformer $6.95

Assorted knobs—push on wood and plastic $1.95

Copperweld #18 Wire

3000 FEET $2.95

TUBES

813	5.95	872A	1.95
VR150	.69	9004	.49
955	.65	9006	.59
9002	.89	50B5	.89
6J6	.95	829	2.95
RK60	.95	VT127A	2.95
9001	.89	35W4	.69
6J4	1.50	3AP1	1.95
5FP7	1.95	3BP1	1.95
78P7	2.95	6J5	.49
9LP7	3.95	5BP1	3.95
6N7	.89	6H6	.59
1T4 — 3Q4—6SN7			.59

3S4—5W4, 6SA7—5U4, 12H6—1G5, 6SH7 } 44¢ ea.

SOCKETS FOR ACORN TUBES	$ .19
POWDERED IRON ⅜ SLUG	.10
JACKS-PL55, PL68	.15
ASST. MICA CONDENSER	1.95
3 LBS. ASST. HARDWARE	1.00
PIN STRAIGHTENER for min. tubes	.49
VARIAC 1AMP.	3.95
EAR PHONES, 2000 OHMS, used	.95
JOHNSON SOCKETS #210-25W	.39
5V FILAMENT TRANS. 60AMP.	5.95
SCR 625 MINE DETECTOR	49.50

HERSHEL RADIO CO.

Minimum Order $2.00 F.O.B. Detroit

5249 GRAND RIVER AVENUE • DETROIT 8, MICHIGAN

Mich. Sales Add 3% Sales Tax

20% DEPOSIT ON ALL C.O.D. ORDERS—F.O.B. DETROIT

RADIO-ELECTRONIC CIRCUITS

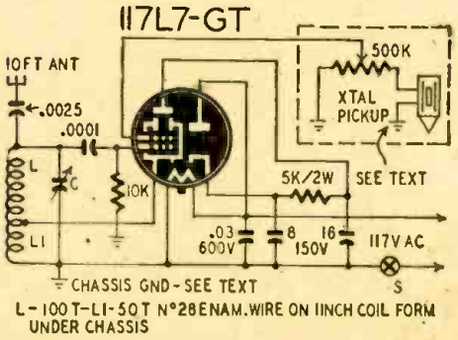
PHONO OSCILLATOR

I constructed the phono oscillator shown on page 42 of the October, 1945, issue of RADIO-CRAFT and was unable to eliminate hum from the signal. Finally, I made some changes in the basic circuit and it works perfectly. The grid leak was disconnected from the cathode and returned directly to ground and one side of the volume control and crystal pickup were grounded. The revised circuit is shown here.

The oscillator coil consists of 150 turns of No. 28 enamel wire on a 1-inch form with the cathode tap at 50 turns from the ground end. The coil is tuned with a 365-μμf trimmer condenser.

M. PAUL BEAUDRY,
Montreal, Canada

(It is recommended that the common negative lead be isolated from the chassis to remove the possibility of shock or personal injury from contact with a hot chassis. Connect a .05-μf, 600-volt condenser between the common negative lead and the chassis, and return the grounded side of the pickup to the chassis.—*Editor)*

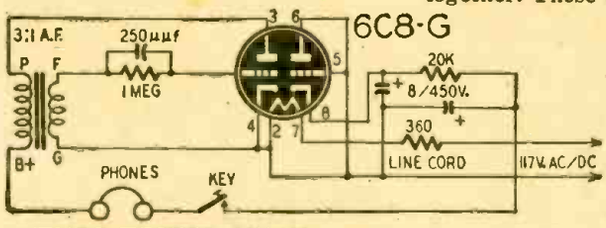


L - 100 T-L1-50 T N°28 ENAM. WIRE ON 1INCH COIL FORM UNDER CHASSIS
C=.000365 COMPRESSION TYPE

CODE OSCILLATOR

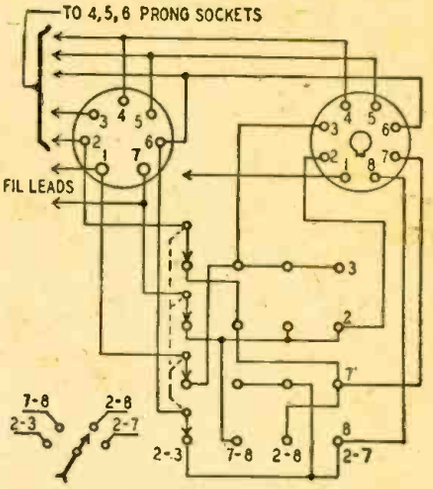
The accompanying circuit is of a code oscillator which has its own power supply and can be constructed compactly. One of the triodes of the 6C8-G is used as the oscillator and the other has its plate and grid tied together and is used as a half-wave rectifier. Very little cash outlay is required, since most parts can be found in the junk box or purchased at bargain counters.

RALPH MYERHOLTZ, JR.,
Canton, Ohio



TUBE-TESTER KINK

A number of octal-based tubes cannot be tested in the older type testers because provisions were not made for the various pin combinations used for the heater connections. I use a 4-pole, 4-position switch to check octal tubes with heaters brought out to pins 2 and 3, 7 and 8, 2 and 8, and 2 and 7. As



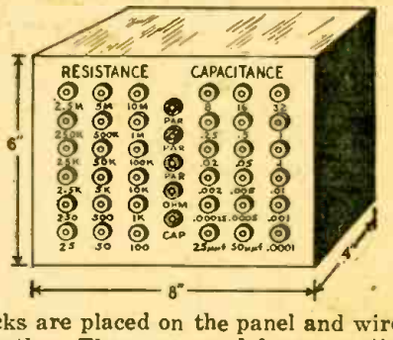
filament leads are switched to a set of pins, other terminals are switched to connect to the proper leads for emission testing.

FR. VERSWEYVELD,
Poppel, Belgium

C-R SUBSTITUTION BOX

A number of condenser and resistor substitution boxes and decades have been described in the past. Most of these have limited application because multi-point switches are used for making the selections.

I have developed an R-C decade using 18 condensers and an equal number of resistors mounted in a 6 x 8 x 4-inch box and wired as shown. The free ends of the components terminate in red pin jacks, and their common terminals in black pin jacks. Three additional black



jacks are placed on the panel and wired together. These are used for connecting any condensers or resistors in parallel in almost any possible R-C combination. Phone-tipped flexible leads are used for connecting the various condenser or resistor combinations. The resistors are ½-watt size or larger, and the condensers are rated at 400 volts or more.

JACK V. ROBERSON, ETM 1/c,
Treasure Island, Calif.

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RSE

LOWEST PRICES • HIGHEST QUALITY • NO WAR SURPLUS

GENERATOR CONDENSERS

PHILCO part No. 61-0177—.5 mfd.—⅝" x 1⅛"—4" lead-slotted mounting strap for easy installation—Standard Merchandise—*not* war surplus—Present list price $1.00.
Our special—over 85% off **14c**

OUTPUT TRANSFORMERS

Clean stocks — long leads — mounting feet — made to fit where you need them.
For 6F6-6K6—to 4 ohm voice coil—size 2" x 1⅝" x 1⅝".
50L6-35L6-25L6 to 4 ohm voice coil 1⅝"x 1⅝" x 1⅝".
Specify quantity of each type you need at..... **49c**

CATHODE CONDENSERS

10 Mfd. at 25 working volts—1⅛" x 1¾" tubular type—aluminum cans—overall cardboard sleeve—tinned leads—quality construction by a national manufacturer—backed by the famous R. S. & E. guarantee—list price **75c.** Priced to make you money at **12c** each lots of 10 for..... **1.08** 100 for..... **9.00**

MIDGET I. F. TRANSFORMERS

400-500 Kc range—1¼" square x 2½" high—ceramic based mica trimmers—high gain iron cores—pep up old receivers—ideal for new construction. List price $2.10—up to 88% discount—stock up now for future use.
Each **29c** Dozen **3.39** Hundred **25.00**

AEROVOX GL 8-600

Genuine Aerovox 8 mfd.—600 volt working—inverted screw mounting—aluminum can 1⅜x4½"—6" insulated leads. List Price $4.00—quantity limited—order now on this one time item at only..... **99c**

CITCO MODEL 451A AC-DC

Volt—Ohm—Milliammeter

A dependable instrument of wide utility—sensitivity 1000 ohms per volt.
Ranges: Volts AC, DC, and Output Ranges, 0-10/50/100/500/1000;
Ohms full scale, 500,000.
Ohms center scale, 7200.
NET complete with batteries **14.90**

CITCO MODEL 312

Volt—Ohm—Milliammeter

An economy pocket meter featuring a 2" moving vane meter.
Reads: AC-DC volts, 0-25/50/125/250;
Mills AC-DC, 0-50;
Ohms, 100,000;
mfd. .05-15.
Jacks provide range selection.
NET Complete with cord and plug..... **6.75**

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TEST EQUIPMENT, TUBES, PARTS, TOOLS, EVERYTHING
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Standard types—Set Manufacturers close-out—all Guaranteed

Webster F2—Replaces L26-L40-L70 etc.—pin type terminals—1 oz. pressure—1 volt output—5000 cycle cu
List price $5.00—you pay us..... **1.49**

SHURE P93—W57A—pin type terminals—¾" oz. pressure—1.6 volt output—6000 cycle cut off.
List price $4.45—our Special.. **1.98**

Astatic L-70—new postwar design—solder terminals—1¼ oz. pressure—1 volt output—4000 cycle cutoff.
List price $5.55—we quote you... **1.98**

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At last! All the parts you need to restore brilliant tone and volume to "sick" changers! You'll need all three items—sell your customer a 100% reconditioning job—
Selenium cell only, no holder..... **$1.80**
Sapphire needle only, no mirror..... **$1.20**
Special original equipment lamp..... **27c**
RECONDITIONING KIT—all three above items—postpaid—special at..... **3.21**

RADIO RULE

Here is a clear 6" plastic rule—a necessity for radio students, draftsmen, hams, all who desire cleaner, more precise work—National advertised at $2.00. Order yours today postpaid only..... **35c**

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Two types—for A.C. or D.C. measurements

MODEL 671—for A.C. current. Seven switch selected ranges of 0-5, 10, 25, 100, 250, 500, and 1000 milliamperes.
MODEL 675—for D.C. current. Eight switch selected ranges of 0-1, 5, 10, 25, 100, 250, 500, and 1000 milliamperes.
Here are two meters you can't afford to pass up—just the thing for radio servicing, transmitter trouble-shooting, general lab and experimental work.
A One-Time only Special buy at **7.95**

TRIPLETT 606B-VOLTAGE TESTER

Checks voltage and polarity. Range: 0-440 AC-DC volts—definite indications for 115, 220, and 440 volt lines. Separate polarized vane for AC or DC indication. Built in test leads. Excellent for checking wiring, fuses, general factory installation and maintenance. Every plant — every electrician needs several at this low price. Regular net 16.67
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TRIPLETT VOLTMETERS

Panel meters by Triplett! Top quality Instruments—new—boxed—five popular types—priced right—your chance to get those meters you've always wanted—
MODEL 332—0-150 A.C. volts—3" round flush mounting black brass case.
MODEL 231—0-150 A.C. volts—2" round flush mounting bakelite case.
MODEL 237—0-150 A.C. volts—2" square flush mounting bakelite case.
MODEL 221—0-30 D.C. volts 2" round flush mounting bakelite case.
MODEL 324—0-400 D.C. volts—3" round projection mounting—bakelite case.
Supply limited—order now—list models you desire. **2.95 EACH**

RESISTANCE LINE CORDS

Standard 3 terminal 135 ohm AC-DC cords—sturdy construction—flexible—5½' long—complete with plug—for sets having approximately 69-75.2 volts drop in the filaments—Regular list price 1.17—
Only 33c

Include full remittance with orders of $3.00 or less. Include 25% deposit with all C.O.D. orders of $3.00. or more. All shipments sent express collect if postage is not included. Prices subject to change without notice.
BE SURE TO INCLUDE SUFFICIENT POSTAGE. EXCESS WILL BE REFUNDED.

RADIO SUPPLY & ENGINEERING CO., Inc.

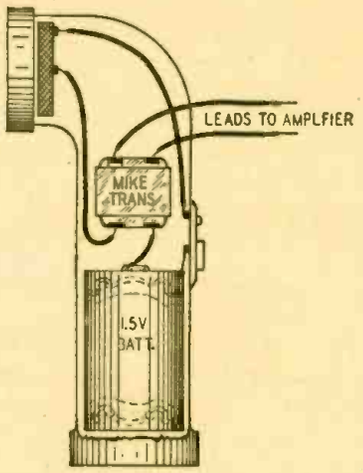
125 SELDEN AVE, DETROIT 1, MICH.

TRY THIS ONE

NOVEL MIKE CASE

A useful and practical application for surplus Army flashlights is to use them for mounting small carbon microphones.

Assembly is simple. Remove the lens,



bulb, and reflector. Replace the reflector with the microphone, and install a small mike transformer and a single flashlight cell. Connect the switch, mike, and battery as shown and bring a shielded lead from the secondary of the transformer through a small hole in the case. The flashlight makes a handy case for the mike and eliminates the external transformer and battery.

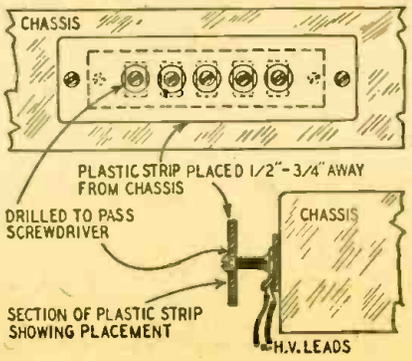
NED FLEISHMAN,
Fayetteville, N. C.

(These flashlight cases can also be used for mounting crystal headphone units or dynamic speaker-microphones, many of which are available from surplus stocks. The small push-button switch is ideal for push-to-talk operation—*Editor)*

SAFETY TERMINALS

This simple and practical device provides a safety covering for exposed high-voltage terminals.

It consists of a piece of clear plastic cut somewhat larger than the over-all dimensions of the terminal strip with holes drilled to permit screw-driver tightening of each terminal. The cover is mounted on bushings to space it from ½ to ¾ inch from the chassis. Changes



can be made readily, yet the terminals are protected against accidental contacts.

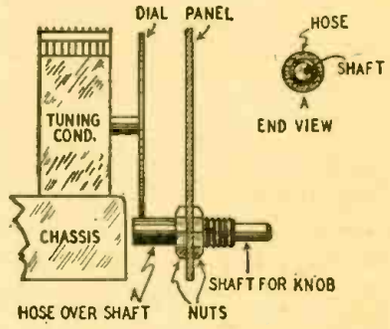
OTTO L. WOOLLEY,
Colorado Springs, Colo.

SIMPLE DIAL DRIVE

I was called upon to repair an old friction-drive radio dial and found no replacement or spare parts available. I removed the bushing and shaft from an old volume control and fastened it in a hole in the front panel. This hole was placed so the end of the shaft was just below the bottom edge of the dial. I slipped a piece of heavy rubber hose over the shaft so it made firm contact with the rim of the dial. The friction provides positive action between dial and shaft.

EUGENE KAAGE,
St. Louis, Mo.

(If the dial is fairly large, tuning will be slow, thus making this system an excellent one for use on homemade short-wave receivers.— *Editor)*



SOLDERING ALUMINUM

It is easy to make solder stick to aluminum if you can clean the surface and prevent re-formation of oxides.

This is the method that I use. Float a pool of fluxless solder on the surface to be soldered and move the tip of the iron back and forth in the pool while applying firm pressure. The vigorous scraping motion loosens the aluminum oxide and it floats to the top of the solder. The surrounding solder readily adheres to the pure aluminum surface since air is excluded, thus preventing oxidation. This method should work with other metals that form troublesome oxides, providing the oxides can be scraped off.

E. JOHNSON,
Brooklyn, N. Y.

METER OR DIAL SCALES

Whenever I need an evenly divided scale for a meter or dial, I find it simple to make one out of polar co-ordinate graph paper. I select a circle of the desired diameter and cut it out, removing segments where necessary. This gives a finely divided scale that is hard to beat.

N. SCHVEDMAN,
Bronx, N. Y.

AMAZING VALUE!

BRAND NEW 5" CATHODE RAY TUBES

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$1.95 EACH IN ORIGINAL CARTON

ADD 35c TO COVER HANDLING AND POSTAGE

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AIRCRAFT TRANSMITTERS

only $3.30

BC-457-A, 4 to 5.3 MC and BC-458-A, 5.3 to 7 MC. These transmitters are companion sets to the 453, 4, and 5 receiver series. They are used, but in excellent condition. It's really built rugged and makes an excellent 55 watt transmitter. With tubes.

Shipped Express Collect

RADIO CONTROLLED BOMB-FIN

$9.85

This unit was originally used to control a guided Bomb; it contains a 24-volt Willard rechargable battery pack, which operates a gyroscope, and low geared reversable motor. The unit also contains a precision built 5-tube RF Receiver complete with dynamotor.

Shipped express, charges collect

NEW MINE DETECTOR

MODEL AN-PRS-1

SHIPPED EXPRESS CHARGES COLLECT $9.50 EACH

REEL CONTROL BOX BC-461

For use with Antenna Reel RL-42B. Contains a 2 way switch, pilot light and a counting mechanism that counts to 1000.

$.75

Add 25c to cover handling and postage

ELECTRIC ANTENNA REEL

Antenna Reel RL-42B used to wind in a trailing antenna on aircraft, operates on 24 volts AC or DC. Motor can also be adapted as a beam rotor. Shipped express charges collect. $2.50

Reel control Box BC-461, as described in this ad, is used in conjunction with this unit.

50" Flexible Shaft for use with above reel..... $1.00

82" Flexible Shaft for use with above reel..... $1.50

BENDIX CONTROL BOX

$1.00

Model 3616, makes an excellent set up for an intercom. set. Contains 3 multiple type wafer switches, one panel type fuse, one volume control, one master 2 pole double throw switch, one lock type sending and receiving telephone key, one local remote transmitter control, one single pole switch, one 24-volt Leach relay with 2 contacts.

Add 25c to cover handling and postage

PHANTOM ANTENNA

85c

A transmitting antenna, for use on approximately 450 MC. Complete with standard coax connector. A weatherproof unit.

Add 25c to cover handling and postage

BC-434 F CONTROL BOX

Contains 3 band dial, a reostat, to control 3 grain of wheat dial lights, an audio volume control, a milliammeter, jack plug, switch, and resistors. $1.25

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MORE REAL VALUE

N-6-A Gun Sight, containing a f 1.9 lens system plus a mirror and many other valuable parts... $1.00

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Throat Mike, complete with cord and switch..... .95

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DYNAMOTORS

DM-32-A, Input 28 volts at 1.1 amps, Output 250 volts at .06 amps.

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DM-36-C, Input 28 volts at 1.4 amps, Output 220 volts at .08 amps.

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$1.00 EACH

24" Headphone cord, complete with lugs..... .09

74' 4 conductor shielded cable, with PL 108 plug on each end..... .15

Continuity Tester, with 12 extra penn light cells..... $1.95

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Head Set H-16/U, 8000 ohm impedance..... $1.85

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Surplus

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Bargains

New Radio-Electronic Patents

By I. QUEEN

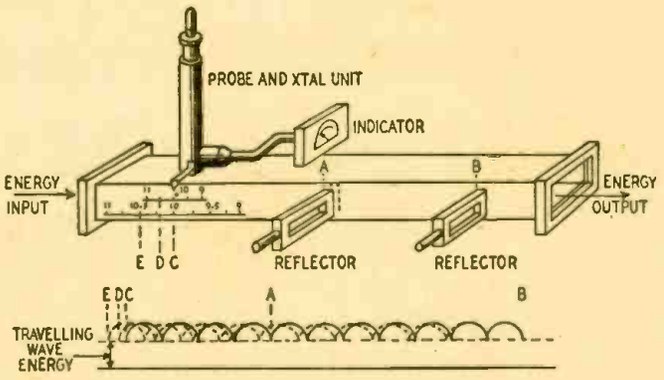
PRECISE LECHER MEASUREMENTS

Glenn R. Frantz, Pt. Washington, N. Y.
Allen F. Pomeroy, Bernardsville, N. J.
(assigned to Bell Tel. Laboratories, Inc.)
Patent No. 2,419,208

Low wavelengths are conveniently measured by Lecher Wires. The r.f. current is introduced along a transmission line which is shorted at some point. A detector is connected across the line and its distance from the short is varied until it shows a voltage node. The detector is moved further along the line until another node is indicated. The distance between consecutive nodes equals ½ wavelength. For very short wavelengths, a wave guide is used instead of a transmission line. The detector is coupled to a probe inserted into the guide.

The relative error of a measurement of length increases at short lengths. This invention reduces the error by measuring over a distance of several wavelengths. As shown, 2 reflectors are used to short-circuit the guide. The distance between them is equal to any number of half-wavelengths at the average or median wavelength which it is proposed to measure. Each reflector is equipped with a handle so that it may be inserted or withdrawn from the guide. The probe is movable over a limited distance, the position being measured by calibrated scales.

To make a measurement of wavelength, v.h.f. energy is introduced into the guide, and the reflector A is inserted. If the wavelength equals the average or medium value for which the equipment is calibrated, the probe will pick up no voltage at C, exactly 4 half-wavelengths from A. At this point the scales indicate the average wavelength of the equipment. If the wavelength is higher, the probe must be moved back, say to D, to obtain a null. The length CD is 4 times the change of wavelength. The new wavelength is read on the upper scale.



For still higher precision, A is withdrawn and B inserted. Now the probe must be moved back to E for a minimum pickup. CE equals 11 times the change in wavelength because this reflector is 11 half-wavelengths from C. The lower scale is now observed for actual wavelength. It is clear that this scale will have more widely spaced and readable calibrations due to the fact that the actual wavelength change has been multiplied by 11 instead of 4.

Still greater precision is obtainable by placing a reflector still further from the probe.

FM-AM DETECTOR

Frederick C. Everitt, Brecksville, Ohio
(assigned to Radio Corp. of America)
Patent No. 2,422,087

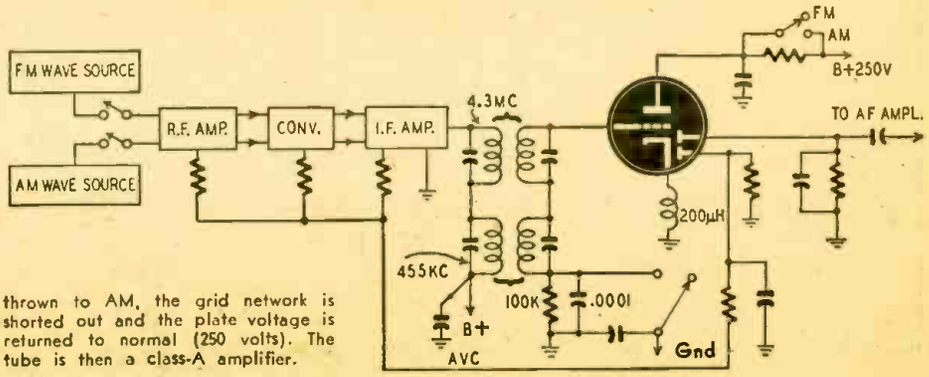
Both FM and AM have advantages of their own and several manufacturers are now selling receivers which can be switched to pick up either type of broadcast. Each requires a different band width and a different intermediate frequency, so there must be 2 separate i.f. channels. This patent discloses a single detector stage which can be used on both, however.

Output from the 2 i.f. channels are combined and connected across 2 i.f. transformers in series. One is tuned to the 4.3-mc FM channel and the other to the 455-kc AM channel. Each transformer has negligible impedance at the frequency of the other, so it is not necessary to switch or short one out while the other is effective.

When the 2 switches are in the FM position (as shown), the plate voltage is dropped to about 25 by the plate resistor, and at the same time an R-C network is placed in the grid circuit. Therefore the triode acts as a limiter. When the switches are thrown to AM, the grid network is shorted out and the plate voltage is returned to normal (250 volts). The tube is then a class-A amplifier.

The detector circuit is rather unconventional. The cathode coil has an inductance of about 200 μh and a natural frequency of 4.2 mc. Its reactance varies with frequency when FM broadcasts are being picked up. The deviations from the center frequency of 4.3 are thus translated into amplitude changes of voltage on the cathode. Since the 2 diode plates are normally at ground potential, their potential (with respect to the cathode) changes in the same way. Currents therefore flow through the diode resistors. One diode is used as a detector, the other as a.v.c. supply.

An important advantage of this system is that there is no loading of the i.f. transformer secondaries when AM broadcasts are received. The grid circuit does not carry current. This gives better selectivity and sensitivity. On the other hand, the triode produces no gain since its load is in the cathode circuit.



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Complex and unusual radio faults may waste hours of your valuable time. The author has foreseen all possible problems (above the elementary level) and provided explanations and practical solutions in this unique on-the-job manual. Keep it on your work bench to aid and guide you on tough repairs. Use the thousands of hints and advanced servicing suggestions to speed up routine jobs. No other training book or course can compare to this new manual. Published in September, 1947. Be first to use it and forge ahead of others. Learn to do complicated repairs in minutes instead of hours.

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PORTABLE P.A. AMPLIFIER

(Continued from page 29)

The meter may also be used to judge the level being fed to a remote speaker located at some point where it cannot be heard. The amplifier can develop 11 volts across 7.5 ohms (or 74 volts across 500 ohms) without serious distortion, and the series meter resistance can be changed to indicate this value.

The lower deck contains the power supplies and the plate current meter (see Fig. 3). Screw-driver adjustments are brought out to the panel for the output tube bias adjustment, and between them is located a 3-position switch. This switch connects the meter to either or both plates. The bias is adjusted so that each tube draws 55 ma.

When connected to both plates, the meter becomes a distortion indicator. When the total plate current swings more than 20 ma, serious distortion will result, as the output tubes will draw excessive grid current.

Power supply

The power supply panel also contains the main power switch, a fuse, indicator lamp, and two 117-volt outlets for a lamp or for 2 recording or playback turntables.

The high-voltage supply consists of 325 volts at 160 ma, using a 5U4G rectifier tube and filtered with 80 microfarads of capacity and a 15- and 10-henry filter choke. The power transformer has a bias tap which is rectified by an 80 tube and filtered with an R-C filter. The various voltages are brought out to a terminal strip located on the side of the case. The amplifier decks are connected separately to it so that they are individually removable.

The chassis were made of 1/16-inch aluminum held to the panel by cut down rack panel brackets (see photographs).

The negative plate supply bus is not grounded in the power supply deck at all, but is fed directly to the 2 amplifier decks. It is grounded to each deck in 1 place only. The 6.3-volt heater supply is grounded in the preamplifier deck in one place only. This is essential to elim-

(Continued on page 82)

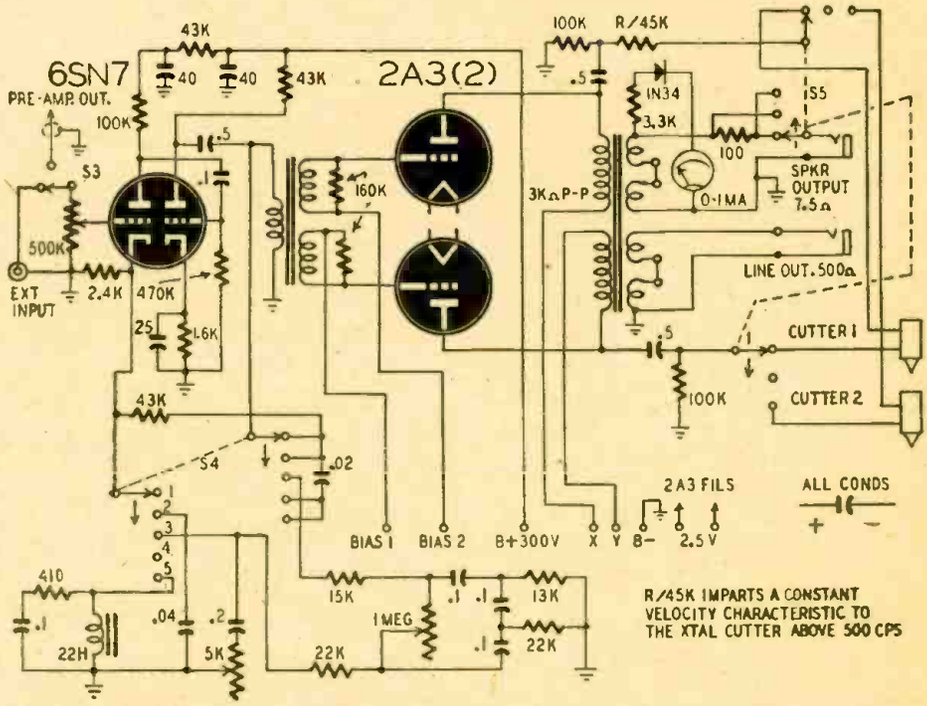

Fig. 2—Power Amplifier section. The driver plate is shunt-fed through a 43,000-ohm resistor.

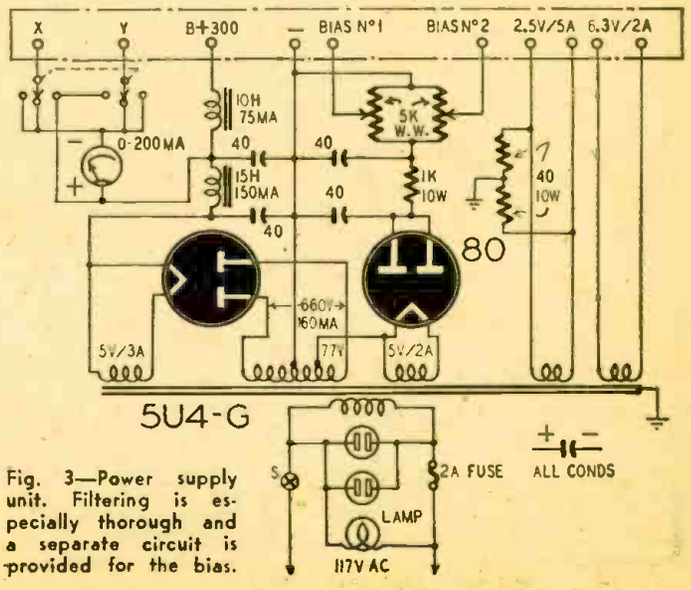

Fig. 3—Power supply unit. Filtering is especially thorough and a separate circuit is provided for the bias.

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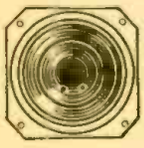

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WIRE RECORDER SERVICING

In servicing wire recorders, says *Sylvania News* in a recent article on that subject, several simple points should be checked. They are listed as follows:

A. Mechanical

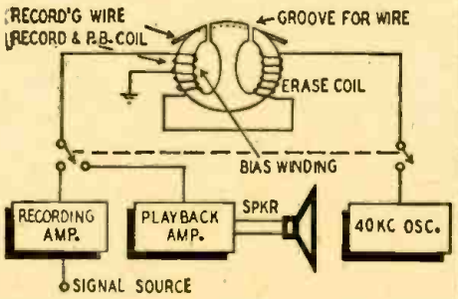
1. No loose parts.
2. No varying friction or "drag" in the mechanism to make the wire tension change.
3. All adjustments set so that no loose windings develop and the wire is properly wound.
4. Brakes set properly.
5. Head oscillates to wind the wire uniformly.

B. Electrical

1. No opens or shorts in the recording head.
2. Check bias for frequency and voltage.
3. Check recording current.
4. Check rest of amplifier in normal way.
5. Make sure the wire rests properly in the groove of the recording head.

Heart of the recorder, says the article, is the magnetic recording and playback head, shown in the illustration. It consists of 2 coils which can be wound on separate cores or on a common one as in the sketch.

Functions of these coils are; Erase coil to provide enough energy to erase a signal on the wire, and provide the proper supersonic bias for proper recording. The bias is primarily used to raise the recording head to a linear portion of the wire hysteresis curve. Record coil provides the required magnetization which is impressed onto the wire. For playback the record coil is



generally used to pick up the signal from the wire.

Essentially, in recording, the varying input signal varies the amount of magnetization on the wire. This variation of magnetization of the wire in playback induces voltage in the playback coil which in turn is amplified and provides the neeessary signal for listening. As shown in the figure, when the wire passes over the erase or record coil, it passes over a small gap. The wire effectively short circuits the magnetic circuit and is thus magnetized in the process. In general, the erase gap is in the order of 5 to 10 times as great as the record gap. The gap distance for the record circuit is approximately 1 to 2 mills. (0.001 —0.002 inch).

The gap width in the record coil determines the frequency response of the head and wire. Generally speaking, a larger gap gives more lows but less highs; therefore, an optimum value is selected, the upper and lower frequency limits depending to some extent on the applications desired.

"TAB"

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TRANSFORMERS 115V/60cycles inpt:
15000V, 35ma/$15.95; 1200 VCT, 300ma $5.95
500VCT/60ma, 6.3V/4A/$1.49;1100VCT/212ma 6.50
700VCT/120ma 6.3V/2.4A, 5V/2A—$2.69 ...2 for 5.00
1350VCT/150ma, 6.3V/5A,5V/2A cased UTC 7.50
640VCT&1540V/250ma/$4.95 ..... 2 for 8.95
1100VCT/150ma, 6.3V/3A,5V/3A HVins 3.95
2500V/15ma/$5; 5V/11A Kenyon 7.95
1000VCT/110ma, 6.3V/5A,5V/3A,4x6.3V/.65&1.25A 4.25
1000V/45ma, 795VCT/80ma, 3x5V/3A, 6.3VCT/1A 6.3V/.3A Hmtclly cased HVinsltd 7.95
772V/2.5ma,2.5V/3A/$3.95; 1230V/262ma 5.98
3200VCT/200ma,780VCT/200ma,12VCT/.5A 12.95
6.3/4A,6.3VCT/1A $2.49; 2100V/10ma 3.95
7.5VCT/6.5A, 6.3VCT/3A/$3.75;10V/8A/12.5KVins 6.95
2x5V/8A/12.5KVins/$6.95;6.3V/6A,5V/4A&8A ... 3.95
300VCT/150ma,6.3V/2.5A,6.3V/.6A 3.00
1000VCT/250ma/$4.25 ;30V/4A 3.25
6.5V/8A,6.5V/6A.2.5V/1.75A,5V/3A 3.00
760VCT/120ma.10V/3.25A.2.5V/10A.6.3VCT/2A 5V/3A HLLCRFTRS—610/HVinsltd.. ..... 5.95
830VCT/125ma.6.3V/6A.6.3V/1A.5V/3A 3.95
1000VCT/200ma.90V.6.3V/5A.5V/6A.18V/55A 4.75
9800V/15ma.Pri 115V/60&400cy/csd oil 7.95
115or230V/50—60cy/1400Watt 14.95
110&220V TO 220&440V/190Watt 4.50
AUTO Transf 115/160/170/180V/1.95A 2.95
230or117/112/103/93V/7Amp GE 12.95
90/80/70V/1A/$2.95;7.5VCT/6.5A,6.3VCT/3A 3.75
7.5V/12A/HV $2.95; 10.4V/5A 3.95
5V/20A/Pri 220V/$6.95.2.5V/10A/Pri 220V 3.95
Universal Vibrator Transf 6-12-24-115VCT 115/230 VAC/50-60cy.420VCT/60ma,6.3V/2A 1.95
TELEVISION Pulse Transf GE 1.49
MODULATION Trans PPparallel 6L6's—807's to RF 807's/2000ohm load-cased 2.95

"TAB" • Dept. 9RC, Six Church Street. New York 6, N. Y., U.S.A. • "TAB"
THAT'S A BUY • • • CORNER CHURCH & LIBERTY STS., ROOM 200 • • • THAT'S A BUY

CARRIER CURRENT

(Continued from page 27)

fier (plate to cathode) by the plate current expressed in amperes. The proper taps on the modulation transformer for the correct impedance should be used.

If the microphone and speaker of the receiver are separated a few feet, it will be possible to operate duplex phone (talk back and forth without turning the carrier on and off). This system is quite satisfactory if the carriers are tuned to frequencies of sufficient difference to eliminate interference with the reception of the signal heard on your receiver by side bands produced by your transmitter.

The noise level noticed with phone operation was very low. The main disturbance was found to be the a.c.-d.c. receiver. The half-wave rectifier operating directly from the power line pro-

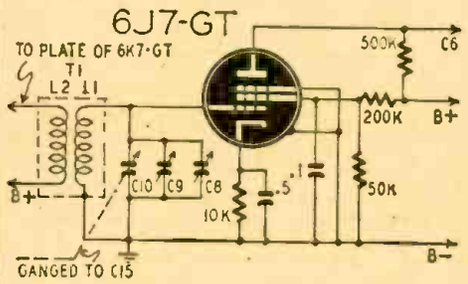
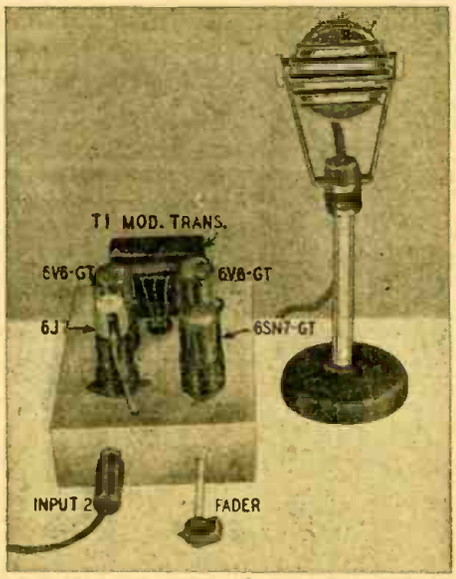


Fig. 3—Detector circuit for short ranges.



The modulator unit. Input 1 is behind chassis.

duces an unpleasant hum on the carrier of carrier-current stations.

For local use up to several hundred feet, it is suggested that the receiver described should have a nonregenerative, biased detector instead of the grid-leak detector. (See Fig. 3.)

By using a single carrier-current phone transmitter and several receivers, it would be possible to fill a large room or even several rooms with sound. The tonal quality of such a system for speech or playing recordings compares favorably with any public address system or radio. Several of these portable plug-in-the-wall receiver-speakers would make an excellent PA system.

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2. Fundamentals of DC and AC Theory.
3. Essentials of Radio Communication.
4. Communication Networks.
5. Advanced Radio Telephony for the Broadcast Operator.
6. Audio and Radio Components and Systems (Design of Receiver and Transmitter Equipment).

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Contractors to the Canadian Broadcasting Corporation

RC-11 Terminal Tower
CLEVELAND 13, OHIO

Approved for Training under "G-I Bill of Rights"

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Cleveland Institute of Radio Electronics, RC-11, Terminal Tower, Cleveland 13, Ohio.
Gentlemen: Please send information about your home courses in Radio Electronics.

NAME .....
ADDRESS .....
CITY .....
ZONE ..... STATE .....

I desire training in ☐ A ☐ B ☐ C
I have had experience in broadcasting ☐ servicing ☐ operating ☐ mfg. ☐ CAA ☐ Army-Navy ☐ amateur ☐ other .....I am a High School Grad. ☐ College ☐ Degree .....
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Approved for Veteran Training under "G-I Bill of Rights"

IT'S EASY IF YOU FOLLOW OUR PLAN!

Thousands of new jobs are opening up—FM, TELEVISION, MOBILE COMMUNICATIONS SYSTEMS, are only a few of the radio fields which require licensed operators.

TIME IS IMPORTANT TO YOU!

You can get your License quickly with NILSON'S MASTER COURSE in RADIO COMMUNICATION and exclusive CIRE Workbooks of Instructional Aids. Saves you many hours or random, undirected study.

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FREE BOOKLET tells you the Government Requirements for all classes of commercial licenses — Sent immediately upon receipt of coupon.

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RC-11 Terminal Tower
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MAIL THIS COUPON

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RC-11 Terminal Tower, Cleveland 13, Ohio

Gentlemen: Please send information about your Home Study Course for preparation for FCC Commercial License Examinations (this course does not cover amateur license examinations).

Name _____
Address _____
City _____ Zone _____ State _____
☐ If a Veteran check here

17-TUBE FM RECEIVER

(Continued from page 21)

matically obtained (point of zero voltage); therefore, tuning the receiver through an FM carrier will indicate positive and negative voltage swings.

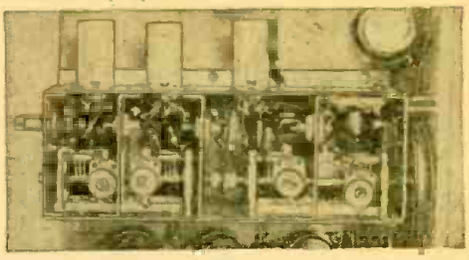
The output of the 6J5 first audio amplifier is fed through a network designed to give treble and bass compensation. Due to the loss in gain in this network, one half of a 6SN7 tube is used to give additional gain, and the output of this stage is fed to a negative-current feedback triode phase inverter. The output of this phase inverter is used to drive 2 push-pull 6V6 tubes.

To take advantage of the wide frequency response obtainable through frequency modulation, a high-fidelity audio system must be used. An amplifier capable of reproducing this extended range is not too difficult to construct but is of little value without high-fidelity output components capable of reproducing this extended range properly. A UTC linear standard output transformer and the new Jensen Model RD-151 articulated coaxial speaker unit are used in the author's model, and the results are excellent.

Some construction details

The tuning unit housing is constructed as shown in the sketch appearing in Fig. 1. Two double-section 35-μμf tuning condensers (Cardwell ER35AD) are mounted on the upper left side of the housing and coupled with a flexible coupling. Before mounting these condensers, 2 stator plates must be removed from all sections but the high-frequency oscillator section in order to insure proper tracking. The shield plates of the housing are constructed in such a way as to isolate completely one stage from another and form 4 shielded compartments in which the various tube sockets and associated wiring are placed. Insulated feed-through bushings are mounted on the upper right side of the 3 compartment-forming shields to couple one stage to another. The high-frequency coil forms are mounted on the left shield plate directly beneath each condenser gang. These coil forms are slug-tuned; therefore a hex nut must be soldered to the end of each slug screw to make tuning accessible from the side of the unit with an open end wrench. Construction of the coils is shown in Fig. 2. All are constructed on National XR50 forms. Directly across each condenser gang is mounted a 13-μμf trimmer condenser having a zero temperature coefficient. The oscillator tube is placed inside the unit to help keep wiring leads short and also as an aid to stability because in this location only its own heat affects the stability of the receiver.

Since it was desired to have a slide-rule tuning dial and also a pinch-type drive, the dial shown was made up of a Crowe 535 and a National BM dial.



Heart of the set. The shielded tuning unit.

The pinch and steel scale from the National BM were used. The constructor may follow his own taste in this matter however. The lettering and scale numbers were put in with red cellulose paint and a ruling pen, as scales for the new FM band were not available.

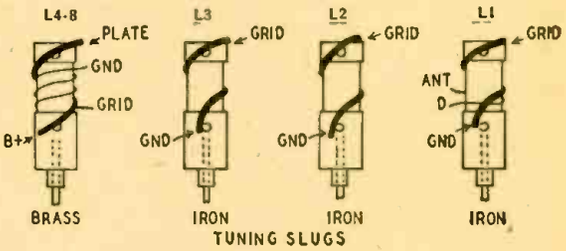
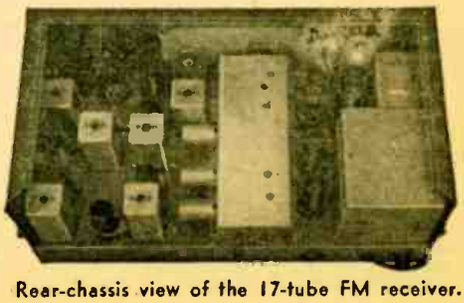


Fig. 2—How coils are wound. All are on National XR50 coil forms.

Receiver alignment

The first step in adjustment of an FM receiver is discriminator alignment. A stable signal generator is set to 10.7 mc (center frequency of the transformer used) and its *unmodulated* output connected between grid and ground of the last limiter tube. Then connect a sensitive vacuum-tube voltmeter across the cathodes of the discriminator tube. Tune the primary tuning slug of the discriminator transformer for maximum output as indicated on the v.t.v.m. Then rotate the secondary tuning slug until zero output voltage is obtained. Rotating the tuning slug to either side of this zero

Front view of the set. The dial is home-built.



Rear-chassis view of the 17-tube FM receiver.

voltage point will give an increase in output voltage but of opposite polarity.

To check the discriminator alignment, shift the signal generator 50 to 100 kc to either side of the center frequency (zero voltage point). This should give equal but opposite meter variations. If the readings are not equal, repeat the alignment procedure. (Center frequency is that frequency to which the discriminator was tuned and gave zero voltage output.)

The signal generator is now set back to center frequency and its output leads are connected between grid and ground of the mixer tube. A microammeter is inserted in series with the ground end of the first limiter grid resistor. The sensitivity of the meter to use depends upon the output capabilities of the generator and just how far out of alignment the transformers are. A meter with a 0-200-microampere movement should be sufficient for the job.

Each transformer is now tuned for maximum indication of the microammeter, starting at the first-limiter input transformer and working back toward the mixer. Tuning of these transformers should be repeated 2 to 3 times to assure exact peak adjustment and symmetrical response of the i.f. stages to the incoming frequency-modulated signal. Symmetrical response of the transformers is checked by shifting the generator frequency 50 to 100 kc to either side of the i.f. center frequency and noting the readings on the microammeter. They should be equal for a given frequency shift to either side.

The microammeter is now removed from the grid resistor of the first limiter and inserted in series with the ground end of the second limiter's grid resistor. With the signal generator set back to center frequency, the limiter coupling transformer should be peaked for maximum reading on the microammeter. Again check for over-all symmetrical response of the i.f. system by shifting the generator 50 to 100 kc to either side of the center frequency. Look for an equal but opposite meter reading at the output of the discriminator. The signal generator is now set for a frequency of 105 mc and maximum output, and connected to the antenna terminals of the tuning unit. The microammeter is placed back in series with the ground end of the first-limiter grid resistor so that it may serve as a resonance indicator. With the tuning slug of L6 set approximately half way into the coil, proceed with the alignment as indicated in the chart below.

Step	*Set Dial and Signal Generator to*	*Adjust for Correct Dial Settings*	*Trim or adjust for Maximum Output as Indicated on the Microammeter*
1	105 mc	C4	C1, C2, C3
2	90 mc	C5	L1, L2, L3
3	Repeat steps 1 and 2		
4	98 mc	L4	
5	Repeat steps 1 and 2		

If the desired signal is outside the limits of the variable padder C5, it will be necessary to adjust L4 to bring the signal within the limits of this padder.

ADVERTISING

(Continued from page 24)

it is generally possible to specify the page on which the ads shall appear. Advertising handled on such an arrangement is also more economical.

It is imperative that ads be changed periodically, since the oftener an ad is repeated, the less effective it becomes. Therefore, copy should be frequently changed. This can be quite a chore, but after some practice and by observing the advertising of other firms it will become easier. I visit the public library and find that an hour or two spent reading ads in the out-of-town papers provides enough ammunition to write ads for as long as 2 months. Newspapers are picked at random, from Portland, Oregon, to Portland, Maine. No ad is copied verbatim, but the ideas are modified for my ads, some of which are written on the spot.

Some words should be avoided in writing advertising copy because they are misleading. One example is the word "serviceman," which this writer used for years with fair results. However, it has become associated with members of the Armed Forces. For that reason, the words "serviceman" and "service" are no longer used. Technical terms should likewise be avoided. With this in mind every ad should be looked over after it is written. Every word and sentence should be scanned closely so no misleading ideas will creep into the copy.

Use a slogan!

All radio repair advertising should hinge on a *catch phrase*. Every bit of advertising should carry it. It should be the keystone of all public appeals and appear whenever the shop's name appears. In selecting a catch phrase to use in advertising, brevity and originality should be the important factors. Study your competitors' advertising, and be very careful to have yours different in every respect. Then repeat and repeat your own catch phrase until you are blue in the face. Keep that catch phrase in constant use in all advertising. Some examples of catch phrases are:

"Repairing Radios for—Years"
"RADIO Is Our BUSINESS—Not a Sideline"
"All Repairs Guaranteed For—Days"
"Our Sincere Effort Is To Please You"
"Guaranteed Workmanship"
"Quality Repairs"
"Radio Repair Specialists"
"We Can Repair Any Make, Any Model"

If you have a nickname, use it! People are human, and they much prefer to know you as "Red" or "Slim," rather than as "Mr. Doaks." Be a regular guy in your ads, and take your potential customer to your bosom. Talk to him as you talk to your neighbors—he *is* your neighbor. Above all, talk "to" him, not "at" him. You need not be a spellbinder, but your ads represent YOU and you should make the most of the oppor-

tunity they offer. Failure to do so means that you are wasting good money and time on ineffective advertising.

It pays to remember always that the average man with a defective radio under his arm knows nothing about it except that it doesn't work. He is not interested in what makes it work. He just wants to hear programs and is much more interested in how soon he can get it fixed. He will take it only to the one man he believes CAN repair it. He paid hard-earned wages for his set, and he will not risk taking it to someone in whom he has no confidence. If you want that customer to come into your shop, you must gain his confidence; so write your ads to appeal to *him*. If you can assure him that you do good work and will stand back of it, he will bring it to you rather than take it to someone he does not know. All repair advertising *must* keep that fact in mind.

A potential customer comes into your shop because of a definite urge. Advertising creates that urge. If he is confident that you can and will cure his trouble, you will find him an agreeable fellow to do business with. He will not haggle over price, and will give you plenty of time to do a good job. If he is satisfied, he will be the best kind of an ad. His confidence can be gained with the proper kind of advertising, but you will have to keep forever at it—and back it up with quality work to retain it.

Build your reputation!

Be simple, direct, and *honest*. Do not advertise anything that you cannot live up to. If you guarantee your work, do it right in the first place, and put a definite guarantee *in writing* on it before it leaves the shop. Then advertise that your work is guaranteed for a definite period of time. An occasional job will bounce back in your lap, but if it does, take care of it graciously and *thoroughly;* and the time spent will bring in more business.

Some of the radio tube manufacturers have advertising *mats* available for radio repair shops to use in newspaper ads. In general, these are not as satisfactory as ads written by you—to appeal to your neighbors. But they do incorporate good ideas for ads, and should be studied.

Other advertising aids can be used. In the smaller towns, one of the most effective advertisements per dollar invested consists of movie trailers run in the local theater. Select subjects carefully, and avoid trailers of a technical nature. The accompanying sound track or screen lettering boosting the local shop must be carefully written to be sure it will not be misleading, since it may sound much different than it looks in writing. Contact the manager of the local theater before ordering trailers since he invariably has tie-ins with the film makers and his suggestions in the selection of sources may be valuable.

Several firms make trailers especially for radio shop advertising. Among these are Alexander Film Company, Colorado

(Continued on page 76)

ADVERTISING

(Continued from page 75)

Springs, Colorado; Filmack Corp., 1327 South Wabash Avenue, Chicago 5, Illinois; and United Film Productions, 1558 Vine Street, Hollywood, California. Any of these firms can furnish trailers with sound tracks or lettering to suit individual needs. One or two firms furnish the trailers outright, or they may be contracted for with a periodic change of copy to insure their not going stale. A postcard to any of these firms will bring all the information needed.

Broadcast your ads!

If there is a local broadcasting station in town, one or two daily spot ads will bring future business. If they are slanted to stress poor or distorted reception, they will be very good advertising. The station's engineer and advertising agent will have many good ideas.

Broadcasting, newspaper, and theater advertising require a constant change of copy, and are a periodic monthly expense that should be charged to overhead. They can be highly effective and, if properly prepared, will bring in lots of business. For best results with any of the above forms of advertising, a weekly change of copy is imperative.

I have tried one advertising stunt with success in a small town located 60 miles from broadcasting stations. It consists of mimeographed weekly Listener's Guides made up for free distribution in local stores and gas stations. They contain complete listings of popular radio programs, together with station frequency and time. These Listener's Guides are made up from information gladly furnished by the broadcasting stations. The local paper does not list the radio programs and a real need is being filled as well as business for the radio shop being brought in. A small paragraph at the bottom of the sheet gives the radio shop credit.

Tell the tourists!

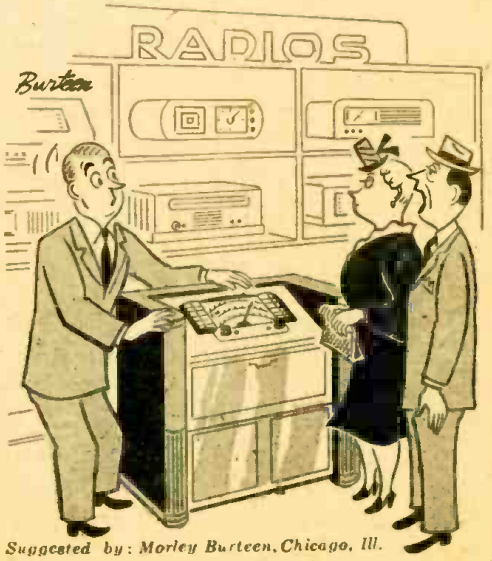
Many smalltown radio shops find road signs an efficient means of advertising. Such signs, properly made and placed on the main roads leading into town, will pay for themselves in a short time, and maintenance costs will be negligible for a considerable period if the signs are well constructed and painted.

Roadsignsshould be placed where they can be seen by approaching traffic. A Sunday afternoon spent investigating road signs, their makeup and location, will be well worth the gasoline and time. The type of traffic using the highway should be studied. If it is tourist travel, signs advertising auto radio repairs will bring considerable work of this nature, provided the shop is equipped to handle it on short notice. Most tourist work has to be handled quickly, since these customers will not wait. Farm to market traffic, on the other hand, will respond to signs dealing with home radio repairs.

The ideal location for a road sign is on a curve, where it can be seen by occupants of cars approaching the curve. Property owners should be contacted before placing signs, and their permission obtained. Ordinances should be studied, too, since most states and counties have ordinances covering the placing of such signs a minimum distance from the highway boundary. Signs should be neat, simply worded, and not too large. If placed some distance from town, the distance to town can be shown on a smaller sign attached to the road sign. This will draw attention. Average cost of a well-constructed and painted road sign should be in the neighborhood of $15 for one 3 x 5 feet, plus the cost of placing it.

Many shops have public address systems installed in the shop's truck. These can bring in business, but it should be noted that they can also kill business if operated in neighborhoods where people are sleeping during the daytime. A survey should be made and use of the public address system avoided during hours that wage-earners or children might be napping. It is regrettable that a few owners of this equipment have been so short-sighted in their operations that some communities have found it necessary to ban them.

A more effective way to use the public



Suggested by: Morley Burteen, Chicago, Ill.

"I don't care if it is FM—I want one that plays in the P.M.!"

address system is to donate its services for local sports events, to be used for announcing, etc., with an occasional plug for the local radio shop. The radio shop public address system can be a real community asset if properly handled.

Other advertising means will come to mind. Their value can be gauged, as can all advertising, by the usual yardstick of customer appeal and the ability of the advertising to reach the greatest number of potential customers at the lowest cost. The best advertising is useless if it does not draw the attention of potential customers and get a favorable reaction. Advertising that reminds the potential customer that the old set needs repairs is not as effective as that which will go one step farther and persuade him to have it repaired. Properly written and displayed advertising can do just that. Coming events, such as elections and world series ball games, can be used as the basis for some of that advertising. Advertising those events a few days or a week in advance, can goad some radio owners into action.

Got to have the goods

To sum up, the best advertising any radio repair shop can ever get is the workmanship turned out. Much business will result from satisfied customers. But business can be expanded tremendously by a thoughtful advertising campaign designed to produce a favorable customer reaction. The advertising can be slanted to reduce customer resistance to the point that when the customer does walk into the shop, he will leave some of his hard-earned wages in the till.

Handling customers in the shop requires study, too. The best advertising in the world will only bring about customer contacts. A smile and intelligent handling is appreciated by the average person. Small favors take only a minute. For example, if you feel that it pays to test tubes free, do so. Be the *best* radio repairman in your community. Try to blow your own horn as much as possible, but do it softly, and let the customers who walk out happy really play a loud tune on it for you. If you do that, you will find the cash register playing a long, loud tune too.

MAGNETISM

(Continued from page 30)

auxiliary elements required for magnetic playback. Here, too, it should be noted that a preamplifier is used after the playback (whose output voltage is in the order of 0.75 millivolt at 1,000 cycles). In addition, a fixed equalizer is employed to flatten the normal tape response curve. A variable response control is provided to enable the operator to set the over-all response (within predetermined limits) in accordance with his personal preference.

Fig. 4 indicates elements utilized in the magnetic erasing process.

Unique advantages

Even a casual knowledge of magnetic recording and playback principles enables technicians to realize readily some of the profound advantages of this method over the more conventional recording and playback systems.

The troublesome problems of *needles* (the necessity for changing, needle wear, record wear, needle tracking, needle chatter, needle scratch, needle frequency distortion) and all the complex problems associated with the conversion of mechanical motion to electrical energy, all of these, and more too, are completely eliminated by the one simple principle of Poulsen's applied magnetism.

No disc record, no matter what it is made of or how carefully it is handled, will continue to give the same quality of performance as it did when first played. Every record wears with each playing. Both the increase in scratch and the loss of high frequencies are proportional to the number of plays. The average good record is unbearable to the critical listener after a hundred plays on better than average playback equipment. Magnetic tape records have not shown a noticeable increase in surface noise or loss of high-or low-frequencies after a thousand plays!

Everything that can be recorded on high-grade disc records can be carried over to magnetic tape. Specifically, this means that both the dynamic range and the frequency range of good commercial discs can be equalled (and in some semi-professional machines actually surpassed) on magnetic tape recording and playback units.

More permanent records

Magnetic tape records are far more permanent and far less fragile than commercial discs. Tape is not subject to warpage, breakage, scratches, chipping, or the record maker's plague of eccentric centering holes. Of course, paper-coated magnetic tape will tear (it takes a 5- to 6-pound pull to do it), but it can be spliced in less than 5 seconds with ordinary Scotch tape and a pair of scissors—and you can't hear the splice as it passes through the pickup head. In this respect it is far better than splicing sound tracks on film which requires a special treatment, which is called

"blooping" in order to silence the splice.

Magnetic tape records provide unlimited playback facilities without deterioration of valuable disc records. A single playing of a record is all that is needed to copy it onto tape which may in turn be played many hundreds of times without touching the original discs or fussing with needles. Also, for the first time, record enthusiasts may indulge in what was heretofore exclusively reserved for commercial and motion-picture technique—corrective re-recording, which is a process of re-recording an already recorded program and simultaneously applying frequency and amplitude correction, like accentuating high frequencies, or eliminating low frequencies, or vice versa, or making soft passages louder or still softer, or controlling loud passages. Special re-recording technique also may be employed to provide noise suppression while copying from an abnormally scratchy record.

Special effects

Musical enhancement, in all its phases, formerly confined to advanced sound laboratories only, also may be applied. For example, controlled compression may be employed during recording and complementary expansion during playback to recreate the original dynamic range of live programs.

Narration may be added before, after, or during any program to catalog, identify, or explain special passages or unusual points of interest in a valuable collector's item for educational or other purposes. Passages, solos, or sections may be repeated during a continuous program.

An extraordinary feature of magnetic tape recording (as compared to disc recording) is ease of erasure of any program and reuse of the tape to record anew. This process can be carried on indefinitely.

From an economy viewpoint the process is unusually attractive for no tape is ever wasted. Cut-out sections may be respliced, erased, and reused in one simple operation.

To clear up any prevailing misconceptions about the process, the following facts should be kept in mind:

1. Under ordinary conditions of storage, recorded tape should last indefinitely.
2. The magnetic coating on the tape does not rust when stored in damp climates.
3. The magnetic properties of the tape are not affected by dropping a reel. (Reels were dropped 20 feet without damage to the tape—the reels did bend out of line, but were easily straightened.)
4. An appreciable amount of magnetic energy in actual contact with the tape is required to erase any program material. Bringing magnetizeable material in close proximity of the recorded tape does not affect the tape.
5. Erasure of used tape is complete,

(Continued on page 80)

MAGNETISM

(Continued from page 79)

in properly designed and operated equipment.

6. An interesting advantage of magnetic tape over wire is that it has no tendency to snarl or become entangled. In an experiment, 1,250 feet of magnetic tape were strewn over a floor, and rewound in a matter of minutes with the rewind motor recording units.
7. The magnetic interaction between one layer of recorded material and its adjacent layers is negligible.
8. The metal reels on which the tape is normally wound have no effect on the program material.
9. The recorded reels may be stored in ordinary cardboard containers.
10. The over-all quality obtained is a function of the quality of the recording amplifier, the playback amplifier, and the loudspeaker.

The magnetic tape recorder may be connected to any radio for pickup of radio programs and may also play back through the radio or other special amplifying equipment the user may have.

An unsuspected number of critical factors enter into the design and application of practical high-fidelity magnetic tape recorders. These will be disclosed in detail in the next issue of RADIO-CRAFT.

In the meantime, the writer will be pleased to answer questions addressed care of this magazine. To insure speedy replies, please include a postage prepaid and self-addressed envelope.

HIGHWAY RADAR

(Continued from page 22)

errors due to angularity are less than 2% at any distance within 15 feet of the traffic path. At distances between 15 and 25 feet the error may increase to 5% on the low side. The equipment is so constructed that it can be handled by a nontechnical operator. Since it is a radio transmitter, an FCC station license is required. Any authorized employee of the state police department may then operate it without a special operator's license.

The meter is constructed to work from either a 6-volt storage battery or the 120-volt 60-cycle a.c. normally used for traffic signal control power. The 3 units can be packed in a case 26 x 6 x 9 inches. The weight, including the case, is only 45 pounds. Since the range to be covered is short, output power is low—approximately 0.1 watt at 2,455 mc.

The equipment is now being used to study traffic trends, road safety, and safe speeds. Later, postcards will be sent to speeders, "telling them when and where they were exceeding the speed limit" and warning that further violations will result in prosecution. Only then will the speed meter records be introduced in court and the speeder confronted with the unanswerable testimony of an electronic instrument.

TRANSATLANTIC NEWS

(Continued from page 37)

to be driven to the verge of distraction by the problem of getting a car quickly to the place where it was urgently wanted. Then she bethought herself of the radio systems used during the war by tank commanders for controlling formations of armored fighting vehicles. Why not apply one of them to the control of taxicabs scattered over a large area? Once formed, the idea was quickly put into practice and it has proved a magnificent success. At the center there is something like a wartime operations room, containing a large-scale table map of the area. Every cab has its own number, and a small metal block, bearing a corresponding number, indicates on the map the position of each car at any time. Indicators on the blocks also show whether a cab is engaged in doing a job or available for hire.

The equipment is a suitably modified v.h.f. tank radio. There is a master transmitter and receiver at the center and each cab carries its own transmitting and receiving equipment, with a small loudspeaker and a hand microphone on the dashboard. All drivers call up the center at regular intervals when they are free, reporting at once when they are hired or have finished a job.

The idea is one that might well find wide appreciation and application. Thousands of tank radios are being offered cheap as war surplus, and it is a simple matter to make the necessary modifications.

Solar radio

Radiations from the sun on 3 specially marked frequencies, 200 mc, 90 mc, and 60 mc, have been under observation for some time now in this country and in Australia. The main radiation at these comparatively low frequencies takes place from sunspots and from *prominences*, those gigantic spouts of flaming gas which may rise several hundred thousand miles above the sun's surface. It has been calculated that the 200-mc radiation from near the base of a prominence may be equivalent to the output of a 1,000,000-kilowatt transmitter. Radiation from the higher parts of a prominence is of lower frequency. That at 90 mc corresponds to a height of 90,000 kilometers, and that at 20 mc to a height of 200,000 kilometers. It seems likely that this solar broadcasting plays a considerable part in the radio blackouts which are associated with periods of great sunspot activity. During the almost world-wide blackout on March 8 this year, there was at first strong radiation on 200 mc; in less than 3 minutes the 90-mc radiation began, as the prominence rapidly gained height. Between 4 and 5 minutes later the 60-mc radiation began to be recorded.

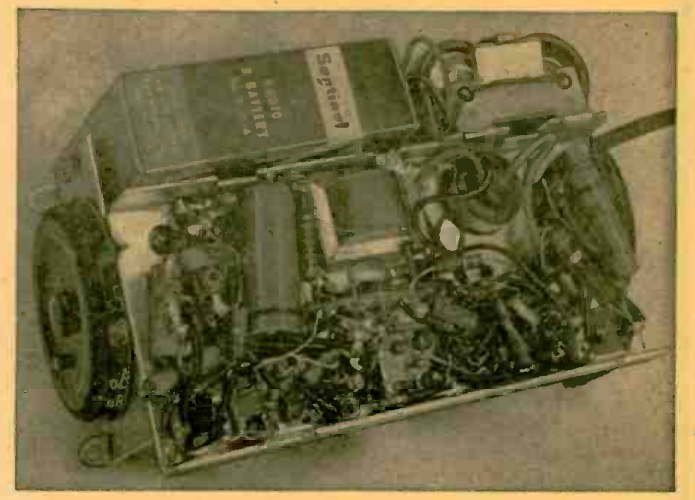
RADIO SET AND SERVICE REVIEW

(Continued from page 36)

even on the high frequency end of the band.

Circuit is the conventional superheterodyne with 4 miniature tubes and a selenium rectifier. The tube line-up is: 1R5 converter; 1T4 455-kc i.f. amplifier; 1S5 detector-a.v.c- first a.f. amplifier; 3Q4 power amplifier. The 3Q4 drives a 4-inch PM speaker.

A single 67½-volt B-battery and a pair of standard 1½-volt flashlight cells supply current for battery operation. The tube filaments are connected in parallel through the power selector switch and heated by the 1½-volt cells in parallel. When the set is a.c.-d.c. operated, the filaments are connected in series through the switch and the filament current supplied from the selenium rectifier through a 2,360-ohm dropping resistor.



An under-chassis view of the receiver, showing battery placement.

The set is easy to service. The bottom cover is removable for battery replacement or for removing the line cord for a.c.-d.c operation. A dime or other thin coin is inserted in the slot of a quick release screw in the bottom cover. A half turn unlocks the cover for removal. Four screws hold the chassis in the case. When these are removed, the chassis slides out without having to remove knobs or unsolder the loop antenna. Spring contacts inside the case and on the chassis connect the antenna to the set when it is in the case.

The 1620-kc oscillator trimmer is adjusted with the chassis out of the case. Bridge the antenna terminals with a 1-megohm resistor and connect the output of the test oscillator across this resistor. The 1400-kc loop antenna trimmer is adjusted with the set in the case. The test oscillator signal is fed into a 2- or 3-inch loop consisting of 5 to 10 turns of No. 20 to 30 wire. This loop is coupled loosely to the loop antenna and the trimmer adjusted for maximum output. A cut-plate variable condenser with the oscillator section smaller than the r.f. section is used, so there are no padder problems in the alignment procedure.

The diagram shows an interlock switch to break the a.c. line when the bottom cover is removed. This switch was not present on the model tested, although provisions were made on the cabinet for mounting it.

PORTABLE P.A. AMPLIFIER

(Continued from page 66)

inate any hum which may be due to ground loops.

The hum level of the finished unit is extremely low. This is partly due to the unusually high filter capacitor values, and to the careful grounding and excellent shielding.

The close positioning of the components, together with the negative feedback system, made the unit prone to oscillation. Therefore certain precautions were taken.

A bottom plate was bolted to the preamplifier deck. This bottom plate provides electrostatic, electromagnetic, and thermal shielding. The plate was cut from a photograph ferrotype tin which was chrome-plated. The chrome side faced down to reflect the heat of the output tubes. Ventilation holes are provided in the back of the case.

The speaker and recorder lead wires must be shielded or oscillation may result, especially when the frequency-response switch is in a high-boost position.

When the unit was completed, it was subjected to exhaustive tests and found to be excellent. It has served as a public address system, driving two 12-inch speakers with excellent quality. The response adjusting system made it easy to eliminate acoustic feedback in all cases.

The unit has been used as a remote amplifier to feed program material to a telephone line in broadcast work. In this instance, a patch cord was used to patch the auxiliary 500-ohm output of the preamplifier to the output amplifier so that the level meter and a speaker could be used for monitoring without loading the 500-ohm output of the preamplifier. Several concerts have been recorded with sufficient quality to use the recordings as masters from which to have shellac and vinylite pressings made.

RADIO ITEMS OF THE MONTH

An aviation guiding system now helps pilots in thick weather by projecting on the windshield points of light resembling the field landing lights, in exactly the spots the pilot would see them. The inventors state that the blind-flying pilot feels far more sure of himself when he can "see" the landing lights than when he has to read his data from a number of dials.

View through the windshield is otherwise unobstructed, so that if the pilot can get sight of the visual landing aids he will be reassured by seeing them in exactly the same positions as the radioed light dots on his C-R tube.

Marine radar equipment to a value of more than a million dollars has been installed in nearly a hundred merchant vessels during the year, reports George F. Shecklen of the Radiomarine Corporation of America.

TRACER PROBE

I have found that handy probes for signal tracers can be made from microphone plugs such as the Signal Corps PL-68 or equivalents. The barrel of a plug of this type has ample room for mounting small ceramic resistors, crystal rectifiers, or condensers that may be required.

A portion of the outer conductor and insulation is removed to permit the inner conductor, which is about the diameter of a standard phone tip, to be used as the contact point.

CHARLES MCCLURE,
Paducah, Ky.

PHONO MOTOR

Being unable to obtain a 6-volt phono motor, I dug down into the junk box and found a defective a.c. rim-drive motor and turntable, a 6-volt automobile fan motor, and an automobile heater rheostat.

The a.c. motor was replaced by the 6-volt d.c. motor to complete the motor and turntable. The rheostat was placed in series with the motor to control its speed. The completed job draws about 2½ amperes and works very well.

This method should work wherever a low-voltage d.c. phono motor is needed.

D. L. FUQUA,
Fairfield, Iowa

HIGH FIDELITY

(Continued from page 25)

of thing that raises all the hairs on the back of your head and sets your teeth on edge.

Duet of the banshees

Naturally I jumped for the volume control but it was turned down all the way so I yanked the a.c. plug and the squeal died away lingeringly. The company took their fingers from their ears and regarded me indignantly. The XYL's glance was not indignant; it wasn't even curious. She just looked at me with a completely blank stare as though I were some stranger she would rather not meet.

I tried to laugh it off. "Oh, I know what's happened. I'm feeding back the wrong phase from the voice coil, and I've got positive feedback instead of negative." I tried to smile reassuringly at the XYL (to hell with the company) and she smiled back. Encouraged, I said, "It won't take me a minute to change that."

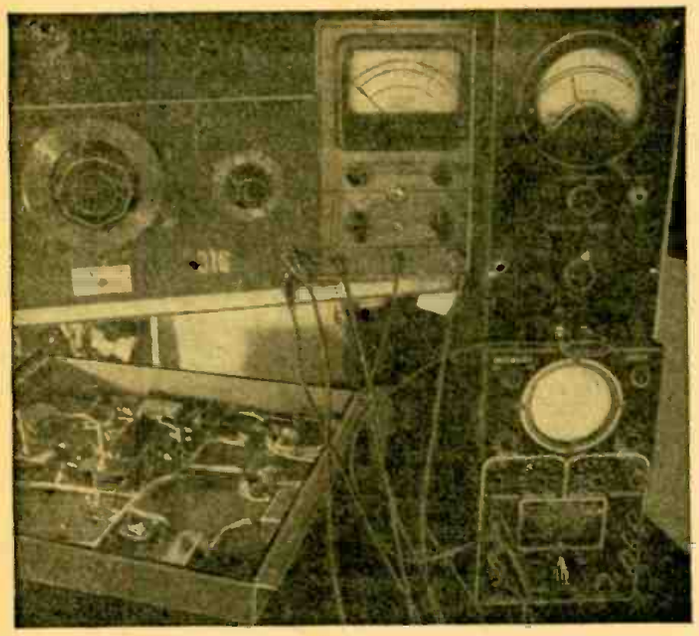
I started carrying the chassis over to the table and then had to stop before I pulled the speaker and turntable along. The company, who had just sat down again, started nervously to their feet, but the XYL tossed me a screw driver and they sat down once more.

I flopped the chassis upside down on the table and began digging inside. The company kept giving me jittery glances and remarked that they hadn't intended staying but just thought they'd drop in for a minute and—

"Oh, stick around a minute or so.

I'd like you to hear this." I really did. I was challenged. It was an easy change to make and it wasn't more than a minute before I carried the chassis back and began plugging things in. The company got up with a wary look. The sort of look an elderly aunt gives a small boy with a firecracker.

I smiled to reassure them, and it started again. It built up in the same way but the pitch was lower. Unfortunately the intensity was every bit as high. The a.c. plug stuck in the wall a little and by the time I turned around the XYL was at the door waving goodby to the company.



The amplifier (bottom up) and some of the instruments used on it.

Things got a little unpleasant around then because it seems the company had been rather special friends of the XYL. Presently, however, I managed to switch her line of thought from the sociological to the technical. That was better but not much. She went over and pushed at the speaker cone. "Wise guy, huh. You've bent the voice coil. See? It rubs."

"I think it was already warped. It needed a new cone anyhow."

She gave me one of those looks. "Better go back to 2A3's."

I spent the rest of the evening fiddling around alone while the XYL went to bed and read. I listened to the amplifier with headphones from then on because there's no sense in antagonizing people. Anyhow my results were very discouraging; switching feedback polarity should have given negative feedback on one position but both polarities made with the banshee shriek. One high soprano and one baritone banshee. Breaking the feedback loop stopped the squeal but brought up the distortion like anything. I checked resistor values and tried again. I was in a pretty nasty frame of mind when I went to bed.

The next day I took the amplifier over to the technical school. I became more analytical and discovered that anything over 7 db of feedback was too much—it would squeal. Anything less sounded lousy.

Of course I thought about that old interstage xformer, so I yanked it out and rigged a phase inverter and managed to get 15 db of feedback. I ran a response curve and looked at the wave form on a scope—things looked pretty good. The speaker came back with a new cone, and I carried the whole business home and hitched it up again.

The XYL was inclined to be stubborn about it. It didn't sound so hot to her so I showed her the curves. She shook her head. "I don't listen to curves. The 2A3's sounded better."

It's a mistake to try to prove things to women by talk. You have to show them. I put the interstage xformer back into the old 2A3 job and then rigged the 2 amplifiers side by side. With a switch I could key from one to the other. This'll show her, I thought. There'll be a whale of a difference.

There *was* a whale of a difference but instead of showing her it showed me. The 2A3's *did* sound better. A damn-sight better. Keying from one amplifier to the other made it perfectly obvious to both of us.

It should have held me but it didn't. I took the thing back to the technical school and worked on it some more. I studied up on steep-fronted waves and phase distortion. Transient distortion and intermodulation distortion were new to me, so I really worked. I redesigned and rewired that cussed thing. I used VR tubes for plate and screen regulation, ran a single ground system, matched the output tubes—delved into things deeply.

The perfect amplifier

I ended up with a super amplifier. The response curve was down 3 db at 12 cycles and 37 kc; there was 22 db of feedback from the voice coil back to a cathode; a 2,000-cycle square wave would go through the thing and come out as pretty as you please; it had up to 18 db of boost at 50 cycles and 5 kc and a microphone stage. The fellows at the school all agreed it was a well-engineered amplifier. We hitched it up to the school's co-axial speaker and it sounded great. At louder than 4½ watts it drove us out of the auditorium. It overloaded at around 13 watts.

I called home from school and told the XYL to invite some company that liked music for that night. "This 6L6 job sounds great, honey!"

She sounded a little dubious over the phone but she seemed O.K. when I got home and she listened to it. The company came and listened to records and

(Continued on page 88)

A new "self-servicing" radio has the components of each stage mounted in plug-in cans. If there is trouble in any stage, the whole section (less tube) is simply pulled out and another inserted.

FM AND TELEVISION DESIGN

(Continued from page 33)

corporate special temperature-compensating capacitors which vary with temperature change in a direction opposite to that of the tube capacitance. To use these compensating capacitors effectively, we must reduce changes in value, caused by temperature changes, of all other components in that circuit to a minimum. This calls for careful construction, which is generally not economically adaptable to current mass production methods.

A second solution, which has much in its favor, is the use of an oscillator functioning at a frequency half that required for mixing. The second harmonic is then used in the mixer for the production of the i.f. voltage. The advantage gained by cutting the oscillator frequency in half is the increase in inserted capacitance to the point where the tube and wiring capacitances form only a small portion of the total capacitance shunting the coil. In this way, changes in their effective values have negligible effect on the oscillator frequency. Harmonic oscillator operation is used in Zenith FM sets.

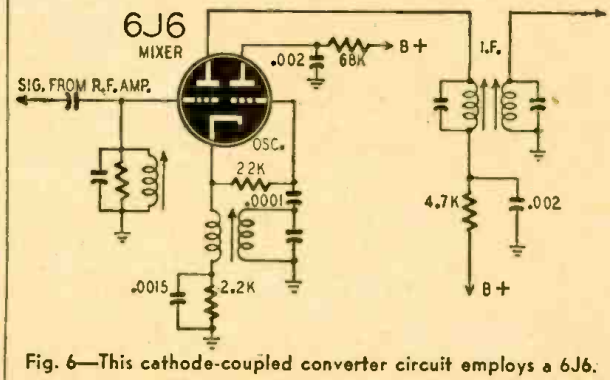


Fig. 6—This cathode-coupled converter circuit employs a 6J6.

Triode mixers and oscillators are extensively used in FM and television receivers. Some manufacturers prefer to use the recently developed 6SB7 pentagrid converter, but they do so at the expense of increased noise.

Two cathode terminals

Some high-frequency tubes have 2 cathode terminals at the tube base even though there is but one internal cathode. One example is the 6AG5 tube. Why a tube should require 2 cathode terminals can be traced directly to its behavior as the input frequency is increased. At low frequencies, the input impedance of a tube is normally so high as to be considered infinite. As we raise the frequency of the applied signal, the input impedance drops and at 100 mc a conventional tube may have an input impedance of several hundred ohms. (See Table 1.)

The decrease in input impedance is due chiefly to 2 factors: electron transit time, and cathode lead inductance. Both factors are approximately equally responsible for the decrease. To reduce transit-time effect, the electrodes are situated closer together and the operating voltages are raised somewhat. To counteract the effect of cathode lead inductance, 2 cathode terminals are provided. Let us analyze this latter aspect more closely because it directly concerns the man who is going to construct or repair a set.

The schematic diagram of a tube with its cathode lead inductance is shown in Fig. 7. Even though the cathode terminal is grounded directly to the chassis, at the tube base, it must be realized that there is inductance in the internal wire connecting the cathode prong to the cathode structure itself. It is this inductance (shown for convenience outside the tube) which is labeled L_K in Fig. 7. The tube current passes through this inductance and, in so doing, develops a voltage. At frequencies below 60 or 70 mc, the inductance of this short length of wire is negligible and may be disregarded. At frequencies of 100 mc or more, sufficient voltage is developed across this inductance to make itself felt.

The voltage E_K, being in the cathode of the tube, will affect both the grid and plate circuits. So far as the plate circuit is concerned, this voltage is of little significance. But to the grid circuit it acts somewhat as a feedback voltage which decreases the effective input impedance.

To eliminate the effect of the lead inductance voltage on the grid circuit, manufacturers have designed tubes having 2 cathode terminals. One terminal is used exclusively for the completion of the plate circuit path, the other for the grid circuit. In the circuit of Fig. 8, a 6AG5 tube is shown as an r.f. amplifier. Even though both terminals are grounded, they are still kept separate. The grounded ends of the grid coil and condenser connect to terminal 2; for the plate circuit, the grounded ends of the plate and screen by-pass condensers connect directly to terminal 7. In this manner the alternating currents in each circuit are kept separate. The d.c. component of the current divides equally between each terminal, but this is not important since the d.c. component does not contribute to the decrease in input impedance.

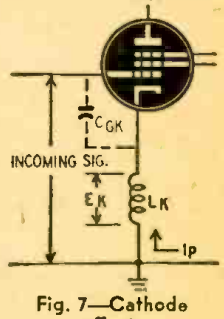


Fig. 7—Cathode effect.

When d.c. cathode bias is to be obtained with a tube of this type, the circuit is arranged as shown in Fig. 9. Bias is required only in the grid circuit; hence the cathode resistor and con-

denser attach to terminal 2. The d.c. plate current returns to the cathode via terminal 2, whereas the r.f. component of the plate current is by-passed directly to terminal 7.

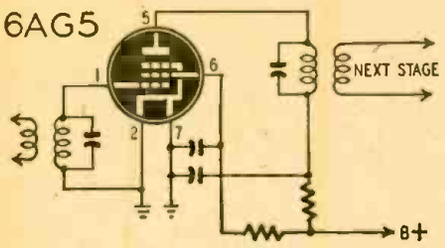


Fig. 8—How two cathode terminals are used.

The purpose of this arrangement should be borne constantly in mind when constructing or repairing circuits containing these tubes. If, for some reason, we inadvertently connect the cathode terminals together, the result is a decrease in input resistance and the over-all sensitivity of the receiver will also decrease. It is important to note, too, that often the schematic diagram of the receiver containing such a tube does not indicate clearly the 2 separate terminals. Servicemen are only too familiar with the fact that many diagrams differ from the receiver as laid out on the chassis, and these differences must be watched especially sharply in v.h.f. and u.h.f. circuits.

TABLE 1

Tube Type	Input Impedance 50 mc.	100 mc.
6C6	2000 ohms	450 ohms
6D6	2300 ohms	500 ohms
56	1900 ohms	350 ohms
6AC5	3000 ohms	750 ohms
6L7	2900 ohms	650 ohms
1851	3000 ohms	750 ohms
1852	3000 ohms	750 ohms
6K7	7100 ohms	1900 ohms
6SK7	7100 ohms	1900 ohms

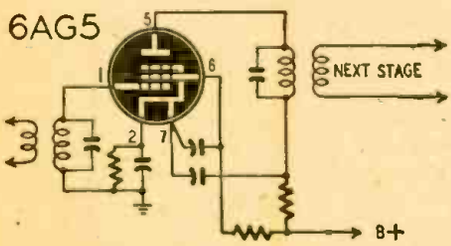


Fig. 9—D.c. bias for two-cathode circuit.

This is the first of a series of two articles on high-frequency FM and television circuits. The second will appear in an early issue.

IMPROVED RECORD PLAYER

A number of portable record players or phono amplifiers have speakers enclosed on all sides except for the small mounting hole in front. This often causes low volume and poor tone quality. In most cases, it is possible to drill three or four 1-inch holes in the back of the case immediately behind the speaker. This improves the tone and also helps dissipate heat from the amplifier often mounted in the speaker enclosure.

THOMAS J. AMBROSE,
New Haven, Conn.

RADIO-CRAFT needs more photos of service shops and service benches. We will pay $6.00 for each 6 x 8-inch or 8 by 10-inch glossy photo accepted. Do not "dress-up" your bench, but take a bona-fide photo, preferably with men working.

HIGH FIDELITY

(Continued from page 85)

saw my curves. They said it was marvelous.

"Just a matter of engineering," I told them and tapped a cigarette on the back of my hand.

The next day we invested in a recorder turntable and lead screw arrangement, and I bridged the crystal cutter across the output. It was grand. Make our own records. Sunday symphony stuff. Not cheap but fun.

Then I bowed to the little woman and did some cabinet work. Threw away the apple boxes and cartons and rigged it up really nice. Then we fussed with pickups and styli and speakers for awhile. Then the war was on us—personally that is.

Back to the old love

During a leave I came home to find the damndest hookup you ever saw. The XYL had pulled the cabinet away from the wall far enough to stick that old, no-good, beat-up, lousy, dusty 2A3 amplifier in there and had a switch rigged up to shift outputs to the recorder and speaker from the 6L6 job to the old one. "How come?"

She looked at me apologetically. "It sounds better."

"It can't. It can't sound better."

"It does."

"Show me."

She did. She hunted through the broadcast band till she found some music with plenty of highs. She cut it on a 12-inch disc and flipped the switch each 30 seconds. To make sure there was no mixup I whistled a brief peep into the mike each time she started the cut with the 6L6 amplifier. Then she played it back the same way—that is, switching so that the stuff recorded through the old deal was played back through the old deal and vice versa.

It was true. That lousy old battered 2A3 job made a cleaner cut than this lovely, well-engineered 6L6 amplifier. Recording and playing back made it obvious. There was a bunch of stuff like bells in the music—the XYL says it was a celeste but it sounded like bells—and over the old job it sounded like bells. The 6L6's made it sound—well, you could tell they were meant for bells but they didn't sound just right.

I had only 5 days but right away I snaked those amplifiers out of that cabinet and carried them over to the technical school. There must be something wrong with that amplifier. I spent the rest of the day running a complete set of curves and that 6L6 job was clean as a whistle. Square waves looked square, response was flat, everything was as it should be.

I gave up. I yanked those beam bottles out of there and put in triodes. I used 6A5's which are the same as 2A3's except for a 6-volt heater cathode which simplifies the hum problem. I ran them strictly in Class A—not A'—and managed about 18 db of feedback. I used the same output xformer and it runs plenty cool, as does the power supply.

With triodes the curves weren't as nice-looking. Response was down 3 db at 35 cycles and 15 kc, and the upper corners of a 2-kc square wave are just slightly rounded. There was no apparent distortion. It overloaded around 8½ watts.

(Incidentally the curves on the old 2A3 amplifier were *lousy.)*

"Triodes sound best!"

Anyhow I carried both jobs back home again and rigged them to the switch the way the XYL had them and we went through the same routine of testing on recording and playback.

At last we had an amplifier that really sounded good. It was noticeably superior to the old job and the XYL admitted it. "Looks like sonar work has taught you some things about audio!"

I grinned sheepishly. "Those aren't 6L6's any more, honey. I put in triodes."

Now the war is over and radio magazines are playing up intermodulation distortion as the most important thing. I can't give you figures on our outfit because no quantitative test was ever run on it. A fellow came around once and stroked a sort of dinner chime arrangement into the mike and then listened to the playback. He said he couldn't hear any spurious tones and therefore I had little or no intermodulation distortion. As I understand it, intermodulation distortion is the result of unbalance (that was why I hadn't run it Class AB) and my output is balanced pretty carefully. On the school's analyzer, my measured wave-form distortion is less than 1% but I think that's unimportant. I heard a 2A3 job lately with a measured 8% distortion and it was hard to tell the difference when it was keyed back and forth with our rig.

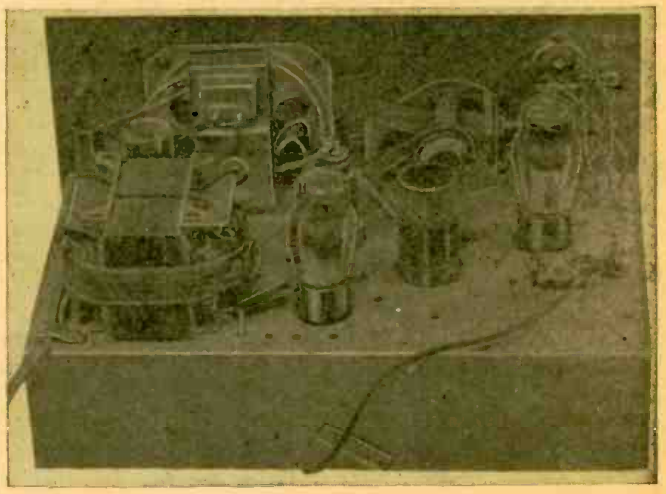
Now I say this and I'm not kidding: You can build yourself a lovely beam-tube amplifier that will display awfully pretty curves but if you want something really clean, if your interest is in the sound rather than the curves, then stick to triodes. The human ear is a peculiar thing and it hears a good deal of what it wants to hear. Witness the apparent bass that comes from a set with a 3-inch speaker. An engineer (or semi-engineer) can look at curves and think he's hearing good stuff. Take a music lover or don't show the engineer the curves and try a keying test and I think you'll find the same thing I did. Triodes sound better!

SIGNAL TRACER-SIGNAL GENERATOR

(Continued from page 23)

uses a tube-tester transformer to supply the filaments and the plate of the rectifier. The filaments of the tubes are connected in series and wired across the 70-volt tap of the transformer. Equivalent tubes with different filament voltage ratings may be used if they are wired in series and are connected to the proper tap on the transformer. All the tubes should have the same current rating. The tracer can be used for hours if a reliable, good-sized, tube-tester transformer is used.

A power supply of this type is an advantage since the chassis is isolated from the line, permitting connection between the tester and a.c.-d.c. equipment without regard to line polarity of either.



Under-chassis and rear views of the unified servicing instrument.

The tracer-oscillator can be used for other purposes such as a radio, phono amplifier, phono oscillator, and code oscillator. The first three uses are readily understood since these are applications of technique used in servicing with the unit. To practice code, connect a telegraph key and small mica condenser between the a.f. input and a.f. output jacks. Tone and volume are controlled with the input gain control.

This versatile instrument can be constructed on almost any chassis that is handy. The author used an old 3 x 7 x 12-inch chassis, and the panel was made from a piece of 7 x 12-inch masonite.

TELEVISION INTERFERENCE CLASSIFIED

Television interference has been classified according to channels by F. J. Bingley, chief television engineer of the Philco Corporation. He finds that certain types of interference are characteristic of one or more bands and give little or no trouble on others. Interference, as he finds it, is encountered as follows:

Channel 1 (44-50 mc) — Considerable diathermy interference; some F-2 and adjacent channel interference.

Channel 2 (54-60 mc)—Direct diathermy interference; diathermy and industrial heating harmonics; amateur harmonics, and some direct amateur interference; some interference due to insufficient image rejection from channel 5; some interference from FM.

Channel 3 (60-66 mc)—Some upper-adjacent channel interference from channel 4; some off-channel diathermy interference.

Channel 4 (66-72 mc)—Some cases of sound from channel 3 interfering with channel 4 image; FM interference in old sets; occasional diathermy interference.

Channel 5 (76-82 mc)—Local oscillator interference from channel 2 in new sets, from channel 4 in prewar sets; occasional diathermy interference; some instances of interference from Navy radio operations noted in Washington, D. C., area.

Channel 6 (82-88 mc)—No experience.

Channels 7 through 11 (174-204 mc)—No experience.

Channels 12 and 13 (204-210, 210-216 mc)—FM harmonics; some interference from diathermy and industrial heating equipment.

MICROTUBES

(Continued from page 17)

headquarters by means of television becomes now a distinct possibility due to the microtube.

For the pocket radio set, which has been in the developmental stage for several years now, the microtube will also become the most important factor due mainly to the great saving of space that can be achieved even over the present-day miniature tubes, still far too big, as we have pointed out a number of times.

There may also come a complete revolution in our radio receiver techniques. Some years ago we used to manufacture a radio tube that had all the elements of three tubes contained in one glass envelope. This tube proved too expensive to manufacture and is no longer made. But with the new microtube, an entirely new possibility, which the writer advances now, seems economically sound and feasible.

Instead of using five separate tubes in a superheterodyne receiver, five separate microtubes could all be placed into one envelope much smaller than the present-day standard tube. The new tube unit would merely have extending from the base the usual tube prongs, and instead of having five tubes we would have only one. This new multiplex tube therefore would be five tubes in one.

It would save an enormous amount of space in every radio set and it still would be cheaper than separate tubes. The wiring would become much simpler, the connections shorter, the weight less, and the cost would be reduced.

Then, if one of the multiple microtube units fails, the entire multitube simply would be discarded and a new one plugged in. It would save the serviceman an enormous amount of servicing time if all radio sets would adopt such a multiple tube.

In this discussion we have merely scratched the surface of this new epoch-making development. In the next few years the microtube can be counted on to revolutionize many branches of radio and electronics, television not excepted.

Suggested by: Lyman Campbell, Vernal, Utah
"And now for some dinner music"

Repairmen—or Wreckers?

IT might be advantageous to the radio serviceman to hear what his competitor tells a customer about a previous repair job done on a radio. Too little is said about the under-chassis appearance of a radio set after it has been repaired two or three times. There are a lot of servicemen. Some of them have been hard at it for 20 years or more. If they have been at it that long, they are good men. No screw-driver mechanic can survive in this business that long. They have a good reputation, and sooner or later the customers are going to take their word as law in the radio business.

The great majority of radiomen follow the line of least resistance when radios come in for repair. Their work might be summed up as follows:

How not to service

A set comes in for reconditioning. It is an a.c.-d.c. type, has a bad 40/20-μf, 150-v condenser, a noisy volume control, a leaky coupling condenser between the 12SQ7 and 50L6-GT. The quickest way OUT of the radio business is just to follow this procedure: Do not bother to remove the old 40/20 condenser; just pile in any 20- and 50-μf separate condensers that might be in stock. Any place in the radio will do. Add 6 inches more wire to them if necessary. It is O.K. if the leads hang down out of the chassis—the cabinet will keep them up anyway after the radio is installed.

Apply the soldering iron intentionally or accidentally to other parts around soldered joints, especially condensers and resistor ends. The owner then can readily see that some work was done for the money. If the volume control will play at near full volume, just pass it as it is. But if it is so bad that it can't be set even in the high position, replace it. Just take a pair of cutters and cut the lugs off the old control and switch, then solder the entire mess on the new control with all possible solder for a good plaster.

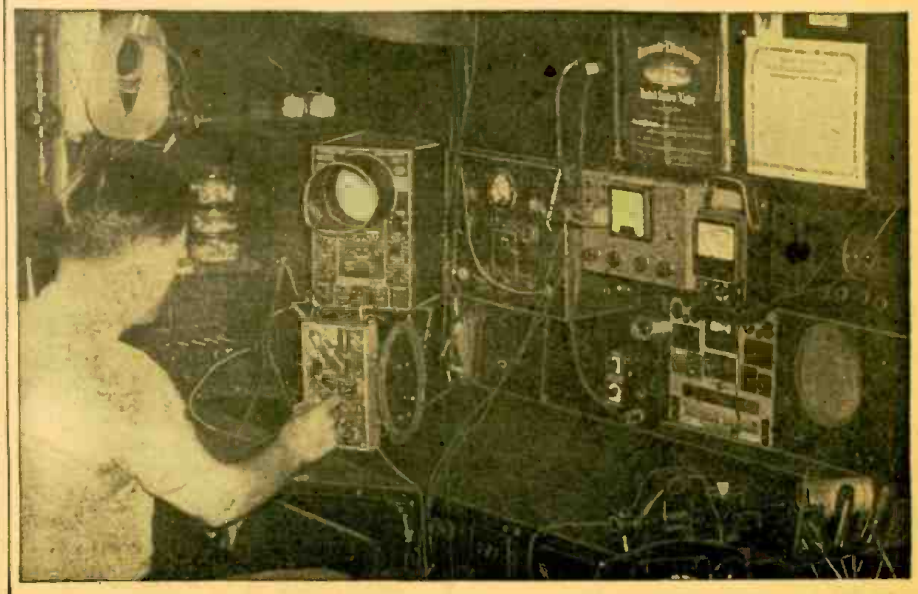
Pile condensers over tube sockets, two or three high, the more the better. If a condenser is replaced, especially the paper tubular type, just cut the leads off at the tube sockets; don't bother to clean off the socket terminals. Just hold the new condenser in place and *plaster*. The object is to get out of the radio business with least possible effort.

If an i.f. transformer is suspected, just check the plate terminals for voltage. If you find the resistance of the 2 primaries to be 8 and 30 ohms, the secondaries 7 and 10, there may be a couple of strands broken in the winding which indicates 30 ohms. Perhaps two strands are holding. One is anyway. So forget the whole matter. Should a primary be burned out, that calls for real ingenuity. Just be sure the new transformer has the same frequency as the one removed; don't bother to get one wound with litz wire just because the old one was so wound. A 39c special will pass plate current just as well as a litz-wire iron-core type. If the old transformer was a large type, and one in stock is one-third the size, just mount it alongside the remaining large unit. You can say they are making them better at half the size. Don't bother to drill holes to mount. One hole will always fit, so fasten it securely with one nut and let the other lug take care of itself.

Let the gang condenser stay corroded, the dial glass and dial dirty. Cleaning dial glasses is a job for a housemaid. Besides denatured alcohol and a brush cost money.

Good servicing

In all seriousness, parts can be installed in a radio to duplicate the clean factory appearance of the original



The well-fitted-up and efficient service shop of L. B. Worden and Co., Utica, New York.

equipment. Leads and wires can be properly placed, parts removed can have wires unsoldered and untied instead of leaving the cut ends on the terminals. Exact duplicate parts are rarely available, in fact it is not advisable to try to carry them in stock, except where a standard part will not fit, or perform its duty. But if a radio uses a large aluminum can condenser, do not replace it with a cartridge type; it looks and is cheap. Avoid questionable parts. The finest may cost a little more, but will not need replacing by the time the radio has some other part out at a later date. Inferior parts will cause pyramiding of costs on succeeding jobs, and dissatisfaction will very certainly result sooner or later.

Install mounting strips where needed. Do not leave connections suspended in midair; all tubular condensers should be tied down at each end, likewise all resistors. Knurled volume control shafts are made to split at the knob end. Fill all holes with solder where wires tie into terminals, but don't allow it to run down and form a lump. Tube types should not be changed in a radio unless the new tube type will equal the old in performance and life, or the old type has been discontinued. Then be careful to make the job so neat that the next repairman will know that it was done by an expert and will not question the accuracy. The very cleanest and smoothest soldering is none too good here. Never unsolder parts to test them if there is any possible way to do so otherwise. Most parts show it, even if they are removed at one end.

It will require more time to do jobs this professional way than just to throw the parts into the set. At first it may be that no higher rate of charge can be made. But eventually this kind of service will enable the serviceman to get a better grade of business, and a higher return for his repair work. Attending to little details will work wonders in the long run.

Most repairmen do just what they have to, skip dials that slip a little, speakers that rattle a little, dump parts into a radio so that there are 18 or 20 electrolytic condensers in a set where 4 or less might be in use. An alarming number of radiomen neglect troubles that should be remedied. Such methods will make the public suspicious of us all.—Gerald Evans.

Radio Thirty-Five Years Ago

In Gernsback Publications

HUGO GERNSBACK
Founder

Modern Electrics	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Radio-Craft	1929
Short-Wave Craft	1930
Wireless Association of America	1908

Some of the larger libraries in the country still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

From November, 1913, ELECTRICAL EXPERIMENTER

An Experimental Radiophone Arc Set, by *H. Winfield Secor*
Coherer Receiving Sets by *Henry Scott*
New French Wireless Apparatus by *H. Gernsback*
Music Via Wireless
How to Make an Interference Preventer
A Compact Radio Test Buzzer
Wireless Telegraph Apparatus
Cryptogram Wireless
Amateur Wireless Phone System
Radio Receiving Set for Time Signals
5 K. W. Wireless Set

Radio technicians of Rochester, N. Y., are holding a 2-day meeting November 15 and 16, to which all radio maintenance men of New York and New England are invited. Meeting is sponsored by the Rochester Radio Technicians' Guild.

Communications

A SUCCESSFUL EXPLORER OF THE WAVES

Dear Editor:

Just a line to let you know I like your magazine. Herewith a photo of the *All-Wave Explorer* which I built recently. I tried to dress it up a little—successfully, I hope. This is only one of a number of things I have constructed from circuits printed in your magazine.

I would like to correspond through RADIO-CRAFT with readers in England and Australia. Am an electrical engineer by profession.

HAROLD DAVIS
Indianapolis, Ind.

Right—The Explorer. The rod projecting out of the picture is the antenna, 18 inches long.

MORE ON CRYSTRONS AND CONTRA-POLARITY

Dear Editor:

I am deeply appreciative of the "assistance" rendered me in my experiments with the CRYSTRON tubes. See COMMUNICATIONS, August, 1947. Without that help so generously proffered, I believe there might have been even more trouble encountered than there was.

Since wearing the pajamas made of the material that counteracts the contra-polar frequencies set up within me (from the radioactivated cells scattered so profusely on those portions of my body cephalicwise from my head), we have found that I can sleep almost shut off (although a faint glimmer still flickers around my eyeballs). This sleep lasts for about 30 minutes—no more.

A few days ago we completed an experimental rig that permits me to sleep almost 2 hours before it is necessary to bleed off the radioactive charge that builds up on my skin directly under the C-P (contra-polar) pajamas. When this concentration of energy reaches a point we call R9, it is immediately necessary to spray my entire person with a mixture of powdered metallic cadmium dust and redistilled heavy water, at the same time switching on the contra-polar sublimating unit (a complex system of Gamma-, Beta-, and Kappa-ray squelching circuits, marked with an X in the photograph). This unit has the same effect on these radioactive rays that a phosphor has on an X-ray; it lowers its frequency so that it becomes benign.

In the photograph you will notice a flexible pipe, marked P1. This is the bleeder pipe that removes these discouraged rays into the condenser. You may notice the co-axial cable entwined

Acme Photo Service, Ocean Springs, Miss.

Authentic photograph of Mr. Thomas and the equipment described in the accompanying letter.

around my legs and torso. This is an auxiliary bleeder that takes over those stray rays that drip down over my body during the discharge process. As you may notice in the photograph (which was taken in the dark with an F2 stop in a Hypex Serolian MagnaKam [Mark LLL] picked up in Jugoslavia in 1944) the emission from my eyes is much greater than that from the rest of my body surface or other objects within range of the radiation.

This is a sort of safety valve, for whenever this degree of radiation is reached the object at which I happen to be looking disintegrates slowly, falling away into a kind of bluish powder. Naturally, when this occurs, I realize that the danger or *fissioning flux point* has arrived, and I immediately reach out and turn the release valve on the cylinder of redistilled heavy water (marked H.W.) which instantaneously slows down the neutronic and deuteronic bombardment to a point of comparative safety again. This is known as the *Sturm und Drangzeit Bitte.*

As you have probably realized by now, all this has gone through hundreds of cycles during our initial manufacture of your wonderful CRYSTRON tube, and we have again reached a dangerously low level in our "Heavy Wasser" tanks. Can you please forward to us, at once, a listing of those firms that carry large stocks of H_6O_6 on hand? We think that type is a little heavier than H_4O_6 that we have had to use to date.

Any other hints will be gladly accepted in the spirit in which they are offered. Please feel free to advise us.

BRUCE L. THOMAS,
Ocean Springs, Miss.

MAJOR HALLOWS REPLIES

Dear Editor:

To put it mildly, Mr. Turner is talking through his hat!

The official figure for television receiving licenses in England is 18,317 as of May 31, 1947. As this includes jobbers, dealers, and experimenters, as well as manufacturers, I should put the number of private owners at not more than 16,000.

The prices Turner quotes are much below those now prevailing.

I don't think that many servicemen would agree with his belief that the servicing of television receivers is child's play! You'd need a good deal of experience and have to know just what to look for to be successful with only a volt-ohm-milliammeter.

Finally, he must have a pretty tough hide if he can laugh off the shocks you can get from the high-voltage supply of a television receiver.

RALPH W. HALLOWS,
Berkhamsted, Herts, England.

(The above is an answer to a letter by John W. Turner of London, England, which appeared last month. He stated that more than 50,000 television licenses are granted in England. As Major Hallows' figures are closely in accord with other British official statements and BBC estimates, it is apparent that Mr. Turner was mistaken.—*Editor)*

INDEX TO ADVERTISERS

RADIO SCHOOL DIRECTORY

(See Page 98)

BOOK REVIEWS

RADIO, HOW, WHEN, AND WHY TO USE IT, by Beatrice K. Tolleris. Published by the National Publicity Council. Paper covers, 8 x 10 inches, 48 pages. Price $1.00.

A booklet written for the benefit of organizations who work in health, welfare, education, or other social service fields, this book points out the benefits and pitfalls of radio as a means of publicity. Suggestions are made on assessing the medium, selecting the type of presentation most adapted to the purpose and means of a given organization, taking advantage of existing opportunities, and working in co-operation with other organizations and individuals.

INTRODUCTION TO ELECTRON OPTICS—The Production, Propagation and Focusing of Electron Beams. By V. E. Cosslett. Published by the Oxford University Press. Stiff cloth covers, 6 x 9½ inches, 272 pages. Price $6.50.

This book is the result of a series of lectures on electron optics given at Oxford University to undergraduates in their last year. In spite of this, mathematics has been used very moderately, and the subject is so presented that even the layman will find it readable and interesting.

Treatment is orthodox. Fundamental theory, fields, focusing by electrostatic and electromagnetic methods, and image aberrations are dealt with in turn. Then follow chapters on electron beams, the cathode-ray tube, and the electron microscope.

The last two chapters are of special interest, as they deal with applications of electron optics in transmitting and special tubes, discussing the magnetron, cyclotron, betatron, and mass spectrograph. The subject of velocity-modulated tubes receives a full chapter.

ELECTRICITY—PRINCIPLES, PRACTICE, EXPERIMENTS, by Charles S. Siskind. Published by McGraw-Hill Book Co. Stiff cloth covers, 5¾ by 8½ inches, 448 pages. Illustrated. Price $2.60.

The author, who is assistant professor of electrical engineering at Purdue University, has written a practical and refreshing treatise on electrical principles, with many useful electrical problems and their solutions. The student can learn from this book something about practical problems of transformers, motors, and dynamos.

Direct-current circuits are discussed first; then the author takes up alternating-current circuits and some related problems most apt to puzzle the student. Graphs are included, where necessary, along with diagrams of the circuit and the necessary mathematics. The effect of introducing inductance into a.c. circuits is very interestingly presented, with practical examples. A section deals with a.c. measurements.

Transformers are explained with special diagrams and pictures of the various types of cores and windings, so that the magnetic and electrical action can be readily grasped. Direct- and alternating-current generators receive excellent treatment.

The author gives a set of quiz questions and problems at the end of each chapter. A list of "visual aids" is included, with data on their source and the width of the film in each case. A thorough index of the subjects covered in the book is included.—*H.W.S.*

CONCISE CHEMICAL AND TECHNICAL DICTIONARY. Edited by H. Bennett. Published by Chemical Publishing Co. Stiff cloth covers, 6½ x 9½ inches, 1055 pages. Price $10.00.

This large book contains 50,000 definitions, covering the fields of chemistry, metallurgy, pharmacy, plastics, mineralogy, electricity, and engineering, according to the slip cover. Radio terms are covered only incidentally, chiefly as they relate to other branches of science. Thus we have *betatron*, but not *radiotron*. *Oscillator* is not defined, but *oscillating crystal X-ray method* is. Coverage of chemical terms is very complete. Cross references appear to be exhaustive, and definitions range all the way to common-language terms like *paint*. Trade names of chemical compounds, especially in the pharmaceutical field, are included.

SCIENCE YEAR BOOK OF 1947. Edited by and with an introduction by J. D. Radcliff. Published by Doubleday & Co. Stiff cloth covers, 5½ x 8 inches, 247 pages. Price $2.50.

Three of the articles in this year's book refer to radio: "Proximity Fuze," "Microwaves on the Way," and "Radio Navigation." Radio and electronics are not deemed important enough to have a section, the first two articles appearing under the head *Chemistry and Physics*, and the third under *Aviation*.

Other articles interesting to the radioman are the three on atomic applications, and perhaps "Extra-Sensory Perception," which after all is a form of wireless communication!

RADIO SCHOOL DIRECTORY

PREPARE NOW FOR SKILLED JOBS IN RADIO AND ELECTRONICS

CORRECTION

An ommission and two errors occurred in the parts list of the tuner for the Portable Recorder-Player described in the August, 1947, issue. Condenser C15 in Fig. 3, tuner circuit, page 64, is a .001-μf, 400-volt paper condenser. The last line of the first column of the parts list for Fig. 3 should read: C9, C17—250-μμf mica condenser. The second line of the second column of the parts list should be: C16—0.01-μf, 400-volt paper tubular condenser.

We thank Mr. R. H. Heiskell of Compton, Calif., for this correction.

Some readers have stated that the General Industries Model GI-R90L recording unit has a crystal cutter. The manufacturer states that this model is available with crystal or magnetic cutting heads. Your distributor will be able to get the model with the magnetic cutter.

BIND YOUR MAGS

Technical magazines that are kept for reference can be bound in convenient volumes of four or six issues. Stack the copies carefully and drill a number of holes through the binding with a small drill. Thread fishing line or strong twine through the holes and tie it after drawing the twine tightly. For a neat job, a small jig may be constructed by drilling through a small board long enough to be used as a stencil for spotting the holes along the length of the bindings.

ELMER C. CARLSON,
Brooklyn, N. Y.

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But Bell Laboratories have found a shorter way. They built an all-electrical replica, an "equivalent circuit" in which electrical resistance stands for air friction in the cap holes; capacitance corresponds inversely to the stiffness of the diaphragm. Over-all performance of this circuit can be quickly measured and design changes economically explored. Later, a model can be built for final check.

The "equivalent circuit" was pioneered by Bell Telephone Laboratories 25 years ago. It is a useful tool in many Laboratories developments—saving time, saving the cost of machine-tooled models, encouraging experimentation. It is one more example of the way Bell scientists get down to fundamentals as telephone progress continues—and service keeps on improving for all subscribers.

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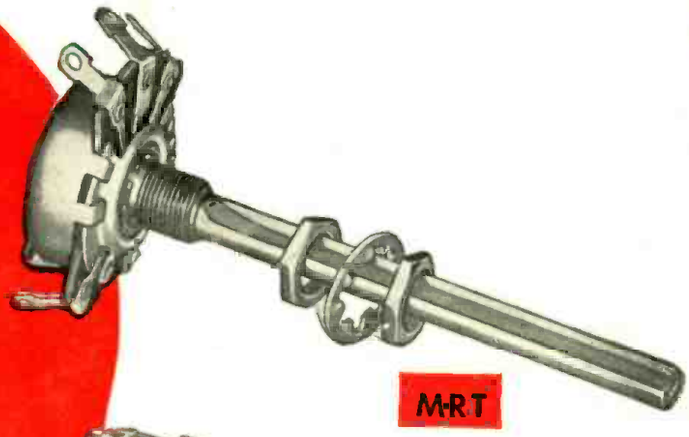

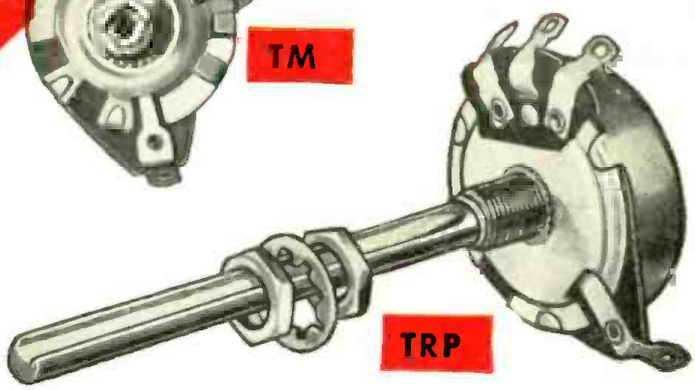

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