TIME TABLE OF SHORT-WAVE STATIONS

MARCH 28 1931 — **15¢** Per Copy

NINTH ANNIVERSARY NUMBER

RADIO WORLD

REG. U.S. PAT. OFF.

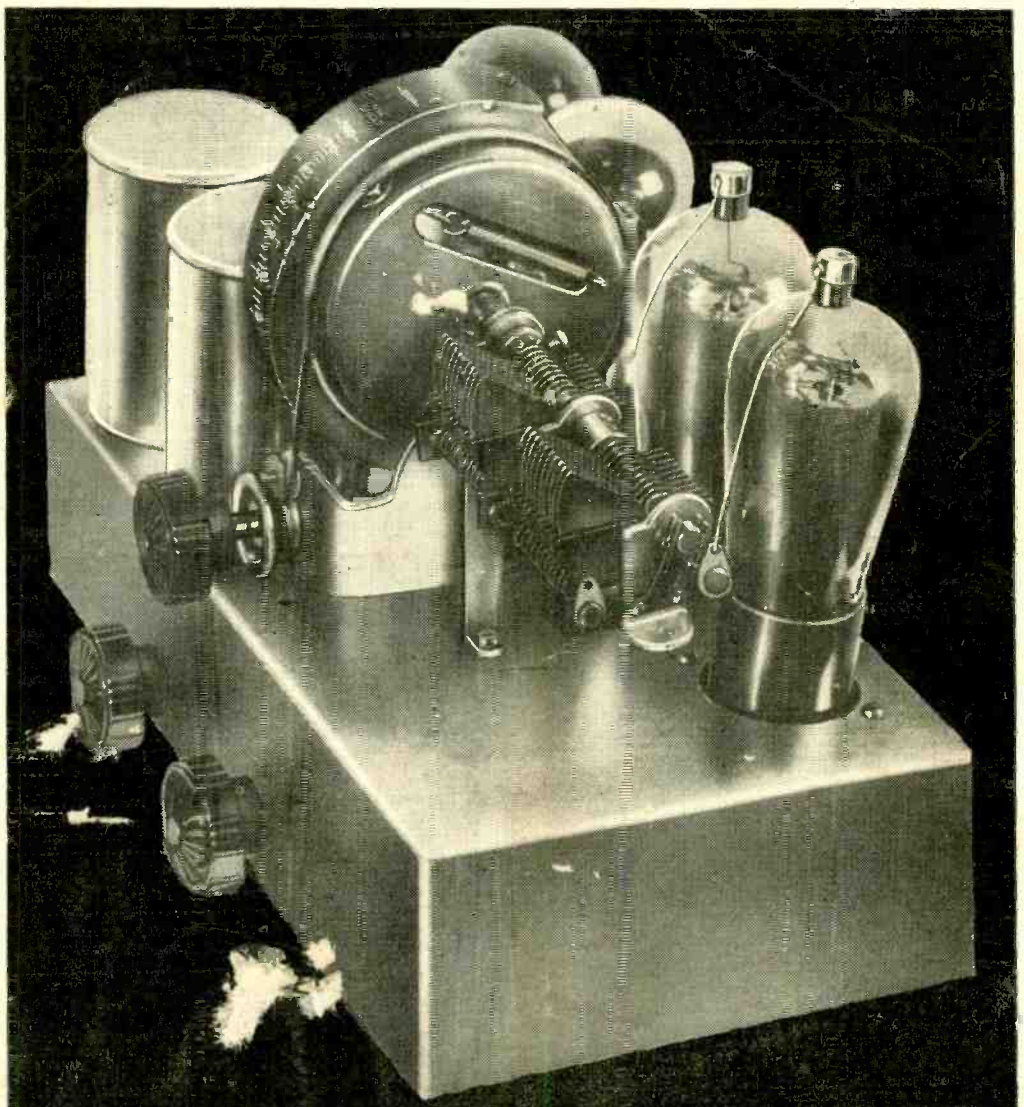
The First and Only National Radio Weekly

470th Consecutive Issue—TENTH YEAR

THE ANDERSON DX TUNER

HOW TO PLOT CURVES TOLD FOR NOVICES

CONSTRUCTION OF DX-4 ALL-WAVE CONVERTER



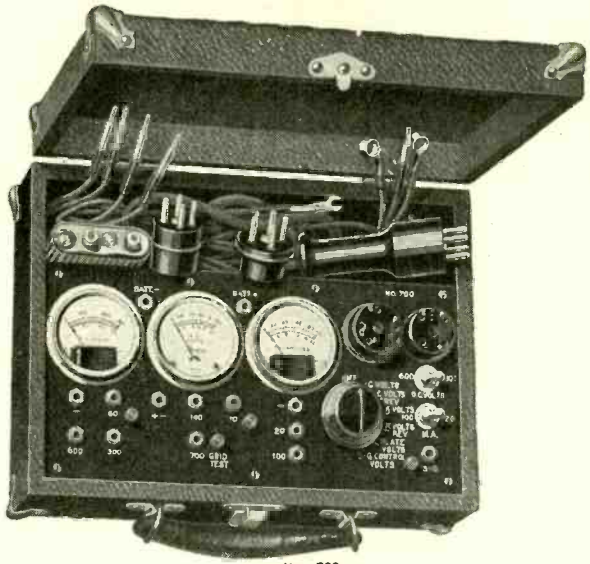
A device like this may be built at small cost for earphone reception of short waves, or for plugging into a set for speaker operation. See page 5.

Subscribers: watch the date line on your wrapper

If the expiration date line on your wrapper indicates that your subscription has expired or is about to expire, please send in renewal so that you will not miss any copies of the paper. Subscription Dept., Radio World, 145 W. 45th St., N. Y.

Set Testing Reduced to Simplicity

With these New Readrite Analyzers



No. 700

THESE three meter analyzers are equipped with a practical selector switch for checking all parts of the tube circuits by connecting to the set sockets. Selection for testing voltages of plate, grid, cathode and screen-grid is done quickly and accurately. Plate current, filament volts, also line and power supply volts are measured. The grid swing test for tubes is used. Just push one button for screen-grid and another button for other tubes. Makes testing of all type tubes simple and thorough. A 4½ volt grid battery is furnished. The battery is used for the grid test and also continuity testing of transformers, chokes, etc. Capacity and resistance charts are furnished showing use of instruments for testing condensers, also measuring resistances up to 100,000 ohms. The eight scale readings of the meters may be used separately with the jack terminals provided. The scale readings are 0-60-300-600 D. C. volts, 0-10-140-700 A. C. volts and 0-20-100 milliamperes. Both A. C. and D. C. filament voltages are accurately measured on the one meter.

Housed in a strong case with leatherette covering. Attractive. Compact. Complete. Fills every need for the expert serviceman or the beginner for radio set analyzing. Size 10¾x3½x8.

No. 700—$25.00 List Price. $15.00 Net to Dealer.

No. 600

The No. 600 contains the same equipment as No. 700. The carrying case is larger with leatherette covering and equipped with lock. Room is provided for carrying tubes, tools and supplies. The test equipment and panel is in a removable tray in the top of the case. The tray equipment may be used separately as a complete test panel for shop purposes. Size 14½x7x7½.

No. 600—$30.00 List Price
$18.00 Net to Dealer

Readrite Meter Works, 12 College Ave., Bluffton, Ohio

Readrite

NEW...
SMALLER—LIGHTER
A CARDWELL QUALITY CONDENSER AT A
LOWER PRICE!

For receiving, up to 365 MMF.
For transmitting, up to 150 MMF.

THE CARDWELL
MIDWAY
FEATHERWEIGHT

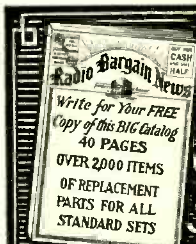
SEE IT!

SOLD IN NEW YORK CITY BY

LEEDS RADIO 45 VESEY STREET
SUN RADIO 64 VESEY STREET
WM. EGERT 179 GREENWICH ST.

LITERATURE ON THESE AND OTHER CONDENSERS ON REQUEST.

THE ALLEN D. CARDWELL MFG. CORP.
95 Prospect Street, Brooklyn, N. Y.



DEALERS AND SERVICEMEN SEND FOR IT

Federated Purchaser
18E Hudson Street New York City

AIR-KING

PRECISION SHORT-WAVE COILS

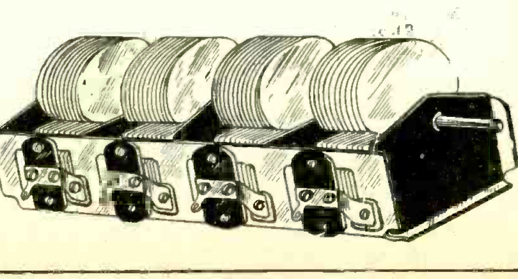
AKP-1, AKP-2, AKP-3 and AKP-3A for oscillator of all-wave converters 10 to 600 meters at any intermediate frequency. Set of four coils....$5.60

AIR-KING PRODUCTS CORP.
216 Wallabout St., Brooklyn, N. Y.

RADIO WORLD'S BOOK SERVICE has been found of great value not only by radio fans, constructors, etc., but also by radio and other technical schools throughout the country. See the radio books advertisement in this issue.

ERLA-DYNAMIC CHASSIS, WESTINGHOUSE RECTIFIER. Sensitive and efficient dynamic speaker chassis. List price, $25; our net price, $9.95. Guaranty Radio Goods Co., 143 W. 45th St., New York.

FOUR-GANG .00035 MFD. WITH TRIMMERS BUILT IN !



This condenser, each of four sections .00035 mfd. has aluminum plates that are removable and adjustable, also a ¼" diameter steel shaft that is removable. It is sturdy and is suitable for popular four circuit screen grdi tuners. Trimming condensers are built in. The condenser may be mounted on its bottom or side. Total overall length, including shaft 11⅞." Overall width, 4". The frame is steel Order Cat 4-G @......................

$3.95

RELIABLE RADIO COMPANY
145 W. 45th St., N. Y. C.

---

115 DIAGRAMS FREE!

115 Circuit Diagrams of Commercial Receivers and Power Supplies supplementing the diagrams in John F. Rider's "Trouble Shooter's Manual." These schematic diagrams of factory-made receivers, giving the manufacturer's name and model number on each diagram, include the **MOST IMPORTANT SCREEN GRID RECEIVERS.**

The 115 diagrams, each in black and white, on sheets 8½ x 11 inches, punched with three standard holes for loose-leaf binding, constitute a supplement that must be obtained by all possessors of "Trouble Shooter's Manual," to make the manual complete. We guarantee no duplication of the diagrams that appear in the "Manual." Circuits include Bosch 54 D. C. screen grid; Balkite Model F, Crosley 20, 21, 22 screen grid; Eveready series 50 screen grid; Erla 224 A. C. screen grid; Peerless Electrostatic series; Philco 76 screen grid.

Subscribe for Radio World for 3 months at the regular subscription rate of $1.50, and have these diagrams delivered to you FREE!

Present subscribers may take advantage of this offer. Please put a cross here ☐ to expedite extending your expiration date.

Radio World. 145 West 45th St., N. Y. C.

Vol. XIX. No. 2 Whole No. 470
March 28th, 1931
[Entered as second-class matter, March 1922, at the Post Office at New York, N. Y., under act of March, 1879]
15c per Copy, $6.00 per Year

TENTH YEAR
Technical Accuracy Second to None
Latest Circuits and News

A Weekly Paper published by Hennessy Radio Publications Corporation, from Publication Office, 145 West 45th Street, New York, N. Y.
(Just East of Broadway)
Telephone, BRyant 9-0558 and 9-0559

RADIO WORLD, owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, president and treasurer, 145 West 45th Street, New York, N. Y.; M. B. Hennessy, vice-president, 145 West 45th Street, New York, N. Y.; Herman Bernard, secretary, 145 West 45th Street, New York, N. Y.; Roland Burke Hennessy, editor; Herhan Bernard, managing editor; J. E. Anderson, technical editor.

A Short-Wave Midget

By Herman Bernard

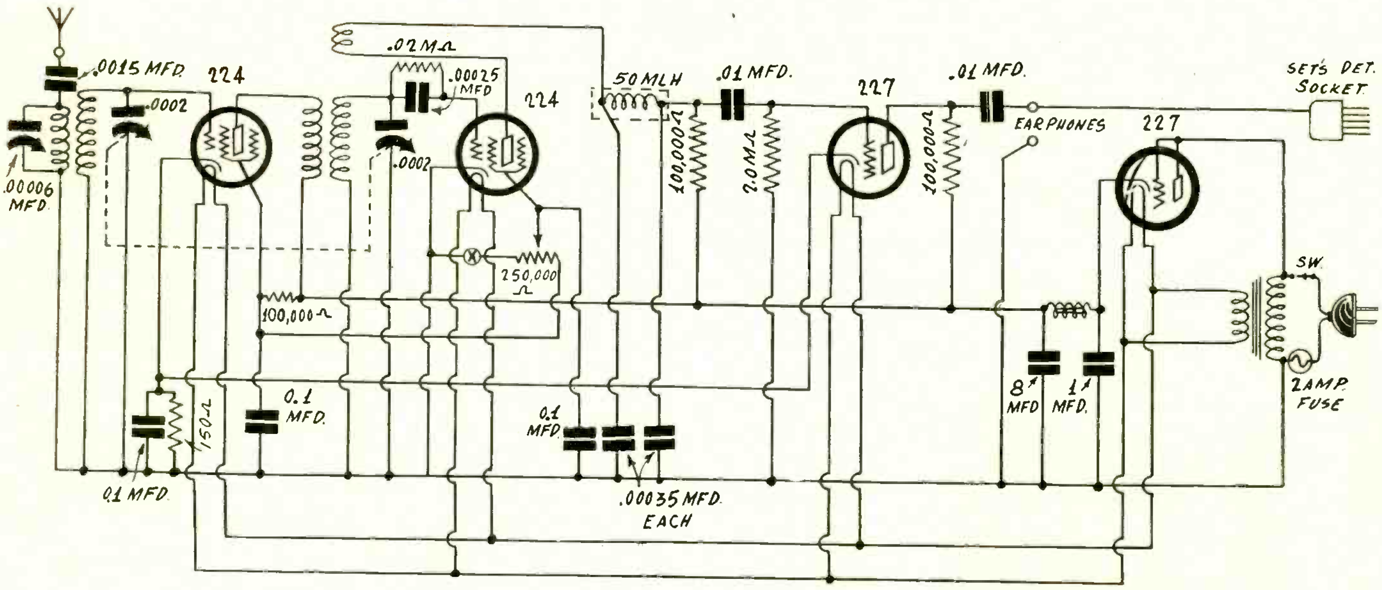


Fig. 1
As short-wave set-adapter combination

RECEPTION of short waves on earphones, with the option of plugging into a broadcast receiver for loudspeaker operation, is afforded by the Short-Wave Midget Set, which may be built for AC operation, as shown in Fig. 1, or for battery operation, as diagrammed in Fig. 2.

The chassis is only 9½ inches wide by 5¾ front to back and 2⅝ inches high. In the AC model the heater transformer is placed inside the chassis, as is the B supply choke coil, while in both models the shielded short-wave plug-in coils go into sockets to the left of the drum as you view the front toward you.

High Sensitivity Developed

The circuit is in all respects a receiver. In the AC model it is a complete, self-operated receiver, since the B and C voltages are derived from the rectifier, a 227 tube, while the secondary of the heater transformer supplies what may be called the A current. The battery model requires 135 volts of B battery and a 6 volt A battery, since the filaments are in series, and exactly 2 volts are applied to the filament of each tube in this way. While four No. 6 dry cells may be used for the 6-volt source, a storage battery is better.

The sensitivity of this type of circuit, using either model, is extremely high, especially in view of the high frequencies involved, and it is considered no kind of a feat whatever to tune in plenty of foreign stations directly, including European stations. Moreover, there is utter dependability and no searching for extra B voltages or correct methods of impedance-matched coupling.

The radio frequency circuit consists of a stage of tuned

(Continued on next page)

LIST OF PARTS

Coils

Two sets of shielded plug-in coils, three coils to a set, total, six coils One B supply choke coil
One 50 mlh, shielded radio frequency choke coil
One 2½-volt 8 ampere filament transformer

Condensers

Two Hammarlund .0002 mfd. junior midline tuning condensers
One Hammarlund .00006 mfd. junior tuning condenser
Three 0.1 mfd. fixed condensers (in one case)
Two .00035 mfd. fixed condensers
One 1.0 mfd. 200-volt filter condenser
One 8.0 mfd. electrolytic condenser
One .0015 mfd. fixed condenser
One .00025 mfd. grid condenser Two 0.01 mfd. condensers

Resistors

One 150 ohm flexible biasing resistor
Three 100,000 ohm (0.1 meg.) pigtail resistors
One 2.0 meg. pigtail resistor One 250,000 ohm potentiometer

Other Parts

One drum dial, with hardware, scale and escutcheon
One aluminum chassis, with six socket holes drilled
One antenna binding post
One AC switch, shaft type Six UY sockets
One twin assembly for earphone connections
Three knobs One front panel
One 5-prong plug and cable to detector plate
One fuse with holder

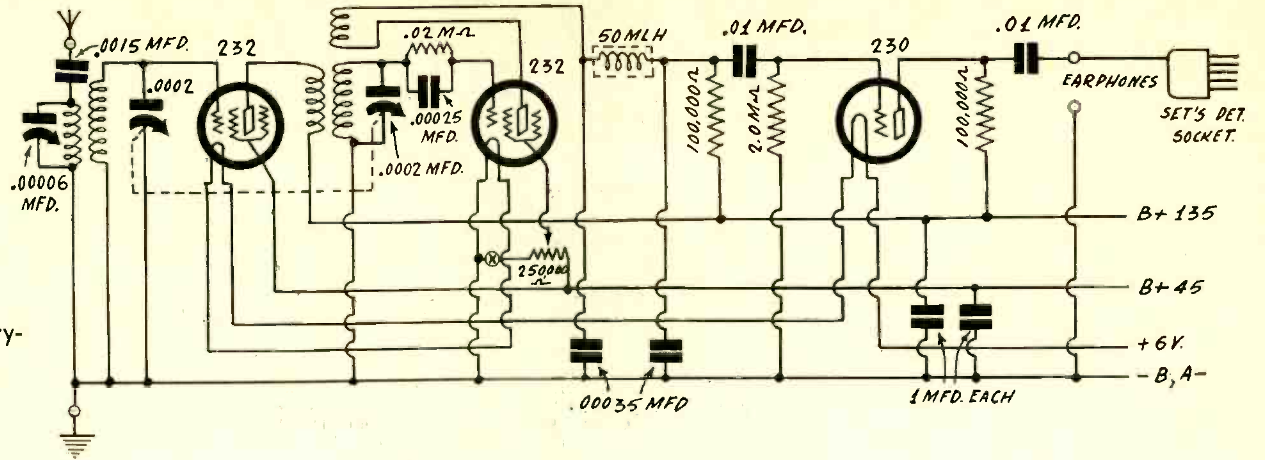


Fig. 2
The battery-operated model.

amplification, with a tuned input to the sensitized detector, following which is a stage of resistance-coupled audio frequency amplification. In the AC model there is a fourth tube, the rectifier.

The trimming of the antenna stage is accomplished by a 60 mmfd. variable condenser across the antenna-ground winding. Due to the close coupling between the primary and secondary in this circuit, the addition of capacity to the primary circuit has the same general effect as would the addition of capacity in the secondary circuit, and besides, some tuning effect in the aerial circuit itself is gained.

No External Ground for AC Model

In the AC model pay particular regard to the fact that no external ground is to be connected, as the circuit already is grounded through the primary of the heater transformer. In the battery model an external ground may be used, in fact, should be, and the connection therefor is shown in Fig. 2.

The purpose of the 100,000 ohm resistor between the screen of the first tube in the AC model and the maximum B voltage line is to drop the maximum voltage to a suitable screen voltage, while the connection of the potentiometer to control the screen voltage of the detector always maintains that tube's screen voltage at a value not greater than the other tube's screen voltage. This apportionment meets the requirement for a detector, because the sensitivity is higher when the screen voltage is lower than that required for amplifier circuits.

The plate winding of the detector is fixed, and the potentiometer adjustment takes the place of more familiar methods of governing the sensitivity. This variation of the detector screen voltage is, or at least can be made, extremely smooth, representing perhaps the most regular and steady method of attaining the desired results in sensitivity without the introduction of extremely critical conditions.

To improve on the smoothness of control, beyond what it would be, were the potentiometer used alon, another resistor may be introduced, at the point marked (X) in each diagram. The object of this additional element is to have the minimum setting of the potentiometer represent a positive voltage. If the minimum setting represents zero voltage, then naturally the full sweep of the potentiometer is not useful for signal response, as the screen grid would be either at zero DC potential, in respect to the cathode, or so slightly positive as not to be effective in producing detection over, say, a quarter of the 270-degree displacement of the potentiometer arm. If a grid leak mounting is used, a resistor of suitable value may be inserted, the particular value giving the desired results being left permanently in position.

Just what this value should be can not be stated for all conditions, since it is not certain just what the plate voltage will be, and there are other variable factors, including, indeed, the tubes themselves, but the value must be low as compared to the total value of the potentiometer's resistance. A pigtail resistor of .02 meg. (20,000 ohms) is suggested as the first value to try, and it will be satisfactory, even if not perfect.

Correct Time Constant

The grid condenser may be of the usual value of .00025 mfd. as used in sets worked on broadcast frequencies, if the grid leak value is small, say, .02 meg. Such a combination establishes a time constant excellent for high frequency work.

The resistance-coupled audio stage is standard, and the output of the first audio tube, the only audio tube in the set, is taken across a capacity-resistor filter. Therefore if earphones are used they would be connected from the free side of the .01 mfd. condenser leading from the output tube's plate, with other side of earphones to B minus.

One stage of audio is highly desirable for earphone work, as some of the short-wave signals, particularly those from overseas, may be weak otherwise, and full enjoyment of the reception would be absent. Moreover, if one desires to plug into a broadcast or even another short-wave receiver for audio gain and loudspeaker operation, the stage of audio in the Midget Short-Wave Set is just as necessary, and it is fair to state that, for volume somewhat commensurate with that obtained from broadcasting stations, one extra stage of audio is necessary. So by no means omit this audio stage from the midget.

Connection to Broadcast Set

The connection from the short-wave set to the broadcast receiver is such that only the high side of the short-wave set output is connected, and there is only one wire, the plate lead. Since audio frequencies alone are involved, and the radio frequency has been adequately filtered out, the presence of this lead, about 2 feet long, causes no feedback troubles.

The connection is made to the plate prong of an old tube base, or a standard adapter to serve the same purpose may be used. The detector tube is removed from the receiver, and it will be a 227 or 224, if the broadcast set is AC operated, so this tube may be used in the short-wave set, and there will be one tube fewer to buy. In the battery model this economy will not be present, as too few sets using 230 or 232 tubes have been circulated thus far.

Of course the output might have been connected to the grid circuit of the first audio tube in the broadcast set, but if that were done, no advantage in volume would be derived from an audio transformer that feeds that first audio tube. The step-up ratio of the transformer is to be utilized, by all means, if a transformer is there, as likely it is, so abide by the connection as recommended.

The rectifier is simplicity itself, and is worked well within its safe limits in the AC model, because the drain is only about 10 milliamperes. When the filtration is good there is no hum, and such filtration is afforded by the specified capacities, used in conjunction with a choke coil of the familiar type for B supplies, or even one of smaller inductance. If you have no choke, but do possess an old filament or power transformer, you may use as a choke the primary connection of the transformer, although then the rest of the windings should not be used, unless as additional choke.

The physical arrangement of parts makes for extreme neatness and compactness. The coils are placed at left, as stated, while the two Hammarlund condensers are ganged by means of a steel strap. It is necessary to mount the condensers to the subpanel independent of the dial mounting, unless one drills a center hole through a bracket that is on the condenser, so that both the bracket of the dial and the bracket of the condenser are pierced by one machine screw.

(*Continued on next page*)

LIST OF PARTS

Coils

Three pair shielded short-wave plug-in coils, total, six coils
One 50 mlh. shielded radio frequency choke coil

Condensers

Two Hammarlund .0002 mfd. junior midline tuning condensers, with steel coupling strap
One Hammarlund .00006 mfd. tuning condenser
One .00025 mfd. fixed condenser
Two 00035 mfd. fixed condensers
Two 1 mfd. bypass condensers
One .0015 mfd. fixed condenser
Two .01 mfd. condensers

Other Parts

One antenna and one ground binding post
One bakelite twin assembly for earphone connections
One UX cable with plate lead connection
One aluminum chassis, 9½ x 5¾ x 2⅝ inches, with six socket holes
One drum dial, bracket and escutcheon
One front panel, 7 x 10 inches
One roll of hookup wire
One UY plug, four cable leads utilized for battery connections

Short-Wave Aids

By Malcolm J. Hemstreet

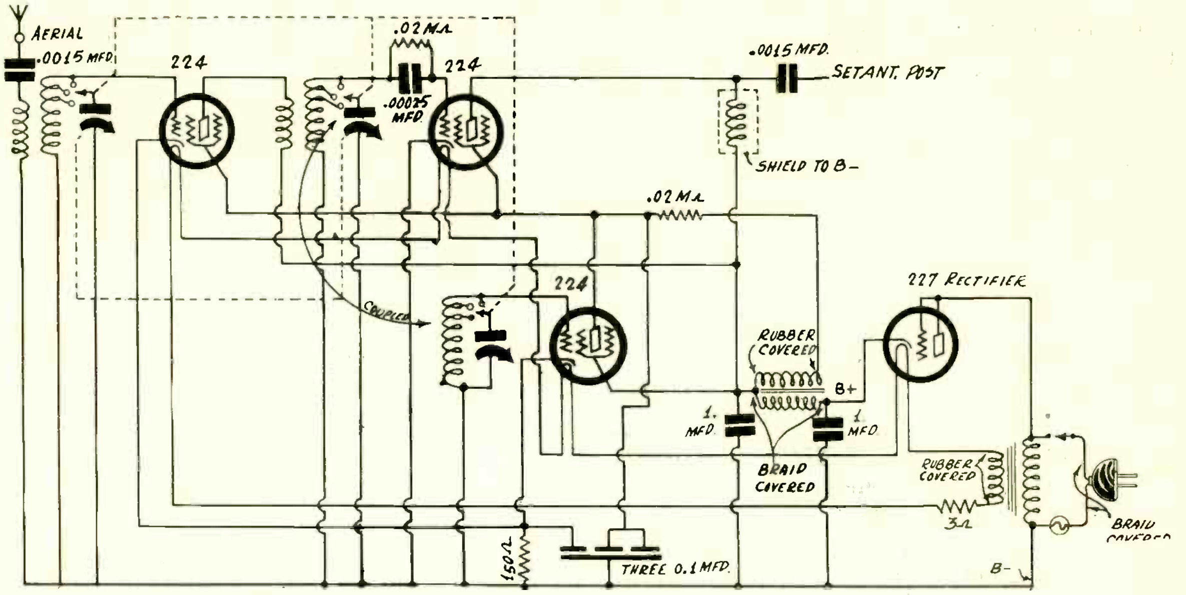


Fig. 1
The circuit of a short-wave converter using a pliodynatron type of oscillator and mutual inductance between the oscillator and the modulator tuned circuits for mixing.

FANS who attempt to receive short-wave signals either with converters or with special sets often fail to get results or satisfactory results. They immediately put the blame on the coils. They think that they are not wound with the right kind of wire, that the primary turns don't match the antenna impedance or the impedance of the tube preceding the coil, that the secondary windings are not correct, that the insulation of the wire is not of the proper kind of the proper amount, that there is not enough shielding around the coils, that there is too much, or that they have got coils designed for another receiver. In most instances these things have nothing to do with the difficulty. The trouble is usually elsewhere, and very often it has to do with the coupling.

It does not make much difference what the size of the wire is, or whether it is made of copper, aluminum, silver or some other good conducting material. It makes little difference whether it is this size or that, just so it is not so large as to make the coil unwieldy or so small as to be difficult to handle. Wire sizes between No. 20 and No. 30 are all right. Sometimes it may be advantageous for some reason or other to make it large and sometimes to make it small, but the reason is never one of first importance.

Insulation

When it comes to the question of reception or no reception the size of the wire is not essential. Also, the type of insulation is not essential. It may be enamel, cotton, silk, air, or combinations of two or more of these. True, one type of insulation may make a coil of slightly lower resistance, and hence higher efficiency, but the difference is not enough to make the set operative or non-operative.

The size of the form on which the wire is wound is also of little importance provided there is the right amount of wire on it, neither too little nor too much. Actually, the size of the form is determined by the size of the wire and the inductance of the coil.

There should be no need of worrying whether or not the primaries match if the only trouble is that the circuit does not bring in any signals. If a circuit does not work at all it is quite likely that the matching has nothing to do with, for regardless of the tubes or antenna used something will come through if the matching is away off. Matching is a refinement and not a matter of operation or nonoperation.

Importance of Secondary Winding

Even the number of turns on the secondary, or tuned, winding is not a matter which determines whether the circuit will work or will not. If there are too few turns lower waves will be tuned in than those intended to be covered by the coil, and if it has too many, higher waves will be tuned in. The point is that a few turns more or less will not stop the circuit from operating.

While shielding may spoil a short-wave set, there are cases where it will help, especially if the shielding is not fitted too closely over the coils. However, shielding should not be used with short-wave coils. This is especially true when the coil is in an oscillator in which the losses in the shielding may stop the oscillation, and that means that the circuit stops functioning if it is a superheterodyne or a short-wave coverter of this type.

It matters little how the leads are connected to the tubes just so both leads of one winding are connected to the same tube. It will not do to cross the leads of the two windings of a radio frequency transformer, or any other transformer for that matter. If one winding is connected in the plate circuit and the other in the grid circuit of the next tube, either pair of leads may be reversed without causing a great deal of change in the circuit.

This does not apply to an oscillator, in which one winding is connected in the plate circuit and the other in the grid circuit of the same tube. The leads must be connected just so or there will be no oscillation. There are four ways of connecting the four leads, but only two of them are correct. The proper way of connecting the windings of an oscillator coil to the oscillator tube is shown in Fig. 2. Note that the two windings of the oscillator section are in the same direction, that of a right handed screw. If (3) is connected to the plate of the tube, (4) to B plus, (5) to the grid and (6) to the filament or cathode or ground the coil is connected properly for oscillation. Also, if both windings are reversed the connections are proper. But if only one winding is reversed, there will be no oscillation.

Incidentally, the coil in Fig. 2 illustrates a method of coupling the oscillator and the modulator circuits that have proved effective. The modulator tuned coil is wound on the same form as the two oscillator windings, with a considerable separation between the two tuned windings. The small mutual inductance between them is sufficient to provide the proper amount of coupling between the two circuits.

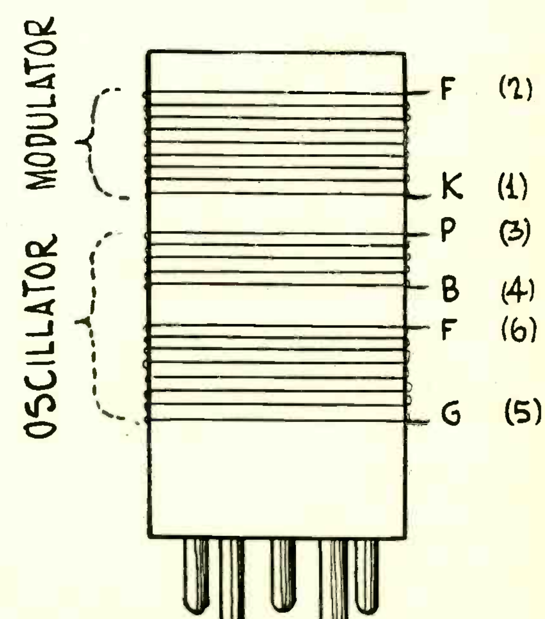


Fig. 2
This shows the arrangement of the tuned windings when using mutual coupling as in Fig. 1 for mixing. It also shows the proper way of connecting the windings of an oscillator coil.

Construction of Panels

All-Wave Converter Has B Supply

THE plan for drilling the subpanel of the DX-4, with sockets arranged in a row at the rear, is shown in Fig. 1. This model is an all-wave converter, tuning from 10 to 600 meters, with any receiver, and has the B supply built in, so that convenience and performance are served abundantly. The front panel dimensions are given in Fig. 2, while the circuit diagram is printed as Fig. 3.

It will be noted that the row of socket holes consists of four holes of equal size, 1⅜ inch diameter, on either side of an opening ⅞ inch in diameter. Five-prong sockets are to go in all five positions, but the smaller center hole is for the coils, one of which is put into this socket at a time. The coils therefore have prongs corresponding to those on tubes, and the connections from coil socket to other sockets are grid spring of coil socket to oscillator grid, cathode spring of coil socket to cathode of the modulator, plate spring of coil socket to plate of the oscillator, heater next to cathode to B minus and heater next to plate to B plus. The B plus lead is simply the end of the choke coil in the rectifier cathode circuit.

The reason for the difference in the size of holes for sockets is that four have to be large enough to pass tube bases, so that the tubes can be driven home in the sockets, and not be obstructed by the thickness of the bakelite of the subpanel.

At the rear drilling line a hole is shown between each pair of large holes. The one at left is for the antenna connection, the one at right for the output. When the DX-4 is completed, only two connections have to be made: (1) aerial is removed from the receiver and connected instead to the antenna post of the converter; (2) the output post of the converter is connected by a wire to the vacated antenna post of the receiver.

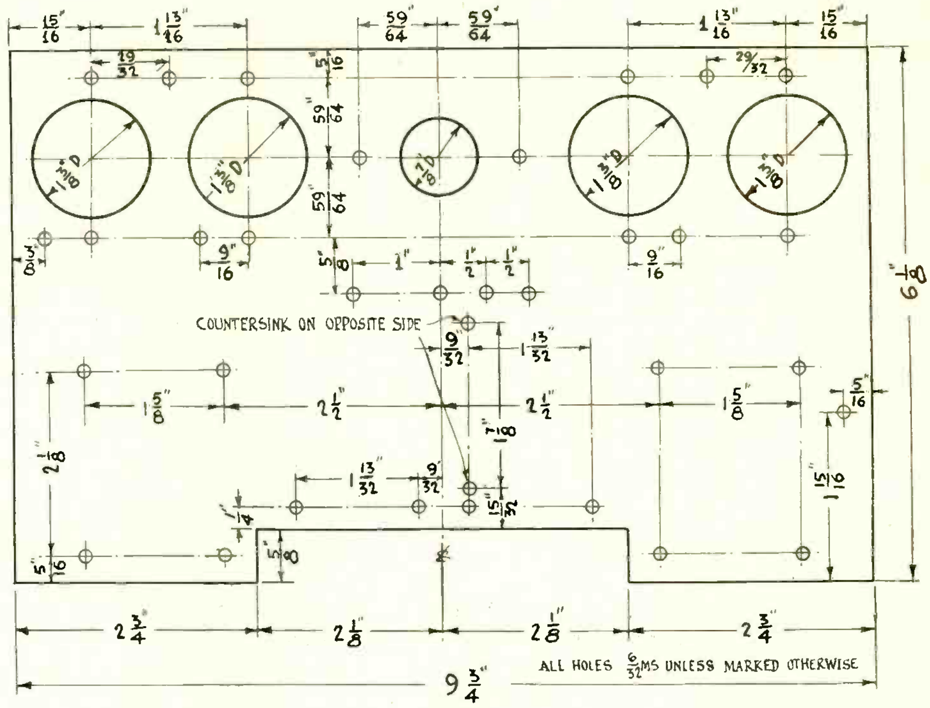


FIG. 1

Dimensions for drilling the subpanel of the DX-4, an all-wave converter that is particularly fine in bringing in short-wave stations. This layout provides utmost symmetry. The AF tube goes at left, oscillator next, coil next, modulator to right of coil, and rectifier at extreme right.

The ground post is left on the receiver as found, and no ground connection is made externally to the converter, as ground is automatically established.

On the second drilling line from the rear three holes are shown off center from the socket holes, and these are for passing through the leads that go to the caps of the three 224 screen grid tubes used in the converter. The fourth tube is the 227 rectifier.

There are two holes marked to be countersunk from the opposite side. Through these holes, from the bottom, two flat-head 6-32 machine screws, about ⅜ inch long, are to be passed. The object of countersinking is to leave the under side of the subpanel at these two points perfectly flat so as not to obstruct other parts that are to be mounted on the bottom. These other parts are two 1 mfd. Polymet 1 mfd. condensers, which may be used for the filter capacities of the rectifier.

Since this model shows a choke coil included, the capacities may be low, for with small current (the drain here is about 15 milliamperes) you may use either large capacity and no choke, for instance 16 mfd., or may use a choke and small capacities, one condenser next to the rectifier (cathode to ground) the other from the opposite end of the choke coil to ground.

What to Use as Choke

The value in inductance of this choke coil is not critical. You may use the primary of an old audio transformer, provided the transformer does not get more than just warm when the current is passed through it, or you may use the primary of a filament transformer, which is an especially welcome suggestion if you have such a transformer with secondary burnt out.

Heater may be connected in series, if desired, or in parallel, as shown. If series heaters are used, a popular brand of transformer, marked 20 volts on the secondary, will give the correct heater voltage when 4 ohms of resistance is placed in series. As 1.75 amperes will flow, this resistor should not be of the 4-ohm type used for dropping the voltage of a 6-volt storage battery to 5 volts for a quarter ampere tube, as such a resistor is rated at one-quarter ampere, and here we are passing nearly 1.75 amperes. So use a resistor of 2 ampere rating, which will be wire-wound.

At front, at extreme left and right, are two holes intended for the heater transformer and the choke coil. Since equal services may be used, only the secondary as choke in one instance, the holes are symmetrical, but at right, where the heater transformer goes, there is an additional hole, 5-16 inch in from the right, which enables mounting a parallel-type (2½ volt) heater transformer, using one hole intended for the other type transformer, and the extra hole just mentioned.

The two extreme left and right holes near the front serve a double purpose. A small metal bracket is placed in each and coincides with the two front panel holes that are 4⅛ inches from center. Thus, by screw fastening, the rigidity of the assembly of front panel to the subpanel is maintained, the principal mechanical coupling being between dial hub and condenser shaft. The two other holes prevent pivoting of the front panel. Decorative screw heads are on the nuts used for this purpose.

The tuning condenser is a Hammarlund .0002 mfd. junior midline, a new product. This condenser has 27 tiny plates. Some builders may wonder why a condenser with 27 plates has a capacity so low as .0002 mfd, but it must be remembered that the capacity of a condenser does not depend on the number of plates, but rather on the area, thickness and material of the plates, the type of dielectric and degree of separation between conductors and dielectric. The commercial rating of .0002 mfd. is remarkably accurate.

This is the only tuning condenser used. It is not to be assumed, however, that there is only one tuned circuit. The condenser governs the frequency of oscillation, hence in conjunction with the intermediate channel, determines the frequency tuned in. The converter should be worked with any broadcast receiver, with the receiver set at some frequency that does not bring in a broadcast station directly, preferably higher than 1,500 kc (lower than 200 meters), particularly if your set is sensitive in that region.

Effect of Intermediate Shift

The coils were designed to afford the advantage of broadcast tuning by the mixing process, as well as short waves, on the basis of use of a high frequency somewhere around the one stated. But if your set is more sensitive at the lower frequency extreme (below 550 kc, above 545 meters), the use such a frequency, although you will not able to tune in the broadcast band, since lowering the intermediate frequency raises the frequency of carriers from which response will be gained. However, the chief value of the converter is for short waves, and whether or not broadcasts can be tuned in becomes of secondary importance. An extra coil will assure broadcasts even if 520 kc is used.

The number of tuned circuits, actually, will be the number of tuned stages in the receiver with which the converter is worked. Suppose you have a tuned radio frequency receiver, using a four-

and Coils for the DX-4

Built In and Affords Fine Results

gang condenser. Then you have four tuned stages. Since the receiver is intended to tune in broadcast stations separated by 10 kc, and since the same selectivity is imparted to the intermediate frequency when the converted is used with the set, and since there is hardly any short-wave work with only 10 kc separation between modulated carriers, it follows that any set even fairly selective for broadcast use will be plentifully selective for short-wave conversion. A few of the short-wave transmitters have a band width of 1,000 kc, and a large number uses a band width of 100 kc.

So on the selectivity score there is nothing whatever to worry about. As for sensitivity, that will depend on the sensitivity of the receiver with which the converted is used. Great sensitivity is not required of the receiver. Many who have built the DX-4 have tuned in foreign stations, using receivers built in 1929 that were not nearly so sensitive as receivers of the 1931 class.

Needs a Good Dial

The volume control of the receiver should be kept to "full on" position when the converter is used, unless oscillation results, due to coupling between receiver and converter, whereupon the volume control may be retarded a little, and the trouble will disappear.

The drilling dimensions for the front panel take into account the use of a National modernistic dial of the flat type (VGE), requiring four holes, as shown. The three other holes are: one, at bottom, for the General Electric AC toggle switch, and two, at the sides, for the decorative-headed nuts. A fine dial like the National type VGE is essential, as without an excellent vernier one is likely to pass right over foreign short-wave stations without even knowing that they are within sensitivity range. Besides, the dial has an attractive appearance, due to the color scheme at the vision window, and the modernistic escutcheon plate.

The subpanel is 9¾ inches wide x 6⅛ inches front to back, while the front panel is 10 inches wide x 7 inches high. The elevation of the subpanel is such that the transformers mounted underneath (one transformer being used as a choke, by connection of the braid-covered primary only) act as supports. Two brackets are used at rear to reinforce the support, to retain rigidity even when tubes and coils are inserted in and removed from sockets. These two brackets are attached to the antenna and output binding posts, and are cut down to fit.

Data on Winding Coils

Looking at the subpanel top, as shown in Fig. 1, the left-hand socket is for the radio frequency amplifying tube, the next socket the modulator (output tube), while the one at right is for the rectifier.

The coils used in the DX-4 are of the precision type, wound on 97 per cent. air dielectric, since only 3 per cent. of the wire used in winding touches the bakelite fins that brace the ring ends. The diameter is an unusual one, but those desiring to wind their own coils, using solid forms, may adhere to a 3-inch diameter, which is close to the one actually used in the precision coils.

The winding data are as follows:

Smallest coil (AKP-1), three turns of space-wound No. 18 enamel wire, tapped at the second turn; one continuous winding tapped. Tickler, separated ½ inch from the other, six turns of space-wound No. 18 enamel wire, wound in the same direction as the other. Spacing between twins may equal the thickness of the wire.

Second largest coil (AKP-2), twelve turns of No. 18 enamel wire, space wound, tapped at the 10th turn. Tickler, separated ⅛ inch from the other, 8 turns of No. 24 silk-covered wire. Space-winding of this tickler is not essential. But both windings must be in the same direction.

Largest coil (AKP-3), twenty-five turns of No. 18 enamel wire, space wound, tapped at the 20th turn. Tickler separated ⅛ inch from the secondary, wound with ten turns of No. 24 silk-covered. not spaced.

The wire that is silk covered may have single or double silk insulation. The connections for the windings, in respect to a five-prong plug, with prongs placed like UY socket prongs, are: beginning of the secondary to the coil prong corresponding to grid of the socket; tap to coil prong corresponding to socket heater next to the cathode; end of continuous winding to coil prong corresponding to cathode of a socket. Tickler terminal adjoining cathode connection on the other winding, to prong of coil socket corresponding to heater adjoining plate; other terminal of tickler winding to coil prong corresponding to heater next to plate.

Broadcast Coil for Lowest Intermediate

These new data on coils permit the coverage of the full band, 10 to 600 meters, with only three coils, using a high intermediate frequency, and replacing data that gave more overlap than quite necessary, and which called for four coils. Using a 1,600-kc intermediate frequency, the lowest frequency you can tune in with the AKP-3 coil, is 500 kc, while using 540 kc, the lowest frequency you can tune in is 1,560 kc, due to the downward shift of the intermediate frequency causing the frequence of response to be shifted upward by a like amount. So at 540 kc intermediate frequency, you would be able to tune from about 1,500 kc or up (or 200 meters down), escaping the broadcast band.

If it is desired to cover the broadcast band as well, even though using the low frequency extreme for intermediate amplification, this can be accomplished by using another coil (AKP-3S) with 50-turn No. 18 enamel wire continuous widing, tapped at the 45th turn, ⅛-inch separation, and a tickler of 20 turns of No. 24 silk-covered wire.

As for tuning, it is very easy indeed. Simply turn on the set, after the two connections have been made as outlined, and with tubes in the converter, turn on the converter. Rotate the dial slowly, and stations will come in. At first you may "rush the dial," thereby passing over many stations, but soon you will get the hang of it, in fact, can do so in half an hour, and after that reception will be plentiful and enjoyable.—Herman Bernard.

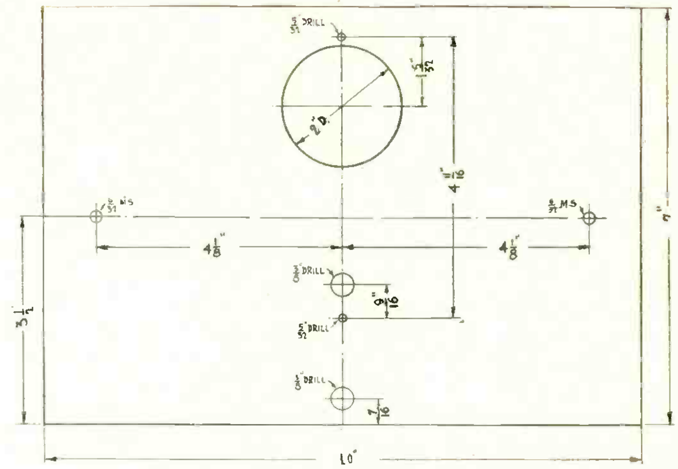


FIG. 2

The front panel is drilled as shown, to accommodate a National dial, a General Electric AC toggle switch, and two ornamental supports.

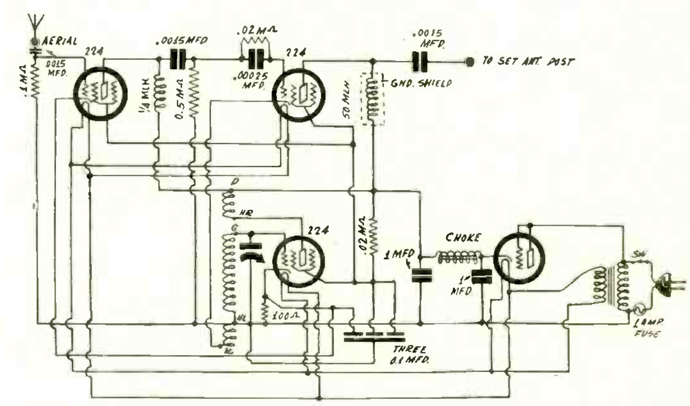


FIG. 3

The circuit diagram of the DX-4. The filter capacities are shown as being 1 mfd. each, adequate if a choke is included in the rectifier cathode lead. If the choke is omitted, the transformer mounted at right may be turned half way about, and one or two 8 mfd. condensers attached to the screws of the transformer.

Cause of Sputtering

A sputtering noise heard only while adjusting the tuning knob is probably due to a loose connection in the tuning condenser or possibly dirt, a bit of wire or metal hair scraping when the dial is moved. Brush between the plates with a pipe cleaner. Look for loose connections, screws needing tightening, or nuts loosened.

The Construction of

By J. E.

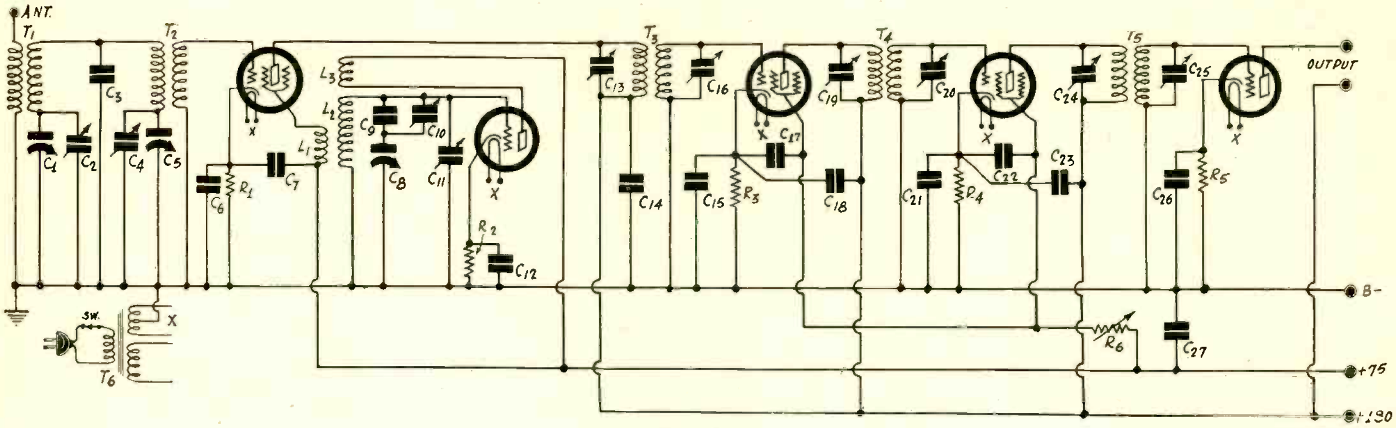


Fig. 1
The diagram of a five tube superheterodyne tuner in which the intermediate frequency transformers have been tuned both in the primaries and secondaries to a frequency of about 175 kc.

HOW many tubes and tuners should there be in a superheterodyne receiver that will compare favorably with the sensitive and selective receivers of this type now available? This is a question often asked in one form or another. The question is rather indefinite and therefore must be answered in the same style. Any number. But let us examine one to see if we cannot be a little more specific about the number of tuners and tubes, leaving aside the question of a favorable comparison with commercial receivers.

We need selectivity in the radio frequency level in order to minimize repeat tuning, for the only practical way to reduce image interference is to tune sharply ahead of the modulator and to exclude all signals not desired. But the sensitivity of a good intermediate amplifier is so great that we do not necessarily need a radio frequency amplifier ahead of the modulator, although we may use it to good advantage when extreme sensitivity is essential. Therefore we can get along very well with a double tuner ahead of the modulator tube, with the two tuned circuits very loosely coupled together.

Band Pass Filter Tuner

The input to the superheterodyne is a band pass filter consisting of two equal tuned circuits coupled by means of a comparatively large condenser C3. Oh, yes, this is the familiar band pass filter only that it has been drawn so as to show the coupling impedance more clearly. The first tuned circuit is C1C2, C3 and the secondary of T1, and the second tuned circuit is C4C5, C3, and the primary of T2. Thus C3 is in both circuits, and that is why the two are coupled.

Now if the inductances of the two coils are the same, and the capacities of the two condensers C1 and C5 are also the same throughout the tuning range, and if C3 is not too small, this band pass filter is very selective and provides sufficient suppression of the undesired signal frequencies. However, it is quite likely that the main tuning condensers will not line up at all points of the dial and it is for this reason that the trimmer condensers C2 and C4 have been connected across the main tuning sections.

It is recommended that the condensers C1 and C5 be of .0005 mfd. capacity, for if they are smaller, say .00035 mfd., it will not be possible to cover the broadcast range, especially if the coils are closely shielded. And they should be shielded from each other and also from the oscillator coil. It is understood that C1 and C5 are to be on one control, for otherwise the trimmer condensers would be entirely unnecessary. The capacity of C3 determines the width of the frequency band passed at any setting of the main condensers. If it is small the band will be wide and there will be two response peaks instead of one. If it is large the selectivity will be good, assuming the tuning condensers are always lined up, by which is meant that they should be equal at all settings. The customary size of the coupling condenser is .05 mfd., but this can be increased to .075 or even to 0.1 mfd. for greater selectivity. This is especially true when the tuning condensers are .0005 mfd.

The RF Transformers

The transformers T1 and T2 can well be coils having 70 turns of No. 28 enameled wire on 1.75 inch tubing for tuned windings and 40 turns of the same wire and on the same forms for untuned windings. For greater selectivity the number of turns on the primary of T1 might be made less than 40, and for greater sensitivity the turns on the secondary of T2 might be more. The number of turns on the untuned windings is not so important as proper alignment of the tuning condenser at all settings.

The modulator in this circuit operates on the grid bias principle and the oscillator is coupled to it by connecting the pick-up coil in the screen circuit of the first tube. This method of modulation has been found to be quite satisfactory in that it does not easily cause interlocking of the tuned circuits and that it does not easily overload the modulator tube. The question of sensitivity does not enter much for it is always possible to impress as much voltage from the oscillator on the modulator as that tube will stand. It is only necessary to vary the turns on the pick-up coils L1 or the coupling between the oscillator winding L2 and the pick-up

Bias on Modulator

The modulator tube should be operated as a power detector, or high signal rectifier. The adjustment for this may be effected by applying recommended voltages on the plate and the screen of the tube and then adjust the grid bias resistor. A suitable value is 5,000 ohms.

The oscillator is a typical tuned grid circuit with a tickler, L2 being the grid coil and L3 the tickler. The grid coil is tuned with C8, a .0005 mfd. section on the same gang as C1 and C5. Condensers C9, C10 and C11 are used to make the ganging practicable by arranging the circuit so that the oscillator is exactly in tune at two points on the dial. That is the best that can be done without special condensers, which are not available. But tying the circuits together at two well selected points in the scale, say at 600 and 1,400 kc., makes the alignment almost as good at other points. The design of the oscillator will be discussed in greater detail in a future issue.

The object of C9 is to reduce the effective capacity of the condenser across the tuned coil and to change the rate at which the capacity changes. It is a fixed condenser. Since no fixed condenser can be found in general that will give the exact series capacity needed the trimmer C10 is connected across it. Hence C9 need only be accurate within half the range of the trimmer condenser. C11 is also a trimmer and it is used to obtain the proper zero setting capacity in the oscillator circuit. As a rule, both C10 and C11 can be of 100 mmfd. each.

The bias resistance R2 for the oscillator may be of 1,000 ohms and the condenser C12 across it 0.1 mfd.

The Intermediate Transformers

The intermediate frequency transformers T3, T4 and T5 are identical in every respect and each consists of two 800 turn duolateral coils mounted as illustrated in Fig. 2. The coils are concentric and the distance between the centers of the two is one and one-sixteenth inch. Each is mounted in an aluminum can approximately 2.25 inches in diameter and in length. Each winding is tuned with a 100 mmfd. trimmer condenser to a frequency of 175 kc. A resonance curve of such a tuned transformer was published in the issue of March 21, without the shield, and next week comparative resonance curves of the same

the Anderson Tuner

Anderson

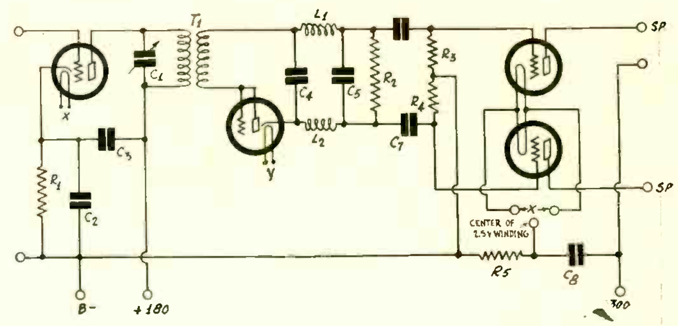


Fig. 3

This is the circuit of a special detector-amplifier invented by the author, and to be described in detail in a later issue.

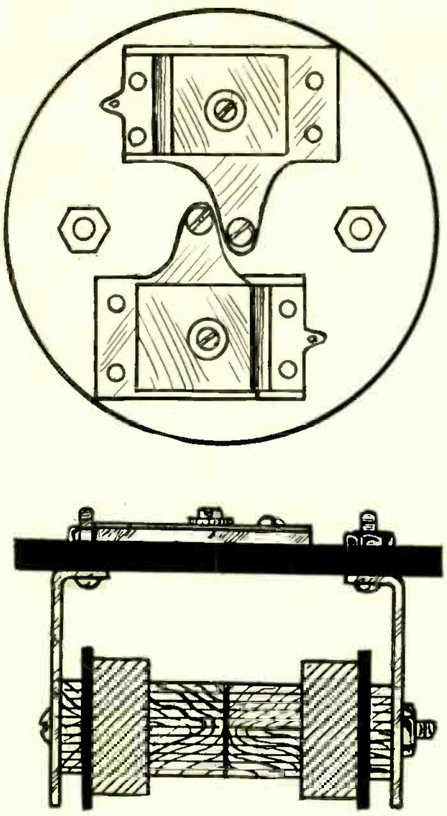


Fig. 2

This shows the assembly of the coils and the condensers of the intermediate frequency transformers used in the tuner shown in Fig. 1

transformer will be published, both with and without the shield. It will be found that with the shield on the output is greater and the selectivity is not appreciably lower.

The mounting of the coils and the trimmer condensers is shown in Fig. 2. A bakelite or hard rubber disc fitting into the can is used for support. On one side of this disc the two coils are mounted by means of two brackets so that the axis of the two coils is parallel to the supporting disc. The two trimmer condensers are mounted on the opposite side of the disc. Very close fitting is necessary if the condensers are not to touch each other and still allow the assembly to fit into the aluminum can. Of course, there is nothing against using a larger can and thus avoid the danger of shorting.

Mounting Condensers

Two holes are required for each trimmer condenser on the support disc, one of ¼ inch diameter for the central stud in which the adjusting screw is set, and the other drilled with a No. 29 drill for holding the condenser firmly to the disc by means of a 6-32 screw and nut. If the holes are located properly there is just enough room for the condensers without touching each other or the sides of the can. The only danger of shorting comes from the possibility of the condensers turning, but this is small if the holes are of the right size and the fit is snug.

The assembled coils and condensers were mounted to the lid of the can with the same screws that held the coil brackets to the insulator plate and all the leads were brought out through holes in the lid. The main part of the can was then put over and screwed down on the lid. The condensers were adjusted after the transformer was in the can and the leads connected in the circuit.

The three transformers are exactly the same. In adjusting them it is not essential that the frequency be exactly 175 kc if there is no ready means for adjusting them to this frequency for some other frequency will work just as well. To adjust them to some frequency just turn each trimmer condenser in turn, after the circuit is in operation, until the sound is as great as it can be made with that condenser. However, first tune the oscillator until the sound is as great as it can be made for that adjusts the intermediate frequency to the mean of all the resonant frequencies of the six tuned circuits . Then leaving the oscillator condenser as it is adjust the trimmers. This will require the least adjustment of the trimmers.

Each of the two intermediate amplifiers has a grid bias resistor of 300 ohm, R3 and R4, and each is by-passed by a 0.1 mfd. condenser, C15 and C21. Each also has a condenser of similar value from the grid to the cathode, C17 and C22, and another from the plate return to the cathode, C18 and C23. C14 should also be of this value.

The final tube may be worked either as an amplifier or as a detector. When worked as a detector R5 should be 15,000 or 20,000 ohms and the condenser C26 across it should not be less than 1 mfd. When the tube is worked as an amplifier the bias resistance should be 2,000 ohms and the condenser may have the same value as before, but preferably it should be 2 mfd. or more. Of course the tube is used as a detector when an ordinary audio frequency amplifier follows it, and it should be used as an amplifier if it is desired to add another stage of IF, or if a special type of detector, to be presented in the future, is used. If the condenser C26 be made 2 mfd. it is only necessary to change the bias resistance to change the tube from a detector to an amplifier, or vice cersa.

Volume is control by means of 25,000 ohm variable resistance R6 connected in the common screen lead serving the two IF amplifiers. An additional volume control may be put in the antenna circuit by connecting a potentiometer of about 100,000 ohms across the primary of T1 and connecting the antenna to the slider.

Condenser C27 is useful in eliminating coupling among the tubes and it might well be 1 mfd.

It is assumed that the plate supply is by-passed thoroughly so that it is not necessary to by-pass the 180 volt lead in the other except by the small condenser C14.

New Edition of "Drake's"

Fourth Edition, Drake's Encyclopedia

In this edition of the cyclopedia many new subjects have been included and others have been extended. There are sections of diagrams of the latest commercial receivers, methods of scanning in television, methods of reconstructing the television, image and on many other recent subjects.

It is difficult, indeed, to conceive of any subject in radio that has not been covered in this book. The subjects are treated in alphabetical order, with numerous cross references, so that any desired subject may be found instantly. The discussions, necessarily brief in many instances due to the wide scope, are uniformly sound.

Multiple Antenna Described to Club

The development of a radio wave distributing system for the operation of the innumerable radio sets in apartment houses was the subject of a paper delivered before the last meeting of the Radio Club of America by J. G. Aceves in cooperation with E. V. Amy and Frank King, co-inventors of the multicoupler antenna system described.

Briefly, the multicoupler antenna system comprises a well-designed and suitably located common or group antenna provided with a downlead to which thirty or more radio receivers may be connected by means of specially designed coupling devices known as multicouplers.

How to Pl

Einar

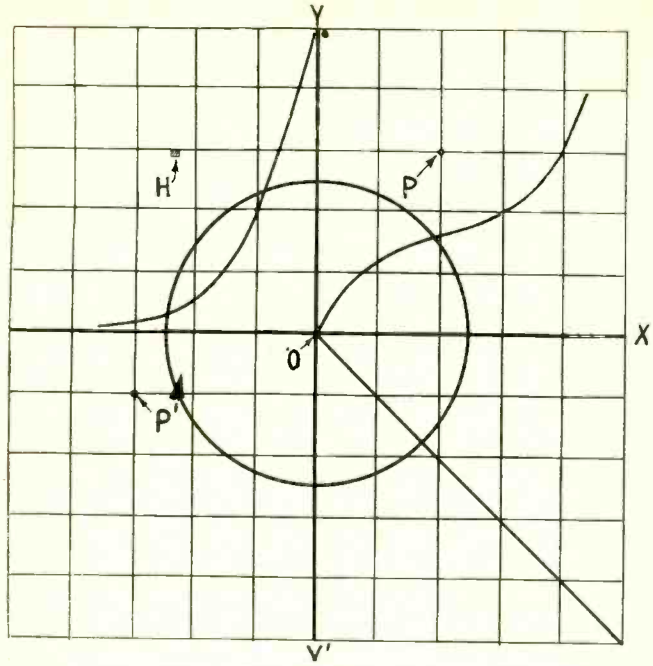


Fig. 1
This illustrates the Cartesian rectangular system of coordinates which is used most frequently in plotting curves. Four different graphs are also illustrated.

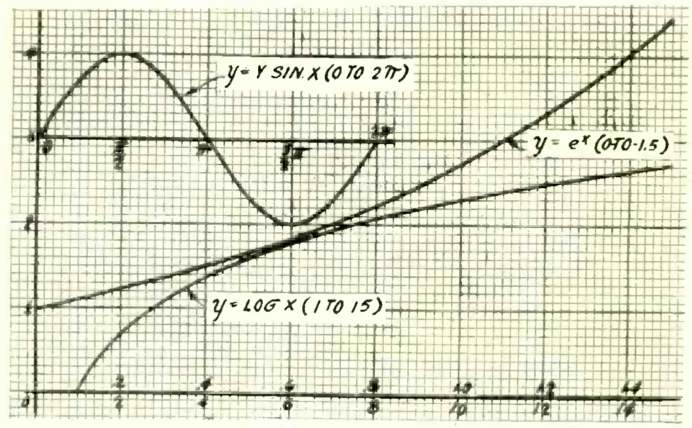


Fig. 2
Three different mathematical curves of the transcendental type.

In mathematics, physics, radio engineering, economics and many other fields a system of **coordinates** is used to give a picture of the relationship between two variable quantities or to specify the location of an object with respect to some fixed point. Thus the location of a ship at sea, or the position of a city on land, is given by the latitude and longitude, the location of a house in a city is often given by the number of blocks north or south of a given street and by a number representing the distance from some other street at right angles to the first, the direction of a star is given by its azimuth and its declination, or its ascension, or the position of a point may be given by the coordinates.

Many Systems

There are many systems of coordinates, some of which are so familiar that they are never thought of as such, for example, the street and number of a house in a city, but there is one system, the Cartesian rectangular, which is used more than any other, especially in mathematics and the various branches of engineering. This system is illustrated in Fig. 1. There are two **axes** of coordinates, XX', the axis of **abscissas,** and YY', the axis of **ordinates.** The intersection, O, of the two axes is called the **origin,** the point from which all distances are measured.

The distance from the axis of ordinates to any point, P, measured along a line parallel to the axis of abscissas, is called the **abscissa** of the point and the distance from the axis of abscissas to the same point measured along a line parallel to the axis of ordinates is called the **ordinate of the point.** The two **coordinates,** that is, the abscissa and the ordinate, definitely fix the location of the point with respect to the origin, both as to direction and distance.

The point, P, in Fig. 1 is located so that its abscissa is 2 units and its ordinate is 3 units. These units may be pure numbers, miles, inches, amperes, ohms, or any other, according to what is being being represented.

Designation of Axes

In pure mathematics it is customary to indicate the axis of abscissas by XX' and the abscissa of any point by x and the axis of ordinates by YY' and the ordinate of a point by y. The axes are then referred to simply as the X-axis and the Y-axis. In applied mathematics and engineering, however, the axes may be differently called, and appropriately to the quantities represented. Thus, the Y-axis may become the Ip-axis when the ordinates represent plate current and the X-axis may become the Eg-axis when the abscissas represent grid voltage.

When it is desirable to designate the location of a point briefly, it is customary to write the coordinates thus (x,y), or (Eg, Ip), the abscissa always being given first. Thus (x, y) represents a point, and point P, in Fig. 1, is (2, 3).

Quadrants

The right angle XOY is called the first quadrant, and any point included in this angle is said to lie in the first quadrant. The angle X'OY is called the second quadrant, the angle X'OY' the third, and the angle XOY' the fourth.

In the first quadrant both the abscissa and the ordinate of any point are positive. In the second quadrant the ordinate is positive and the abscissa negative. In the third quadrant both coordinates are negative. In the fourth quadrant the abscissa is positive and the ordinate negative. That is, ordinates are positive above the X-axis and negative below and the abscissas are positive to the right of the Y-axis and negative to the left.

When an ordinate or an abscissa is negative it is written with a minus sign in front of it, thus, —x or —y. The coordinates of the point P' are (—3, —1), both negative since the point lies in the third quadrant.

The Graph

A graph is the locus of a point which moves subject to certain restrictions, or subject to the relationship existing between the abscissas and the ordinates, or it is the path traced by the moving point as it moves in the plane of the coordinates. A point moving in the fourth quadrant subject to the condition that the abscissa should always be equal to the ordinate traces a straight line which bisects the angle XOY'. It is the graph of the algebraic equation $x + y = 0$, or it is the locus of the point moving in the manner imposed by this equation.

It is customary to call a graph a curve, whatever its shape. Thus the straight line in the fourth quadrant of Fig. 1 is a curve although its curvature is zero. A circle drawn anywhere would also be a curve and if its center coincides with the origin its equation would be $x^2 + y^2 = r^2$. This circle is the locus of a point moving so that its distance from the origin is always equal to r. In the circle drawn in Fig. 1 the value of r is 2.5 units. The graphs lying entirely in the first and second quadrants are also curves. The graph in the second quadrant is the locus of the plate current of a vacuum tube moving as imposed by the grid voltage, and the graph in the first quadrant may represent either the left part of a resonance curve close to zero frequency or the characteristic of a photo-electric cell with gas in it, depending on what the coordinates are.

Vacuum Tube Curve in Second Quadrant

The grid voltage, plate current characteristic of a vacuum tube is always drawn in the second quadrant because any ordinate, the plate current ,is regarded as positive and the grid voltage is always negative with respect to the cathode or emitter. If the curve were extended to positive grid voltage it would be necessary to employ the first quadrant also, but that is rarely done now because a tube is rarely operated with the grid voltage positive, even for a part of the signal cycle. Any point in the curve in the second quadrant, assuming it represents grid voltage and plate current, would be indicated (—Eg, Ip). But when it is so indicated the assumption is that the voltage increases from left to right. When Eg represents the grid bias, assumed to be inherently negative, the minus sign is omitted, and the numbers representing grid bias increase from right to left. The minus sign is understood when the word bias is used.

The use of coordinates to specify the location of houses in cities laid out on the Cartesian system can be illustrated by

ot Curves

Andrews

Fig. 1. Let the black lines represent streets and the white squares city blocks. The two axes are the two main and central thoroughfares and the location of every house is determined by its distance from the intersection of these main streets. The location, or the address, of the house, H, would be 241 East Third St. North, the 241 representing 2.4 blocks from the main north and south street. If the house were on the north side of the street the number would be 240 instead of 241, assuming that the even numbers are on the right when looking out into the suburbs. The address of a house in a city laid out in this manner is simply the coordinates of the house.

Drawing the Curve

For plotting a graph of an equation or the characteristic curve of two related quantities we must have a set of data, or corresponding values of the coordinates. For example, let us plot the graph of the algebraic equation $x + y = 0$. We assign any convenient value to x and from the equation find the corresponding value of y. This we do for a larger number of values of x, or for as many as are required to give us the desired data. First, let x equal zero. Then y also must be zero or the equation is not satisfied. Hence our first pair of coordinates are (0, 0). This point is the origin and our curve must pass through this point. Next let us assign the value 1 to x and determine the value of y. This must be —1 to satisfy the equation and our second point is (1, —1). Next we can assign the value 2 to x, which makes $y = -2$. The point is (2, —2). This we continue until we have a sufficient number to draw the curve, which we do by locating each point on the sheet of cross section paper and placing a dot and then drawing a smooth line through all the dots. In this particular case the curve is a straight line and the curve can be drawn with the aid of a straight edge or ruler. Those who are familiar with analytic geometry recognize that the equation is that of a straight line and they make the graph by locating two points, any two on the curve.

Complex Curves

The circle is plotted in a similar manner. The equation is first solved for y in terms of x, thus, $y = (r^2 - x^2)^{1/2}$. That is, y equals the square root of the difference between the squares of the radius and x. We assign convenient values of x and from this equation find the corresponding values of y and then enter the values on the graph paper, placing a dot for each pair. Then we draw a smooth curve through all the points or dots. One familiar with analytic geometry would recognize the equation as that of a circle with its center at the origin and he would use a compass for drawing the curve, the points separated by a distance r units and with one of them at the origin.

Other equations, algebraic and transcendental, are not recognizable and even when they are their graphs cannot be drawn by simple drawing instruments and the graphs must be made by finding as many points as necessary and drawing a smooth curve through all of them. Transcendental equations are those which contain trigonometric, exponential, logarithmic, and such expressions. Examples of such equations are $y = Y\sin x$, which plots into a sine curve, $y = e^x$, which plots into an exponential curve, and $y = \log x$, which pots into a logarithmic curve. To solve such equations we need suitable mathematical tables. Fig. 2, curves A, B, and C, show the graphs of these three equations.

Empirical Curves

In applied science, such as radio, engineering, economics and others, most graphs are empirical, or they are made from a set of data obtained experimentally. The mathematical equations of them are not known. Hence the graphs must be plotted by entering the points, the coordinates of which have been obtained by experiment, on the cross section paper, and by drawing a smooth curve through all of them, or through as many of them as possible. It should be remembered that some measurement may be in error and that not all the points obtained experimentally will fall on the smooth line where they should fall.

Characteristics

Empirical curves are more informative than mathematical curves because if the mathematical expression is known all the properties of the curve are known whereas the empirical graph pictures all that is known of the relationship and many properties may be deduced from the curve. Indeed, a mathematical relation may sometimes be deduced from the empirical curve

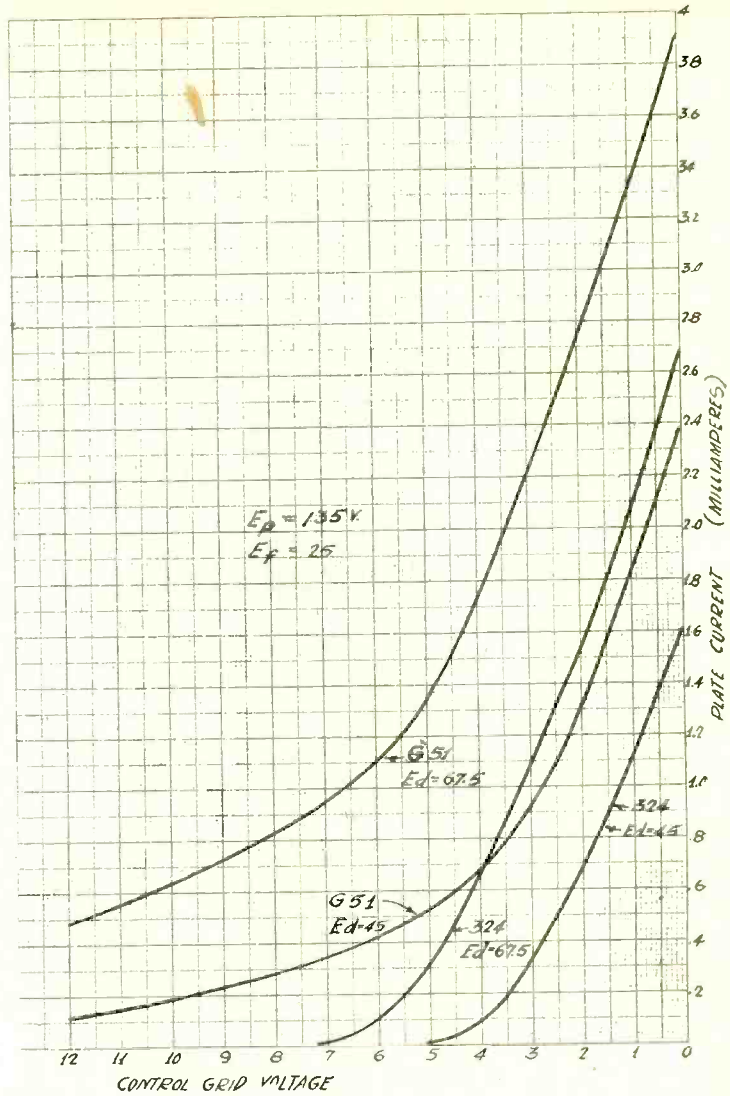


Fig. 3
Characteristic curves of two vacuum tubes showing the manner in which the plate current varies with the grid voltage

and such a relation is referred to as an empirical equation. This equation may not fit the curve except in a limited range of the coordinates whereas a theoretical or mathematical equation fits the curve for all possible values of the coordinates.

Experimental Curves

A characteristic curve is simply a graph giving the relationship between two variable quantities obtained experimentally. That is, it is an empirical curve showing the character of some device upon which the measurement is made. Thus the curve showing the relation between the grid voltage and the plate current, other conditions being constant, is a characteristic of the vacuum tube. Incidentally, we have no other means of knowing the character or the properties of a vacuum tube than the experimental curves.

A few examples of characteristic curves of vacuum tubes are given in Fig. 3, two different tubes being represented. The constant conditions are that the plate voltage is 135 volts and that the filament or heater voltage is 2.5 volts. These refer to all the curves. In addition each curve has another constant, the screen voltage, which is specified for each curve. The variables in these curves are the grid bias and the plate current, the plate currents for different grid voltages being the ordinates and the grid bias the abscissas. All the curves are in the second quadrant since no other quadrant is needed to complete the curves over the region the tube was studied.

Taking the Data

To obtain these curves the plate current was observed for every half volt on the grid from zero to 12 volts or to the point where the plate current was too small to be read. The scales along the axes are laid off to suit the values of the coordinates obtained. In this case the scale along the axis of abscissas is laid out in volts, using the major divisions on the paper for volts, and the scale along the axis of ordinates is laid out in milliamperes, each major division representing 0.2 milliampere.

A Question and Answer Department conducted by Radio World's Technical Staff. Only Questions sent in by University Club Members are answered. Answers printed herewith have been mailed to University Members.

Radio University

To obtain a membership in Radio World's University Club, for one year, send $6 for one year's subscription (52 issues of Radio World) and you will get a University number. Put this number at top of letter (not envelope) containing questions.. Address, Radio World, 145 West 45th Street, New York, N. Y.

Annual subscriptions are accepted at $6 for 52 numbers, with the privilege of obtaining answers to radio questions for the period of the subscription, but not if any other premium is obtained with the subscription.

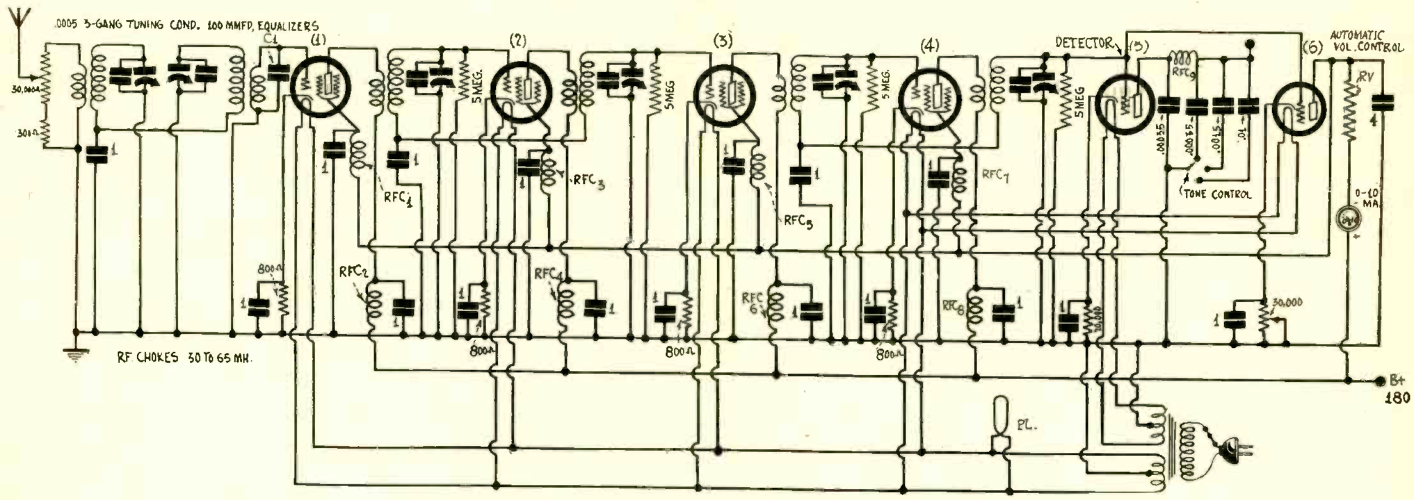


Fig. 902
The diagram of a radio frequency tuner and detector in which a band pass filter is put ahead of the first tube and a tone control after the detector.

Receiver with Tone Control

WILL you kindly publish a circuit diagram of a tuned radio frequency amplifier in which a band pass filter is used in front of the first tube and a tone control in the output of the detector circuit?—A. B. F.

In Fig. 902 is a diagram of a six tube circuit in which both these devices are incorporated. There are in addition four other tuners.

* * *

Effectiveness of Loop Antenna

DOES the effectiveness of a loop as a pick-up of signals depend on the number of turns and the dimensions of the loop? If so, in what manner?—B. W. F.

The effectiveness of a loop as a pick-up is directly proportional to the area of the loop, provided that the sides are small compared with the length of a wave to be received. It is also proportional to the number of turns. Thus the pick-up is proportional to Ld, where L is the length of the wire and d is the length of a side of the square loop. It is advantageous to make d large and the number of turns small if the length of the wire is constant. It is also advantageous to make the wire as short as practicable since its resistance depends on the length. The wire used should also be heavy so that the resistance is low.

* * *

Capacity in Terms of Condenser Plates

I HAVE a condenser which has a total of 27 plates. What is its capacity in microfarads?—W. H. L.

What is the size of each plate and what is the distance between adjacent plates? Capacity is not measured in terms of plates because it depends not only on the number of plates but also on the size of each plate and the distance between adjacent plates.

* * *

Two Types of Variable Mu Tubes

ARE the RCA 235 variable mu tube the same as the G51 variable mu tube, or are there two different tubes?—B. J. W.

There are two different variable mu tubes and the RCA 235 and the G51 are different. The two differ in the following particulars: screen voltage: G51, 90 volts, RCA 235, 75 volts; grid bias. G51, 3 volts, RCA 235, 1.5 volts; plate current, G51, 5.3 milliamperes, RCA 235, 9 milliamperes; plate resistance, G51, 400,000 ohms, RCA 235, 200,000 ohms; mutual conductance, G51, 1,050 micromhos, RCA 235, 1,100 micromhos.

* * *

Short-Wave RF Amplifier

IS there any advantage in using radio frequency amplifiers for short-wave receivers and converters? I have heard that tubes are not efficient as amplifiers at the very short waves.—S. A.

There is very little gain in a stage of RF amplification in the short-wave region and in many instances there is a decided loss. In fact, sometimes the signal is completely lost in the amplifier. It depends on the amplifier. The best way to receive short waves is to use a very simple circuit, say of one tuner and a detector, which may be regenerative. A very good antenna should also be used, and as a rule a short antenna will give much better results than a long one. The lower the resistance of the antenna and of the tuner the louder the signals will be. It is quite possible to get signals from Europe with a circuit of that type whereas with several stages of RF "amplification" it may be impossbile to get a strong station just around the corner. Most of the amplification should be in the intermediate frequency or the audio frequency amplifiers. Converters depend for their sensitivity on the amplification in the broadcast receiver.

* * *

Calibrating Vacuum Tube Voltmeters

IS there any way in which a vacuum tube voltmeter could be calibrated for measuring effective AC values by means of DC and DC instruments? If there is, will you kindly explain, preferably in an article?—C. T. Z.

There are at least two ways in which it could be done. One is by the peak voltmeter method, which was the first vacuum tube voltmeter. In this the grid bias of the vacuum tube voltmeter tube was increased until the plate current was reduced to just zero. The alternating voltage to be measured was impressed in series with the grid bias voltage and the bias was increased until the plate current was again reduced to zero. The difference between the two bias voltages was then equal to the amplitude of the unknown alternating voltage. The trouble with this method is that there is no definite point at which the plate current drops to zero and therefore the readings are uncertain.

The other method is similar and makes use of a diode rectifier, or a three element tube with the grid and the plate tied together. When the alternating voltage is put in series with the circuit a direct current flows. If now a battery be put in series with the unknown and the tube, with the negative terminal toward the plate and the grid, and this voltage is adjusted until no current flows, the value of the voltage connected in series is equal to the peak value of the alternating voltage. This is more definite than the preceding method because when there is no effective voltage in series with the circuit no current flows and if the plate is negative with respect to the cathode, then also no current flows. But the method is somewhat more complicated. In this case it is necessary to connect the grid circuit of the meter to be calibrated in parallel with the source of alternating voltage. There will be two current indicators, one in series with the rectifier and the other in the plate circuit of the tube to be calibrated. The readings on this are taken when the other reads zero. To convert the peak voltage to effective values multiply by 0.707.

* * *

Squealing in Superheterodynes

I HAVE constructed a short-wave converter with plug-in coils to cover the broadcast waves as well as the short waves, and I tune my receiver to 1,000 kc. There is a good deal of squealing in the output which interferes with reception. This is especially strong on stations operating on frequencies close to the 1,000 kc frequency. Also, the converter acts as a booster on the broadcast waves and it seems to spoil the selectivity. What is the trouble?—I. A. C.

The trouble is that you selected 1,000 kc for the intermediate frequency, which lies in the middle of the broadcast band, and then attempt to receive broadcast stations. Make the intermediate frequency considerably lower than the lowest frequency in the broadcast band and the trouble will disappear. At least most of it will.

* * *

Dynatron Characteristics

WILL you kindly explain the difference between a screen grid tube and a dynatron? I notice that the symbols used for the two are exactly the same. If they are the same why have two different names for them?—A. W. S.

As far as the structure of the two is concerned they are the same. But they differ in the manner of operation, that is, in the applied voltages. In the screen grid amplifier the screen voltage is much lower than the plate voltage. In the dynatron the screen voltage is higher than the plate voltage. If plate current, plate voltage curves are taken on the screen grid tubes, for a fixed value of screen voltage, there will be a region in which the plate current decreases as the plate voltage increases. This is the dynatron region of the screen grid tube. In this region the plate circuit resistance is negative and it is for this reason that a dynatron will oscillate when there is a tuned circuit in series with the plate.

* * *

Sensitivity of a Voltmeter

IN the March 14th issue you published a comprehensive tester which you said contained a voltmeter of 2,000 ohms per volt sensitivity. Since the scale had the zero in the middle and the reading at each end of the scale was 0.5 milliampere the full scale must be one milliampere. We all know that a milliammeter of 0-1 milliampere becomes a 1,000 ohms per volt instrument. How do you get 2,000 ohms per volt? Was it a misprint that made it a 2,000 ohms per volt instrument?—G. W. C.

It was not a misprint. The sensitivity of a voltmeter is determined by the maximum current reading and in this case this was 0.5 milliampere. Any meter having a maximum reading of half milliampere becomes a 2.000 ohms per volt voltmeter. However if you took the same instrument and put a 0-1 scale on it. with the zero at the left end then it would be a 1.000 ohms per volt meter when the proper resistance is connected.

* * *

Use of 226 for RF Amplification

IS there any reason why tubes like the 226 could not be used in radio frequency circuits and adjusted so that there is no hum in the output? That is, is it not possible to balance these tubes so that the hum is just as low as if heater type tubes were used?—E. S. F.

Yes. there is a good reason. While the filaments may be balanced so that the hum is extremely low. there is always some residual hum and this is amplified to the point where it becomes excessive. The trouble is that balance varies with the signal.

* * *

Stenode Radiostat

IT is my understanding that the Stenode Radiostat, which uses a piezo electric quartz crystal for tuning with extreme sharpness, can be used for separating modulated waves as close as 3,000 cycles without cutting sidebands. Is this a fact?—W. H. J.

Not quite. The sharp tuner cuts the sidebands, all right, but the claim for the Stenode is compensation may be introduced in the audio amplifier to make up for the reduction in the higher audio frequencies by the very high selectivity. This is a fact. And after the sharp selection and the proper compensation the quality is not impossible and the interference is greatly reduced because it is possible to design the compensating circuit so that the cut-off above the highest essential audio frequency is sharp and complete. The same could be done in tuned circuits of high selectivity composed of coils and condensers.

* * *

Ultra-Short-Wave Circuits

WHAT are the limiting factors producing oscillation by means of tubes at very short waves? What precautions should be taken to insure oscillation. say at one meter?—R. B. W.

The limiting factors are mainly the capacities between the electrodes of the tubes. If the tuned circuit is connected between the grid and the cathode the tuning capacity cannot be less than the grid to cathode capacity. Likewise. if the tuned circuit is connected between the plate and the grid the capacity cannot be made less than the grid to plate capacity. The way to reduce the wavelength of the oscillating circuit is to connect the tuner so that the smallest interelectrode capacity is across the oscillating coil and then make the inductance as small as possible. Usually. the inductance is either a straight rod or a small single turn loop. The Hartley circuit is frequently used because it puts the grid to plate capacity across the coil. and this is the smallest capacity. It is also possible to reduce the capacity by using push-pull oscillators. which are used more and more.

* * *

Characteristics of Variable Mu Tubes

YOU have given the characteristics of variable mu tubes but you do not show any variable factors. You give only one value for the mutual conductance, for example. Under what conditions is the mutual conductance 1.100 micromhos. the value you gave for the RCA 235?—R. M.

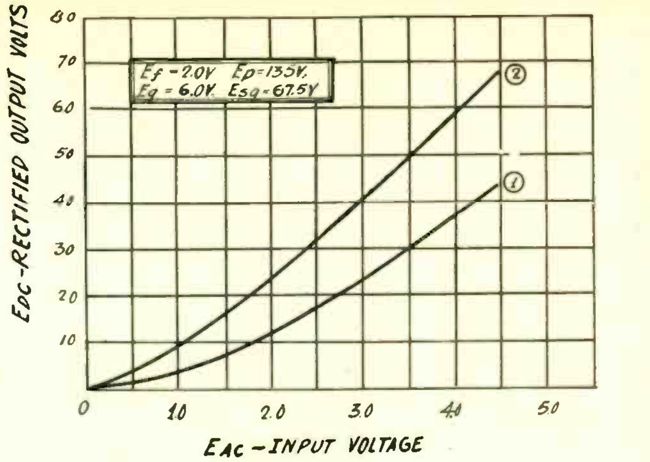


Fig. 903

Curves showing the detecting efficiency of a 232 screen grid tube when working as a grid bias detector into 75,000 and 200,000 ohms.

The mutual conductance has the given value when the other factors have the values given in the same table. If you change any voltage the mutual conductance also changes. We did publish a curve on the G51 tube showing the relationship between the grid bias and the plate current. On the same graph we gave the corresponding curve for a 224 tube. You can get the mutual conductance for this tube from the curve for any bias on the grid. The mutual conductance is the plate current change divided by the corresponding grid voltage change, provided the grid voltage change is small. For example, at 4 volts bias the mutual conductance might be taken by changing the grid bias from 3.5 to 4.5 volts and observing the current change corresponding to this one volt change in the bias. Preferably the grid voltage change should be much smaller, especially if the curve is crooked at the point.

* * *

Detecting Efficiency of 232 Tube

PLEASE show curves showing the detecting efficiency of a 232 screen grid tube when used as a grid bias detector?—R. B. H.

Such curves are given in Fig. 903 for two different load resistances, (1) 75,000 ohms and (2) 200.000 ohms. The conditions of operation of the tube common to the two cases are given in the box in the upper left corner.

* * *

Measuring Resistance of Tuned Circuit

COULD the resistance of a tuned circuit be measured on an AC bridge by connecting the coil and the condenser in series in one of the arms of the bridge and using a frequency to which the tuned circuit is adjusted?—S. L. K.

It could be measured this way for when the circuit is in tune with the frequency used to operate the meter. the impedance of the condenser and coil in series is a pure resistance and it could be balanced against the other resistances in the bridge. It is seldom done this way, though.

* * *

Effect of Metal Shielding

CAN radio frequency currents pass through a metal shield? For example if an oscillator be placed inside a metal box will the oscillation get out through the metal?—F. M.

It seems you are confusing current with the radiation. An electric current can pass through metal very easily. and that is the reason metals are used for conductors. But the radiation cannot get through the metal shielding. The better the shield is as a conductor of electric current the better does it stop the radiation. The radiation does not get through the shield because radio frequency currents are induced in the metal.

* * *

Just a By-pass Condenser

IN the March 14th issue you published a circuit diagram of the De Luxe Ultradyne. In the detector of this circuit there is a condenser connected between the plate and the cathode. Is this condenser used for the purpose of neutralization or for feedback?—P. C.

No. this condenser is just the ordinary by-pass condenser in the plate circuit of the detector.

HOW TO GET QUESTIONS ANSWERED

ONLY questions of general interest are answered by publication in this department. and the answers invariably are to questions submitted by members of RADIO WORLD'S *University Club. Copies of the answers. in such instances. are mailed promptly to the inquirers. so they will not have to wait to see the answers published in this department. We can not undertake to answer questions except those submitted by members of the University Club. For details of acquiring membership in this Club please see notice printed in the heading of this department.—Editor.*

25 Channels Requested for Chain of Locals

Ultimate establishment of some 800 "local" broadcasting stations in the United States, on that basis of 1-watt power for each 1,000 of population, is proposed in an application filed with the Federal Radio Commission in behalf of the Community Radio, a corporation to be formed.

The application was filed by C. R. Cummins, of Williamsport, Pa., as trustee for the proposed corporation, and requests, first, a reallocation of the present broadcast band so that 25 of the present 96 broadcast channels, in a single block, may be set aside for the project. By reducing the channel separation from the standard 10 to 2 kilocycles, the number of channels would be increased from 25 to 125, thus making available the proposed "community station" service to every city and town in the country.

Says $6,500,000 Has Been Pledged

Filing of the application follows the presentation by Mr. Cummins before the Commission of an explanation of the project. He stated then that $6,500,000 had been pledged for the project, should the Commission grant its application. As evidence of the "good faith" of the enterprise, a cash deposit of $250,000 would be offered the Commission.

The application requests authority for the establishment of 267 new local stations in 16 States of the East and West as the first step in the project.

These stations would be located in as many cities and towns, having an aggregate population of 7,396,789. The total power of these would be 7,375 watts, with the individual power ranging from 15 to 100 watts.

The plan is, Mr. Cummins explains, to establish and operate some 400 such community stations in the East and Middle West alone, as compared to the some 200 local stations now licensed for the entire country. A wire-program service, corresponding to the chain programs now furnished by the radio networks, would be served to such community stations in other parts of the country, together with electrical transcriptions.

The application states, according to "The United States Daily," that the power shall be rigidly limited to a maximum of 100 watts on these 25 channels, and that the service should be restricted to towns with populations numbering between 10,000 and 100,000 inhabitants. No station should be granted greater power for operation upon these channels than one watt of power for each 1,000 of population, it states.

The 25 frequencies requested should be placed at one end or the other of the present radio broadcast band, either 550 to 800 kilocycles or 1,250 to 1,500 kilocycles, so that they can be subdivided to provide 125 adjacent local channels having a 2-kilocycle separation each, as against the present separation of 10 kilocycles on standard channels, the application suggests.

"The applicant hereby makes application to the Federal Radio Commission for construction permits for a large group of local or community radio stations in order that the cities or towns hereinafter called communities, listed herein as a part hereof, may be better served with radio broadcast facilities as in public interest, convenience and necessity," states the application.

A Reallocation Would Be Required

As the terms of this application are considered, Mr. Cummins states, "it will become almost immediately apparent that a reallocation of the present assigned frequencies, known as the radio broadcast band between 550-1,500 kilocycles, will become necessary, or that the present broadcast band be extended. Application for this reallocation is included herewith and made a part thereof."

Ownership of any and all stations licensed under the application would be vested in Community Radio, a corporation to be formed, the application states. A provision of the by-laws of the corporation specifies that no stock shall be sold to or owned by a foreign individual or corporation.

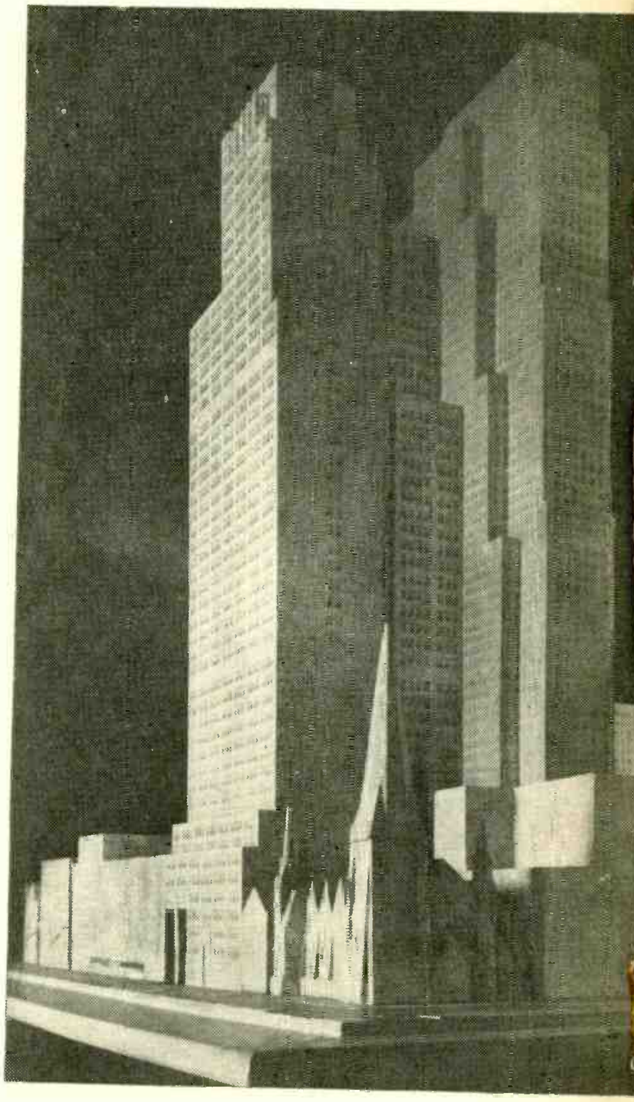
The applicant agrees, it is further stated, that the stations constructed and licensed under the project "shall operate a minimum of 10 hours per day, including Sunday."

As to chain programs, and to electrically transcribed programs, the application states:

"Applicant agrees that the stations included in this application shall be connected by land wires, as rapidly as leased wires or privately-owned cables can be erected, and that program matter originating from studios in the leading amusement and educational centers shall be provided continuously during not less than a 10-hour period each day.

"Applicant will acquire sound studios and equipment, either by lease or direct ownership, wherein will be produced complete electrically transcribed programs, for distribution and use in all of said stations pending the installation of land lines for direct chain hookup. Included in such sound equipment will be provided portables for the purpose of recording program matter where it is impracticable or inconvenient to record such program matter within the studios so established

Cubes and Cy
To Ma



(Wide World)
How the Radio City, on which construction work is about to be Note the cubes and cylinder that typify the architecture. This shows also the church the developers tried to buy, so as to

The architects of the Radio City recently revealed, by the exhibition of a model in their offices, the distinctive type of architecture, embodying prisms and cylinder, with towering guildings accentuated by comparison with small structures of contrasted type, that will grace Fifth Avenue, New York City.

Although work has begun on the gigantic undertaking, buildings having been demolished and preparations made for excavation, the project will not be completed for at least three years, by which time it is expected that television will have reached the commercially practical stage.

The Radio City is dedicated to electrical entertainment, although some other entertainment and cultural attractions are to be included, even the Metropolitan Opera House, if possible, to replace the old structure on Broadway.

Two Enormous Theatres

The most advanced type of broadcasting equipment and studios will be included, with ample provision for the transmission of television, while a movie theatre and another theatre will be in the same group of buildings. Both theatres will be enormous in seating capacity.

The construction will be done by the Rockefeller interests, and

ylinder
rk Radio City

gin, will look from the front facing Fifth Avenue, New York City. photograph of the architects' model of the great enterprise utilize the entire tract, only to be turned down by the pastor.

John D. Rockefeller, Jr., is taking an active interest in the work. The construction is being undertaken for Radio Corporation of America and its two main affiliates, the National Broadcasting Company and Radio-Keith-Orpheum, the radio-vaudeville-movie combination.

"I was advised two years ago," said M. H. Aylesworth, president of the National Broadcasting Company, "that television would be commercially practical in five years, and since then developments bolster the prediction, so that when the Radio City is ready for operation it will also be ready to carry on television.

Roxy to Run Movie House

"The technique of program presentation will be different, of course, when television arrives, because the audience will see the performers, as well as hear them, but we are making all possible preparations."

The movie theatre that will be included in the building group will be managed by S. L. Rothafel (Roxy), who recently resigned as director of the Roxy Theatre in New York, and who is about to assume his duties in connection with the construction of the temple of entertainment that he is to head. It is said his salary will be $100,000 a year.

Studio Signalling Done by Machines

The noiseless system of studio communication, installed in several National Broadcasting Company studios last Fall as an experiment, has proved so practical that soon it will be extended to all of the company's studios. The system is built around special noiseless telautograph machines perfected in cooperation with the Telautograph Corporation.

No longer will it be necessary for production men to run into a studio, whisper to the orchestra leader to "push a soprano closer to the microphone" or wave his hands this way and that in efforts to convey messages.

Machine Delivers Written Orders

Under the new system a man in the control room writes orders on the telautograph machine at his elbow. These are recorded on another machine in the studio. In turn those in the studio can reverse the operation.

Veteran broadcasters shed tears of regret watching installation of mechanical devices which tend to destroy individualism. "What if the old signals were confusing?" they ask, "they were at least human."

Old-timers reflect on the past years when they resorted to setting-up exercises, combined with deaf and dumb language, to convey the message "tone down the bass drum, moove the fife player up a bit, make that crooner turn her face in another direction and speed up the whole show.

What Some of the Signs Meant

Under the long-established practice a finger planted firmly against the side of the nose signified that the program was running according to the time schedule. Hands drawn slowly together meant for the singer, speaker or instrumentalist to move nearer to the microphone. The signal reversed, of course, was interpreted as advice to move away.

If the director saw the production man waving his hands around in circles he knew that the program must be speeded up. Hands lowered with palms down meant play softer. Hands raised repeatedly meant play louder.

When broadcasting was young the control engineer and production man sat in the studio. Soon, however, the engineer and his apparatus were placed in a separate room, adjacent to the studio but separated by sound-proof glass panels. There he could hear the program through a speaker.

Conquest by Machine Age

The production man divided his time between listening in the control room and moving about the studio whispering instructions or giving signals. With the new mechanical arrangement he can devote more time to listening, convey instructions with greater facility and accuracy and in short present a finer program with a minimum of mistakes and no confusion.

"It was a great system while it lasted," lamented William S. Rainey, NBC production manager, as he indorsed the order for more machines. "However, sentiment must give way to efficiency. But don't be surprised if, in the future, you see a production man or engineer wildly waving his arms. It will be just one more individual rebellion against the machine age."

Fifth Kent Audition Offers $25,000 Cash

A Fifth National Radio Audition, offering cash awards of $25,000 to the young amateur singers of the United States, was announced by the Atwater Kent Foundation of Philadelphia. Radio listeners and a board of judges will jointly select the candidates for these awards.

"I believe we are building for the future in searching out talented young singers for that great medium of culture and entertainment —radio," said A. Atwater Kent, president of the Foundation bearing his name. "The discovery of one of those rare voices, of which each generation produces a few, seems to me an event of profound national importance. Even when such a voice could give pleasure to only a few thousand people it was a national treasure. Now that millions may enjoy it through the medium of radio, such a voice becomes priceless.

"So, just as a good voice is a divine gift, radio offers opportunity to share that gift with the greatest number. In previous auditions our records show contestants have come back the second, third and even a fourth time after losing out in a first attempt. This should be encouraging to all who have taken part in earlier contests."

A THOUGHT FOR THE WEEK

RADIO WORLD is entering on its tenth year of success. It is still the only radio weekly, as it was the first. Mortality has been high in the radio publication field. While honestly condoling with those that have passed away, we feel a certain sense of elation over the fact that RADIO WORLD *has kept the good will of its army of readers in the United States and Canada and in many foreign countries. This hard-won success of ours is not lightly prized by the publishers. It shall be their constant endeavor to make this paper of actual value to subscribers. It shall be their constant endeavor that Service and more Service shall constantly be in our mind and we thank all of our readers for their interest and support.*

And may we all be together at the end of our tenth year, which year starts out so happily and auspiciously!

RADIO WORLD

Title Reg. U. S. Pat. Off.

The First and Only National Radio Weekly
Tenth Year

Owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, president and treasurer, 145 West 45ht Street, New York, N. Y.; M. B. Hennessy, vice-president, 145 West 45th Street, New York, N. Y.; Herman Bernard, secretary, 145 West 45th Street, New York, N. Y.

Roland Burke Hennessy, editor; Herman Bernard, managing editor; J. E. Anderson, technical editor; L. C. Tobin, advertising manager.

Detector's Importance

IN many respects, your detector tube is the most important tube in your set. Accordingly, pay attention to it! See that it's a *good* tube in the first place; see that it's properly used and handled in the second place; and your radio reception will be improved from the important standpoints of quietness, sensitivity and quality.

Starting with hum, let's look for the causes. Just grasping the detector tube with your fingers is usually enough to cause a hum in the loudspeaker. This is because some faint traces of alternating current are set up in your body and brought to the tube, thence to be amplified. The most common cause of hum via the detector is induction, which means by the magnetic effect from apparatus carrying AC reaching to the detector tube and that tube's accessories and wiring. Place your hand near the grid condenser and you'll understand. Having electric lamps too near the set or placing B eliminators and other AC units too close underneath or near the set will cause this hum.

As to noise, the detector tube exerts an outstanding effect. Where the detector tube has loosened elements, the slightest jar will cause a loud bell-like sound in the speaker. Furthermore, the impact of the air vibrations from the speaker will cause these elements to vibrate and set up an endless chain of vibrations from speaker to tube, tube to speaker, etc., causing what is known as a microphonic howl. This is a very common effect, and although remedies such as rubber tube shields, rubber insulated sockets, and weighted caps, etc., are often used successfully, the usual remedy is simply a new tube.

Scraping and scratching noises may come from a variety of causes, but a fairly common source is in the grid leak of the detector tube. A new grid leak should be kept on hand and inserted as a test when such sounds develop. Such noises may also come from poor contact between the pins on the tube base and the socket. These may be cleaned with fine sandpaper. Loose contacts in the filament circuits, especially in the case of battery sets, will cause the filament to flicker slightly and be responsible for much loud noise. Terminal connectors on storage batteries are quite often the source of this trouble.

When sensitivity is considered you will find that the detector tube has much to do with this important asset of any radio set. To be sensitive, not only must the tube itself be in perfect condition, but it must have the correct voltages applied to it and the apparatus used must be correct and properly placed and connected. A slight difference in the sensitivity of the detector tube may make a world of difference in the loudspeaker volume on faint and distant stations—always a much greater effect than any similar lack of sensitivity in the audio tubes.

The method used in installing and wiring the connections to the detector tube is important. Particularly is this true in the case of the grid condenser, grid leak and its wires. The grid condenser and leak ought to be of small dimensions, with the leak preferably a part of or closely mounted on the grid condenser. This shortens high voltage leads.

In addition, the grid condenser and leak must be located as close as possible to the grid terminal of the detector socket, so that the connecting wire may be an inch or less in length. You will find that this short wire between the grid condenser and the socket is a common source of inductive hum—just grasp a pencil or piece of wire in your hand and bring it close to this wire! This demonstrates how. Where is the rest?

Microphone Operation

THE microphone used at broadcast studios is the same in its principles as the transmitter on your house telephone. Its action is very interesting, yet very simple to understand.

The air vibrations of voice or music first strike upon a very thin diaphragm, a thin disc of aluminum or iron. At the center of this disc there is a pin, and the outer edge of the disc is held rigidly in the casing of the microphone. The pin at the center is fastened to a small and polished carbon button or disc. Another and similar carbon button is firmly attached to the casing, with a small separation between the two buttons, and some granulated carbon is placed in the gap, partially filling it.

When the sound waves strike the diaphragm, it is made to vibrate back and forth, and thus pushes and pulls on the carbon buttons. This varies the space between the two carbon buttons, alternately pressing the tiny carbon granules together and then loosening them.

Electric current flows from a battery or other source of power through the microphone, and in doing so it must pass through the carbon granules. So long as the buttons are still, the current is steady. But when it vibrates, the granules make better and poorer contact, thus allowing an increase and then a decrease in current, corresponding exactly to the impulses of the speech or musical numbers.

Thus we obtain an electric current which changes in exact imitation of the sounds originating in the studio, and which may again be translated back into sounds through the medium of your loud speaker.

In radio, an improved type of microphone known as the double-button microphone is used, this having two fixed buttons instead of one, so as to take advantage of both the forward and backward movements of the vibrating carbon button. The electric current generated by this unit is more nearly in accordance with the speech or music. In ordinary telephoning, this perfection of detail is not required, and the single-button type is fully satisfactory, and simpler in its construction and in the necessary wiring connections.

Of course, the actual quality of the sounds delivered by the loud speaker depend upon a large number of factors which intervene between the performer and your speaker, but the microphone, which comes first in this chain, is of great importance.

Forum

A Report on Short-Wave Super

I HAVE made a number of trial changes in a short-wave superheterodyne and have learned a good many things.

To begin with, I've learned that a condenser capacity of x mf. may or may not be x at, let us say, 10,000 k.c. if it were x on DC.

Most bypass condensers are possessed of very considerable inductance which I have found have caused me a great deal of grief when by-passing. Long by-pass leads are also a great source of trouble in this connection and this results in considerable instability. In fact, in some cases, instead of adding capacity, such paper dielectric condensers add inductance and make a bad matter worse.

Consequently I find that small condensers like the mica dielectric of small size give the best results of about .15 to .13 mf. for this duty and the elimination of leads almost altogether. I also find that shielding these condensers under the chassis is about the best thing to do.

Then I've found that the addition of a stage or two of RF amplification ahead of a SW super het isn't worth while. If it gives any additional amplification, it is awfully small and is not worth bothering about because far better results can be had with a very short but very good cage antenna. This latter idea is helpful and if care be exercised in the design of the set it won't squeal and cause radiation but I think experimenters should be warned in this regard because there are far too many squeals on the air at the present time in the higher frequency parts of the spectrum for comfort.

I added another IF stage, making four altogether, and the bottom of my chassis now has over a couple of dozen by-pass condensers there. All the same it works just fine and with such remarkable stability that there is nothing to choose between it and regular broadcast reception. I've not had a chance to try it out on any other foreign stations except Chelmsford, England, Tegucigalpa, Honduras, and some French broadcaster who uses phonograph records, but on these stations it sure is a bear and I really believe I am going to get some place before I am through.

I find it very important, however, to make the first detector as a space charge arrangement with very fine bias. My regeneration from last IF to second detector is quite weak and it makes an awful lot of difference as to which way around this is hooked up. If on the LV side, it is very sensitive but very unstable whereas on the HV side it could be controlled quite easily by cutting in or out a series fixed condenser on the second detector plate return ahead of a polarized choke.

One rather curious thing happened after I added to the IF and this was that it altered my oscillator and first detector calibrations to the extent of 140 kc. I am trying to figure this out as to just why this is and the only thing I can think of is that it has resulted in a sort of back emf or possibly the change of some other factor which results in added inductance, although just how, is not certain. I suppose the added IF transformer was tuned 140 kc. away from the others.

G. C. SHADWELL,
Freeport, N. Y.

RCA OWNS ALL CUNNINGHAM

Radio Corporation of America, which owned 55 per cent of the stock of Cunningham Tubes, bought the other 45 per cent.

WJZ AND WBAL, WEAF AND WTIC SYNCHRONIZED

Washington.

The Federal Radio Commission authorized the National Broadcasting Company and its two associate stations, WTIC, Hartford, and WBAL, Baltimore, to continue their synchronization work and to place in regular operation the synchronizing apparatus for which construction permits were granted several months ago.

WBAL synchronizes with WJZ, New York, when not operating on its own wavelength, and similarly WTIC synchronizes with and accepts programs from WEAF, NBC's other metropolitan key station. In the periods when they are not synchronized WBAL and WTIC broadcast independently on the wavelength of 1,060 kilocycles which they now share in the Federal allocations.

Enlarges Their Time

When the plan was first announced, the participating engineers pointed out that the immediate advantage of the synchronization will be to enable WTIC and WBAL to give fulltime service in their respective areas. Under the old scheme, one of the stations was necessarily silent on those days or during those hours when the other was using their joint wavelength. Synchronization with one of NBC's stations in New York permits them to serve their listeners during every broadcasting hour.

"The inauguration of synchronization on a regularly scheduled basis fulfills a dream which radio engineers have had for years," said M. H. Aylesworth, president of NBC. "The success of our general engineer, C. W. Horn, and his associates, represents a high achievement in scientific planning, exhaustive, patient research, and the coordination of the efforts of many men."

Ever since the idea of synchronization was first conceived, Horn has been a guiding factor in its development. It was under his supervision that the first working application of synchronism was effected between the Westinghouse stations, WBZ and WBZA, in Springfield and Boston.

Eliminated Beat Note

Successful synchronization of WBZ with WBZA, however, was not a true solution of the problem, Horn explains, because of local peculiarities in the Boston area. Engineers soon discovered that the plan worked for the Massachusetts stations because of a dead spot between their service ranges—a dead spot which prevented the interference normally encountered in attempting to operate two transmitters on identical frequencies.

"The fundamental difficulty with all previous attempts to solve the problem of synchronization," Horn explains, "is the fact that engineers have concerned themselves only with elimination of the so-called beat note, which reproduces itself in loudspeakers as a discordant whistling noise when two stations are not maintaining exactly the same frequency.

"The beat note we eliminated by controlling our frequencies from a central point. But this absolutely constant frequency didn't quite do away with interference, because even in perfect frequency synchronism, the transmitters showed a tendency to vary in electrical distance from one another.

"In other words, the line which controlled the frequencies, and kept them identical, created an effect known to engineers as a varying phase difference. We finally solved the last obstacle to practical synchronization by evolving a device to overcome this difficulty.

Stabilizer Used

The device, Horn explains, is a stabilizer which is similar in effect to a fly-wheel. It automatically operates the station, and is itself governed by the frequency control which comes over the line from the central point. The stabilizer disregards line variations in voltage, momentary changes in frequency and other disturbing factors, and for all practical purposes maintains the phase relationship between the synchronizing stations in an ideal way.

"Synchronization, as it is developed and applied, will be of utmost importance to the listening public," Horn declares. "If spaced geographically, stations will be able to synchronize and still maintain their own program services without interference. And this possibility will enable many stations which are now limited in power, because they share channels with other stations, to increase their power and extend their service ranges."

Time Table of Unified Stations

The schedule of synchronization of WJZ-WBAL and WEAF-WTIC follows:

WJZ and WBAL
Mondays, after 4:00 P. M.
Tuesdays, until 4:00 P. M.
Wednesdays, after 4:00 P. M.
Thursdays, until 4:00 P. M.
Fridays, after 4:00 P. M.
Saturdays, until 4:00 P. M.
Sundays, after 7:30 P. M.

WEAF and WTIC
Mondays, until 4:00 P. M.
Tuesdays, after 4:00 P. M.
Wednesdays, until 4:00 P. M.
Thursdays, after 4:00 P. M.
Fridays, until 4:00 P. M.
Saturdays, after 4:00 P. M.
Sundays, until 7:30 P. M.

DIXIE CHAIN GETS STARTED

The Dixie Network, with 10,000,000 listeners as a unit of the Columbia Broadcasting System, with WBT, Charlotte, N. C., as key station, recently began operation.

A majority of the programs will originate from WBT, at which Columbia will maintain a complete organization for programs, music, production, publicity, sales and sales promotion.

Eleven stations already have been included: WWNC, Asheville, N. C.; WGST, Atlanta, Ga.; WBRC, Birmingham, Ala.; WDOD, Chattanooga, Tenn.; KLRA, Little Rock, Ark.; WREC, Memphis, Tenn.; WLAC, Nashville, Tenn.; WTOC, Savannah, Ga.; WDSU, New Orleans, La., and KNOX, of Knoxville, Tenn.

Supplementary stations which may be added to the Dixie Network are WTAR, Norfolk, and WDBJ, Roanoke.

The Dixie Network will be identified by the playing at the beginning and end of each broadcast of "Way Down South in Dixie." Programs will be keyed more closely to southern sentiment than those heretofore originating from northern stations.

FAULT FOUND WITH "SUPERS" THAT RADIATE

A note of warning against indiscriminate buying of the superheterodyne type of broadcast receiver has been sounded by Kenneth B. Warner, editor of "QST," the radio amateur's magazine, in a statement which calls attention to the trouble that may result from the purchase of a superheterodyne in which certain necessary design features may be missing.

"Purchasers of new broadcast receivers should realize that the mere fact that a receiver is a superheterodyne is no guarantee of even reasonable satisfaction," points out Mr. Warner. "Even if it is quite excellent as a superheterodyne, it may turn out to be the world's worst broadcast receiver if certain fundamental precautions are neglected. It is an unfortunate fact that with some two dozen American manufacturers rushing production on superheterodynes, these precautions are either partly or entirely neglected in some of the models now offered the public.

Higher Selectivity and Shielding

"The design defects referred to relate to the input selectivity and to shielding. Always the weaknesses of the 'super,' these factors are the more aggravated with modern tubes with their greater sensitivity in reception and their greater power as oscillators.

"Good design requires the presence of a high degree of selectivity between the antenna and the first detector and oscillator, and thorough shielding, particularly of the oscillator and first detector—coils, condensers, tubes and wiring. If these steps are not taken, the first thing that happens is that the receiver radiates, 'blooping' all over the broadcast band and spoiling reception over a wide radius. But any such receiver is also open to a much more formidable source of trouble—the unwanted reception of short-wave signals which get into the first detector or oscillator and there beat against a harmonic of the oscillator to form a signal which is amplified in exactly the same manner as the desired broadcast program. And this through no fault of the short-wave station, which may be many miles away and operating in perfect conformance with government regulations.

Sees Much Grief Ahead

"A properly designed and properly constructed superheterodyne is probably the finest possible receiver for broadcast reception. False economies in engineering and production costs, and in some cases inadequate design skill, threaten to create much grief for manufacturers, dealers and buyers, however. It is possible to construct thoroughly satisfactory superheterodynes; many of the existing models are quite satisfactory. But a good super will never be a cheap set.

"One can't legislate against offering defective receivers for sale. The remedy lies in education. Manufacturers will save themselves much trouble and money if they perfect their models in the respects named. Dealers would be extremely well advised to make sure that the models they stock are free of these defects. And the buying public should be cautious, look over the models first, and make the dealer guarantee the purchased set against the undesirable features referred to."

RECEPTION FINE NOW, WITH SUN SPOTS LOWEST

Springfield, Mass.

Unusual radio reception, the finest in years, is now being enjoyed by the radio public, according to Morris Metcalf, president of the Radio Manufacturers Association, the national industry organization.

"As a rather bright and promising corollary to the business depression through which we have been passing in the radio industry," said Mr. Metcalf, "comes a prophecy from the radio engineers and scientists concerned with the present unusual effect of 'sun spots' upon radio reception.

"The financial statisticians have shown us rather conclusively that periods of business prosperity and depression have followed one another in a regular cyclic order. Experience has shown them that about 10 or 11 years elapse between depths of business depression.

Exceptionally Good Reception

"The astronomers tell us that the number of 'sun spots' also passes through a similar cycle and strangely enough this cycle is of about the same period. The fact has been recently recognized that when the number of 'sun spots' reaches its minimum, radio reception conditions become exceptionally good.

"This is due to the fact that magnetic storms which cause severe variations in radio conditions are also at the minimum and the height of the hypothetic Kennelly-Heaviside layer which reflects back radio waves to the earth is also at its minimum, and provides the greatest intensity of signals over the distance usually encountered in radio broadcasting.

"Those of the radio industry who can recall the winters of 1920 and 1921 can verify the fact that during that period radio reception was excellent. This prophecy is already making itself manifest in actuality and shows a silver lining to the clouds which have darkened the sky for the radio industry.

Layer Falling Steadily

"It is well-known to scientists that the great radio reflecting plane a hundred miles above the earth's surface (which is called the Heaviside-Kennelly layer) has been falling steadily for several years, and that this has changed the transmission constants of radio waves. Prominent engineers have estimated that radio reception conditions during the past season have been from two to four times as good as a year ago. Dr. H. T. Stetson, the great astronomer, who has been measuring radio reception as a function of solar phenomena, reports the strongest signals in years. It is predicted that reception will probably get better in 1932 and the spring of 1933.

"This should be encouraging to makers and users of radio apparatus, and while man seems to be doing everything possible to mess up the radio industry, God and Nature are compensating for his errors."

WTMJ DEFEATS BOARD

Washington.

Assignments of broadcasting stations may not be changed when other stations are injuriously affected, "except for compelling reasons," the Court of Appeals of the District of Columbia ruled in an opinion reversing the Federal Radio Commission's actions involving WTMJ, of Milwaukee, operated by "The Milwaukee Journal."

Device Makes Music Visible

After eight years of experimenting, the Musiclite, an instrument that enables one to see sound waves, has been perfected, it was announced by Phillip Gordon, concert pianist, at his home in New York City. Gordon's new invention makes it possible to see sound waves in color. With the Musiclite it is even possible for mutes to see music.

The Musiclite is six feet long by two feet wide, and can be attached to any piano in ten minutes. The Musiclite, with photo-electric cells, can be attached also to the radio so that the public can see as well as hear the music.

The instrument is a series of lights on an enlarged keyboard C-sharps are red, C-minors green, D-flats blue, etc., and the same notes on different octaves are the same color.

ONE-CYCLE BAND WIDTH CLAIMED

A new system of transmission, which he says has been in successful experimental operation, and for present purposes is the subject of an application for seven frequencies, between 2,300 and 17,000 kc., has been enthusiastically explained by Dr. Sidney N. Baruch, to his friends.

"In my application for permission to use these frequencies," said Dr. Baruch, who formerly operated WBNY, in New York City, "I have asked for waves only one cycle wide, yet my system of transmitting intelligence will require actually less than a one-cycle band width.

"Each transmitter under this system sends out two carrier waves. One carrier will be held constant, by use of a quartz crystal and thermostat control. The other carrier will be displaced in phase, but never allowed to be more than 90 degrees out of phase.

"The reproduction of the program in the receiver will take place by the mixing of the two carriers, utilizing the sum of their frequencies.

"This system will make television practical in the broadcast band as well as in short-wave band. In fact, the system would permit two broadcasters to operate on frequencies within a few cycles of each other, without interference, whereas under the system now in use the separation must be of the order of thousands of cycles."

Dr. Baruch has been a scientific research expert and inventor for many years. He is credited with having invented the depth bomb, used by the Navy during the World War in the fight on German submarines.

"There is $500,000 on deposit in a bank in New York awaiting the proof of commercial practicality of this invention," said Dr. Baruch, gesturing complete confidence in the outcome.

WANTS TO CORRESPOND

I have built a converter as described in RADIO WORLD and have heard several stations in U. S. A. as well as other countries. I would appreciate your publication of my name in your magazine as desiring correspondence with other fans using converters. I will try to answer all letters.

Hoping to hear from fans soon, I remain,

FRED STAFFORD,
106 East Cherry St.,
Sevierville, Tenn.

AMATEURS OFF WAVE STRONGLY WARNED BY U. S.

Washington.

The Department of Commerce issued the following statement:

Failure of a large number of amateur radio operators to adhere to the wave band allocated for this purpose is causing serious interference with commercial and government radio communication services and may possibly interfere with international communications in foreign countries, according to W. D. Terrell, Radio Director, Department of Commerce.

When it is considered that there are 18,994 licensed amateur radio transmitting stations in the United States, it can readily be seen that off frequency operation of many such stations offers a serious hazard to the efficient maintenance of radio communication services generally, Mr. Terrell stated.

It is incumbent upon amateurs, as it is upon all other stations, to operate according to the terms of their licenses and the provisions of the law and Commerce Department supervisors of radio throughout the United States have been instructed to watch the operation of amateur stations more closely.

Mr. Terrell pointed out that while amateurs operating off frequency stations subject themselves to a legal penalty, they may also find it necessary to meet more exacting operating regulations.

He stated that the high regard in which amateurs are held was responsible for their official recognition at the last International Radiotelegraph Conference and unless they maintain their reputation as a self-regulating body certain of the privileges which they now enjoy may possibly be restricted at the forthcoming International Radiotelegraph Conference to be held in Madrid in 1932.

Vatican Station on Short-Wave Schedule

Vatican City

Regular programs are now broadcast from HJV, the Vatican station inaugurated a month ago by Pope Pius. Transmission is made daily except Sundays and holidays. There are two periods a day, one in the morning, local time, and another in the afternoon. The following table gives the schedule in American standard time.

E.S.T.	*C.S.T.*	*M.S.T.*	*P.S.T.*
5-5:50 A.M.	4-4:30 A.M.	3-3:30 A.M.	2-2:30 A.M.
2:30-3 P.M.	1:30-2 P.M.	12:30-1 P.M.	11:30-12 A.M.

The transmission the earlier period will be on 19.84 meters and that during the later period on 50.26 meters.

Ten Per Cent. of Time Devoted to Education

More than 10 per cent of the time on the air of American broadcasting stations is devoted to programs which they construe to be educational in character, according to a survey made by Federal Radio Commissioner Harold A. Lafount, on the basis of questionnaires sent to the entire roster of stations.

Based on returns from 522 stations of the 605 licensed, the tabulation shows that 3,457 hours and 50 minutes were devoted to educational programs during a selected week. The stations were on the air for 33,785 hours and 45 minutes during that week.

HIGHEST COURT HEARS HOTEL IN AIR MUSIC CASE

Washington.

Arguments were heard by the Supreme Court of the United States in the cases of the Jewell-La Salle Realty Company, involving the question whether the playing of a radio, for the benefit of hotel guests, where the broadcasting station transmitted copyrighted music without permission of the copyright owner, constitutes violation of copyright by the hotel.

The company owns the La Salle Hotel, in Kansas City Mo., and afforded facilities to guests to listen to radio reproduction in their rooms, by their turning a switch that brought in the program from the hotel's master receiver located in another room in the hotel.

The American Society of Composers, Authors and Publishers, through its president, Gene Buck, sued both the station and the hotel. The station defaulted, but the hotel won in the lower courts, whereupon the society appealed, and the question finally came before the highest court on the question of whether such reception constitutes a performance within the meaning of the copyright law. The song received was "Just Imagine."

Hotel's Contention

Charles M. Blackmar, counsel for the hotel, in his argument said:

"Radio receiving cannot be held to be performing. Such a holding would prohibit the operation of receiving sets in public places.

"Plaintiffs' rights are limited by the Copyright Act, which is construed to protect the public against financial loss and damage unexpectedly and unwittingly incurred. The purpose and spirit of the statute, as clearly indicated by the provisions of the act itself and by the decisions of this court, is to grant to the copyright owner monopolistic control of performing rights, nothing more, and as the one operating a receiving set has no control over the performance heard through the set, it is not necessary that copyright owners have control of the use of receiving sets, and the rights claimed by the plaintiff are, therefore, not granted by the statute.

"There is no analogy between playing a phonograph record and operating a receiving set.

Says Plaintiffs Beg Question

"No profit was received by the defendant by reason of the hearing of "Just Imagine" over its receiving set. Therefore there was no performance within the meaning of the act.

"The courts have not held that broadcasting is performing. The broadcaster is held to be a performer only when he actually performs the selections he broadcasts. It is, therefore, begging the question to argue that receiving is performing because broadcasting is performing."

WHO-WOC ASK MERGER

Two stations in Iowa, WHO, at Des Moines, and WOC, at Davenport, are synchronized under regular license on the channel of 1,000 kilocycles. These stations, have pending an application to consolidate, with the maximum power of 50,000 watts. Individually, they now use 5,000 watts.

Germans Slight Theatre for Sets

Washington.

The following report was rendered to the Department of Commerce by James E. Wallis, United States Trade Commissioner in Berlin:

"In spite of more or less unsatisfactory conditions in Germany, reports from that country's radio industry indicate that 1930 has been a relatively successful year for manufacturers of this type of equipment.

"There is a growing tendency for the general public in Germany to decrease expenditures for theatre and other amusements and to invest the money thus saved in radio apparatus. The introduction of the electric phonograph pick-up has also greatly influenced the public in the purchase of this type of equipment. Practically all German receiving sets are equipped with phonograph jacks.

"An increasingly greater number of sales are being made on the installment plan. Whereas formerly nearly all sales of radio equipment were made on a cash basis, it is estimated that at present 80 per cent are sold on the installment plan."

EIGHT STATIONS GIVEN LEEWAY

Washington.

Although the Federal Radio Commission has a rule restricting the operation of certain classes of stations, to minimize or prevent interference, an exception was granted in the case of eight stations, as it was found that the rule would keep some of these stations off the air for much of the time.

Simultaneous daylight operation of four stations on separate paired frequencies would be impossible, were the rule applied to them strictly, and since heterodyne interference is at a minimum during daylight service, continuation of simultaneous daylight broadcasting was authorized for the following:

WMMB, Chicago, and KFAB, Lincoln, Nebr., sharing time on 770 kc.

WJBK, Ypsilanti, Mich., and WIBM, Jackson, Mich., sharing time on 1,370 kc.

WOKO, Poughkeepsie, N. Y., and WHEC-WABO, Rochester, N. Y., sharing time on 1,400 kc.

WAPI, Birmingham, Ala., and KVOO, Tulsa, Okla., sharing time on 1,140 kc.

N.B.C. Acquires WENR; Lease Has Buying Option

Washington.

Assignment of the license of WENR, Chicago's 50,000-watt broadcasting station, by the Great Lakes Broadcasting Company to the National Broadcasting Company, was approved by the Federal Radio Commission.

The assignment of the station is under a lease with option to buy. WENR operates one-half time on the 870-kilocycle channel, sharing with WLS, Chicago.

LOG ORDER POSTPONED

Washington.

The Federal Radio Commission announced that the effective date of its new general order (No. 106) requiring broadcasting stations to maintain two logs of their operations, had been extended to April 30th. The order, promulgated on February 16th, was to have become effective March 1st.

W8XK SEEKING A COMMERCIAL 'WORLD VOICE'

Washington.

Short-wave transmission of programs, using any of a group of five frequencies, such as assigned to W8XK, of the Westinghouse Electric & Manufacturing Company, is still in the experimental stage, hence the application of the company for permission to charge for this extra transmission of commercial programs from the Pittsburgh transmitter should be denied, recommended Ellis A. Yost, Chief Examiner, in a report to the Federal Radio Commission.

Wide Coverage Cited

The short-wave adjunct of KDKA, seeking to establish the first world-wide commercial short-wave station, just as it established the first regular broadcasting station, cited the wide coverage now enjoyed in its short-wave transmissions. But Mr. Yost pointed out that different frequencies have to be used for best results at different hours and seasons, and to cover different distances, and, besides, there are very few frequencies available for short-wave relay broadcasts.

Argument by Westinghouse

The Westinghouse representatives, appearing before Mr. Yost, said that short-wave rebroadcasting had developed to the point where a virtual international audience had been formed for the programs of its experimental relay station. This station, broadcasting almost entirely the same programs that are transmitted over KDKA, has increased its operating hours to meet the demands of listeners in foreign countries, and has a record of reception of programs in 59 different countries.

The expense of operating the experimental station from 1924 until 1930, excluding program costs, was placed at approximately $400,000, and the total cost of developing of W8XK was put at $274,701.

Still Experimental

"The results of the experiments of the applicant in short-wave broadcasting and in relay broadcasting exhibited in evidence, while showing interest on the part of numbers of listeners, do not show development in the art beyond the experimental stage with respect to any of the five frequencies specified in the application," Mr. Yost found.

Declaring that the application proposes a service inconsistent with regulations of the Commission, Mr. Yost holds that the assignment of any of the frequencies in the group involved to a particular licensee for commercial use would limit the field that may be devoted to experimental development.

The Commission has not yet acted on the report.

High Power Stations

Mr. Yost said that, under Commission regulations, there are only twenty-seven frequencies available to relay broadcasting stations in North America. Licenses have been issued to ten different companies for the operation of such stations, and assignments for the use of a total of twenty-three of the twenty-seven channels have been made in these licenses. W8XK is assigned 6,140, 15,210, 11,880, 17,780 and 21,540 kilocycles at 40,000 watts.

$550,000,000 SALES IN 1930

Indianapolis.

Radio sales in 1930 were estimated at between $550,000,000 and $600,000,000, and regarded as satisfactory under existing conditions, according to Bond Geddes, executive vice-president of the Radio Manufacturers Association.

The radio business is already picking up, according to the manufacturers' spokesman, through the virtual liquidation of much reduced surplus stocks and virtual disappearance of bargain receiving sets. Mr. Geddes said that the surplus carried over into 1931 was very much smaller than that carried over in the previous year and that manufacturers' warehouses now were virtually clear and new 1931 products well under way.

Radio programs also are developing many new attractive features, according to Mr. Geddes, who denied emphatically that the important national networks and larger stations carried excessive advertising in their programs. A very small number of small broadcasters, it was asserted, is guilty of excessive advertising and responsible for the misinformed statements and propaganda regarding alleged excessive advertising on the air. The broadcasters, generally speaking, are doing a fine job, Mr. Geddes said, and also are developing new radio features which will stimulate sales.

Developments of the farm market, sales to business executives for their offices, motorcar radio, an extremely large replacement market, and a marked trend toward the "two radios in a home" were among the larger sales fields in immediate prospect, he said.

"Our record for 1930 was not bad at all," said Mr. Geddes, "considering that radio was hit harder than almost any other industry and also considering the general business conditions. Our estimated 1930 sales of between $550,000,000 and $600,000,000 were most satisfactory, everything considered, and compared with around $835,000,000 in the big year of 1929. There are already many evidences of improvement in general conditions, and this applies to the radio industry also. The outlook for 1931 is not at all discouraging."

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers concerning standard parts and accessories, new products and new circuits, should send a request for publication of their name and address. Send request to Literature Editor, RADIO WORLD, 145 West 45th Street, New York, N. Y.

Ivan Hassel, R. F. D. No. 1, Lorain, Ohio.
F. J. Golightly, Normal, Ill.
H. G. Simpson, 916 West 85th St., Los Angeles, Calif.
John Burgraff, 723 Hughitt Ave., Superior, Wis.
Lewis Lefler, 3555 Warren Ave. East, Detroit, Mich.
Henry L. Abramson, 49 Highland St., Orange, Mass.
Nelson Ashwood, 144 Hood Ave., Syracuse, N. Y.
J. F. McMullen, Daleville, Ind.
R. H. Love, Valley Center, Kans.
John L. Heffernan, 2086 Young Ave., Memphis, Tenn.
A. R. Miller, 33 Circuit Drive, Riverside, R. I.
A. F. Winter, P. O. Box 572, Savannah, Ga.
E. Light, 403 Hopkins Street, McKeesport, Pa.
H. V. Bayliss, P. O. Box 993, Athabasca, Alta., Canada.
Charles Sandberg, 68 First St., New York City.
Reed Barton, 1718 Ridge Ave., Coraopolis, Pa.
Horace Rosting, Radio Service, 229 W. 111th St., New York City.
D. C. Smith, 630 W. 4th St., Los Angeles, Calif.
E. S. McGuire, 3133 Weaver Ave., Baltimore, Md.
J. R. Thigpen, 1014 Roosevelt Ave., San Antonio, Tex.
Bert Herrick, 328 East Duval St., Jacksonville, Fla.
Harry R. Elkins, Jr., 27 Allison Street, Pontiac, Mich.

Tradiograms

Revival of interest in old games has been brought about by radio during the past few years. A group of listeners soon turn to games that can be played while the family listens to the music and speech coming over the air. This change in tempo of American life has been sensed by toy makers, who are now striving to meet the recreational needs of both juveniles and adults.

* * *

The Newark Wire Cloth Co., 351-365 Verona Ave., Newark, N. J., manufacturers of wire cloth for industrial purposes, is makinga woven wire screen of moeybdenum for use on special tubes.

* * *

The Davis-Jones Insulated Wire Company of Pawtucket, R. I., announce the appointment of Pat Kiley, of 140 Liberty Street, New York City, as metropolitan sales representative. Mr. Kiley, known as "Pat" to the radio trade, was connected in a sales capacity with outstanding radio concerns since the days of the crystal set. He was one of the first employes of the Zenith Radio Corp., of Chicago, travelling extensively throughout the country for them. Later, for several years, he was assistant to Frank Burns, Eastern District Manager for E. T. Cunningham, Inc. In 1927, Mr. Kiley established himself as a manufacturers' representative and handled the metropolitan territory for such concerns as Remler Radio Corp. of San Francisco, Herbert H. Frost, Inc., Elkhart, Ind., and Best Mfg. Co., of Irvington, N. J., manufacturers of BBL products.

* * *

Grigsby-Grunow Company, of Chicago, went into production of three new Majestic models, which include a midget model and two console models. Grigsby-Grunow has increased its employment to 5,795 persons, and is turning out 3,500 sets a day. With the present financing practically assured, it is expected by Don M. Compton, vice-president and general manager, that production in the Majestic refrigeration plant will be started early in April.

* * *

The Radio Distributing Corporation, for the past twelve years a Radiola distributor in New Jersey, has purchased the Victor distributing business of Collings & Co., Inc., of Newark, N. J. The purchase included Victor instruments, Victor records and accessories.

The Radio Distributing Corporation, or Radisco, as it is known by the trade, is now functioning as the distributor for both Radiola and Victor products.

* * *

John J. Mucher, president and sales manager of Clarostat Manufacturing Company, Inc., of Brooklyn, N. Y., announced a graphite element volume control that embodites a rolling contact which eliminates erosion of the resistance element.

* * *

Flechtheim has a new high-power, high-voltage, type ZX, transmitting condenser. The new transmitting condensers utilize a special paper dielectric of extremely high insulating qualities, developed after years of research, in the German factories of the Flechtheim company. The condensers are as follows:

Capacity	List	Weight
1 mfd.	$50	15 lbs.
2 mfd.	$95	35 lbs.
4 mfd.	$175	65 lbs.

* * *

Supertone Products Corporation, 216 Wallabout Street, Brooklyn, N. Y., has added three new products: a band pass pre-selector at $10, a 175 kc. transformer at $3 and shielded TRF and oscillator coils at $2 up.

LIST PRICE OF SETS $46 LESS

Washington.

Commercial radio receivers during 1930 had an average list price, less tubes, of $87, as compared with $133 in 1929, said H. E. Way, assistant chief of the Electrical Equipment Division, Department of Commerce. Lower-priced furniture to house sets, and the popularity of midget receivers contributed to the lessening of list prices.

While total unit sales of radio receivers for 1930 exceeded the expectations of the industry, Mr. Way asserted that the industrial figures show a 44 per cent decrease in dollar volume, due to the advent of the "Midget" set, price-cutting, general business conditions, and heightened sales resistance resulting from growing saturation.

Although the midget trend did become a real factor in the industry until fall of last year, some 1,130,000 units were sold prior to January 1st, 1931, on 30 per cent of the total unit sales. It had been estimated that midget production in 1930 will exceed 50 per cent of the total.

Total radio sales, including sets, accessories, tubes and other parts, aggregated $500,951,500, as against the industry's figure of $842,548,000 for the preceding year.

Console and midget receiver sales totaled 3,672,400 units valued at $298,010,000 for 1930 as against 4,200,000 units valued at $525,000,000 for 1929. Radio phonograph combinations totaled 155,400, valued at $34,188,000, as against 238,000 units of $67,068,000.

Radio tubes, including new installations and replacements, totaled 52,000,000, which realized $119,600,000 in 1930, as against 60,000,000 tubes valued at $172,500,000 in 1929.

Exports in January Increased $149,697

Washington.

The Department of Commerce made the following announcement:

Showing a strong upward tendency, exports of radio apparatus from the United States during January, 1931, surpassed the total for the corresponding month of last year, despite a decrease in the majority of other classes of electrical equipment, according to the Commerce Department's Electrical Division.

Foreign shipments of radio apparatus totaled $1,672,904 during January, 1931, as compared with $1,523,207 in the corresponding month of 1930. Radio receiving sets alone registered a gain of over $500,000, from $560,000, from $562,444 in the 1930 month to $1,075,814 in 1931.

Total exports of electrical equipment amounted to $7,927,454 in January, 1931, a decline of approximately $4,837,000 from the 1930 month.

Mexico and Canada were the largest purchasers of radio receiving sets exported from the United States, these countries taking $214,666 and $201,470 worth, respectively. Receiving sets valued at $145,851 were shipped to Argentina and $74,752 worth to Italy during the month under review, both of these countries offering increasing opportunities for the sale of American radio apparatus. Uruguay took receiving sets valued at $46,340 and the Union of South Africa at $41,925 worth. Brazil and Chile also offered fair markets. The remaining amount of receiving sets found markets which were fairly well scattered throughout all parts of the world.

Foreign shipments of switchboard panels, except telephone, for January, 1931, amounted to $30,581, which represents a gain of $87,792 over the like month of last year.

Short-Wave Stations by Frequencies

WITH SCHEDULE OF HOURS ON THE AIR GIVEN FOR THE FIVE TIME ZONES

Freq.	Wave	Call	Location	AST	EST	CST	MST	PST	
51,400	5.83	W2XBC	New Brunswick, N. J.						
41,000	7.32	W8XI	East Pittsburgh, Pa.						
35,000	8.57	W2XCU	Ampere. N. J.						
34,600	8.67	W2XBC	New Brunswick, N. J.						
31,000	9.68	W8XI	Pittsburgh, Pa.						
30.105	9.96	......	Golfo Aranci, Sardinia	6:50 to 8:50 A.M.	5:50 to 7:50 A.M.	4:50 to 6:50 A.M.	3:50 to 5:50 A.M.	2:50 to 4:50 A.M.	Telephone to Rome Wed. & Sat.
29,190	10.51	PK313	Sourabaya. Java						Experimental
25,960	11.55	G5SW	Chelmsford, England						
25,700	11.67	W2XBC	New Brunswick, N. J.						
25,700	11.67	W3XA	Philade'phia, Pa.						
24,000	12.48	W6AQ	San Mateo. Calif.						Experimental
23,000	13.04	W2XAW	Schenectady. N. Y.						Relays KDKA
21,540	13.92	W8XK	E. Pittsburgh, Pa.						
21,460	13.97	W2XAL	Coytesville. N. J.						
21,420	14.00	W2XDJ	Deal. N. J.						Experimental
21,400	14.01	WLO	Ocean Township, N. J. Lawrence, N. J.						Transatlantic Phone to LMS, Buenos Aires
21,320	14.06	DIV	Nauen, Germany						
21,130	14.15	LSN	Monte Grande, Argen.						Phone
21,130	14.15	W2XAO	New Brunswick, N. J.						
21,000	14.28	OKI	Podebrady, Czecho-slovakia						
20,680	14.50	LSN LSH	Monte Grande, Argentina, Buenos Aires	11:30 P.M.	10:30 P.M.	9:30 P.M.	8:30 P.M.	7:30 P.M.	Telephony with Europe
20.680	14.50	FMB	Tamatave, Madagascar						
20,680	14.50	FMB	Bandoeng, Java						
20,680	14.50	FSR	Paris, France						Phone with Saigon
20,500	14.62	W9XF	Chicago, Ill.						WENR
20,450	14.65	PMB	Malabar, Java	11 A.M. 4 P.M.	10 A.M. 3 P.M.	9 A.M. 2 P.M.	8 A.M. 1 P.M.	7-12 A.M.	Phone
20,140	14.89	DGW	Nauen, Germany	11 A.M. 4 P.M.	10 A.M. 3 P.M.	9 A.M. 2 A.M.	8 A.M. 1 P.M.	7 A.M. Noon	Testing (Phone)
19,950	15.03	LSG	Monte Grande, Arg.	10 A.M. 2 P.M.	9 A.M. 1 P.M.	8 A.M. Noon	7 A.M. 11 A.M.	6 A.M. 10 A.M.	Telephone to Paris and Nauen
19,950	15.03	DIH	Nauen. Germany						Phone
19,906	15.07	......	Monte Grande, Arg.	9 to 11 A.M.	8 to 10 A.M.	7 to 9 A.M.	6 to 8 A.M.	5 to 7 A.M.	Phone to St. Assise
19,850	15.10	WMI	Deal, N. J.						
19.850	15.10	SPU	Rio de Janiero, Brazil						
19,830	15.12	FTU FTD	St. Assise, France						Phone
19,460	15.40	FZU	Tamatave, Madagascar						
19,400	15.50	......	Nancy, France	5 to 6 P.M.	4 to 5 P.M.	3 to 4 P.M.	2 to 3 P.M.	1 to 2 P.M.	
19,400	15.50	VK2ME	Sydney, Australia						Phone
19,300	15.55	FTM	St. Assise, France	11 to 1 P.M.	10 to Noon	9 to 11 A.M.	8 to 10 A.M.	7 to 9 A.M.	
19,220	15.60	WNC	Deal, N. J.						Phone to GBU Rugby
18,820	15.94	PLE	Bandoeng, Java	11 A.M.-4 P.M. 2:40-4:40	10 A.M.-3 P.M. 1:40-3:40 P.M.	9 A.M.-2 P.M. 12:40-2:40	8 A.M.-1 P.M. 11:40 A.M.-1:40	7-12 A.M. 10:40-12:40	Phone Daily Tuesday
18.820	15.94	......	Saigon, Indo-China						
18,620	16.10	GBJ	Bodmin, England						Telephony with Montreal
18.610	16.11	GBU	Rugby, England						Phone to WMI
18,400	16.30	PCK	Kootwijk, Holland	2 to 7:30 A.M.	1 to 6:30 A.M.	0 to 5:30 A.M.	11 P.M. to 4:30 A.M.	10 P.M. to 3:30 A.M.	Daily
18,350	16.35	WND	Deal Beach, N. J.						Transatlantic telephony
18,310	16.35	GBS	Rugby, England						Telephony with N. Y. (to WND)
18,310	16.38	FZS	Saigon, Indo-China	2 to 4 P.M.	1 to 3 P.M.	Noon 2 P.M.	11 A.M. 1 P.M.	10 A.M. Noon	Sundays
18,240	16.44	FRO FRE	St. Assise, France	9-10 A.M.	8-9 A.M.	7-8 A.M.	6-7 A.M.	5-6 A.M.	To Saigon Phone
18,170	16.50	CGA	Drummondville, Canada						Telephony with England to GBK
18,150	16.52	PMC	Bandoeng, Java	12-2 P.M.	11:00-3 P.M.	10-2 P.M.	9-1 P.M.	8-12 A.M.	Phone
18,130	16.54	GBW	Rugby, England						Phone to WNC
18.120	16.57	GBK	Bodmin, England						Phone to CGA
18,050	16.61	KQJ	Bolinas, Calif.						Phone
17,950	16.70	FZU	Tamatave, Madagascar						"Radio Malabar"
17,850	16.80	PLF	Bandoeng, Java	12-4 P.M.	11-3 P.M.	10-2 P.M.	9-1 P.M.	8-12 A.M.	Phone
17,850	16.80	W2XAO	New Brunswick, N. J.	4 to 10 A.M.	3 to 9 A.M.	2 to 8 A.M.	1 to 7 A.M.	12 to 6 A.M.	Phone
17,830	16.82	PCV	Kootwijk, Holland						
17,780	16.87	W8XK	E. Pittsburgh, Pa.						KDKA
17,750	16.90	HSIPJ	Bangkok, Siam	8-10:30 A.M. 2-4 P.M.	7-9:30 A.M. 1-3 P.M.	6-8:30 A.M. 12-2 P.M.	5-7:30 A.M. 11 A.M.-1 P.M.	4-6:30 A.M. 10 A.M.-12	Sundays
17,300	17.34	W2XK	Schenectady, N. Y.	1 to 6 P.M.	12 to 5 P.M.	11 A.M. to 4 P. M.	10 A.M. to 3 P.M.	9 A.M. to 2 P.M.	Tues., Thurs., Sat.
17,300	17.34	W8XL	Dayton, Ohio						
17,300	17.34	W6XN	Oakland. Calif.						
17,300	17.34	W6AJ	Oakland. Calif.						
17,300	17.34	W7XA	Portland, Ore.						
17,300	17.34	W7XC	Seattle, Wash.						
17,300	17.34	W2XCU	Ampere, N. J.						
17,300	17.34	W9XL	Anoka. Minn.						
17,300	17.34	VE9AD	Glace Bay, N. S., Canada						
17,110	17.52	WOO	Deal, N. J.						Transatlantic telephone
17.110	17.52	W2XDO	Ocean Gate, N. J.						Phone to England
16,320	18.37	VLK	Sydney, Australia						Phone to Java
16,300	18.40	PCL	Kootwijk, Holland	11-1 P.M. 2:40-3 P.M.	10-2 P.M. 1:40-2 P.M.	9-1 P.M. 12:40-1 P.M.	8-12 A.M. 11:40-12 A.M.	7-11 A.M. 10:40-11 A.M.	Sat. broadcasts
16,250	18.44	WLO	Lawrence, N. J.						Phone to LSM
16,200	18.50	FZR	Saigon, Indo-China						Phone to St. Assise. Also on 18.76
16.150	18.56	GBX	Rugby, England						Afternoons
15,950	18.80	PLG	Bandoeng, Java						French phone to ships
15,375	19.50	F8BZ	Paris, France						
15,340	19.56	W2XAD	Schenectady, N. Y.	2-4 P.M.	1-3 P.M.	12-2 P.M.	10 A.M. to 1 P.M.	9 A.M. to Noon	Relays WGY
15,300	19.60	OXY	Lyngby, Denmark						EXP
15,280	19.63	W2XE	Jamaica, N. Y.						
15,250	19.66	W2XL	New York, N. Y.						
15,250	19.66	W6XAL	Westminster, Calif.						
15,210	19.72	W8XK	Pittsburgh, Pa.	9 A.M. to	8 A.M. to	7 A.M. to	6 A.M. to	5 A.M. to	Tues., Thur., Sat.,

(*Continued on next page*)

Freq.	Wave	Call	Location	AST	EST	CST	MST	PST	
			(KDKA)	1 P.M.	Noon	11 A.M.	10 A.M.	9 A.M.	Sun.
15,120	19.83	....	Vatican City (Rome)						
15,000	19.99	CM6XJ	Central Tuinucu, Cuba						
15,000	19.99	LSJ	Monte Grande, Argentina						Tel. with WLO via Madrid
14,620	20.50	WMI	Deal, N. J.						Tel. with GBW
14,620	20.50	XDA	Mexico City	3:30-4 P.M.	2:30-3 P.M.	1:30-2 P.M.	12:30-1 P.M.	11:30-12 A.M.	
14,480	20.70	W8XK	East Pittsburgh, Pa.						
14,480	20.70	GBW	Rugby, England						
14,480	20.70	WNC	Deal, N. J.						
14,420	20.80	VPD	Suva, Fiji Islands	11 P.M.- 8 A.M.	10 P.M. 7 A.M.	9 P.M.- 6 A.M.	8 P.M.- 5 A.M.	7 P.M.- 4 A.M.	Irregular
14,340	20.90	G2NM	Sonning-on-Thames, England	2:30-4 P.M.	1:30-3 P.M.	12:30-2 P.M.	11:30 A.M. to 1 P.M.	10:30 A.M. to Noon	Sundays
14,300- 14,100	20.97 -21.26								Amateur telephon,
13,940	21.50	....	Bucharest, Roumania	3-6 P.M.	2-5 P.M.	1-4 P.M.	Noon to 3 P.M.	11 A.M. to 2 P.M.	Wed. and Sat.
13,890	21.59	....	Mombasa, East Africa						
13,500	22.20	....	Vienna, Austria						
13,400	22.38	WND	Deal Beach, N. J.						Transatlantic Telephony
13,325	22.50	GFWV	S.S. "Majestic"						
13,325	22.50	GLSQ	S.S. "Olympic"						
13,043	23.00	OBE	La Punta, Peru	3 P.M.	2 P.M.	1 P.M.	Noon	11 A.M.	Time signals
13,043	23.00	....	Rabat, Morocco	9-10 A.M.	8-9 A.M.	7-8 A.M.	6-7 A.M.	5-6 A.M.	Tues., Thurs., Sat.
12,850	23.35	W2XO	Schenectady, N. Y.	1-6 P.M.	Noon to 5 P.M.	11 A.M. to 4 P.M.	10 A.M. to 3 P.M.	9 A.M. to 2 P.M.	Also 9 P.M. Mon. to 3 A.M. Tues.E.S.T.
12,850	23.35	W6XN	Oakland, Calif.						
12,850	23.35	W2XCU	Ampere, N. J.						
12,850	23.35	W2XDO	Ocean Gate, N. J.						
12,850	23.35	W9XL	Anoka, Minn.						Exp. and Relay broadcasters
12,630	23.86	....	Rabat, Morocco	9-8 A.M. 5-7 A.M.	8-9 A.M. 4-6 A.M.	7-8 A.M. 3-5 A.M.	6-7 A.M. 2-4 A.M.	5-6 A.M. 1-3 A.M.	Tues., Thurs., Sat.
12,550	23.90	VBS	Glace Bay, N. S., Canada						
12,350	24.23	GDLJ	S.S. "Homeric"						
12,280	24.41	GBU	Rugby, England						Phone
12,250	24.46	FTN	Ste. Assise, France	10 A.M. to 2 P.M.	9 A.M. to 1 P.M.	8 A.M. to Noon	7-11 A.M.	6-10 A.M.	Works Buenos Aires, Indo-China and Java
12,250	24.46	KIXR	Manila, P. I.	6-10 A.M.	5-9 A.M.	4-8 A.M.	3-7 A.M.	2-6 A.M.	Except Sunday
12,250	24.46	GBS	Rugby, England						
12,450	24.57	FQO FQE	Ste. Assise, France						
12,280	24.63	....							Airplane
12,150	24.68	GBS	Rugby, England						Transatlantic phone to Deal, N. J.
12,090	24.80	....	Tokio, Japan	6-9 A.M.	5-8 A.M.	4-7 A.M.	3-6 A.M.	2-5 A.M.	
12,045	24.89	NAA	Arlington, Va.	9:55 A.M. 10:55 P.M.	8:55 A.M. 9:55 P.M.	7:55 A.M. 8:55 P.M.	6:55 A.M. 7:55 P.M.	5:55 A.M. 6:55 P.M.	Time signals twice daily lasting 5 minutes each time
12,000	24.98	FZG	Saigon, Indo-China	3 P.M.	2 P.M.	1 P.M.	Noon	11 A.M.	Time signals lasting 5 minutes.
12,000	24.98	....	Oporto, Portugal	9-10 A.M. 4-5 P.M. 7-10 P.M.	8-9 A.M. 3-4 P.M. 6-9 P.M.	7-8 A.M. 2-3 P.M. 5-8 P.M.	6-7 A.M. 1-2 P.M. 4-7 P.M.	5-6 A.M. 12-1 P.M. 3-6 P.M.	
11,945	25.10	KKQ	Bolinas, Calif.						
11,880	25.24	W8XK	Pittsburgh, Pa. (KDKA)	1-6 P.M.	Noon to 5 P.M.	11 A.M. to 4 P.M.	10 A.M. to 3 P.M.	9 A.M. to 2 P.M.	Tues., Thurs., Sat Sun. (See note)
11,880	25.24	W9XF	Chicago, Ill. (WENR)						
11,880	25.24	W2XAL	New York, N. Y. (WRNY)						
11,880	25.24	VUC	Calcutta, India	9-11 A.M.	8-10 A.M.	7-9 A.M.	6-8 A.M.	5-7 A.M.	
11,840	25.34	W2XE	Jamaica, N. Y. (WABC)						
11,820	25.36	KIXR	Manila, P. I.						See note
11,800	25.42	UOR2	Vienna, Austria	6-8 A.M.	5-7 A.M.	4-6 A.M.	3-5 A.M.	2-4 A.M.	Wed. and Thurs. Also on Tues. 2 hours later in day
11,800	25.42	W2XAL	New York, N. Y.						
11,800	25.42	W9XF	Chicago, Ill.						
11,750	25.53	G5SW	Chelmsford, England	8:30-9:30 A.M. 3-8 P.M.	7:30-8:30 A.M. 2-7 P.M.	6:30-7:30 A.M. 1-6 P.M.	5:30-6:30 A.M. 12-5 P.M.	4:30-5:30 A.M. 11 A.M.-4 P.M.	Daily Daily except Sat. and Sun.
11,720	25.60	CJRX	Winnipeg, Canada						
11,670	25.68	KIO	Kahuku, Hawaii						
11,530	26.00	CGA	Drummondville, Canada						Phone
11,490	26.10	GBK	Bodmin, England						Phone
11,440	26.20	KIXR	Manila, P. I.	12:15-1:15 P.M. 3-5 A.M.	11:15-12:15 P.M. 2-4 A.M.	10:15-11:15 A.M. 1-3 A.M.	9:15-10:15 A.M. 12-2 A.M.	8:15-9:15 A.M. 11 P.M.-1 A.M.	
11,435	26.22	DHC & DHA	Nauen, Germany	6-11 A.M.	5-10 A.M. 5 P.M.	4-9 A.M.	3-8 A.M.	2-7 A.M.	Fri., Sat., Sun.
11,280	26.60	....	Brussels, Belgium						
11,230	26.70	IBDK	S.S. "Elettra"						Marconi's yacht
10,980	27.30	ZLW	Wellington, N. Z.	4-9 A.M.	3-8 A.M.	2-7 A.M.	1-6 A.M.	12-5 A.M.	Testing
10,800	27.75	GBX	Rugby, England						
10,710	28.00	CTIBO	Lisbon, Portugal						
10,710	28.00	....	Casablanca, Morocco						
10,630	28.20	PLR	Bandoeng, Java	8 A.M.	7 A.M.	6 A.M.	5 A.M.	4 A.M.	Works with Holland & France. Starting time sometimes 2.5 hrs. later
10,540	28.44	WLO	Lawrence, N. J.						
10,510	28.50	RDRL	Leningrad, U.S.S.R. (Russia)						
10,510	28.50	VLK	Sydney, Australia	2-8 A.M.	1-7 A.M.	12-6 A.M.	11 P.M. to 5 A.M.	10 P.M. to 4 A.M.	
10,410	28.80	PDK	Kootwijk, Holland						
10,410	28.80	KEZ	Bolinas, Calif.						
10,390	28.86	GBX	Rugby, England						
10,350	28.97	LSX	Buenos Aires, Argentina	9-11 P.M.	8-10 P.M.	7-9 P.M.	6-8 P.M.	5-7 P.M.	Testing
10,340	29.00	......	Paris, France	2:30-4 P.M. 10 A.M.	1:30-3 P.M. 9 A.M.	12:30-2 P.M. 8 A.M.	11:30-1 P.M. 7 A.M.	10:30-12 A.M. 6 A.M.	Daily Sundays
10,160	29.50	HSG HS2PJ	Bangkok, Siam	9-12 P.M.	8-11 P.M.	7-10 P.M.	6-9 P.M.	5-8 P.M.	Sun., Tues., Fri.
10,000	29.98	CM2LA	Havana, Cuba						
10,000	29.98	......	Belgrade, Jugoslavia	4-5 P.M.	3-4 P.M.	2-3 P.M.	1-2 P.M.	12-1 P.M.	Monday
9,940	30.15	GBU	Rugby, England						
9,930	30.20	W2XU	Long Island City, New York						
9,930	30.20	......	Posen, Poland						
9,890	30.30	LSN	Buenos Aires, Argentina						Phone to Europe
9,830	30.50	NRH	Heredia, Costa Rica	6-7 P.M. 11-12 P.M.	5-6 P.M. 10-11 P.M.	4-5 P.M. 9-10 P.M.	3-4 P.M. 8-9 P.M.	2-3 P.M. 7-8 P.M.	
9,790	30.64	GBW	Rugby, England						
9,750	30.75	......	Agen, France	4-5:15 P.M.	3-4:15 P.M.	2-3:15 P.M.	1-2:15 P.M.	12-1:15 P.M.	Tues., Fri.
9,750	30.75	WNC	Deal, N. J.						
9.700	30.90	WMI	Deal, N. J.						
9,640	31.10	......	Monte Grande, Argentina	11:30 P.M.	10:30 P.M.	9:30 P.M.	8:30 P.M.	7:30 P.M.	Works Nauen after time given

(*Continued on next page*)

Freq.	Wave	Call	Location	AST	EST	CST	MST	PST	
9,600	31.23	LGN	Bergen, Norway						
9,590	31.26	PCJ	Hilversum, Holland (Eindhoven)	2-4 P.M. 7-11 P.M.	1-3 P.M. 6-10 P.M.	12-2 P.M. 5-9 P.M.	11 A.M.-1 P.M. 4-8 P.M.	10 A.M.-12 3-7 P.M.	Thurs., Friday Thursday
9,590	31.26	......		8 P.M.-1 A.M.	7-12 P.M.	6-11 P.M.	5-10 P.M.	4-9 P.M.	Friday
9,590	31.26	KIXR	Manila, P. I.						
9,580	31.28	W3XAU	Byberry, Pa.	5-1 P.M.	4 P.M.-12 M	3 P.M.-11 A.M.	2 P.M. 10 A.M.	1 P.M.-9 A.M.	Daily except Thurs. and Fri. Relays WCAU daily
9,580	31.28	VK2ME	Sydney, Australia						
9,580	31.28	VPD	Suva, Fiji Islands						
9,570	31.35	W1XAZ	Springfield, Mass. (WBZ)	8:30 A.M. 12	7:30 A.M. 11 P.M.	6:30 A.M. 10 P.M.	5:30 A.M. 9 P.M.	4:30 A.M. 8 P.M.	
9,560	31.36	......	Zeesen, Germany	11-12 A.M. 12:30-2:30 P.M.	10-11 A.M. 11:30-1:30 P.M.	9-10 A.M. 10:30 A.M.-12:30 P.M.	8-9 A.M. 9:30-11:30 A.M.	7-8 A.M. 8:30-10:30 A.M.	Relays Berlin
9,560	31.36	NAA	Arlington, Va.	4-8:30 P.M.	3-7:30 P.M.	2-6:30 P.M.	1-5:30 P.M.	12-4:30 P.M.	Sometimes an additional hour
9,560	31.36	KAIXR	Manila, P. I.						
9,560	31.36	ZL2XX	Wellington, N. Z.						
9,530	31.48	W2XAF	Schenectady, N. Y.	6:30-12 P.M.	5:30-11 P.M.	4:30-10 P.M.	3:30-9 P.M.	2:30-8 P.M.	Relays WGY
9,530	31.48	W9XA	Denver, Colo.						Relays VOA
9,530	31.48	......	Helsingfors, Finland						
9,500	31.56	OZ7RL	Copenhagen, Denmark	8 P.M.	7 P.M.	6 P.M.	5 P.M.	4 P.M.	
9,500	31.56	VK3ME	Melbourne, Australia						
9,490	31.60	OXY	Lyngby, Denmark	2 P.M.	1 P.M.	Noon	11 A.M.	10 A.M.	
9,460	31.70	......	Buenos Aires, Argentina						
9,430	31.80	......	Posen, Poland	2:45-5:45 P.M. 2:30-9 P.M.	1:45-4:45 P.M. 1:30-8 P.M.	12:45-3:45 P.M. 12:30-7 PM.	11:45-2:45 P.M. 11:30-6 P.M.	10:45-1:45 P.M. 10:30-5 P.M.	Tues. Thurs.
9,375	32.00	EH9OC	Berne, Switzerland	4-6:30 P.M.	3-5:30 P.M.	2-4:30 P.M.	1-3:30 P.M.	12-2:30 P.M.	
9,375	32.00	OZ7MK	Copenhagen, Denmark	8 P.M.	7 P.M.	6 P.M.	5 P.M.	4 P.M.	Irregular
9,375	32.00	3UZ	Melbourne, Australia						
9,375	32.00	W8XAO	Detroit, Mich.						
9,350	32.06	CM2MK	Havana, Cuba	6-10 P.M.	5-9 P.M.	4-8 P.M.	3-7 P.M.	2-6 P.M.	
9.330	32.13	CGA	Drummondville, Canada						
9,290	32.26	......	Rabat, Morocco						
9,250	32.40	GBK	Bodmin, England						
9,230	32.50	FL	Paris, France	5:56 A.M. 5:56 A.M.	4:56 A.M. 4:56 P.M.	3:56 A.M. 3:56 P.M.	2:56 A.M. 2:56 P.M.	1:56 A.M. 1:56 P.M.	Time signals daily. Last 4 min.
9,230	32.50	VK2BL	Sydney, Australia						
9,200	32.59	GBS	Rugby, England						Transatlantic phone
9,110	32.80	SUS	Cairo, Egypt						
9,010	33.26	GBS	Rugby, England						
8,872	33.81	NPO	Cavite, P. I.	10:55 P.M.	9:55 P.M.	8:55 P.M.	7:55 P.M.	6:55 P.M.	Time signals. Last 5 min.
8,810	33.98	WSBN	S.S. "Leviathan"						
8,820	34.00	VK3UZ	Melbourne, Australia	4-6 A.M.	3-5 A.M.	2-4 A.M.	1-3 A.M.	12-2 A.M.	Mon. and Wed.
8,780	34.10	GLSQ	S.S. "Olympic"						
8,780	34.10	GFWV	S.S. "Majestic"						
8,690	34.50	W2XAC	Schenectady, N. Y.						
8,690	34.50	HKF	Bogota, Colombia	6-8 P.M. 12-2 A.M.	5-7 P.M. 11 P.M.-1 A.M.	4-6 P.M. 10-12 A.M.	3-5 P.M. 9-11 A.M.	2-4 P.M. 8-10 A.M.	
8,650	34.68	W2XCU	Ampere, N. J.						
8,650	34.68	W9XL	Chicago, Ill.						
8,650	34.68	W3XE	Baltimore, Md.	1:15-2:15 P.M. 11:15-12:15 P.M.	12:15-1:15 P.M. 10:15-11:15 P.M.	11:15-12:15 P.M. 9:15-10:15 P.M.	10:15-11:15 P.M. 8:15-9:15 P.M.	9:15-10:15 A.M. 7:15-8:15 P.M.	
8,650	34.68	W2XV	Long Island City, N.Y.						
8,650	34.68	W8XAG	Dayton, Ohio						
8,650	34.68	W6XN	Oakland, Calif.						
8,650	34.68	W4XG	Miami, Florida						
8,630	34.74	WOO	Deal, N. J.						
8,630	34.74	W2XDO	Ocean Gate, N. J.						
8,400	35.70	VBS	Khabarovsk, Siberia	6-8:30 A.M.	5-7:30 A.M.	4-6:30 A.M.	3-5:30 A.M.	2-4:30 A.M.	
8,530	35.89	WSBN	Glace Bay, N.S., Can.						
8,330	36.00	3KAA	S.S. "Leviathan"						
8,160	36.74	......	Leningrad, Russia	3-7 A.M.	2-6 A.M.	1-5 A.M.	12-4 A. M.	11 P.M. to 3 A.M.	Mon., Tues., Thurs., Fri.
8,120	36.92	PLW	Mombasa, East Africa	7-11 A.M.	6-10 A.M.	5-9 A.M.	4-8 A.M.	3-7 A.M.	
8,100	37.02	EATH	Bandoeng, Java	6.30-8 P.M.	5:30-7 P.M.	4:30-6 P.M.	3:30-5 P.M.	2:30-4 P.M.	Mon. and Thurs.
8,100	37.02	JIAA	Vienna, Austria	6-9 A.M.	5-8 A.M.	4-7 A.M.	3-6 A.M.	2-5 A.M.	Testing
8,100	37.02	HS4PJ	Tokio, Japan	9-11 A.M.	8-10 A.M.	7-9 A.M.	6-8 A.M.	5-7 A.M.	Sunday
8,030	37.36	NAA	Bankok, Siam	9:55 A.M.	8:55 A.M.	7:55 A.M.	6:55 A.M.	5:55 A.M.	Time signals twice daily, lasting 5 minutes
8,015	37.43	......	Arlington, Va.	10:55 P.M.	9:55 P.M.	8:55 P.M.	7:55 P.M.	6:55 P.M.	
7,980	37.65	VK2ME	Airplanes						
7,930	37.80	DOA	Sydney, Australia						
7,890	38.00	VPD	Doeberitz, Germany	2-4 P.M.	1-3 P.M.	12-2 P.M.	11 A.M. to 1 P.M.	10 A.M. to 2 P.M.	Reichpostzentralamt Berlin
7,830	38.30	PDV	Suva, Fiji Islands	10 A.M.	9 A.M.	8 A.M.	7 A.M.	6 A.M.	Starts at time given
7,770	38.60	FTF	Kootwipk, Holland						
7,770	38.60	PCK	Ste. Assise, France	10 A.M. 8 P.M.	9 A.M. to 7 P.M.	8 A.M. to 6 P.M.	7 A.M. to 5 P.M.	6 A.M. to 4 P.M.	
7,660	39.15	FTL	Kootwijk, Holland						
7,600	39.40	......	Ste. Assise, France						
8,570	35.00	RB15	Riobamba, Ecuador						
7,550	39.70	DDDX	S.S. "Bremen"						
7,550	39.70	HKF	Bogota, Colombia	6-8 P.M. 12-2 A.M.	5-7 P.M. 11 P.M.-1 A.M.	4-6 P.M. 10 P.M.-12	3-5 P.M. 9-11 P.M.	2-3 P.M. 8-10 P.M.	
7,500	40.00	......	"Radio Touraine," France	5 P.M. 11:30 to 2:30 A.M.	4 P.M. 10:30 to 1:30 A.M.	3 P.M. 9:30 to 12:30 A.M.	2 P.M. 8:30 to 11:30 P.M.	1 P.M. 7:30 to 10:30 P.M.	Daily except Sun.
7,460	40.20	FYR	Lyons, France		1-2 P.M.	12-1 P.M.	11-12 A.M.	10-11 A.M.	Mon. and Thurs.
7,400	40.50	......	Eberswalde, Germany						Testing
7,410	40.50	J1AA	Tokio, Japan						
7,310	41.00	F8LH	Paris, France ("Radio (Vitus")	5 P.M.	4 P.M.	3 P.M.	2 P.M.	1 P.M.	Testing
7,310	41.00	......	Moscow, USSR	818:45 A.M.	7-7:45 A.M.	6-6:45 A.M.	5-5:45 A.M.	4-4:45 A.M.	
7,230	41.46	DOA	Doeberitz, Germany	8 A.M. and 2 P.M.	7 A.M. and 1 P.M.	6 A.M. and 12 Noon	5 A.M. and 11 A.M.	4 A.M. and 10 A.M.	1st and 3rd Sun.
7.220	41.50	HB9D	Zurich, Switzerland	6:30 P.M.	5:30 P.M.	4:30 P.M.	3:30 P.M.	2:30 P.M.	Testing
7,190	41.90	EAR58	Canary Island (Spain)	8 P.M.	7 P.M.	6 P.M.	5 P.M.	4 P.M.	Irregular time.
7,120	42.12	OZ7RL	Copenhagen, Denmark						
7,060	42.50	......	Liakov Island, Siberia						
7,020	42.70	EAR125	Madrid, Spain	7-8 P.M.	6-7 P.M.	5-6 P.M.	4-5 P.M.	3-4 P.M.	
7,000	42.80	FM8KR	Constantin, Algeria	6:30-8 P.M.	5:30-7 P.M.	4:30-6 P.M.	3:30-5 P.M.	2:30-4 P.M.	Tues. & Sat.
6.980	43.00	EAR110	Madrid, Spain	8-9 P.M.	7-8 P.M.	6-7 P.M.	5-6 P.M.	4-5 P.M.	Friday
6.980	43.00	CT1AA	Santos, Portugal	5-6 P.M.	4-5 P.M.	3-4 P.M.	2-3 P.M.	1-2 P.M.	Friday
6.900	43.50	IMA	Rome Italy	1-3:30 P.M.	Noon to 2:30 P.M.	11 A.M. to 1:30 P.M.	10 A.M. to 12:30 P.M.	9-11:30 A.M.	Sun., Tues., Wed., Sat.
6.875	43.60	F8MC	Casablanca, Morocco						
6.875	43.60	D4AFF	Coethen, Germany	5-7 A.M. 1-3 P.M.	4-6 A.M. 12-2 P.M.	3-5 A.M. 11 A.M.-1 P.M.	2-4 A.M. 10 A.M.-12	1-3 A.M. 9-11 A.M.	Sundays Tues. and Fridays
6,860	43.70	KEL	Bolinas, Calif.	5-7 P.M.	4-6 P.M.	3-5 P.M.	2-4 P.M.	1-3 P.M.	Thursdays
6.840	43.84	VRY	Georgetown, British Guiana	8:15-10:15 P.M. 6:45-9 P.M.	7:15-9:15 P.M. 5:45-8 P.M.	6:15-8:15 P.M. 4:45-7 P.M.	5:15-7:15 P.M. 3:45-6 P.M.	—4:15-6:15 P.M. 2:45-5 P.M.	Wed. Sun.
6,810	44.0	XDA	Mexico City, Mexico.						
6,753	44.40	WND	Deal, N. J.						
6,600	45.00	......	Berlin, Gerfmany.						
6,515	46.05	WOO	Deal, N. J.						

(Continued on next page)

Freq.	Wave	Call	Location	AST	EST	CST	MST	PST	
6,515	46.05	WDXG	Miami. Florida.						
6,425	46.70	W2XCU	Ampere, N. J.						
6,425	46.70	W9XL	Anoka, Minn.						
6,380	47.00	CT3AG	Funchal, Madeira Iss-						And other stations.
			ands.	6-8 P.M.	5-7 P.M.	4-6 P.M.	3-5 P.M.	2-4 P.M.	Saturday
6,380	47.00	HC1BR	Quito, Ecudor	9-12 P.M.	8-11 P.M.	7-10 P.M.	6-9 P.M.	5-8 P.M.	
6,335	47.35	W1OXZ	Airplane Television						
6,335	47.35	VE3AP	Drummondville, Canada						
6,335	47.34	......	Casablanca, Morocco						
6,250	48.00	......	"Radio-Maroc," Rabat, Morocco						
6,250	48.00	MTH	Rio de Janeiro, Brazil						
6,205	48.30	HKC	Bogota, Colombia	10:45 P.M.-12:30 A.M.	9:45-11:30 P.M.	8:45-10:30 P.M.	7:45-9:30 P.M.	6:45-8:30 P.M.	
6,170	48.62	HRB	Tegucigalpa, Honduras	3 P.M.-1 A.M.	2-12 P.M.	1-11 P.M.	12-10 P.M.	11 A.M.-9 P.M.	Mon., Wed., Frid., Sat.
6,155	48.74	W9XAL	Chicago, Ill. (WMAC)	12:30-1 P. M.	11:30-12 P.M.	10:30-11 A.M.	9:30-10 A.M.	8:30-9 A.M.	Sat.
6,155	48.74	VE9CL	Winnipeg, Canada						And irplanes
6,155	48.74	W2XDE	Bell Tel. Lab., New York						
6,140	48.83	KA1XR	Manila, P. I.	4-5:30 A.M.	3-4:30 A.M.	2-3:30 A.M.	1-2:30 P.M.	12-1:30 A.M.	Sometimes one hour longer
				6-10 A. M.	5-9 A.M.	4-8 A.M.	3-7 A.M.	2-6 A.M.	
				3-4 A.M.	2-3 A.M.	1-2 A.M.	12-1 A.M.	11 P.M.-12 P.M.	Sat.
6,150	48.83	W8XK	East Pittsburgh, Pa.	6 P.M.-1 A.M.	5-12 P.M.	4-11 P.M.	3-10 P.M.	2-9 P.M.	Tues., Thurs., Sat., Sun.
6,125	48.91	7LO	Nairobi, Kenya, Africa	12 noon-3 P.M.	11 A.M.-2 P.M.	10 A.M.-1 P.M.	9 A.M.-Noon	8-11 A.M.	
6.120	49.99	......	Motala, Sweden "Rundradio"	7:30-8 A.M.	6:)0-7 A.M.	5:30-6 P.M.	4:30-5 A.M.	3.30-4 A.M.	
				11-4:30 P.M.	10-3:30 P.M.	9-2:30 P.M.	8-1:30 P.M.	7-12:30 P.M.	
				6 A.M.-6 P.M.	5 A.M.-5 P.M.	4 A.M.-4 P.M.	3 A.M.-3 P.M.	2 A.M.-2 P.M.	Holidays
6,120	48.99	NAA	Arlington, Va.						
6,120	48.99	......	Chi-Hoa (Saigon), Indo-China	7:30-8:30 A.M.	6:30-7:30 A.M.	5:30-6:30 A.M.	4:30-5:30 A.M.	3:30-4:30	
6,120	48.99	W2XE	New York, N. Y.	9 A.M.-12	8 A.M.-1 A.M.	7 A.M.-11 P.M.	6 A.M.-10 P.M.	5 A.M.-9 P.M.	Relays WABC
6,120	48.99	FL	Eiffel Tower, Paris						
6,120	48.99	......	Toulouse, France	3:30-5 P.M.	2:30-4 P.M.	1:30-3 P.M.	12:30-2 P.M.	11:30-1 P.M.	Sunday
6,120	48.99	MTH	Rio de Janeiro, Brazil	6-8 P.M.	5-7 P.M.	4-6 P.M.	3-5 P.M.	2-4 P.M.	
6,120	48.99	EAR25	Barcelona, Spain	4-5 P.M.	3-4 P.M.	2-3 P.M.	1-2 P.M.	12-1 P.M.	
6,110	49.07	VVB	Bombay, India	1:30-2:15 P.M.	12:30-1:15 P.M.	11:30 A.M.-12:15 P.M.	10:30-11:15 A.M.	9:30-10:15 A.M.	Mon., Wed., Fri.
6,100	49.15	W3XAL	Bound Brook, N. J.	6-7:30 P.M.	5-6:30 P.M.				Testing
				12-2 A.M.	11 P.M.-1 A.M.	10-12 P.M.	9-11 P.M.	8-10 P.M.	WJZ
6,095	49.17	VE9GW	Bowmanville, Ont., Can.	2:45-6 A.M.	1:45-5 A.M.	12:45-4 A.M.	11:45 P.M.-3 A.M.	10:45 P.M.-2 A.M	Daily
				1-8 P.M.	12-7 P.M.	11 A.M.-6 P.M.	10 A.M.-5 P.M.	9 A.M.-4 P.M.	Daily
				6-8 P.M.	5 A.M.-7 P.M.	4 A.M.-6 P.M.	3 A.M.-5 P.M.	2 A.M.-4 P.M.	Sundays
6.090	49.26	......	Copenhagen, Denmark						
6,080	49.31	W2XCX	Newark, N. J.						Relays WOR
6,080	49.31	W9XAA	Chicago, Ill.	7-8 A.M.	6-7 A.M.	5-6 A.M.	4-5 A.M.	3-4 A.M.	
				8-9 A.M.	7-8 P.M.	6-7 P.M.	5-6 P.M.	4-5 P.M.	
				10:30-11:15 P.M.	9:30-10:15 P.M.	8:30-9:15 P.M.	7:30-8:15 P.M.	6:30-7:15 P.M.	Relays WCFL
6,080	49.31	W6XAL	Westminster, Calif.	12-1 P.M.	11-12 P.M.	10 A.M.-1 P.M.	9-12 P.M.	8-11 P.M.	
				11 P.M.	10 P.M.	9 P.M.	8 P.M.	7 P.M.	Saturdays
				7 A.M.	6 A.M.	5 A.M.	4 A.M.	3 A.M.	Sundays
6,080	49.31	HS2PJ	Bangkok, Siam	7-7:30 A.M.	6-6:30 A.M.	5-5:30 A.M.	4-4:30 A.M.	3-3:30 A.M.	
6,070	49.40	UOR2	Vienna, Austria	6-8 A.M.	5-7 A.M.	4-6 A.M.	3-5 A.M.	2-4 A.M.	
				6-8 P.M.	5-7 P.M.	4-6 P.M.	3-5 P.M.	2-4 P.M.	Tues. & Sat.
				10-11 A.M.	9-10 A.M.	8-9 A.M.	7-8 A.M.	6-7 A.M.	Thursdays
6,065	49.46	SAJ	Motala, Sweden	7:30-8 A.M.	6:30-7 A.M.	5:30-6 A.M.	4:30-5 A.M.	3:30-4 A.M.	
				12-5:30 P.M.	11 A.M.-4:30 P.M.	10 A.M.-3:30 P.M.	9 A.M.-2:30 P.M.	8 A.M.-1:30 P.M.	
6,060	49.50	W8XAL	Cincinnati, Ohio	7:30-12 A.M.	6:30-11 A.M.	5:30-10 A.M.	4:30-9 A.M.	3:30-8 A.M.	
				2:30-4 P.M.	1:30-3 P.M.	12:30-2 P.M.	11:30-1 P.M.	10:30-12 A.M.	
				7 P.M.-2 A.M.	6 P.M.-1 A.M.	5-12 P.M.	4-11 P.M.	3-10 P.M.	
6,060	49.50	W9XU	Council Bluffs, Ia.						
6,060	49.50	W3XAU	Byberry, Pa.	9 A.M.-5 P.M.	8 A.M.-4 P.M.	7 A.M.-3 P.M.	6 A.M.-2 P.M.	5 A.M.-1 P.M.	Early Relays
				5 P.M.-1 A.M.	4 P.M.-12	3 P.M.-11 P.M.	2-10 P.M.	1-9 P.M.	WCAU
									Thurs. & Fri.
6,040	49.67	W9XAQ	Chicago, Ill.						
6,040	49.67	W2XAL	New York						
6.040	49.67	PK3AN	Sourabaya, Java	7-10 A.M.	6-9 A.M.	5-8 A.M.	4-7 A.M.	3-6 A.M.	
6.020	49 80	W9XF	Chicago, Ill.						
6.020	49 80	W2XBR	New York, N. Y.						
6,000	49.97	ZL3ZC	Christchurch, N. Z.	11 P.M.-1 A.M.	10 P.M.-M.	9-11 P.M.	8-10 P.M.	7-9 P.M.	Tues., Thurs, and Fri.
6,000	49.97	HRB	Tegucigalpa, Honduras	10:15 P.M.-1 A.M.	9:15-12 P.M.	8:15-11 P.M.	7:15-10 P.M.	6:15-9 P.M.	Mon., Wed., Fri.,
				12-1 A.M.	11-12 P.M.	10-11 P.M.	9-10 P.M.	8-9 P.M.	Sat.
6,000	49.97	EAR25	Barcelona, Spain	4-5 P.M.	3-4 P.M.	2-3 P.M.	1-2 P.M.	12-1 P.M.	Sat.
6.000	49.97	RFN	Moscow, Russia	9-10 A.M.	8-9 A.M.	7-8 A.M	6-7 A.M.	5-6 A.M.	Tues., Thurs., Sat.
6,000	49.97	......	Eiffel Tower, Paris, France						
5.970	50.23	......	Vatican City						
5.833	51.40	HK	Barranquilla, Colombia	9:30-11:30 P.M.	8:30-10:30 P.M.	7:30-9:30 P.M.	6:30-8:30 P.M.	5:30-7:30 P.M.	Except Sunday
5,770	52.00	AFL	Bergedorf, Germany						
5,710	52.50	VE9CL	Winnipeg, Canada						
5.690	52.72	......	Aircraft						
5,510	54.44								
5,680	52.80	OCTU	Tunis, No. Africa						
5,550	54.02	W8XJ	Columbus, Ohio						
5.500	54.51	W2XBH	Brooklyn, N. Y.						
5,300	56.70	AGJ	Nauen, Germany	8 P.M.	7 P.M.	6 P.M.	5 P.M.	4 P.M.	Ocassionally
5,170	58.00	OK-MPT	Prague, Chechoclovakia	2-4:30 P.M.	1-2:30 P.M.	12-2:30 P.M.	11 A.M.-1:30 P.M.	10 A.M.-12:30 P.M.	
5,170	58.00	PMB	Sourabaya, Java						
5,000	59.96	......	Bratisava, Czecho-slovakia						
4,975	60.30	W2XAV	Long Island City, N.Y.						
4,920	60.90	LL	Paris, France						
4,900	61.22	......	Television						
4,800	62.50	......							
4,800	62.50	W8XK	Pittsburgh, Pa.						
4,800	62.50	W1XAY	Lexington, Mass.						
4,800	62.50	W2XBU	Beacon, N. Y.						
4,800	62.50	WENR	Chicago, Ill.						
4,795	62.56	W9XAM	Elgin, Ill.						Time Signals
4,795	62.56	W3XZ	Washington, D. C.						
4,795	62.56	WSXDD	New York, N. Y.						Bell Telephone Laboratories portable.
4,795	62.56	W9XL	Chicago, Ill.						
4,785	62.69	.....	Aircraft						And experimental stations.
4,785	62.70	VZA	Drummondville, Can.						
4.770	62.80	ZL2XX	Wellington, New Zeal'd						
4,750	63.13	WOO	Deal, N. J.						
4,750	63.13	WXDO	Ocean Gate, N. J.						
4,700	63.79	W1XAB	Portland, Me.						
4.600	65.22	......	Television						
4,500	66.67	......							
4,500	66.67	W6XC	Los Angeles, Calif.						
4,430	67.65	DOA	Doeberitz, Germany	7-6 P.M.	6-7 P.M.	5-6 P.M.	4-5 P.M.	3-4 P.M.	Mon., Wed., Fri.
				3-4 P.M.	2-3 P.M.	1-2 P.M.	12-1 P.M.	11-12 A.M.	
4,340	68.30	WSBN	S.S. "Leviathan"						
4,280	70.00	OHK2	Vienna, Austria	2-8 P.M.	1-7 P.M.	12-6 P.M.	11 A.M.-5 P.M.	10 A.M.-4 P.M.	First 15 minutes of each hour and Sun. only.
				6:30-11.30 A.M.	5:30-10:30 A.M.	4:30-9:30 A.M.	3:30-8:30 A.M.	2:30-7:30 A.M.	
4,273	70.20	RB15							
4,273	70.20	GDLJ	S.S. "Homeric"						
4,120	72.70	GLSQ	S.S. "Olympic"						

(*Continued on next page*)

Freq.	Wave	Call	Location	AST	EST	CST	MST	PST	
4,180	71.77	......	S.S. "Majestic"						Phone
4,100	72.98	......	Aircraft						
4,116	72.87	WOO							
4,110	72.90	WGBN	Deal, N. J.						Phone to ships
4,105	74.72	NAA	S.S. "Leviathan"						
3,750	80.00	F8KR	Arlington, Va.	10 A.M.-11 P.M.	9 A.M.-10 P.M.	8 A.M.-9 P.M.	7 A.M.-8 P.M.	6 A.M.-7 P.M.	Time signals
4,120	72.70	GFWV	Constantine, Tunis, Africa						Mon., Fri.
3,750	80.00	I3RO	Rome, Italy (Prato Smeraldo)	12-2 P.M. 3:30-6 P.M.	11-1 P.M. 2:30-5 P.M.	10-12 A.M. 1:30-4 P.M.	9-11 A.M. 12:30-3 P.M.	8-10 A.M. 11:30 A.M.-2 P.M.	
3,750	80.00	......	Turin, Italy						
3,620	82.90	DOA	Doeberitz, Germany						
3,560	84.24	OZ7RL	Copenhagen, Denmark	7 P.M.	6 P.M.	5 P.M.	4 P.M.	3 P.M.	Te'evision Tues. & Sat.
3,550	84.46	......	Amateur Telephony						
3,500	85.66	......							
3,490	86.00	......	Aircraft						
3,460	86.50	......							
3,256	82.50	W9XI	Chicago, Ill.						
3,256	82.50	W6XBA	S.S. "Metha Nelson"						
3,256	92.50	W2XDD	Portable						And experimental
3,166	94.76	WCK	Detroit, Mich.						Police Dept.
3,142	95.48	......	Aircraft						
3,070	97.71	......							
3,124	96.03	WOO	Deal, N. J.						
3.088	97.15	W1OXZ	Airplane Television						
3,076	97.53	W9XL	Chicago, Ill.						
3,030	98.95	......	Motata, Sweden	12:30-1 P.M. 5-11 P.M.	11:30-12 A.M. 4-10 P.M.	10:30-11 A.M. 3-9 P.M.	9:30-10 A.M. 2-8 P.M.	8:30-9 A.M. 1-7 P.M.	
2,950	101.7	......							
2,850	105.3	......	Television						
2,850	105.3	W1XAV	Boston, Mass.						
2,850	105.3	W2XR	New York, N. Y.	5-7:30 P.M. 8:30-11 P.M.	4-6:30 P.M. 7:30-10 P.M.	3-5:30 P.M. 6:30-9 P.M.	2-4:30 P.M. 5:30-8 P.M.	1-3:30 P.M. 4:30-7 P.M.	
2,850	105.3	W9XR							
2,870	104.4	......	Chicago, Ill.	3 P.M.	2 P.M.	1 P.M.	12	11 A.M.	
2,885	105.0	W1XY	Milan, Italy						
2,833	105.3	W6XAN	Tilton, N. H.						
2,833	105.3	W7XAB	Los Angeles, Calif.						
2,833	105.3	W2XAO	Spokane, Wash.						
2,850	105.3	......	Yacht "MU-1," New York, N. Y.						
2,750	109.1	......	Television						
2,850	105.3								
2,750	109.1	W2XBO	Long Island City, N.Y.						
2,850	105.3								
2,750	109.1	W9XAA	Chicago, Ill.						
2,850	105.3								
2,750	109.1	W9XG	West Lafayette, Ind.						
2,722	110.2	......	Aircraft						
2,938	112.1	W6XAF	Sacramento, Calif.						State Dept. of Agriculture
2,452	122.3	W7XAU	Portland, Ore.						Police Dept.
2,416	124.2	W7XP	Seattle, Wash.						Police and Fire Depts.
2,398	125.1	W9XL	Chicago, Ill.						And Experimental stations
2,398	125.1	W2XCU	Ampere, N. J.						
2.398	125.1	W2XAD	Schenectady, N. Y.						
2.398	125.1	W2XAF	Schenectady, N. Y.						NBC
2,392	125.4	W10XAL	Portable						NBC
2.392	125.4	W10XAO	Portable						
2,340	128.0	......	Aircraft						
2,320	129.0								
2,325	129.0	W10XZ	Airplane Television						Testing
2.306	130.0	DDDX	SS. "Bremen" and "Europa"						
2,220	135.0	......	Stockholm, Sweden						
2.220	135.0	......	Oslo, Norway						
2,200	136.4	......	Television						
2.100	142.9								
2.200	136.4	W2XBS	New York, N. Y.						1,200 R.P.M. 60 lines deep, 72 wide
2,100	142.9								
2.200	136.4	W2XCW	Schenectady, N. Y.						
2.100	142.9								Portable
2.200	136.4	W3XAK	Bound Brook, N. J.						
2.100	142.9								
2.200	136.4	W8XAV	Pittsburgh, Pa.	2:30-3:30 P.M.	1:30-2:30 P.M.	12:30-1:30 P.M.	11:30 A.M.-12:30 P.M.	10:30-11:30 A.M.	1,200 R.P.M. 60 lines. Mon., Wed., Friday
2.100	142.9								
2,200	136.4	W9XAP	Chicago, Ill.						
2,100	142.9								
2,100	142.9	......	Television						
2,000	150.0								
2.100	142.9	W2XAP	Jersey City, N. J.						
2,000	150.0			9-11 P.M.	8-10 P.M.	7-9 P.M.	6-8 P.M.	5-7 P.M.	Mon., Wed., Fri.
2,100	142.9	W2XCR	Jersey City, N. J.	4-6 P.M.	3-5 P.M.	2-4 P.M.	1-3 P.M.	12-2 P.M.	Mon., Wed., Fri.
2,000	150.0			9-11 P.M.	8-10 P.M.	7-9 P.M.	6-8 P.M.	5-7 P.M.	
2,100	142.9	W3XR	Wheaton, Md.	4-6 P.M.	3-5 P.M.	2-4 P.M.	1-3 P.M.	12-2 P.M.	
2.000	150.0			2-3 P.M.	1-2 P.M.	12-1 P.M.	11-12 A.M.	10-11 A.M.	
2,100	142.9	W2XBU	No. Beacon, N. Y.						
2.000	150 0			9-11 P.M.	8-10 P.M.	7-9 P.M.	6-8 P.M.	5-7 P.M.	Except Sat. & Sun.
2.100	142.9	W2XCD	Passaic, N. J.						
2,000	150 0								
2.100	142.9	W9XAO	Chicago, Ill.						
2,000	150.0								
2,000	150.0	......	Smolensk, Russia						
2,000	149.9	......	Amateur Telephony & Television						
1,715	174.8	......							
1,723	174.0	ZL2XS	Wellington, N. Z.						
1,715	175.0	W9XAN	Elgin, Ill.						And other express stations
1,715	175.0	W6XK	Los Angeles, Calif.						Police Dept.
1,712	175.2	WKDU	Cincinnati, Ohio	12-4 P.M.	11 A.M.-1 P.M.	10-12 A.M.	9-11 A.M.	8-10 A.M.	Music and Police reports
1,712	175.2	WMP	Framingham, Mass.	6 P.M.	5 P.M.	4 P.M.	3 P.M.	2 P.M.	Police Dept.
1,712	175.2	WRBH	Cleveland, Ohio						Police Dept.
1.712	175.2	KGJX	Pasadena, Calif.						
1.712	175.2	......	Oventin, France	6 P.M.	5 P.M.	4 P.M.	3 P.M.	2 P.M.	Wednesday
1.712	175.2	F8FY	Cannes, France	5 A.M.	4 A.M.	3 A.M.	2 A.M.	1 A.M.	Sunday
1,700	176.5	......	Orly, France						Police Dept.
1,684	178.1	WDKX	New York, N. Y.						
1,662	180.4	......	Michigan State Police						
1,608	186.6	W9XAL	Chicago, Ill.						(WMAC) and Aircraft Television
1,608	186.6	W2XY	Newark, N. J.						Wired Radio
1,604	187.0	W2XCU	Ampere, N. J.	9-11 P.M.	8-10 P.M.	9-9 P.M.	7-9 P.M.	5-7 P.M.	
1,604	187.0	W2XCD	Passaic, N. J.						
1,604	187.0	W2XAD	Schenectady, N. Y.						
1,604	187.0	W2XAF	Schenectady, N. Y.						
1,604	187.0	W9XX	Cartersville, Mo.						
1,604	187.0	W5XN	Dallas, Texas						

SUBSCRIBERS! Look at the Expiration Date on Your Wrapper

Please look at the subscription date stamped on your last wrapper, and if that date indicates that your subscription is about to expire, please send remittance to cover your renewal. Please give our subscription department two weeks to make changes in expiration dates, street addresses, etc.

In this way you will get your copies without interruption, and keep your file complete.

SUBSCRIPTION DEPARTMENT

RADIO WORLD, 145 West 45th St., N. Y. City

SHORT-WAVE MIDGET SET

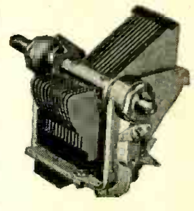
Listen to short waves on earphones, if you like, or plug into the detector socket of your set for loudspeaker reproduction, using the Short-Wave Midget Set. Shielded plug-in coils are used. Wave coverage, 15 to 200 meters. Single tuning control, Hammarlund condensers. The rectifier is built in.

All parts for AC model (less two 224 and two 227 tubes, less front panel) order Cat. SWMS @ $24.86

All parts for battery model (less two 232 and one 230 tube and less front panel) order Cat. BMSWM @ $19.92

Polo Engineering Labs., 125 W. 45 St., N. Y. C.

Hammarlund SFL



Hammarlund's precision .0005 mfd. condenser, removable shaft; excellent for calibrated radio frequency oscillators, short-wave converters and adapters and TRF or Superheterodyne broadcast receivers. Lowest loss construction; rigidity; Hammarlund's perfection throughout.

Order Cat. HAM-SFL, list price $5.50; net price..........$3.00

GUARANTY RADIO GOODS CO.
143 West 45th St., New York, N. Y.

"MATHEMATICS OF RADIO."—A great help to everybody interested in radio. $2 postpaid. Radio World, 145 W. 45th St., N. Y. City.

Trouble-Finding Dial FREE!

Here is an 8" diameter dial that you slide around to shoot trouble in an audio circuit or B supply or power amplifier. Trouble is divided into five groups: distortion, howl, dead amplifier, weak signals and hum. By sliding the dial to one of fifty different positions the cause of the trouble is read in the slotted opening. Invented by John F. Rider. Send $1.00 for eight weeks subscription for Radio World and get a Trouble-Finding Dial free with instructions on back. If extending an existing subscription please so state

Radio World, 145 West 45th St., New York, N. Y.

Save Money on Tubes!

Get a Guarantee Just the Same!

QUALITY tubes at enormously reduced prices enable you to save money and obtain full satisfaction. **Any tube will be replaced on request within thirty days of its sale!**

These tubes are made by a manufacturer of national reputation and are not "distress merchandise." No tube is shipped until it is carefully checked on a Readrite No. 9 Radio Test Kit.

Type	List Price	Your Cost	Type	List Price	Your Cost	Type	List Price	Your Cost
☐ 201A	$1.25	49c	☐ WD-12	$3.00	59c	☐ 245	$2.00	59c
☐ 226	1.75	49c	☐ 171A	2.25	59c	☐ 280	1.90	59c
☐ 199-UX	2.50	59c	☐ 171AC	2.25	59c	☐ 224	3.30	59c
☐ 199-UV	2.75	59c	☐ 112A	2.25	59c	☐ 222	4.50	95c
☐ 120	3.00	59c	☐ 227	2.20	59c	☐ 281	7.25	95c

☐ 250, List $11.00, your cost, 95c.

[Remit with order for tubes and we pay postage]

DIRECT RADIO CO.
143 West 45th St., New York, N. Y.

Fixed Condensers

Dubilier Micon fixed condensers, type 642, are available at following capacities and prices:

.0001 mfd.	10c
.00025 mfd.	10c
.0003 mfd	10c
.00035 mfd.	12c
.001	12c
.0015	12c
.002	18c
.006	20c
.00025 with clips	20c

All are guaranteed electrically perfect and money back if not satisfied within five days.

GUARANTY RADIO GOODS CO.
143 West 45th St., New York, N. Y.

RECENT NUMBERS
for the current year are procurable at the rate of 15c a copy, or 7 copies for $1.00. RADIO WORLD, 145 West 45th St., N. Y. City.

FREE AID TO A NEW JOB!

SITUATIONS WANTED AND HELP WANTED ADVERTISEMENTS WITHOUT COST!

Address: Industrial Dept., RADIO WORLD, 145 W. 45th St., N. Y. C.

SITUATIONS WANTED

RESEARCH OR LABORATORY POSITION WANTED by 1929 graduate, BS in EE. Thesis, Vacuum Tubes, used as basis of college lab. manual. Formerly, head instructor in Radio School. Engineer in tube plant, experimental department. Hold radio operator's license, broadcast class. Experienced on motion picture sound apparatus. All references of highest order. Age 25. W. A. Woehr, Geneseo, Ill.

RADIO SERVICE—A married man with a family; have had nine years experience in building and servicing sets; also a recent graduate of R.C.A. Institute. Have and use an up-to-date set analyzer and tube checker. Am willing to locate any place. Address 20 Royce Ave., Middletown, New York. Beryl A. Wallace.

YOUNG MAN, 21 YEARS OF AGE, desires position in experimental laboratory or factory. Has five years' experience as radio service man. Object is more experience rather than large salary. Will go any place in the United States. Harris A. Sprague, Jr., 48 Nelson Place, Worcester, Mass.

RADIO SERVICE MAN would like to make connection with store or factory or take care of radio service work for store on contract basis. 5 years' experience, 3 years outside. Reference, National Radio Institute, Washington, D. C. Louis Schudde, 155 Meserole St., Brooklyn, N. Y.

RADIO REPAIR AND SERVICE MAN. Age, 19 years. High school graduate. Course in Radio and Television Institute, Chicago. Would consider radio position of any kind, anywhere in U. S. Willing to start at reasonable salary, with chance of promotion. Lloyd B. Phillips, R. F. D. No. 2, New Bethlehem, Pa.

EXPERIENCED SET CONSTRUCTOR, both short-wave and broadcast receivers. Man 20, desires situation. Harley Wood, Box 64, Fishers Island, N. Y.

FIRST-CLASS RADIO TECHNICIAN. — Young man. Have had seven years' experience in service work and custom set building. Public address and sound equipment a specialty. Willing to go anywhere. William Wallace, Box 431, Wallaceburg, Ont., Can.

YOUNG MAN, 19 YEARS OF AGE, desires position in radio. Has had six years' experience in building broadcast sets, short-wave sets and transmitters. Interested in servicing and research work. George McClellan, 136 E. Arndt St., Fond du Lac, Wis.

RADIO GRADUATE OF THE I. C. SCHOOLS, with technical training both in servicing and construction, wishes steady job in store or factory. Francisco Bou, Jr., 4448 Elizabeth St., Philadelphia, Penn.

YOUNG MAN, 22 YEARS OF AGE desires position in experimental laboratory or factory. Has over five years experience as radio service man, and also has had experience with sound and acoustical work. Will work anywhere in the U. S. or foreign country. Will start with a reasonable salary. Write Wm. Palmer, Box 167, Crystal, W. Va.

A REGISTERED RADIO TECHNICIAN wishes position either store or factory. Anywhere in United States. Have three years' experience. Fred Kelly, 1909 4th Ave., North, Minneapolis, Minn.

NATIONAL RADIO INSTITUTE GRADUATE—10 years' experience in radio service, desires position anywhere at anything. Prefers store work as combination salesman and radio service man. Has test equipment and tools. Can furnish bond and first-class references. Write National Radio Inst., Washington, D. C., Student No. 74A25 for information as to ability. H. M. Goodrich, Box 1301, Ft. Lauderdale, Fla.

RADIO COLLEGE STUDENT, age 23 years, married. Understands theoretical and practical radio, experienced in servicing. Desires steady position. Robert L. Smith, Seat Pleasant, Md.

MEMBER OF INSTITUTE RADIO ENGINEERS, 30 years of age. Many years varied experience as asst.-Chief Engineer, Development, Technical, and Apparatus and Research Engineer with reliable firms. For past two years member of technical staff of Engineering Dept. of Arcturus Radio Tube Co. Business and personal references of the highest order. Gilbert Emerson Maul, 651 Lincoln Ave., Mountain Station, Essex County, N. J. Phone: Nassau 4-6845M.

YOUNG MAN, 19, RADIO OPERATOR COMMERCIAL CLASS—desires position as operator either aboard ship or ashore. Familiar with all commercial procedure, and competent touch-typist. Write Harold J. May, 277 Morris Ave., Springfield, N. J., or phone Millburn 6-0623-M.

YOUNG MAN, 25 YEARS OF AGE, with 7 months' training in short-wave at the McKim Radio and Electric School, Akron, Ohio. Would like work in laboratory of a radio manufacturing company. Very much interested in shortwave work. Willing to start at the very bottom and work up. Good character. John A. Williams, Box 13, Star City, W. Va.

Quick-Action Classified Advertisements

7c a Word — $1.00 Minimum Cash With Order

FILAMENT TRANSFORMER FOR SERIES OPERATION, new Radio World circuits, $2.50. Apfelbaum, 2711 Girard Ave., Philadelphia, Pa.

FILAMENT TRANSFORMERS, 1½, 2½, 5, 7½ volt, center tapped. State voltage wanted. $1.15 each. V. C. Cook, 3406 Frederick, Detroit, Mich.

"A DISCUSSION OF RADIO TUBES FOR THE LAYMAN," a copyrighted article by L. G. Mason will help you sell radio tubes in competition with mail order and chain store houses. $1.00 per hundred. $7.50 per thousand. Mason-Radio, 6212 Florida Ave., Tampa, Florida.

"HANDBOOK OF REFRIGERATING ENGINEERING, by Woolrich.—Of great use to everybody dealing in refrigerators. $4. Book Dept., Radio World, 145 W. 45th St., N. Y. City.

"MATHEMATICS OF RADIO"—A great help to everybody interested in radio. $2 postpaid. Radio World, 145 W. 45th St., N. Y. City.

SHORT-WAVE NUMBERS OF RADIO WORLD. Copies of Radio World from Nov. 8, 1930 to Jan. 3, 1931, covering the various short-wave angles, sent on receipt of $1.00. Radio World, 145 W. 45th St., N. Y. City.

BALKITE A-5 RECEIVER, eight-tube, three stages of Neutrodyne RF and two stages audio with push-pull output. Good distance-getter and very sensitive. Has post for external B voltage for short-wave converters. Brand new in factory case. Berkey-Gay walnut table model cabinet. Price $35 (less tubes). Direct Radio Co., 143 West 45th St., New York.

MAJESTIC, RADIOLA, etc. Drum Dial Cable by foot or mile. Service men's test prods, 50c, 75c, $1.00. Blan, the Radio Man. Inc., 89 Cortlandt St., New York.

BARGAINS in first-class, highest grade merchandise. Phono-link pick-up with vol. control and adapter, $3.32; four-gang .00035 mfd. with trimmers built in, $1.95; .00025 mfd. Dubilier grid condenser with clips, 18c. P. Cohen, Room 1214, at 143 West 45th Street, N. Y. City.

MILLION PARTS. Replacements for Freshman, Earl, etc. Radio hardware, small and big stuff. Price list just out for out-of-town experimenters, repair men. Experimenters Radio Shops, 129 West St., N. Y. C.

"FORD MODEL 'A' CAR." Its Construction Operation and Repair, By Victor W. Pagé, M.E. 545 Pages, 251 Specially Made Engravings. $2. postpaid. Radio World, 145 W. 45th St., N. Y. City

A-B-C- POWER PACKS 110 volt, 60 cycle, for sets using 1½, 2½ and 5 volt tubes or for electrifying battery sets. Packs are well made, filtered with Potter Condensers and are remarkably free from hum. Complete with 280 tube, $6.25. Cash Radio, 1013 N. McDonel St., Lima, Ohio.

NEW PHILCO 96, 1931, A.C. 9 Tubes, Highboy. Cost $189.00. Sell $85.00. E. A. Fountain, 436 E. 138th Street, Apt. 5L, New York.

RADIO WORLD AND RADIO NEWS. Both for one year, $7.00. Radio World, 145 W. 45th St., N. Y. City

HORN UNIT, $1.95—This is the Fidelity Unit and has stood the test of time. Guaranty Radio Goods Co., 143 W. 45th St., New York.

SOUND PICTURES TROUBLE SHOOTER'S MANUAL, by Cameron and Rider, an authority on this new science and art. Price $7.50. Book Dept., Radio World, 145 W. 45th St., N. Y. City.

"A B C OF TELEVISION" by Yates—A comprehensive book on the subject that is attracting attention of radioists and scientists all over the world. $3.00, postpaid. Radio World, 145 West 45th St., N. Y. City.

VERSATILE SPEAKER UNIT— FOR HOME OR PORTABLE

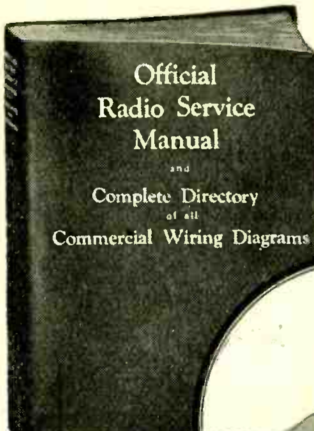
FIDELITY HORN UNIT. Stands up to 450 volts without filtering. Order Cat. FDU, with 50-inch tipped cord, weight 2½ lbs.; size 2¾-inch diameter, 2⅜-inch height. Price, $1.95. Guaranty Radio Goods Co., 143 West 45th St., N. Y. C.

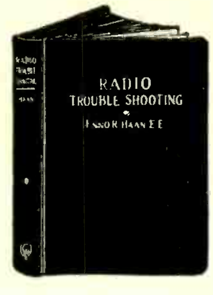
CIRCUIT DIAGRAMS

115 Circuit Diagrams of Latest Commercial Receivers and Power Supplies, by John F. Rider Each in black and white on separate sheets 8½ x 11. Send $1.50 to RADIO WORLD for 3 months' subscription and get this FREE.

+ RADIO BOOKS +

SERVICE MANUAL **RAMSAY** **HAAN** **RADIO MANUAL**





"Official Service Manual," by Gernsbach and Fitch, 1,000 illustrations, diagrams of commercial receivers and power amplifiers; 352 pages; includes course on servicing Weight, 2½ lbs. Complete 5-page index. Flexible leatherette cover, loose-leaf binding. Order Cat. ORSM ● $3.50

The index to the commercial wiring diagrams takes up five pages alone. The index is an alphabetical array of the manufacturers' names, with model names and numbers stated.

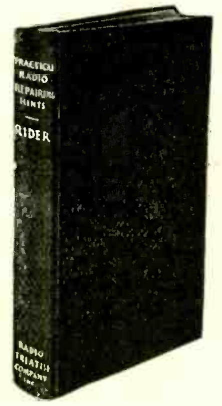
"Radio Trouble Shooting," by E. R. Haan, passes over theory, tells what to do to cure troubles. 300 illustrations, flexible binding 361 pages 6x9". Order Cat HAAN... ● $3.00

"Experimental Radio by R. R. Ramsey, Ph.D., Prof. Physics. Indiana University 255 pages, 168 illustrations. Cloth cover. Order Cat REX......@ $2.75

"Fundamentals of Radio," by Ramsey. 374 pages, 402 illustrations. Order Cat. RFM @ $3.50

The new edition of "The Radio Manual" answers questions about the principles, methods, or apparatus of radio transmitting and receiving. A complete course in radio operation in a single volume. 20 big chapters include: Elementary Electricity and Magnetism; Motors and Generators; Storage Batteries and Charging Circuits; The Vacuum Tube; Circuits Employed in Vacuum Tube Transmitters; Modulating Systems and 100% Modulation; Wavemeters; Piezo-Electric Oscillators; Wave Traps. Nearly 900 pages, 369 illustrations; flexible fabrikoid cover. Order Cat MAN ● $6.00

BOOKS BY JOHN F. RIDER



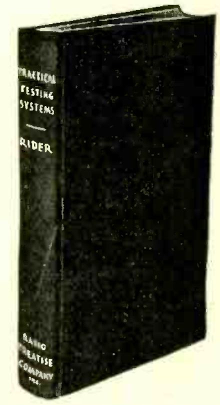
Two new books by Rider are:

(1)—"Practical Radio Repairing Hints," a handbook for the radio worker. Replete with facts and figures, hints and kinks. No Theory. No Formulae. In it you will find explanations of the modern radio systems, automatic volume control circuits, new forms of voltage distribution, automobile radio sets, public address systems, etc. Order Cat PRRH .... @ $2.00

(2)—"Practical Testing Systems," the first complete collection of accurate and practical testing circuits of interest to the service man, professional set builder and experimenter. Among the many testing systems described in this book are tube testers, capacity measuring systems, signal generators, radio frequency oscillators, audio oscillators, vacuum tube voltmeters, resistance testers, continuity testers, etc. Material for the man who wants a simple test unit or desires a laboratory arrangement. Order Cat. PTS .... ● $1.00

Other books by Rider are:

"Trouble Shooter's Manual," the first comprehensive volume devoted exclusively to the topic. It is not only a treatise for service men, telling them how to overcome their most serious problems, and diagramming the solutions, but it is a course in how to become a service man. It gives details of servicing and includes more than 100 actual factory-drawn diagrams of commercial receivers. 240 pages, 8 x 11," 200 illustrations Order Cat. TSM .... @ $3.50



"Supplement No. 1," containing 115 diagrams of commercial receivers, supplementing the diagrams in "Trouble Shooter's Manual," but not duplicating any. These 115 diagrams are supplied loose. They are a necessary adjunct to those in "Trouble Shooter's Manual." Order Cat. SUPP-1 .... @ $1.20

"Mathematics of Radio," by Rider, 128 pages, 8½ x 11", 119 illustrations, bridges the gap between the novice and the college professor. It gives a theoretical background so necessary for a proper understanding of radio and audio circuits and their servicing. Formulas for capacity, inductance, impedance, resistance, etc., are explained. Flexible cover. Order Cat. MOR..@ $2.00

TWO MASTERPIECES BY PROF. MORECROFT

"Principles of Radio Communication," by Prof. John H. Morecroft, second edition. Prof. Morecroft, of the Electrical Engineering Department of Columbia University and past president of the Institute of Radio Engineers, is a noted authority. Prior electrical and mathematical knowledge required. 1,001 pages and 831 illustrations. Cloth-bound. Order Cat. M-PRIN. .... @ $7.50

"Elements of Radio Communication," written in plain language, requiring little foundation knowledge of radio, is another fine Morecroft book. The book is a complete course on the eelments of radio, containing much material never before published. 226 pages, 170 illustrations and a complete index. Cloth bound. This is one book you must have in your library. Order Cat. M-ELEM @ $3.00

THREE BOOKS BY MOYER AND WOSTREL

The need for an up-to-date book on radio tubes that answers all the important questions has been filed by James A. Moyer, Director of University Extension, and John F. Wostrel, instructor in radio engineering, Division of University Extension, Massachusetts Oepartment of Education. This book is a complete discussion of tube principles, functions and uses. The essential principles underlying the operation of vacuum tubes are explained in as non-technical a manner as is consistent with accuracy. The book covers the costruction, action, reactivation testing and use of vacuum tubes as well as specifications for vacuum tubes and applications for distant control of industrial processes and precision measurements. 297 pages, cloth bound. Order Cat. MWT. .... @ $2.50

"Practical Radio," including the testing of radio receiving sets. 378 pages, 223 illustrations. Cloth bound. Order Cat. MWP. .... ● $2.50

"Practical Radio Construction and Repairing." 319 pages, a companion volume to the above. New edition new price. Order Cat. MWC. .... @ $2.50

Radio World, 145 West 45th Street, New York, N. Y.

Enclosed please find $.......... for which please send at once, postpaid, books indicated by my crosses

☐ Cat. ORSM @ $3.50	☐ Cat. TSM @ 3.50
☐ Cat. HAAN @ 3.00	☐ Cat. SUP-1 @ 1.20
☐ Cat. REX @ 2.75	☐ Cat. MOR @ 2.00
☐ Cat. RFM @ 3.50	☐ Cat. M-PRIN @ 7.50
☐ Cat. MAN @ 6.00	☐ Cat. M-ELEM @ 3.00
☐ Cat. ORA @ 6.00	☐ Cat. MWT @ 2.50
☐ Cat. PRK @ 3.50	☐ Cat. MWP @ 2.50
☐ Cat. PRRH @ $2.00	☐ Cat. MWC @ 2.50
☐ Cat. PTS @ 1.00	☐ Cat. RTT @ 7.50

Name ....

Address ....

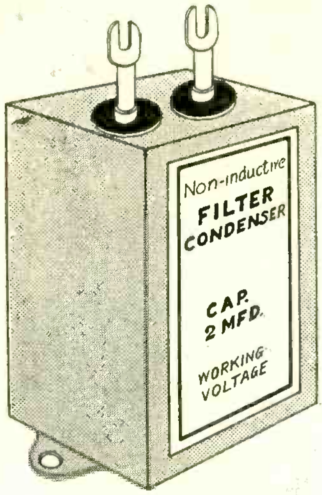
City .... State ....

☐ Check here if C. O. D. is desired.

Remit with Order for Books and We Pay Postage

High-Grade Parts of Great Utility

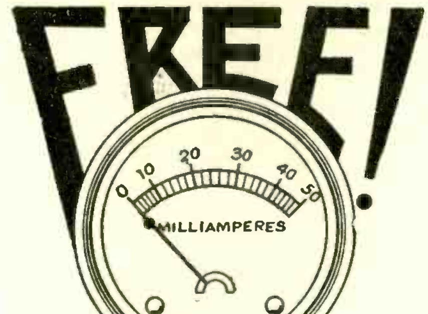
FILTER CONDENSERS



Flechtheim filter condensers for circuits using 245 output tubes, singly or in push-pull, or other circuits using lesser B voltage. Illustration is actual size. Capacities are 1 mfd. and 2 mfd. Continuous working voltage, 800 volts DC, 400 volts AC root mean square. Tested at 1,000 volts DC. Breakdown voltage 1,500 volts DC. Equipped with mounting feet.

Two condensers of 1 mfd. sent free with each 6 months' subscription at $3.00. Order PR-HVD-1.

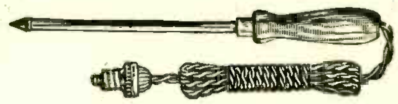
One condenser of 2 mfd. free with 6 months' subscription at $3.00. (26 issues). Order PR-HVS-2.



Your Choice of NINE Meters!

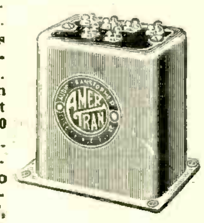
To do your radio work properly you need meters. Here is your opportunity to get them at no extra cost. See the list of nine meters below. Heretofore we have offered the choice of any one of these meters free with an 8-weeks subscription for RADIO WORLD, at $1, the regular price for such subscription. Now we extend this offer. For the first time you are permitted to obtain any one or more or all of these meters free, by sending in $1 for 8-weeks' subscription, entitling you to one meter; $2 for 16 weeks, entitling you to two meters; $3 for 26 weeks, $6 for 52 weeks, entitling you to six meters. Return coupon with remittance, and check off desired meters in squares below.

SOLDERING IRON



Works on 110-120 volts, AC or DC; power, 50 watts. A serviceable iron, with copper tip, 5 ft. cable and male plug. Send $1.50 for 13 weeks' subscription for Radio World and get these free! Please state if you are renewing existing subscription. Order PR-SO.

AMER-TRAN AUDIO

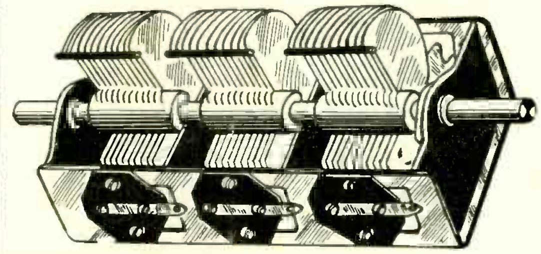


First stage, de luxe (illustrated), primary, in detector circuit, has 200 henrys inductance at 1 milliampere; turns ratio, 1-to-3. Order PR-AMDL, free with 1½ years' subscription at regular rate **$9.60**

Push-pull input transformer, turns ratio, 1-to-2½; single primary; two separate windings for secondary. Order **PR-AMPP**, free with 2½ years' subscription @ **$15.00.**

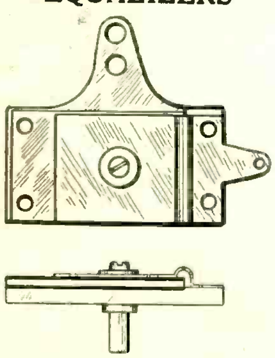
These audio transformers are recognized as being predominant. They afford tone realism unexcelled and deliver fully adequate volume. You can never go wrong with Amertrans. And remember that RADIO WORLD circuits show how best to use these transformers. Read RADIO WORLD weekly.

THREE-GANG SCOVILL .0005 MFD. WITH BRASS PLATES



One of the best three-gang condensers made Plates, utterly rigid and expertly aligned, are of brass, the most expensive metal used for this purpose. Capacity of each section .0005 mfd. Shaft, ⅜" diameter of genuine steel, protrudes at both ends. For ¼" diameter dial use at extension shaft (Cat XS-4 @ 12c extra). Trimming condensers not built in, but mounting holes are provided for them. Condenser should be mounted on narrow side for drum dial operation Rotor tension adjusters are built in. Frame is steel. Total shaft length overall 8⅛" total frame width overall, 4⅓". Order PR-3G, free with 26 weeks' subscription @ **$3.00**

HAMMARLUND 100 MMFD. EQUALIZERS



The most precise and rugged equalizing condenser made, with 20 mmfd. minimum and 100 mmfd. maximum, for equalizing the capacity where gang condensers are used that are not provided with built-in trimmers. Turning the screw alters the position of the moving plate, hence the capacity. Cross-section reveals special threaded brass bushing into which screw turns, hence you can not strip the thread. If you turn the screwdriver down with accidental excess of force the screw simply stops, no injury results, as this special equalizer does not rely on the delicate thread in bakelite. The screw receptacle is strong brass. Useful in all circuits where trimming capacity of 100 mfd. or less is specified. Maximum capacity stamped on the condenser Order PR-EQ-100, and three condensers will be shipped; subscription, three months @ $1.50 regular rate.

BOOKS THAT BUILD UP YOUR RADIO KNOWLEDGE

TWO GREAT STANDBYS

"Principles of Radio Communication," by Prof. John H. Morecroft, second edition. Prof. Morecroft, of the Electrical Engineering Department of Columbia University and past president of the Institute of Radio Engineers, is a noted authority. Prior electrical and mathematical knowledge required. 1,001 pages and 831 illustrations. Cloth-bound. Order PR-MPRN, free with subscription for 1 year and 34 weeks (86 issues) @ $10.00

"Elements of Radio Communication," written in plain language, requiring little foundation knowledge of radio, is another fine Morecroft book. The book is a complete course on the elements of radio, containing much material never before published. 226 pages, 170 illustrations and a complete index. Cloth bound. This is one book you must have in your library. Order PR-MELEM, free with 26 weeks' subscription @ $3.00

BOOKS BY J. F. RIDER

"Practical Radio Repairing Hints," by John F. Rider, just published. A handbook for the radio worker. No theory. No formulae. Explanations of the modern radio systems, automatic volume control circuits, new forms of voltage distribution—automobile radio sets, public address systems, etc. Order PR-PRRH, free with 26 weeks' subscription @ $3.

"Practical Testing Systems," the first complete collection of accurate and practical testing circuits of interest to the service man, professional set builder and experimenter. Order PR-PTS, free with 3-month subscription @ $1.50.

THE SUPERHETERODYNE

This is a new volume by Anderson and Bernard dealing with the principles and practice of the Superheterodyne method of receiving. It explains the function of the oscillator, the modulator, the premodulator selector, and the intermediate frequency amplifier. It explains the cause of repeat points and gives methods for avoiding them or minimizing their effect. It expounds the relative advantages and disadvantages of high and low intermediate frequencies, and shows the effect of selectivity on the quality.

It illustrates various forms of oscillators and tells of the advantages of each. Different types of modulators and pick-up systems are explained and their advantages stated. Different methods of coupling in the intermediate frequency amplifier are shown. Order PR-ABSA, free with 6 months' subscription (26 issues) @ $3.00

FOOTHOLD ON RADIO

In simple English that any one can understand, the technical side of radio is presented by Anderson and Bernard in their book, "Foothold on Radio." Any one who can read English can understand this book. It is intended for the sheer novice. The treatment is non-mathematical. Order PR-FOR free with 16 weeks' subscription @ $2.00

PLEASE USE THIS COUPON

RADIO WORLD, 145 West 45th Street, New York, N. Y.

I hereby take advantage of your extra-special premium offers and subscribe for RADIO WORLD for the number of weeks specified in the list below Please send indicated premium. My remittance of $........... is enclosed

- ☐ PR-HVD-1 (26 wks., $3.00)
- ☐ PR-HVS-2 (26 wks., $3.00)
- ☐ PR-AMDL (1½ yrs., $9.00)
- ☐ PR-AMPP (2½ yrs., $15.00)
- ☐ PR-EQ-100 (3 mos., $1.50) (Three condensers supplied.)
- ☐ PR-ABSH (26 wks., $3.00)
- ☐ PR-FOR (16 wks., $2.00)
- ☐ PR-PRRH (26 wks., $3.00)
- ☐ PR-PTS (13 wks., $1.50)
- ☐ PR-MPRN (1 yr., 34 wks., $10)
- ☐ PR-MELEM (26 wks., $3.00)
- ☐ PR-3G (26 wks., 3.00)

- ☐ PR-326—0-6 Voltmeter D.C.
- ☐ PR-327—0-50 Voltmeter D.C.
- ☐ PR- 23—6-Volt Charge Tester D.C.
- ☐ PR-338—0-10 Amperes D.C.
- ☐ PR-325—0-25 Milliamperes D.C.
- ☐ PR-350—0-50 Milliamperes D.C.
- ☐ PR-390—0-100 Milliamperes D.C.
- ☐ PR-399—0-300 Milliamperes D.C.
- ☐ PR-394—0-400 Milliamperes D.C.

[One for $1, 8 wks. Two for $2, 16 wks. Three for $3, 26 wks. Six for $6, 52 wks.]

State here how many meters..........
☐ PR-SO (13 wks., $1.50)

NAME ....

ADDRESS ....

CITY .... STATE ....

☐ **Put cross here if renewing an existing RADIO WORLD subscription, as this facilitates speedy service.**