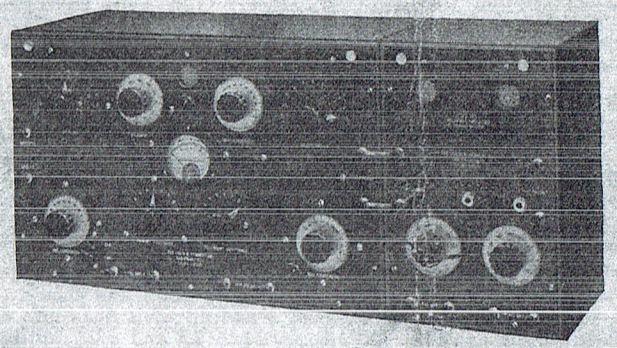
IMPORTANT

Please fill out and mail the stamped, addressed post card enclosed with these instructions.

KENNEDY

The Royalty  *of Radio*

INSTRUCTION SHEET 110-E — MAY 1, 1923



Instructions

For the Installation and Operation of Kennedy Type-110 Universal Regenerative Receiver

and

Type-525 Two-Stage Audio Frequency Amplifier

All Kennedy Regenerative Receivers are licensed under Armstrong United States Patent Number 1,113,149

THE COLIN B. KENNEDY COMPANY
SAINT LOUIS — SAN FRANCISCO

AN EASY WAY

To Tune the Kennedy Universal Receiver for Telephone Broadcasting

EACH control on the Kennedy Type-110 Universal Receiver is necessary either to adapt your set to your own peculiar aerial conditions, or to assist in eliminating interference. All but two of them, however, can be set at fixed, or approximate, positions, and the tuning for broadcasting stations done with the REGENERATION and the SECONDARY CONDENSER knobs.

AFTER making sure that your wiring is right and that your detector "B" battery voltage is not over 12 to 22½ volts (for UV-200 or C-300 tubes), REMOVE the detector tube and turn on the rheostat to any position on the dial and see if your voltmeter reads at least 6. If it reads less than that, your "A" battery is not fully charged and the set will not operate properly. Now insert the tube, turn on both amplifier rheostats to about 80 and, with the phones plugged in at the first stage, proceed as follows:

SET the COUPLING at 3 and then FORGET IT. Set the PRIMARY CONDENSER at 50. (This you will need to change later.) Use the SERIES-PARALLEL switch on PARALLEL. Set the PRIMARY INDUCTANCE at 2 and SECONDARY INDUCTANCE at 1. (More about this later.) Set the GRID CONDENSER at 50 and FORGET IT. Set the vernier arrows (on the two small knobs) with arrows pointing straight up. Set the SECONDARY CONDENSER at 50. Set the REGENERATION at 0.

INCREASE FILAMENT (turning dial to right) until a hiss is heard in the phones. It is a very definite hissing point and should appear with a voltmeter reading of between 4 and 5. If it does not, readjust the detector "B" battery voltage between 12 and 22½ until the proper point is found. The lower the voltage you can use, the better. If these adjustments do not show a hissing point, try a new detector tube. This is the most important adjustment to be made preparatory to the actual tuning. The proper place for the filament dial for ALL STATIONS is JUST BELOW the hissing point.

EVERYTHING is now ready for the actual process of picking up a carrier wave. Increase the REGENERATION until the same hissing point is found again, but not beyond. Slowly rotate the SECONDARY CONDENSER between 20 and 100 until a whistling sound is heard. Get as near to the "center" of this whistle as possible with the SECONDARY CONDENSER knob, then reduce the REGENERATION slightly until the signal is clear, and by turning the small knob (vernier) beside the SECONDARY CONDENSER dial one way or the other, you will come right upon the music or voice. If it is still distorted, reduce the REGENERATION very slightly. If clear, but not loud enough, increase the REGENERATION.

SEE now if you can make the signal stronger by turning the PRIMARY CONDENSER knob. If it comes loudest at 0, set the PRIMARY INDUCTANCE switch at 1 and try the condenser between 0 and 100. If loudest at 100 with PRIMARY INDUCTANCE switch at point 2, set the switch at 3 and try adjusting the dial again from 0 upward.

THIS setting depends entirely on your aerial. Once found, it remains constant as far as the PRIMARY INDUCTANCE switch is concerned for practically ALL broadcasting stations. For very long aerials, it is sometimes necessary to set the primary switch on point 4 and the SERIES-PARALLEL switch on SERIES, and then readjust the PRIMARY CONDENSER. If you can tune your station on PARALLEL, however, you will ordinarily get louder signals.

TYPE-110 SECONDARY CALIBRATION

Setting of SECONDARY INDUCTANCE Switch	Setting of SECONDARY CONDENSER	WAVE-LENGTH in METERS	Approximate Position of PRIMARY INDUCTANCE Switch. SERIES-PARALLEL Switch at PAR.
1	0	175	1
	10	240	1
	20	310	1
	30	350	2
	40	385	2
	50	410	2
	60	435	2
	70	460	2
	80	485	3
	90	510	3
	100	530	3
2	0	370	2
	20	530	3
	40	660	3
	60	760	3
	80	850	4
	100	940	4
3	0	780	3
	25	1045	4
	50	1275	4
	75	1450	5
	100	1600	5
4	0	1310	4
	25	2060	5
	50	2540	5
	75	2930	6
	100	3300	6
5	0	2550	5
	25	4300	6
	50	5650	6
	75	6600	7
	100	7450	7
6	0	4550	6
	25	7500	7
	50	9650	7
	75	11300	8
	100	12950	8
7	0	9300	7
	25	15300	8
	50	19800	8
	75	23400	9
	100	26900	9

NOTE: The settings given for the PRIMARY INDUCTANCE Switch are of necessity only approximate. They may vary a point to the right or left of those given, depending on the antenna used. The settings given are for the Parallel position of the SERIES-PARALLEL Switch.

The PRIMARY CONDENSER should be set at 50 in the beginning, so that it may be turned to either the right or left in tuning.

It should be remembered that the calibration given above may vary a little, depending upon the settings of the other controls, as each of these has a slight effect upon the secondary tuning.

Prepared by Dr. J. H. Dellinger, Chief, and L. E. Whittemore, Assistant Chief, of the Radio Laboratory of U. S. Bureau of Standards at Washington, D. C.

2. "THE PRINCIPLES UNDERLYING RADIO COMMUNICATION"—Radio Communication Pamphlet No. 40 of the Signal Corps, U. S. Army. Prepared by the Bureau of Standards. Price, $1.00. Obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C. (This book has an appendix which lists books and publications of interest to those interested in radio, both those interested purely in a general way and those whose interest is that of the student or experimenter.)

3. "RADIO INSTRUMENTS AND MEASUREMENTS." Circular No. 74 of the Bureau of Standards. Price, 60 cents. Obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C. (The study of this book should not be attempted until the student has a fairly good idea of the fundamental principles of radio communication. Some of the treatment is mathematical.)

The new regulations provide for broadcasting on wave-lengths ranging from 222 meters to 550 meters. Reference to page 23 shows that if the SECONDARY INDUCTANCE is set at 1 you can tune from 175 to 530 meters (or practically the entire broadcasting range) by adjusting the SECONDARY CONDENSER from 0 to 100. If you want to go *higher* than 530 meters, place the SECONDARY INDUCTANCE switch at 2 and adjust the SECONDARY CONDENSER between 0 and 25. You can also tune down as low as 370 meters with the SECONDARY INDUCTANCE set at 2.

THE SMALL knob marked "FILAMENT" (a vernier rheostat used on sets built since March 1, 1923) is sometimes useful to bring up faint signals, though the same result can be obtained by using the REGENERATION control a very little higher and readjusting the SECONDARY CONDENSER vernier.

UNLESS you have slipped up somewhere, you have now found your station. Let us review the steps briefly and at the same time inquire into the reasons for the various settings. This will help fix them in your mind. First, you set the COUPLING at 3. The coupling control is a device with which you determine how sharply you are going to tune. If there is much interference, i. e., many broadcasting stations working at the same time, you want to tune sharply, of course, in order to eliminate all but the one you desire. If there is no interference from other stations, you will get louder signals as you approach 5. NEVER use coupling greater than 5 for broadcasting wave-lengths and do not change this setting while tuning in. Set it first and then forget it.

NO TWO aerials are exactly alike. Therefore, the primary condenser and primary inductance switch are placed on the set to enable you to adjust your set to the particular aerial you are using. The aerial circuit (primary circuit) tunes broadly; thus any approximate setting will suffice while the rest of the set is being tuned. Later you were told how to make the final adjustments in this circuit. Once found, they will vary only a little for stations on broadcasting wave-lengths—the condenser being ALL that you need change.

INDUCTANCE (wire wound in the form of a coil) and capacity (condenser) together determine the wave-length, and a change in one usually necessitates a change in the other. If you set the secondary inductance switch on point 1, you will find the broadcasting between 20 and 100 on the secondary condenser. When the switch is set on point 2, you will find broadcasting between 0 and 30. Further explanation of this is given in the body of the instruction book.

NOW for a few "Don'ts." DON'T use large values of coupling if you want the set to be selective—go to 0 if necessary. DON'T crowd your tube above the hissing point found by setting the regeneration at 0 and increasing the filament. DON'T turn every knob on the panel in an attempt to "get something" because ALL BUT TWO (the REGENERATION and SECONDARY CONDENSER) are the WRONG ones. DON'T turn the SECONDARY CONDENSER rapidly or you may pass over stations without hearing them. DON'T blame the set if you don't know how to tune it. Write and ask us about it if these instructions are insufficient to enable you to tune properly.

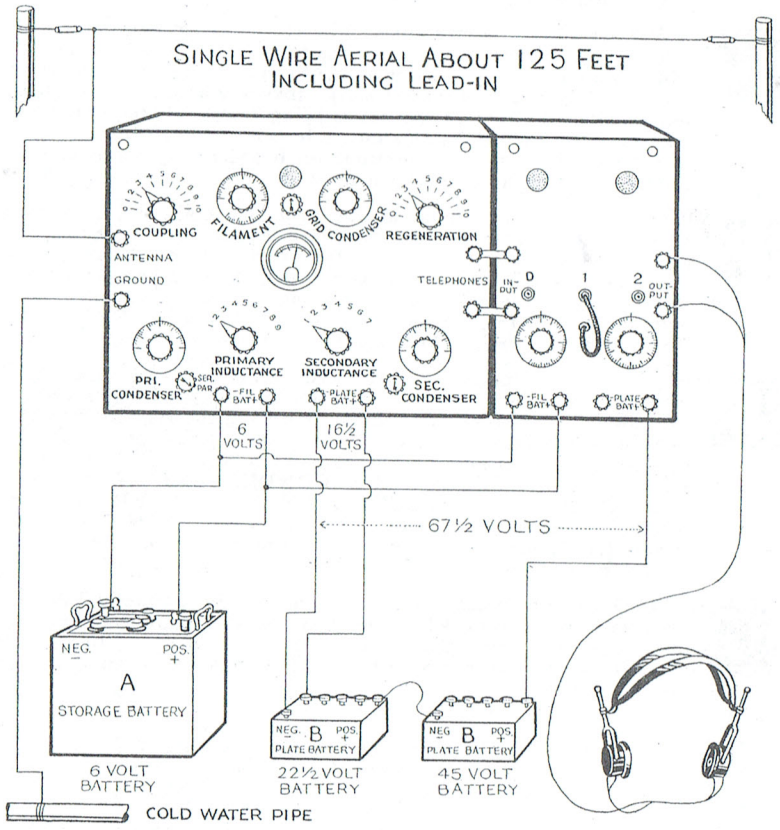
GETTING down to brass tacks on the matter, the Kennedy Type-110 is a very easy set to tune when you learn to forget most of the controls after you have found the correct settings for them. They are placed there for a purpose, but once this purpose is accomplished, they should be left alone.

NOTE.—The first time you tune your set, try it on a local station and therefore select a time when such a station is operating. You will find it easier to tune for more distant stations after you have tried the set on the nearby ones first. (You may not be able to find the "hissing point" on your tube when you are "tuning in" a local station.)

More Elaborate Instructions are given in the following pages

DIAGRAM OF CONNECTIONS

Kennedy Type-110 Receiver and Type-525 Amplifier



The above diagram shows clearly how the various connections are to be made. For complete details read the following instructions.

4. FAILURE TO MAKE THE SET OSCILLATE

If difficulty is encountered in making the receiver oscillate, the principal cause will be found to be either a rundown "B" battery or storage battery. In the former case this must be remedied by a new "B" battery; in the latter by recharging the storage battery. Rundown "B" batteries occasionally cause unsatisfactory operation of the set which is unjustly charged to the receiver. It is well to try out new "B" batteries, as one of the first steps in locating any possible failure of receiver or amplifier to function properly.

5. FAILURE OF RECEIVER TO FUNCTION

If after making connections as outlined above and tuning in accordance with the instructions no results are obtained from the receiver, the difficulty probably lies with some of the external connections and we suggest that these be gone over very carefully with a view to locating the trouble. For example—if the positive and negative "B" battery connections are in any way reversed, the receiver will not function at all. It is, therefore, extremely important to see that all connections are made in accordance with specific instructions given.

All parts entering into Kennedy Receivers are thoroughly inspected and tested during their process of manufacture and the completed instrument is given a thorough inspection and rigid test in operation on actual signals before it is packed for shipment. Therefore, there should be no difficulty in making the instrument function properly when the right connections are made to it.

XII. REFERENCES FOR FURTHER STUDY

To those interested in studying further into the operation of receiving apparatus, we suggest the reading of one or more of the elementary text-books on radio. There are many such on the market and we cannot, of course, list them all here. Consequently, we are naming below only three which we know to be reliable. The first is the most elementary in its treatment of the subject; the second goes into greater detail, while the third is a considerably more theoretical and advanced treatise, although it may still be considered as a somewhat elementary introduction to the very large technical field involved in a thorough understanding of the science of radio communication. The reader will find that these books give references to other works by the use of which the student may go as far as he likes in his study.

1. "LEFAX RADIO HANDBOOK," published by Lefax, Inc., Sheridan Building, 9th and Sansom Streets, Philadelphia. Price, $3.50. A loose-leaf hand-book in convenient form giving an understandable elementary treatment of the subject.

go above this value with a Kennedy Receiver. Lower "B" battery voltages are usually required in the Kennedy Receiver than in other apparatus, due to the high degree of sensitivity of the apparatus.

2. NOTES ON "B" BATTERIES

Precautions

Care should always be taken with both storage and "B" batteries that the terminals are never short-circuited, as this causes the battery to deteriorate very rapidly and in the case of storage batteries, may cause serious internal damage as well.

Great precaution should be taken to avoid connecting the "B" battery to the "A" battery terminals on the receiver or amplifier, as this mistake is certain to result in the destruction of vacuum-tube filaments because of the high voltage of the "B" battery.

The life of a "B" battery is ordinarily from six to twelve months if given proper care.

3. NOTES ON STORAGE BATTERY

Most storage batteries are rated in accordance with their ampere-hour capacity, which gives a good indication as to the length of time it takes for the battery to run down and require recharging. The standard vacuum tubes on the market require about one ampere of current each; therefore, a receiving set consisting of a receiver and a two-stage amplifier, and therefore using three vacuum tubes, consumes about three amperes of current. In other words, if the set is operated steadily for an hour, three ampere-hours are drawn from the battery and a 60-ampere-hour battery would be completely discharged in 20 hours. It would then need recharging before it could be used further.

It is recommended in permanent installations of radio apparatus that a battery charger be purchased and installed. These devices will operate from the regular lighting circuits at small expense and are very convenient for charging the battery without removing it. They may also be used for charging automobile storage batteries, thus serving a double purpose.

It is a good plan to have a hydrometer for testing the storage battery, which will indicate when it needs charging. This may be purchased from any battery service station at a small cost.

From time to time **distilled** water should be added if the battery is charged at home. Enough should be added so that the liquid in the battery at all times covers the plates about a quarter of an inch. **Only distilled water should be used.**

Complete Instructions

for

The Installation and Operation of Kennedy Type-110 Universal Radio Receiver

and

Type-525 Two-Stage Amplifier

1. INTRODUCTION

THE purpose of these instructions is to give to the radio novice the necessary information for properly installing and operating his Kennedy Type-110 Universal Receiver and Type-525 Amplifier.

An attempt has been made to cover even such details as the correct construction of the antenna so that the user who installs his own set completely will have proper information.

For those whose installation is already made, a very brief and simple method of tuning is outlined on pages 2 and 3. The following pages, however, give a somewhat more comprehensive treatment of the subject for those who wish to go a little deeper into the theory of tuning.

II. RESULTS TO BE EXPECTED

1. THE RECEIVING SET

The amount of energy sent out from a broadcasting station is comparatively small. This will be appreciated if it is realized that most of the more powerful broadcasting stations of the present day send out into the ether a total amount of energy no greater than that required to light all the electric lights of a small home. The marvelous performance of the radio telephone can best be appreciated when one considers the short distance which would be reached by the light from a single group of electric lamps utilizing this amount of energy. We all know that it would be seen in all directions not more than a few miles from its source. In the case of the radio telephone broadcasting station, however, thousands of homes within a distance of several hundred miles in all directions are reached under favorable conditions, and through the medium of radio receivers in these homes the music and voice broadcast are heard by countless thousands. Of the very small initial amount of energy sent out, each receiving station catches an exceedingly minute share, and yet this energy produces sufficient effect in the sensitive radio receiver so that the sounds are clearly heard in the head telephones or the loud-speaker.

Many newspaper stories have been printed, telling of freak or exceptional distances covered by the radio telephones and the uninitiated public have been led, in many cases, to expect the impossible without realizing just what it means. This false impression as to great distances covered as a regular performance has also been unwittingly promoted by the enthusiastic radio amateur who talks glibly of very clearly hearing various distant stations. In his enthusiasm he fails to make clear that the average amateur—particularly those who maintained radio telegraph stations before the broadcasting days—considers that if a station is heard sufficiently loudly to distinguish what is being said, it is being heard clearly. Usually it is not explained that these remarkable performances are exceptional or unusual and consequently the uninitiated have been led to believe that such things are regular daily occurrences. As a result those who are not familiar with radio and its capabilities have oftentimes been disappointed after they install a receiver and do not succeed at the outset in hearing regularly stations 500 to 1,000 miles away with sufficient volume to operate the loud-speaker.

There are many factors which enter into a determination of the distance from which you may expect to receive satisfactorily. The first, and perhaps most important of these, is the power of the transmitting station, together with the conditions surrounding it; there are many conditions which may prevail at the broadcasting station which will reduce the amount of energy reaching distant points.

signal increases in strength as you turn the PRIMARY CONDENSER up to 100, turn the PRIMARY INDUCTANCE switch a point to the **right** and adjust the PRIMARY CONDENSER until maximum signal strength is obtained. If maximum signal strength is still found at 100, it will be necessary to add still more inductance to the primary by turning the PRIMARY INDUCTANCE switch another point to the right. This condition, however, will very seldom be encountered except with a very small antenna.

14. After this readjustment of the Primary Circuit, it may be necessary to readjust the SECONDARY CONDENSER and REGENERATION dials very slightly. If any adjustment is found necessary, it will be very slight.

X. TUNING FOR TELEGRAPH STATIONS

1. FOR SPARK STATIONS

Tuning for spark telegraph stations is the same as tuning for broadcasting stations except that their wave-lengths are somewhat different and the setting of the secondary condenser will consequently be different. When receiving spark telegraph signals, the set should ordinarily not be oscillating, but if the signals are very weak, it may be desirable to put the receiver in its most sensitive state by allowing it to oscillate. The principal objection here is that the signals are rough in quality instead of possessing a clear musical quality.

2. CONTINUOUS-WAVE SIGNALS

When tuning for continuous-wave (C. W.) telegraph signals, the receiver must be in an oscillating condition, consequently the plate dial should be turned far enough to the right so that the whistling sound of the carrier wave, which indicates oscillation, is heard. The whistling sounds in the case of C. W. telegraph stations are the actual signals themselves, otherwise tuning is the same as for broadcasting telephone stations.

XI. GENERAL NOTES FOR BEST RESULTS

1. PROPER "B" BATTERY VOLTAGE

It is important for the best operation of the set that the proper detector "B" battery voltage be used for the particular vacuum tube which you are using in the receiver. For a given class of tubes, this voltage varies considerably, ranging from as low as eight volts occasionally, to as high as 22½. It will, therefore, be seen that when you have tuned in on the set, you should try changing the positive "B" battery connection on the detector battery throughout the entire range of the battery until the best value is found. It will ordinarily be found between 12 and 16½ volts and usually you should not

6. Set the REGENERATION at 0.
7. Set the GRID CONDENSER at 50.
8. Set the SECONDARY INDUCTANCE at 1.
9. Set the SECONDARY CONDENSER at 50, with the small vernier knob at the left pointing straight up. Have the FILAMENT Rheostat Vernier (the small FILAMENT knob) pointing straight up.

10. Turn the Amplifier first-stage dial to about 80. Plug the phones in at 1, then turn the FILAMENT Rheostat Dial to the right until a hissing sound is heard in the phones. Turn the dial then slightly back to the left until the hissing just ceases.

11. Leave all of these knobs set in these positions, except the SECONDARY CONDENSER and REGENERATION dials. Take one of these in each hand; move the SECONDARY CONDENSER dial slowly back and forth between 5 and 100 (which covers practically all broadcasting stations), at the same time gradually turning the REGENERATION dial to the right until you hear a whistling sound. This whistle is a sound produced by the carrier wave of a broadcasting station when the receiver is oscillating. Leave the REGENERATION dial at this position and turn the SECONDARY CONDENSER very slightly in both directions. You will find that this whistle varies in pitch, going down to a certain point where it disappears, and then up again in pitch. At the mid-point where the whistle disappears, the SECONDARY is exactly tuned to the wave-length of the station whose carrier wave you have just heard. The small vernier knob to the left will enable you to find this point very accurately.

12. Turn the REGENERATION dial slightly back to the left until the music becomes clear and distinct, keeping the station tuned in meanwhile by the use of the small vernier knob. You will note that the strength of the signal decreases as the REGENERATION dial is moved to the left; consequently, it should be kept as far to the right as possible without distortion. After you have used this receiver for a while you will see that in general the further to the right your SECONDARY CONDENSER dial is set, the further to the right will you have to set the REGENERATION dial, as in general an increase in the SECONDARY CONDENSER capacity will require an increase in REGENERATION for best results. Similarly, as you tune for a shorter wave-length by turning the SECONDARY CONDENSER to the left, you will have to turn the REGENERATION dial to the left also.

13. Now try adjusting the PRIMARY CONDENSER, turning it slowly to the right and left. If you get maximum signal strength when this is at 0, move the PRIMARY INDUCTANCE switch one point to the left and come back with the PRIMARY CONDENSER toward 100 until you get the best signal strength. If, however, the

The second factor relates to conditions surrounding the receiving station, such as the height of the antenna and its distance from surrounding objects, such as buildings, trees and large masses of steel or other magnetic or metallic material which might absorb a large part of the incoming energy. A third and very important factor is, of course, the efficiency of the receiver.

With a Kennedy Receiver it should be possible, ordinarily, when the antenna is good and other conditions are favorable, to receive the more powerful broadcasting stations at a distance of approximately 500 miles. In many instances very much greater distances have been satisfactorily covered, but likewise, under unfavorable surrounding circumstances, distances even of this magnitude should not be expected.

The commercial transmitting range of the average high-class broadcasting station (250-500 watts) would be rated at about fifty miles. The so-called "commercial range" is the distance which the station may be called upon to cover under all ordinary conditions, day or night, and such a station therefore would be used for commercial work for distances of not more than fifty miles.

We can, therefore, realize that when we hear a broadcasting station 500, 1,000 or 1,500 miles away, it is accomplishing a far greater transmitting distance than ordinarily we have a right to expect.

A factor which is often lost sight of by the radio novice is the difference in reception between day and night. Distances which may be regularly covered at night are often not possible in the daytime, since transmitting conditions are very much better in the former case. Transmission is also better in the winter time than in the summer, so that much greater distances are covered during the former season. The "commercial range" above mentioned, however, takes account of these less favorable conditions.

2. THE LOUD-SPEAKER

Many a user of a radio set is somewhat disappointed because he does not receive distant stations clearly and loudly through the medium of his loud-speaker. It should be remembered that signals will be heard much more clearly and distinctly in the head telephones than is possible in the best loud-speaker. In fact, a very distant station may be heard in the head telephones with hardly an indication of its presence being given by the loud-speaker. It is for this reason that the recommendation is made later in these instructions that tuning be done with the head telephones rather than with the loud-speaker, especially for distant stations.

It is also possible to distort the music and voice if the loud-speaker is not handled properly. This fact will be recognized by

anyone who has heard many of the public demonstrations of radio, particularly in cities where the music is often thrown out into the street by some of the dealers in radio apparatus. Here the person handling the receiver is interested in getting all the volume possible and often forgets the importance of maintaining the proper quality. As in many other forms of sound production, maximum volume is usually attained at a sacrifice of quality.

It is to be recommended that the user of a radio set listen with his head telephones occasionally if he doubts the quality of the music and voice as it comes from his receiver. He will quickly note that the quality of the voice heard, and consequently of the music, is far superior to that which he hears in his daily use of the wire telephone. It is suggested that when distorted and unsatisfactory signals are heard from the loud-speaker, the difficulty should be sought in the latter rather than in the receiving apparatus itself, providing the receiver has been tuned properly in accordance with these instructions.

III. ACCESSORIES NEEDED

Ordinarily the Kennedy Type-110 Receiver is used with the Type-525 Amplifier. In this case the complete installation of the receiver, amplifier and accessories will include the following:

1. **A 6-volt Storage Battery,** preferably of 80- to 120-ampere-hour capacity. The larger its capacity the less frequently does it need to be charged. (If the new style low-current tubes are used, a smaller battery is sufficient.)

2. **One 22½-volt tapped "B" Battery** (Plate Battery). The large size unit is recommended, as it has a longer life than the smaller size and the cost is but little more. The taps should provide a variation, if possible, from 12 to 22½ volts.

3. **One 45-volt "B" Battery** for Amplifier.

4. **A Detector Tube,** such as the Radiotron UV-200 or Cunningham C-300.

5. **Two Amplifier Tubes,** such as the UV-201, C-301, UV-201A or C-301A.

6. **One pair of Head Telephones.**

7. **Antenna and Ground Equipment,** consisting in general of—

   Approximately 200 feet of antenna wire.
   Two or more suspension insulators.
   One lead-in insulator.
   One lightning arrester.
   One ground clamp.

duces the same effect as shortening the antenna and, therefore, decreasing its wave-length. It is, therefore, necessary to compensate for this shortening effect by adding more wire (**inductance**) by means of the PRIMARY INDUCTANCE switch. Consequently, with the SERIES-PARALLEL switch in the SERIES position, the PRIMARY INDUCTANCE switch is turned about two points farther to the right than it would be for the same wave-length when the SERIES-PARALLEL switch is in the PARALLEL position.

7. GRID CONDENSER

The GRID CONDENSER is a refinement added for the purpose of adjusting the receiver so that it operates most effectively with all standard detector tubes. Until the user of the receiver becomes thoroughly familiar with its operation, it is best to leave this set at approximately 50, since the effect which it produces is but small. When he has thoroughly mastered the operation of the other controls, he can then afford to experiment with this additional refinement to determine its best setting. For the very long wave-lengths (such as used by high-power radio **telegraph** stations) a higher setting is necessary than that used for short-wave work.

IX. SPECIFIC TUNING INSTRUCTIONS FOR BROADCASTING STATIONS

When tuning the Kennedy Universal Receiver within a limited band of wave-lengths, such as employed for broadcasting, it is necessary to tune primarily with only two knobs, as the other controls may all be set in the proper positions once and allowed to remain there. The two controls which are thus used for tuning are the SECONDARY CONDENSER and REGENERATION. It will be assumed, in the outline which follows, that we are tuning for a broadcasting station, and consequently working within the band of wave-lengths covered by the new Class B stations which operate between 300 and 550 meters.

1. In tuning for distant or semi-distant stations, it is usually easiest to use the first stage of amplification in conjunction with the head phones rather than a loud-speaker. When the user becomes expert, he may satisfactorily use the loud-speaker without using the phones except for very great distances. To use the first stage of amplification, the phones or amplifier plug should be plugged in at "1." If the phones are connected on a plug, the regular amplifier plug should not be plugged into position.

2. Set the COUPLING at 3.

3. Set the PRIMARY INDUCTANCE at 2.

4. Set the PRIMARY CONDENSER at 50.

5. Set the SERIES-PARALLEL switch at PARALLEL (PAR).

5. FILAMENT CONTROL

The large dial marked FILAMENT controls the filament rheostat. The battery is turned off when this knob is turned to the extreme left, and the filament brilliancy is increased as it is turned to the right. This should be adjusted just below the "hissing" point when tuning the receiver, and ordinarily will not require further adjustment.

The small knob with the arrow to the right of this, also marked FILAMENT, provides a means of fine adjustment of the filament current. It is seldom necessary to use this, but it may be useful for a very fine final adjustment. It is sometimes helpful in getting the maximum possible signal strength without distortion from a distant station which is still heard only faintly after it is tuned in.

A voltmeter is provided for indicating the voltage applied across the terminals of the filament of the vacuum tube, and also to indicate the condition of the "A" battery. When the vacuum tube is removed from its socket in the receiver and the receiver FILAMENT dial is turned to 100, this voltmeter should indicate six volts, or slightly over, providing, of course, the "A" battery is an ordinary six-volt storage battery used in conjunction with the standard six-volt tubes. If a lower voltage is indicated by the meter, the battery is in need of charging. If the 1½-volt tubes are used, the voltmeter should similarly indicate 1½ volts when the battery is new. As the batteries are used this voltage will decrease, but the batteries are still effective with this tube until the voltage drops to approximately one volt. Similarly, when the UV-199 tubes are used, the initial voltage should be 4½ volts, which may decrease nearly to 3 volts before it is necessary to substitute new batteries. When the tube is inserted the voltage will be lower, depending upon where the FILAMENT dial is set. It will be noted for a given detector tube that the hissing point will always be found at approximately the same voltage each time, providing the settings of the other controls are the same.

6. SERIES-PARALLEL SWITCH

The SERIES-PARALLEL switch, controlled by the small knob at the right of the PRIMARY CONDENSER, is for the purpose of providing greater flexibility in tuning the primary circuit of the receiver under the varying conditions encountered in different antenna installations.

Under ordinary conditions, this switch will be turned to the right to the parallel connection (PAR.). When the receiver is used with some antennae, however, it is possible that there may be certain wave-lengths to which the primary can be tuned most effectively by turning this switch to the left or series position (SER.). This pro-

8. **Wire for Connection Purposes.** For connections to the storage battery, No. 12 rubber-covered copper wire should be used. For other connections No. 16 or No. 18 insulated copper wire (such as annunciator wire, lamp cord or silk-covered fixture wire) is satisfactory.

9. A loud-speaker may also be used if desired in place of or in addition to the head telephones.

IV. NOTES ON CONSTRUCTION OF ANTENNA AND GROUND

1. THE ANTENNA OR AERIAL

The simplest and most effective antenna for radio broadcast reception is, in general, a single aerial wire 75 to 150 feet in length, insulated and supported at each end, stretched as high in the air as possible and as far from surrounding objects of any size as practicable. A wire should be connected to the receiving set by as short and direct a route as possible from the nearest point of the aerial. It is best to have this wire lead directly from the receiver to one end of the aerial without doubling back upon itself and reversing its direction. In other words, it should as nearly as possible approximate the shape of an inverted "L."

The "lead-in," as this wire is called, should be insulated at every point where it comes in contact with anything other than the aerial wire itself or the apparatus to which it is connected. It is for this purpose that insulators are provided and that a lead-in insulator is used for bringing the antenna wire through the wall or window. All joints should provide as secure and clean metallic and electrical contact as possible by the wrapping of one wire several times around the other and having them well scraped or cleaned before connecting them. It is very important that these joints be soldered, also.

When an antenna longer than 60 feet cannot be made available, two parallel wires spaced about 3 feet apart may be used instead of the single wire previously described. They should also be insulated at all points of contact except where connection is made to the lead-in wire. The lead-in should be connected to the nearest point, as with the single-wire antenna.

The higher the antenna, within reasonable limits, the greater will be its capability of picking up energy from the transmitting station. Similarly, a large antenna will pick up more energy than a small one. The larger the antenna, however, the longer the wave-length to which it is inherently tuned and for this reason there is a practical limit of antenna size for reception from broadcasting

stations which operate on comparatively short wave-lengths. This is the reason for specifying a single-wire aerial of approximately 125 feet in length as being most desirable for broadcasting reception. If it is remembered that the better the antenna, the better the signal strength from the receiver, it will be understood that a good antenna is a comparatively inexpensive means of obtaining amplification.

An antenna suspended directly above a tin roof, or near some other large body of metal, is highly undesirable, as a large portion of the energy received by the antenna is absorbed by the mass of metal in its vicinity.

The installation of an approved lightning arrester is required by the Fire Underwriters' rules. The radio dealer can advise regarding approved devices of this sort. It should be connected between the antenna "lead-in" wire and ground (not necessarily the same ground connection as used for the receiver) as near as possible to the entrance of the antenna to the building.

The wire most commonly used for aerial construction is of bare stranded hard-drawn copper or phosphor bronze. This may be procured from any radio dealer. No. 14, or larger, bare, solid hard-drawn copper wire is, however, very frequently used and is thoroughly satisfactory. Another type of antenna wire which is frequently used is a steel-core wire with a copper exterior. This provides the advantage of considerable strength.

Glazed porcelain, or other standard types of insulators, should be used at the two ends of the antenna. The insulating length of these should be about three inches each. An insulating tube should be used for bringing the antenna wire through the wall or window in order that there may be no leakage of the current picked up by the antenna.

Further details of antenna construction may be obtained from the Lefax Radio Handbook referred to on page 21 of this bulletin.

2. THE GROUND

The ground wire may be the same size and kind as that used for the antenna, although insulated wire is to be preferred for this purpose. The same kind as used for connecting the storage batteries (No. 12 rubber-covered copper wire) may be used satisfactorily, although wire of much smaller size is sufficient. Ordinarily, the best ground connection is a wire leading by the most direct route from the GROUND binding post on the receiver to the nearest cold-water pipe or steam radiator, preferably the former. If a ground clamp is not used, this connection should be soldered to insure good electrical contact. If the installation is in a rural district where the water supply system is a private one, this will also furnish an excellent ground. If neither a water supply pipe nor a steam radiator is available, it will be necessary to provide an independent ground,

The small knob below and to the left of the SECONDARY CONDENSER dial is a vernier or fine adjustment for this condenser. When the arrow points straight up, the vernier is in its middle position and should be left there while adjusting the main condenser. For a final very fine adjustment of wave-length, this knob should be turned slowly from left to right until the very best position is found.

3. COUPLING

The dial marked COUPLING controls the relation in the receiver between the primary and secondary circuits. This is usually set somewhere below 5—for ordinary use, at about 3. This is the feature of the receiver which, in conjunction with the carefully balanced design and co-ordination of the various parts, gives the desirable characteristic of selectivity, or the capability of eliminating stations which we do not wish to hear. When both primary and secondary circuits are tuned very accurately to a given wave-length and the coupling is set at a very low value, only signals upon that wave-length are transferred across from primary to secondary and the receiver is said to be selective.

In tuning the receiver it is best to set the coupling at approximately 3 and let it alone, unless there is interference between two or more stations, one of which it is desired to hear. In this case the coupling should be reduced to a lower value, sometimes even as low as 0, and the receiver then retuned. The tighter the coupling (that is, the higher on the scale), the easier it is for other wave-lengths to be transferred across between the primary and secondary than those which we desire, and the less selective the receiver. The looser the coupling, the greater the selectivity. Unless there is interference, however, it is slightly easier to get the signals desired with the coupling as high as 3 or 4. For wave-lengths below 1,000 meters, the coupling should never be higher than 5. For wave-lengths greater than 1,000 meters, any value of coupling up to 10 may be used.

4. PLATE CIRCUIT

The plate circuit of the receiver controlled by the dial marked REGENERATION, is that one which controls the feature of regeneration. As this dial is turned from left to right, the receiver becomes more and more sensitive until the tube reaches the point where is oscillates. Although the sensitivity increases still further beyond this point, the receiver should not be permitted to oscillate except when receiving certain types of telegraph signals. The dial should, therefore, be set just below the oscillation point. This will be described later.

right. Each step adds a considerable amount of wire (inductance) to the antenna circuit and consequently increases the wave-length of that circuit.

In order to make small changes, however, in the wave-length of the primary circuit, the PRIMARY CONDENSER is provided. As this is turned from 0 to 100, condenser capacity (and consequently wave-length) is added in very small steps. Therefore, if we start with the PRIMARY INDUCTANCE switch at 1, we can gradually increase the wave-length of our primary or antenna circuit by turning the PRIMARY CONDENSER from 0 to 100. If we need to increase the wave-length still further, the next step is accomplished by turning the PRIMARY CONDENSER back to 0 and moving the PRIMARY INDUCTANCE switch to 2, then increasing the PRIMARY CONDENSER again toward 100. In this way we can increase the wave-length of the primary or antenna circuit from the lowest value to the highest as gradually as we choose.

The approximate settings of the PRIMARY INDUCTANCE switch for various wave-lengths are given on page 23. This assumes the use of an average antenna and the SERIES-PARALLEL switch in the PARALLEL position. It should be understood that since the setting of this switch depends upon the characteristics of the antenna, it is impossible to give more than an approximate setting.

2. SECONDARY CIRCUIT

The secondary circuit is entirely self-contained within the receiver and consequently is practically independent of the antenna for its tuning. It must also be tuned to the wave-length of the incoming signals. To increase the wave-length of the secondary circuit, we use the SECONDARY INDUCTANCE and SECONDARY CONDENSER in exactly the same manner as we do the PRIMARY INDUCTANCE and PRIMARY CONDENSER in tuning the primary circuit. In this case, however, it is possible to calibrate the secondary with a very much greater degree of accuracy, because of its very much greater independence from the antenna circuit. Page 23 shows settings of the SECONDARY INDUCTANCE switch and the SECONDARY CONDENSER for different wave-lengths. It is, therefore, possible to determine the position of the SECONDARY CONDENSER within a few degrees on the dial for a given known wave-length. It should be remembered, however, that thus far broadcasting stations in general have not operated accurately upon their normal wave-length ratings, and therefore it has not been possible to tune for most stations by this method. It is believed, however, that the new regulations permitting a greater range of broadcasting wave-lengths and providing for more accurate tuning at the transmitting station will make this possible in the future.

preferably by burying a copper plate about 1/32 inch thick and two feet square or larger, as deep in the moist earth as practicable. To this should be securely soldered the wire which leads by the shortest route possible to the GROUND binding post on the receiver.

3. THE LIGHTING CIRCUIT USED AS AN ANTENNA

There are a great many devices now on the market for permitting the use of the house-lighting or telephone circuit instead of an outdoor antenna. Although this type of antenna gives good results on reception from nearby stations, its use is not recommended when it is desired to receive from distant stations, as the energy picked up by this kind of antenna is very much smaller than that collected by the more effective outdoor type.

V. CONNECTING THE SET FOR OPERATION

The proper connections between the batteries and the receiver and amplifier, as well as those from the instruments to the antenna, ground and telephones, are shown in illustration on page 4, which is self-explanatory.

It should be noted that the two "B" batteries are connected in series and, therefore, no connection should be made from the (—) "B" connection on the amplifier to the "B" battery, this connection already being made by the wiring within the set. If two entirely separate "B" batteries are used, however (there being no connection between them), leads must be run from the (—) "B" connection on the amplifier to the negative terminal of the amplifier "B" battery and from the (+) "B" terminal on the amplifier to the positive terminal on the amplifier "B" battery. The amplifier "B" battery should supply from 45 to 90 volts.

If the new Type UV-201A or 301A vacuum tubes are used in the amplifier, the negative terminal of the "A" battery should be connected to ground.

If the dry-cell type of vacuum tube, such as the WD-12 or the UV-199 is used, care should be taken that the voltage specified for the tubes on their containers is not exceeded, otherwise the filament will be burned out. The WD-12 tube uses a filament voltage of 1½ volts, which is supplied by a single ordinary dry cell or by two or more in PARALLEL. If the UV-199 tubes are used, the filament voltage should not exceed 4½ volts, which is obtained by connecting three standard 1½-volt dry cells in series. The entire voltage of a storage battery must NOT be used if WD-12 or UV-199 tubes are employed. *If the UV-199 tube is used, an external rheostat of approximately 30 ohms resistance should be connected in series with the "A" battery.*

VI. USE OF VACUUM TUBES

Kennedy instruments are designed for use with the standard 6-volt vacuum tubes. The method of insertion of the tube in the socket and turning to the right as far as it will go should be obvious.

A detector (or soft tube) is used in the receiver and standard amplifier tubes in the amplifier. As previously mentioned, the standard amplifier tubes are the Types UV-201, C-301, UV-201A or C-301A. The latter two types of tubes use only approximately one-fourth of the current from the storage battery required by the former two. In case the latter tubes are used, however, care should be taken that the negative terminal of the "A" battery is connected to ground; there is otherwise a tendency toward "singing" or "howling."

The UV-199 and WD-12 tubes are designed for use with dry cells as substitutes for storage batteries for supplying the filament current. When these tubes are used, certain precautions such as outlined in the preceding section must be observed, otherwise there is serious danger of burning out the filament and thereby destroying the tube.

VII. WHY TUNING IS NECESSARY

For purposes of illustration let us assume that your receiving set is being installed in New York City for the purpose of receiving music and speech from the various broadcasting stations both far and near. Within a very few miles of you are located large, very high-powered radio telegraph stations sending messages continuously across the Atlantic Ocean to such distant points as Carnavon, Wales; Bordeaux, France; Nauen, Germany; Stavanger, Norway; and Rome, Italy, as well as Buenos Aires, Argentina and many points in other directions. At the same time high-powered United States Naval Stations are likewise sending messages up and down the coast, to ships at sea, across the continent to points on the Pacific Coast, and to our Island possessions in the Pacific Ocean. Numerous other types of stations in your vicinity, such as amateur, experimental, ship and shore stations are also exchanging messages almost continually.

Nevertheless, with a good radio receiver, you are able to receive from the broadcasting stations without hearing these myriad other stations which are transmitting at the same time. The reason for this is that these various types of stations are required to transmit on different wave-lengths from those used by broadcasting stations. The wave-length at which a station transmits is controlled by the adjustment of the apparatus in that station—in other words, the tuning of the transmitting apparatus. Similarly, at the receiving end, the receiver must be adjusted or tuned to the same wave-length

in order to receive from this station. Consequently, if you have a selective receiver, and it is tuned to a broadcasting wave-length, you will not hear those transmitting stations which are adjusted to other wave-lengths.

The Kennedy Type-110 Universal Regenerative Receiver is designed so that it may be tuned to operate efficiently on any wave-length between 200 and 25,000 meters, or, in other words, to any wave-length in practical use in radio communication. Consequently, it will receive all stations transmitting with power enough to enable their waves to reach the receiving antenna with sufficient intensity—not only the radio telephone broadcasting stations in which the greatest number of people are interested, but also all radio telegraph stations. The necessary tuning is accomplished by means of the various knobs and dials on the face of the panel. The detailed procedure, together with a brief explanation of the theory of tuning, is outlined in the paragraphs that follow.

VIII. HOW THE RECEIVER IS TUNED

There are two principal circuits or parts of the receiver which must be tuned to the wave-length of the desired transmitting station, namely, the primary and secondary circuits. A third, or auxiliary circuit, known as the plate circuit, also forms an important part of the Type-110 Receiver. The functions of the various controls in tuning these circuits are briefly described in the paragraphs that follow. The proper order of procedure in tuning, however, is outlined under Section IX, "Specific Tuning Instructions," as well as in the "Easy Tuning" instructions on pages 2 and 3.

1. PRIMARY CIRCUIT

The primary circuit is the part of the instrument that is connected directly to the antenna and ground which actually form an external part of this portion of the receiver. Every antenna and ground system has a certain definite wave-length to which, unaided by additional apparatus, it is inherently tuned. This wave-length is determined principally by the length of wire used.

For purposes of explanation let us assume that the natural or inherent wave-length of your antenna is 160 meters and that you want to receive from a station transmitting on 360 meters. It is consequently necessary to tune your primary to 360 meters. This means that you must add enough wire (inductance) to your antenna to increase its wave-length from 160 to 360 meters, or, in other words, to add 200 meters of wave-length inside the receiver. This is done by turning the PRIMARY INDUCTANCE switch from left to