PLEASE FILL OUT AND MAIL THE STAMPED, ADDRESSED POST CARD ENCLOSED WITH THESE INSTRUCTIONS.

THE COLIN B. KENNEDY COMPANY

INCORPORATED

RADIO APPARATUS OF QUALITY

SAINT LOUIS — KENNEDY EQUIPMENT — SAN FRANCISCO

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INSTRUCTIONS

FOR

THE INSTALLATION AND OPERATION OF

KENNEDY TYPE 220 INTERMEDIATE-WAVE

REGENERATIVE RECEIVER

AND

TYPE 525 TWO-STAGE

AUDIO FREQUENCY AMPLIFIER

All Kennedy Regenerative Receivers are licensed under Armstrong

CONTENTS

SETTINGS FOR PRINCIPAL WAVE-LENGTHS USED

Wave-Length in meters	Principal use of This Wave-Length	Approximate Setting of Primary Inductance Switch Knob No. 2 (No. 8 Switch at "Par.")	Setting of Secondary Inductance Switch Knob No. 5	Setting of Secondary Tuning Condenser Knob No. 6
200	Amateur stations—principally telegraph	1	1	4
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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 Series—Parallel Switch in the *Parallel* position.

The Primary Tuning Condenser should be set at 50 to begin with, so that it may be turned to either the right or left in tuning.

Interesting information concerning the various radio stations of the world (principally telegraph) may be obtained from the many radio directories now on the market.

TABLE II.

APPENDIX

Position of Secondary Inductance Switch. KNOB NO. 5 (Positions Numbered from the left)	Setting of Secondary Tuning Condenser DIAL NO. 6	WAVE-LENGTH in METERS	Approximate Position of Primary Inductance Switch. KNOB NO. 2 (No. 8 Switch at "Par.")
1	0	185	1
	10	250	2
	20	305	2
	30	350	3
	40	390	3
	50	420	4
	60	450	4
	70	480	4
	80	510	4
	90	535	4
	100	560	4
2	0	380	4
	10	460	4
	20	530	4
	30	590	4
	40	650	5
	50	715	5
	60	770	5
	70	825	5
	80	880	5
	90	920	6
	100	960	6
3	0	730	6
	10	835	6
	20	950	6
	30	1060	6
	40	1170	6
	50	1260	6
	60	1350	7
	70	1440	7
	80	1525	7
	90	1600	7
	100	1650	7
4	0	1270	7
	10	1500	7
	20	1790	7
	30	2060	7
	40	2290	8
	50	2500	8
	60	2700	8
	70	2890	8
	80	3060	9
	90	3210	9
	100	3350	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 Series—Parallel Switch in the *Parallel* position.

The Primary Tuning Condenser should be set at 50 to begin with, so that it may be turned to either the right or left in tuning.

TABLE I.

INSTRUCTIONS
FOR
THE INSTALLATION AND OPERATION OF KENNEDY TYPE 220 INTERMEDIATE-WAVE REGENERATIVE RECEIVER AND TYPE 525 TWO-STAGE AUDIO-FREQUENCY AMPLIFIER

I. INTRODUCTION

This pamphlet is intended to give to the uninitiated the necessary information for the proper installation and operation of his Kennedy Type 220 Intermediate-Wave Regenerative Receiver and its companion instrument, the Type 525 Two-Stage Audio-Frequency Amplifier.

It is recommended that the user read these instructions through before attempting to operate his set, for it is believed that the information contained herein will be of real assistance to him.

There are some, of course, who are sufficiently familiar with the principles of radio receiving equipment, the necessary connections and the procedure in tuning so that much of this information will seem unnecessary. To these it is suggested, however, that a reading of the instructions on page 14 under the heading "SPECIFIC TUNING INSTRUCTIONS," will be helpful.

In the preparation of these instructions the idea has been kept in mind that the beginner in radio will tune his set far more intelligently and therefore more effectively if he has a definite idea of the reasons for the various adjustments. An attempt has been made, therefore, to give a brief, simple explanation of the functions of the various parts of a radio receiver before outlining the actual operations of tuning. It is, consequently, recommended that the reader study the various subjects covered by this pamphlet in the order presented.

Many novices seem to believe that tuning a receiver consists in a "hit or miss" turning of the various control knobs. This is far from the truth. There is a definite reason for every adjustment and if the user clearly understands these reasons he will tune his receiver most intelligently and therefore obtain the best results.

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 when 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 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 covered by the light from a single electric lamp utilizing this amount of energy. We all know that it would be seen only faintly 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 broadcasted is heard by countless thousands. Each receiving station's share of the very small initial amount of energy sent out is exceedingly minute and yet it 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 radio telephones and the uninitiated public have been led, in many cases, to expect the impossible without realizing what it meant. 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. These remarkable performances have not been described as being exceptional or unusual and the uninitiated have consequently 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 1000 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. 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 larges masses of steel, 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 of this sort should not be expected.**

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

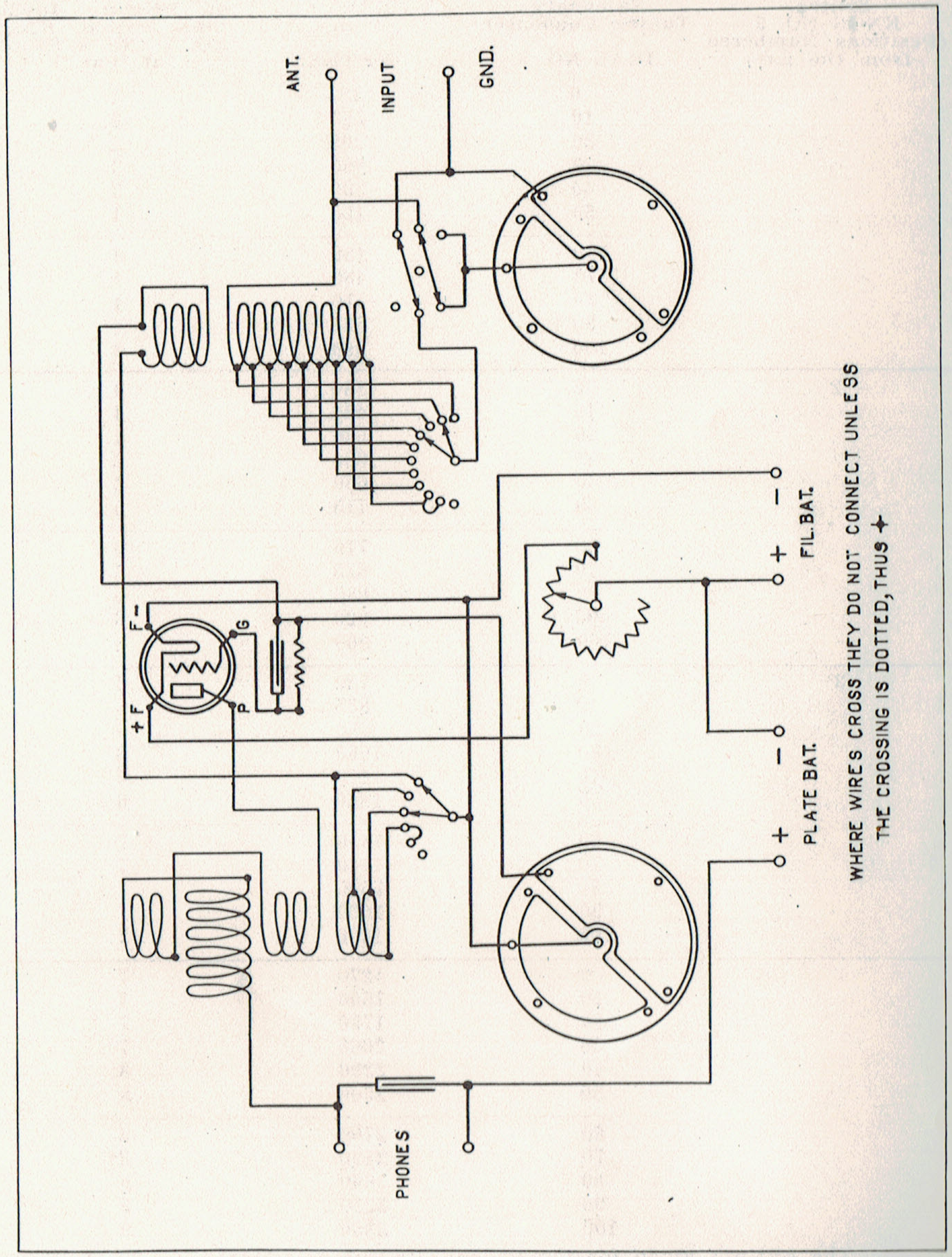

Figure 2.

Wiring Diagram of Kennedy Type 220 Intermediate-Wave Regenerative Receiver. (Back View.)

pose 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, there may be certain wave lengths to which the primary can be tuned most effectively by turning the series-parallel switch to the *left* to the *series* position (SER.). This produces the same effect as *shortening* the antenna and therefore *decreasing* its wave length. It is necessary, therefore, to compensate for this shortening effect by adding more wire (*inductance*) by means of the primary inductance switch. Consequently, when the series-parallel switch is in the *series* position, the primary switch (Knob No. 2) is turned about two points *farther to the right* than it would be for the same wave-length with the series-parallel switch in the *parallel* position.

4. FILAMENT RHEOSTAT.

Every vacuum-tube detector has a definite filament brilliancy at which it operates best As there is considerable variation between detector tubes, means are provided in the receiver for adjusting the current which lights the filament to the proper value best suited to the particular tube in use. This is accomplished by means of a filament rheostat controlled by Knob No. 7 marked "FILAMENT."

This control serves two purposes—(1) that of switching the filament current on and off, and (2) that of definitely adjusting the filament brilliancy to the proper value. *When the receiver is not in use, the current should always be turned off by turning the filament rheostat knob to the extreme left against the stop.*

When the receiver is to be used the current should be turned on and the proper adjustment determined by first setting the *regeneration* at 0 and then turning the filament rheostat knob (No. 7) to the *right* until a hissing sound, similar to that of escaping steam, is heard in the telephone receivers or loud-speaker. The knob should then be turned very slightly to the *left* until the hissing just ceases. This is the proper filament adjustment for the particular detector tube in use and it will need very slight, if any, further adjustment when the receiver is tuned.

X. SPECIFIC TUNING INSTRUCTIONS FOR KNOWN WAVE LENGTHS

It is to be recommended that the receiver be always tuned by the use of head telephones rather than a loud-speaker, and without the use of the amplifier, even though an amplifier be connected to the receiver. If an amplifier is connected, the plug should be placed in the first jack marked "D" on the amplifier and a pair of head telephones connected in place of the loud-speaker (if one of the latter is employed). This is of particular importance when tuning for distant stations, as it is difficult to accomplish tuning of this sort when using the loud-speaker, on account of the very small amount of energy reaching the receiver from a distant station.

After the desired station is satisfactorily tuned in, the amplifier and loud-speaker may be connected in and used as described below.

Before the desired signal is heard there are two separate circuits or parts of the receiver that must be adjusted or tuned to the exact wave-length of the transmitting station. These are the *primary* and *secondary* circuits.

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

For purposes of explanation, let us assume that the natural or inherent wave-length of your particular antenna is 160 meters and that you desire to tune the primary of your receiver to 360 meters in order to receive from a station adjusted to transmit at that wave-length. To tune the *primary* to 360 meters it is necessary to add enough wire (*inductance*) to your antenna to increase its wave-length from 160 to 360 meters. In other words, 200 meters of wave-length must be added within the receiver before the primary circuit is tuned to 360 meters. Wire (*inductance*) is *added* to the antenna circuit as the *primary switch* (Knob No. 2 on Figure 1) is turned to the *right*, thereby tuning or adjusting the primary circuit to a *higher* wave-length. When this knob is turned to the extreme *left*, the smallest amount of wire is added and the primary is consequently tuned to the *shortest wave length*. Every time this switch is moved a step to the *right* a certain amount of wire is *added* to the primary, thereby tuning it to a *greater wave length*. Inversely, as this knob is turned back to the *left*, the *primary wave-length is decreased*, since wire is then taken out of the circuit.

A glance inside the set by raising the top of the cabinet will reveal the coils of wire (*inductance*) which are connected in and out of the circuit by means of the primary switch.

As a large amount of wire (*inductance*) is *added* or *subtracted* from the *primary circuit* by turning switch No. 2 to the *right* or *left*, respectively, the resultant change in tuning for each step on the switch is large. Therefore, the primary may be adjusted only approximately to the wave-length of the transmitting station by this method. Since the primary must be adjusted to the *exact* wave length used by the sending station, a *finer adjustment* is accomplished by the use of the *primary tuning condenser*, which is controlled by Knob No. 3 on Figure 1, which is labeled "PRI. COND."

As this condenser is turned from left to right by means of Knob No. 3, the effect on the tuning of the primary is the same as if extremely small amounts of wire were added to the primary circuit, thereby permitting a very *gradual increase* in the wave length to which the primary is tuned. Although the effect is the same as would be obtained by adding very small amounts of wire (*inductance*), the primary tuning condenser actually adds what is known as *capacitance* (more commonly called *"capacity"*). Starting with this dial in a given position, turning it to the *right* gradually *increases* the wave-length while turning it to the *left* gradually *decreases* the wave-length of the *primary circuit.*

It should now be clear that to tune the primary to a given wave-length we must *first* make an *approximate* adjustment with the *primary switch*

(No. 2) and then adjust to the *exact* wave-length by means of the *primary tuning condenser* (Knob No. 3).

As the inherent wave-length of every antenna is different, due principally to the length of wire used in its construction, the *exact* setting of the primary switch for the different wave lengths cannot be given in advance. The *approximate* setting of this switch for different wave lengths is given, however, in Tables I and II.

The method of locating the *exact* settings of the primary switch and the primary condenser is explained under "SPECIFIC TUNING INSTRUCTIONS."

2. SECONDARY CIRCUIT.

Controlled by

Secondary Inductance Switch, "SECONDARY" (Knob No. 5).

Secondary Tuning Condenser, "SEC. COND." (Knob No. 6).

The next circuit or part of the receiver to be tuned or adjusted to the exact wave length of the transmitting station from which reception is desired is the *secondary*. This is the circuit which is connected to the vacuum tube detector. Unlike the primary, the secondary circuit in the receiver is entirely independent of, and therefore unaffected by, changes in the antenna; consequently, exact settings for the secondary switch and the secondary condenser are given in Tables I and II.

In tuning the secondary circuit, the procedure is exactly the same as in the case of the primary. Turning the secondary inductance switch (Knob No. 5 labeled "SECONDARY") to the *right adds* wire (*inductance*) to the *secondary* circuit and thereby *increases* the wave length. Turning the secondary tuning condenser (Knob No. 6, labeled "SEC. COND.") to the *right increases* the wave-length very gradually, while turning this knob to the *left* similarly gradually *decreases* the wave-length.

IX. OPERATIONS OF OTHER CONTROLS

1. THE COUPLER.

The coupler, which is controlled by the use of Knob No. 1, marked "COUPLING," is the connecting link *between* the *primary* circuit, which is connected to the antenna or ground, and the *secondary* circuit, which is connected to the detector tube in the receiver.

Interference from nearby sending stations, or from more distant stations tuned to nearly the same wave-length as the station to which you are listening, can be greatly reduced by the proper adjustment of the coupling. When considerable interference is experienced, the coupling should be set at a very low point, say 10 to 15—sometimes even as low as 5. Somewhat greater coupling should be used, however, when no interference is experienced, for with greater coupling the strength of the received signal is often greater.

When tuning to the wave-lengths of transmitting stations which operate at adjustments *below* 1,000 meters, the *maximum* coupling which should be used is approximately 50. When the wave-length on which the receiver is being tuned is *above* 1,000 meters, however, any value of coupling up to 100 may be used safely.

It should be noted that every time the coupling is changed, the tuning of the primary and secondary circuits is thereby slightly disturbed, necessitating a small readjustment of these circuits by means of Knobs 3 and 6.

Many receivers on the market combine the primary and secondary circuits and eliminate the coupler in order to reduce the number of parts in the receiver and the number of operations in tuning the set. It will be found, however, that in Kennedy Receivers, where these two circuits are used and the coupling or inter-action between them can be controlled, it is possible to eliminate stations which it is not desired to hear, which could not be eliminated with "single circuit receivers." Kennedy Receivers use the principle of "inductively coupled circuits," which provides what is in effect an electrical filter and which is recognized as the best radio engineering practice for obtaining this desirable feature of selectivity. This principle is utilized in all high-grade commercial and government receiving equipment.

2. REGENERATION.

The regenerator is controlled by the dial (No. 4) marked "REGENERATION." This is a feature which is used only in receivers employing the patented Armstrong Regenerative Circuit, and is used for the purpose of greatly amplifying or increasing the strength of the received signal by placing the receiver in a more sensitive state.

For every setting of the secondary tuning condenser "SEC. COND." (Knob No. 6), there is a certain definite point at which the regeneration must be set for *maximum* signal strength. For purposes of explanation, we shall assume that the receiver primary and secondary circuits have been tuned to a semi-distant broadcasting station and the music and speech are being heard in the head telephones. As the *regeneration* is now *increased* from 0 by turning the knob to the *right*, the *intensity* of the music and speech *increases* up to a point where the music beomes very rough in quality and distorted, but much louder than at first. The regenerator has, therefore, been turned slightly too far to the right and the receiver begins to *oscillate*. When receiving speech and music, therefore, the regeneration should be turned very slightly back to the *left* until the signals are free from distortion. In other words, the regeneration should be set *just below* the point, mentioned above, where the receiver oscillates.

When no signals are being heard, the oscillation point is distinguished by a dull click in the head telephones as the regenerator reaches the oscillating point. The location of this point varies with the different settings of the secondary condenser (SEC. COND.).

When tuning for distant stations, the regenerator should always be kept at this oscillating point, or *slightly above* it, until the primary and secondary circuits are in tune, because the receiver is then in its most sensitive state and is in the best condition for receiving weak or distant stations. The signals are then accompanied by a high whistling note and the music or speech is rough and distorted. The whistle and distortion are removed after the primary and secondary circuits are tuned by turning the regeneration dial slightly back to the left, as explained above.

3. SERIES-PARALLEL SWITCH.

The series-parallel switch, controlled by Knob No. 8, is for the purexact tune or resonance a dull click known as the **"primary resonance click"** is heard. This sounds somewhat like the oscillation click mentioned above.

3. If greater signal strength is desired from the receiver, the **regeneration** knob (No. 4) should be turned slowly to the **right**. As it is progressively moved to the right the signal strength will increase up to the point where distortion or roughness in the signal quality is encountered. The dial should then be turned slightly **back to the left** until the distortion is eliminated.

4. If there is another nearby station operating on a wave-length near that at which you are receiving and causing some interference, the **coupling** (Knob No. 1) may be turned to the left to a very low value, thereby greatly reducing the interference. When the coupling is thus "loosened" or reduced, the resultant signals may be somewhat weaker than before. They may be brought back to practically their original intensity, however, by slightly retuning the primary and secondary circuits and possibly slightly readjusting the regeneration. This point was mentioned in Section IX-1 on The Coupler.

Final Adjustments for Distant Broadcasting Stations on 360 Meters.

Tuning the receiver for distant stations is exactly the same as tuning to nearby stations except that the receiver should be in its most sensitive state in order to respond to the extremely small amounts of energy coming in from the great distance. The adjustments below should follow those given above under "Initial Settings."

1. In order to put the receiver in its most sensitive state, turn the **regeneration** dial (No. 4) to the **right** until the receiver is oscillating freely (well beyond the point where the dull click indicating oscillation is heard).

2. Readjust the **secondary tuning condenser** (Knob No. 6) by slowly turning the knob **slightly** to the **right** and **left** of its original position until the whistling note or the distorted music or voice from the broadcasting station is brought to its greatest intensity.

3. The whistling and distortion may now be eliminated by turning the **regeneration** dial (No. 4) slowly back to the **left** until these effects disappear and the resulting signals are clear and distinct. As explained above, the purpose of permitting the set to oscillate while tuning the secondary is to accomplish this tuning while the receiver is in its most sensitive state and therefore most responsive to the weak signals from distant stations.

4. If the station to which you are listening is at a great distance and the signals are very faint after this resetting of the regeneration dial, a slight improvement may now be obtained by a **very small readjustment** of the **secondary tuning condenser.**

5. The next step is to slightly readjust the **primary** circuit as indicated above for nearby stations.

6. A final **very slight adjustment** of the **coupling dial** (No. 1) may be found helpful. After considerable experience with the receiver you may find it also helpful to make a **slight adjustment** of the **filament rheostat** after all other adjustments are completed.

connected to the **negative or (—) lead from the storage or "A" battery.** The **right-hand** terminal marked "+" should be connected to the **positive or (+) terminal of the storage or "A" battery.** As suggested above, these connections should be made with No. 12 rubber-covered copper wire. **If, however, the storage battery is installed in the basement or elsewhere at any considerable distance from the set, even larger wire, such as No. 6, 8 or 10 is recommended; otherwise a considerable portion of the "A" battery voltage is lost in the wires.**

"PLATE BAT."—The **left-hand** or (—) terminal should be connected to the **negative or (—) terminal of the 22½-Volt "B" battery.** The **right-hand** or (+) binding post should be connected to the **positive or (+) terminal of the same "B" battery.**

"PHONES"—If no amplifier is used, the **head telephones** should be connected to these two binding posts, one phone terminal being connected to each binding post.

2. CONNECTIONS TO THE AMPLIFIER.

"INPUT"—The **upper** binding post should be connected directly across to the **upper binding post on the receiver marked "PHONES."** The **lower** binding post should be similarly connected to the corresponding **lower binding post on the receiver.**

"FIL. BAT."—The **left-hand** terminal marked "—" should be connected to the **negative terminal of the same storage battery** that is connected to the corresponding "FIL.BAT." binding post on the receiver.

The **right-hand** or (+) binding post is similarly connected to the **positive or (+) terminal of the same battery.**

"PLATE BAT."—**The left hand or (—) binding post should be left with no external connection unless an entirely separate "B" battery is used for the amplifier.**

The **right-hand** or (+) terminal should be connected to the **positive or 45-Volt (+) terminal of the 45-Volt "B" battery,** the (—) terminal of which should be connected across to the 22½-Volt (+) terminal of the 22½-Volt "B" battery used for the receiver. This connection is clearly illustrated on the diagram (Figure 1).

If entirely separate "B" batteries are used for receiver and amplifier, the **negative** or (—) terminal of the 45-Volt or amplifier "B" battery is connected to the (—) or **left-hand "PLATE BAT."** binding post on the amplifier and *no connection is made between the amplifier "B" battery and the receiver "B" battery.*

Connections shown on the diagram and previously explained, however, wherein the two "B" batteries are connected in series, give the advantage of an amplifier "B" battery voltage of the 45 Volts of the amplifier battery, plus the 22½ Volts of the receiver "B" battery, or a total of 67½ Volts, which is highly desirable.

"OUTPUT"—Either the **head telephones** or a **loud-speaker** may be connected to these two binding posts.

VI. INSERTION OF VACUUM TUBES

Sockets are provided in receiver and amplifier for the detector and amplifier tubes. There is a slot in the socket for the small pin on the side of the vacuum tube base. To insert the tube, therefore, the base of the tube is inserted in the socket in such manner that the pin enters this slot. The tube is then pushed downward as far as it will go and then turned gently to the right until the contacts snap into place. Care should be taken that the correct tubes, as previously listed, are used in their proper places. For the **receiver,** a **detector tube** should be used and standard **amplifier tubes** for the **amplifier.**

VII. WHY TUNING IS NECESSARY IN RADIO

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 Carnarvon, 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 using the ether 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 and your receiver is tuned to the wave-length of one of these broadcasting stations. In order to receive from any transmitting station, it is necessary to tune (that is, adjust) your receiver to the same wave-length as is used by that transmitting station.

The Kennedy Type-220 Intermediate-Wave Regenerative Receiver is designed so that it may be tuned to any wave- length between 200 and 3200 meters. It is, therefore, possible to receive signals from any of the stations using wave-lengths within these limits providing, of course, that the station in question is using enough power to enable its waves to reach your receiving apparatus with sufficient intensity. Tuning is accomplished in the receiver by making the proper settings of the various knobs and dials. The procedure is explained in the following paragraphs.

VIII. HOW PRIMARY AND SECONDARY CIRCUITS ARE TUNED

1. PRIMARY CIRCUIT.

Controlled by

Primary Inductance Switch, "PRIMARY" (Knob No. 2).
Primary Tuning Condenser, "PRI. COND." (Knob No. 3).

As in driving an automobile, the best operation of the radio receiver is obtained after the user has had some little experience with it. It is obviously impossible in a book of instructions of this kind to cover every possible point that will improve the results obtained. After the user operates his receiver for a short time in accordance with these directions he will find that he instinctively tunes his receiver just as he instinctively goes through the various actions necessary in driving his automobile.

1. TUNING FOR A 360-METER BROADCASTING STATION.

Initial Settings:

Numbers referred to for various controls shown in Figure 1.

1. Set the **regeneration** (Knob No. 4) at 0.
2. Adjust the **filament rheostat** to the proper point by turning Knob No. 7 to the **right** until the hissing sound is heard, then turning back to the **left** until this just ceases.
3. Set the **coupling** (Knob No. 1) at 25.
4. Turn the **series-parallel** switch (Knob No. 8) to the **right** to the **parallel** position (PAR.).
5. Set the **primary inductance switch** (Knob No. 2) at point 3 (approximate setting in accordance with Table II).
6. Set the **primary condenser** (Knob No. 3) at 50.
7. Adjust the **secondary inductance switch** (No. 5) at point 1, at the left. (See Table II.)
8. Set the **secondary tuning condenser** (Knob No. 6) at 32 (in accordance with Table II).

Final Adjustments in Tuning to the Exact Wave Length of Nearby Broadcasting Stations on 360 Meters.

1. Adjust the **secondary tuning condenser** by turning **slightly** to the **right** and **left** of the position at which it was placed above, until the greatest strength of received signals is obtained. Leave it in this best position.

2. Readjust the **primary circuit** as follows (the former setting being only **approximate**):

Slowly turn the **primary tuning condenser** knob (No. 3) to the **right** and **left** until maximum signal strength is obtained. If a constant increase is found up to 100 as the knob is turned to the **right,** this indicates that still more wire (*inductance*) is required in the primary circuit. The **primary inductance switch** (No. 2) should therefore be turned one step farther to the **right** and the **primary tuning condenser** (Knob No. 3) then turned toward 0 until the best signal strength is heard. The primary is then tuned to the exact wave-length.

If, however, the signal strength **increases** as the **primary tuning condenser** (No. 3) is turned to the **left** toward the point 0, this indicates that there is too much wire (*inductance*) in the **primary** circuit. Therefore, the **primary switch** (Knob No. 2) must be turned **back** one point to **the left.** The **primary tuning condenser** (Knob No. 3) is **then** turned to the **right** until maximum signal strength is obtained. The primary at this point is in exact tune with the transmitting station. When the primary tuning condenser is turned to the point that brings it into trolling the first stage of amplification. The left-hand knob controls the filament brilliancy of the amplifier tube in the first stage exactly as the filament rheostat knob on the receiver controls the brilliancy of the filament in the receiver. When the knob is turned all the way to the left the current is turned off. As the knob is turned to the right a greater amount of current is allowed to flow through the filament, thereby increasing its brilliancy. There is, however, no critical point in the brilliancy of the amplifier filament as there is in the case of the detector tube. The controlling knob should be turned to the right until the maximum signal strength is obtained. It is better not to go beyond this point, as the life of the tube is thereby decreased; it is consequently desirable to use as small current as possible to get the best results.

If still further strength of signal is desired, the second stage of the amplifier may be connected in and adjusted in exactly the same manner by moving the plug over to the jack labeled "2," similarly adjusting the second amplifier tube.

XII. TURNING OFF THE SET

To shut off the set completely and to cut off all current supplied by the batteries, it is only necessary to turn the three filament rheostat knobs (No. 7 on the receiver and the two on the amplifier) to the extreme left. The set may be allowed to stand in this position for any length of time without drawing any current from the batteries.

In turning off the set this way without adjusting any of the other settings, the circuits of the receiver are left tuned to the station which was last heard. If this station is operating when the set is next used, all that is necessary to bring in its signals is to place the rheostats in turn at their proper positions.

XIII. IN GENERAL

1. 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.

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. As explained elsewhere, however, the larger the antenna 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. This is the reason for specifying a *single wire* aerial of approximately 150 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.

The installation of an antenna 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 arrestor 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 coming into considerable use 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 where the antenna wire comes 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 20 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. The same kind as used for connecting the storage batteries, for which a No. 12 rubber-covered wire was recommended, 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 water pipe or steam radiator. If a ground clamp is not used this connection should be soldered. If the installation is in a rural district where the water supply is a private one, this will also furnish an excellent ground. If neither a steam radiator nor a water supply pipe is available, it will be necessary to provide an independent ground, preferably by burying a copper plate about 1/32 inch thick and approximately two feet square, as deep in the moist earth as practicable and securely soldered to 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 when receiving from nearby stations, we do not recommend its use when it is desired to receive from distant stations, as the energy picked up by an antenna of this sort is very much smaller than that collected by the more effective outdoor type. The reasons for this should, of course, be apparent. Not only must the received energy penetrate the walls of the building with some inevitable loss, but this kind of indoor antenna has obviously poor characteristics due to the lack of control of its shape, size, shielding and other features.

V. CONNECTING THE SET FOR OPERATION

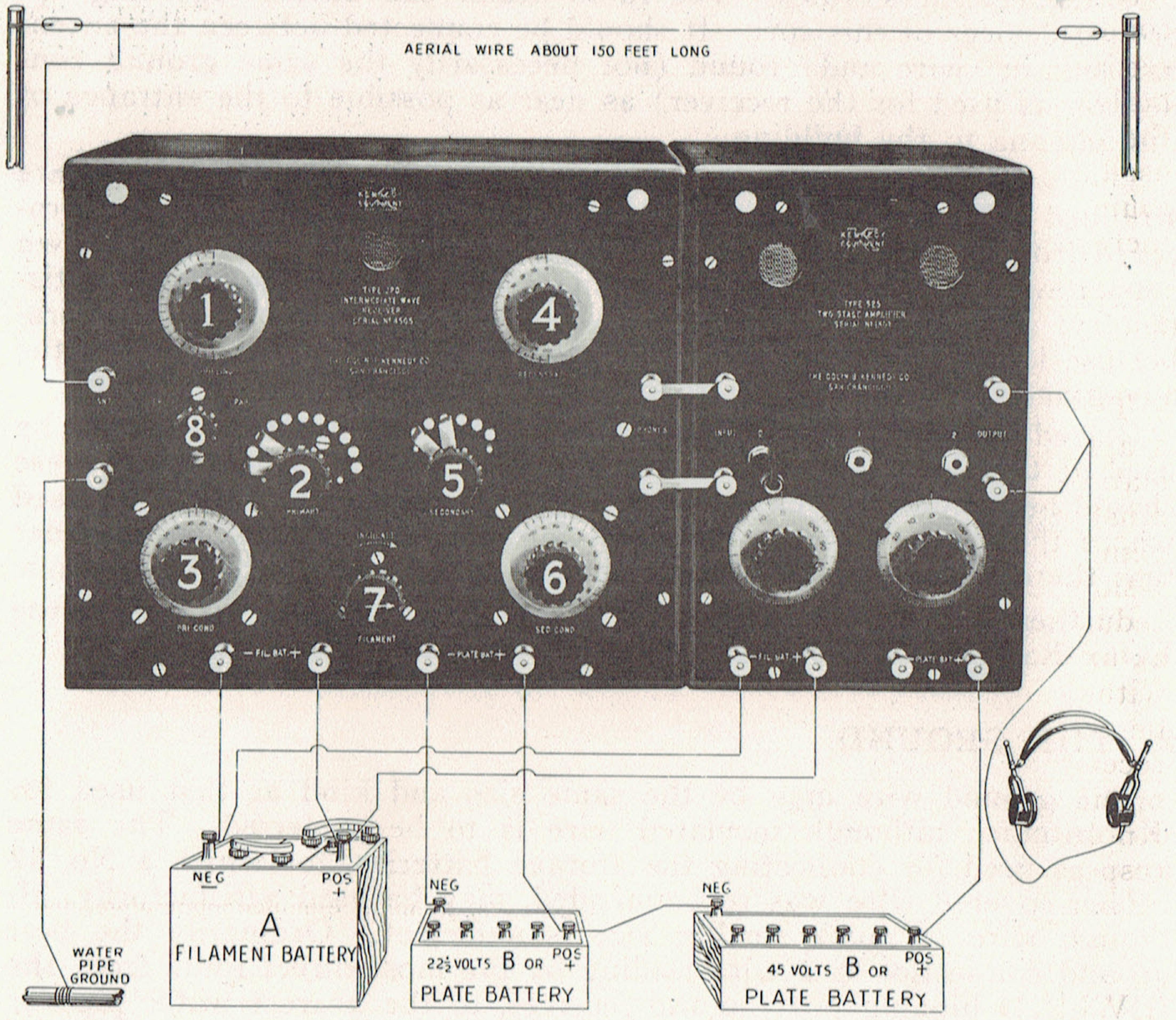

Figure 1.

1. CONNECTIONS TO THE RECEIVER.

"ANT."—Connect this binding post to the **antenna lead-in wire.**

"GND."—This terminal is connected to the **ground wire.**

"FIL.BAT."—The binding post to the **left** marked "—" should be

2. TUNING FOR A 400-METER BROADCASTING STATION.

The tuning procedure for a 400-meter broadcasting station is exactly the same as that outlined above for a 360-meter transmitter except that the **secondary tuning condenser knob** (No. 6) is set at 43 in accordance with Table II, in order to tune it for the slightly longer wave-length. The procedure above outlined should then be followed explicitly. It will be found, of course, that the final setting of the **primary tuning condenser** will also be at a higher point on account of the greater wave-length.

3. TUNING FOR 600-METER RADIO TELEGRAPH STATION USING THE SPARK SYSTEM.

The tuning procedure is exactly the same as that used for the 360-meter broadcasting stations except that it must be remembered that the primary and secondary circuits must be tuned to 600 meters. The settings for the secondary inductance switch and the secondary tuning condenser for 600 meters may be found in Table II. The **approximate** setting of the primary inductance switch may be found in the same table. The proper setting for the regeneration (Dial No. 4), as in the case of telephone broadcasting stations, should be just below the oscillating point. If, however, the signals are very weak it may be found desirable to permit the set to oscillate, for the signals are then increased in strength, although somewhat rough and distorted in quality.

4. TUNING TO RADIO TELEGRAPH STATIONS USING CONTINUOUS-WAVE TRANSMITTERS.

The principal difference between tuning for a continuous-wave telegraph station and a spark telegraph station or a telephone broadcasting station is that in the case of continuous-wave reception the receiver must **always** be in an oscillating condition. In other words, the regenerator dial (No. 4) should be turned approximately 10 or 15 divisions past the point where oscillation begins. Otherwise, the procedure in tuning for a continuous-wave station is precisely the same as used in tuning for a distant telephone broadcasting station. It goes without saying, of course, that the primary and secondary circuits must be tuned to the wave length at which the station which you want to receive is transmitting. Reference should be made to the tables for primary and secondary settings to determine the proper positions of Knobs Nos. 2, 5 and 6, controlling the primary and secondary circuits respectively.

XI. WHEN AN AMPLIFIER IS USED

When a Type-525 Two-Stage Audio-Frequency Amplifier is used in connection with the Type-220 Intermediate-Wave Receiver, tuning on the receiver should be done as explained above with the head telephones and without the use of the amplifier. This means that the plug on the amplifier should be connected in the first jack which is marked **"D."** After the receiver is entirely tuned and the desired signal is heard with the plug in the **"D"** position, the signal strength may be increased by moving the plug over to the jack marked **"1,"** con-

XIV. 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. 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.)

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.

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 without even 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.

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.

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, therefore, 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

1. INSTALLATION WITHOUT AMPLIFIER.

When no amplifier is used the complete installation of the Kennedy Intermediate-Wave Receiver consists of the following units:

1. **Kennedy Type-220 Intermediate-Wave Regenerative Receiver.**

2. A 6-Volt Storage Battery of 80 to 120 ampere-hours capacity. The larger the storage battery—that is, the higher its ampere-hour rating—the less frequently does it need to be charged. If it is intended to add an amplifier at a later date we heartily recommend that a storage battery of at least 100 or 120 ampere-hours capacity be procured.

3. One 22½-Volt "B" Battery (Plate Battery). We recommend the use of one of the larger batteries of this voltage. Its life is much longer than that of the smaller batteries and its cost but little more. It should have several **positive** terminals or taps so that a variation of voltage may be obtained when necessary. The voltage best suited to the different detector tubes varies between 16 and 22½ volts.

4. One detector tube, such as the standard Radiotron UV-200 or the Cunningham C-300.

5. One pair of Head Telephones or Receivers.

6. Antenna and Ground Equipment. (Read "Notes on the Installation of Antenna and Ground," as the location and conditions surrounding your antenna somewhat determine the amount of wire, insulators and other accessories to purchase.) In general, the equipment required will be:

a—Approximately 200 feet of antenna wire.
b—Two or more suspension insulators.
c—One lead-in insulator.
d—One lightning arrestor.
e—One ground clamp.

7. Wire for connection purposes. For connections to the storage battery, No. 12 rubber-covered copper wire should be used. For other connections, No. 16 insulated copper wire is satisfactory.

2. INSTALLATION WITH AMPLIFIER.

When the Kennedy Type-525 Two-Stage Audio-Frequency Amplifier is employed, the equipment comprising the installation consists of that listed above in addition to the following:

1. **Kennedy Type-525 Two-Stage Amplifier.**
2. Two amplifier tubes such as the standard Radiotron UV-201 or Cunningham C-301.
3. A loud-speaker may also be employed if it is desired to project the sound out into the room.

IV. NOTES ON THE INSTALLATION OF ANTENNA AND GROUND

1. THE ANTENNA OR AERIAL.

The simplest and most effective antenna for this receiver is, in general, a single aerial wire seventy-five to two hundred 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.** The wire should be connected to the receiving set by as short and direct a route as possible from one end of the aerial. If more convenient, however, the lead-in may be connected to the aerial wire at a central point instead of one end. 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 75 feet cannot be made available, two parallel wires spaced about 3 feet apart should be used. These should be connected together at both ends and a lead-in taken from one end. They should also be insulated at all points of contact with any but the connection leading to the receiver.

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.*

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.

Adjustment of "B" Battery Voltage.

It may be found that the detector tube in the receiver operates better on some plate voltage other than the 22½ volts originally supplied by the "B" battery. To satisfy yourself on this point, move the **positive** connection on the "B" battery which leads to the (+) or **right-hand** "PLATE-BAT." terminal of the **receiver** from the 22½-volt (+) terminal in turn to the other positive terminals on the battery and leave it connected at that one which gives the best results in the receiver. This trial should obviously be made when the set is tuned in and operating in order to determine the point at which the tube operates best.

3. 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. Run-down "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.

4. FAILURE OF RECEIVER TO FUNCTION.

If after making conections 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.