

SETS, RADIO TELEPHONE AND TELEGRAPH

TYPES SCR-109-A AND SCR-159

Radio Communication Pamphlet No. 27

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The following publication, entitled "Sets, Radio Telephone and Telegraph, Types SCR-109-A and SCR-159," Radio Communication Pamphlet No. 27, is published for the information and guidance of all concerned.

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BY ORDER OF THE SECRETARY OF WAR:

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SETS, RADIO TELEPHONE AND TELEGRAPH.

(Types SCR-109-A and SCR-159.)

SECTION I.

PURPOSE OF SETS—RANGES.

	Paragraph.
Purpose of sets—ranges.....	1

1. *Purpose of sets—ranges.*—The SCR-109-A and SCR-159 are ground radio sending and receiving vacuum tube sets providing three means of communication—undamped wave radio telegraphy, buzzer modulated radio telegraphy, and radio telephony. The two sets differ only in the antenna equipment. Their range of transmitting wave lengths is from 300 to 500 meters and receiving wave length from 300 to 1,100 meters. The SCR-109-A set will furnish reliable communication with a similar set over a distance of 60 miles by undamped wave telegraphy; over a distance of 30 miles by buzzer modulated telegraphy; and over a distance of 20 miles by telephony. The SCR-159 set will furnish reliable communication with a similar set over a distance of 80 miles by undamped wave telegraphy; over a distance of 50 miles by buzzer modulated telegraphy; and over a distance of 30 miles by telephony. The minimum output of either set is 34 watts and under favorable circumstances the distances given above may be greatly increased.

SECTION II.

GENERAL DESCRIPTION OF SETS.

	Paragraph.
Parts of set.....	2
Transportation—weight and bulk.....	3

2. *Parts of set.*—Each set is composed of power, radio, and antenna equipment. The power and radio equipment of both sets are alike. The power equipment consists of twelve storage batteries and a dynamotor. The radio equipment is contained in two chests—one carrying both the radio transmitter and the radio receiver, the other carrying the auxiliary radio apparatus and spare parts, as well as the dynamotor. The SCR-109-A set is provided with a V antenna, each leg of which is 175 feet long. The SCR-159 set is provided with a 40-foot umbrella antenna. Appropriate counterpoises are furnished with each antenna.

3. *Transportation—weight and bulk.*—The sets are too heavy to be transported by hand, thus motor or wagon transport must be provided. The chest containing the radio transmitter, which is mounted in one box, and the radio receiver, which is mounted in another box, measures 13 by 35½ by 17 inches high and weighs 35 pounds empty. This chest may be mounted upon the second chest and fastened to it by means of clamps provided. The second chest measures 13 by 35½ by 17 inches high and weighs 28 pounds empty. It is provided with three main compartments, the dynamotor being carried in the middle compartment. The boxes containing the radio-transmitting and the radio-receiving apparatus are 9½ by 16½ by 14½ inches high and 9½ by 14½ by 14½ inches high, respectively. Their respective weights are 30 and 25 pounds. The V antenna complete weighs 240 pounds, and has a bulk of 8 cubic feet. The mast sections are each 6 feet 10 inches long. The 40-foot umbrella antenna complete weighs 250 pounds and has a bulk of 12 cubic feet. Its mast sections are each 5 feet long. Each storage battery is 8 by 8 by 11 inches high and weighs 30 pounds. The dynamotor is 8¾ by 10 by 7¼ inches high and weighs 20 pounds. All figures given are approximate.

SECTION III.

DESCRIPTION OF POWER EQUIPMENT.

(Used in both sets.)

	Paragraph.
Storage batteries	4
Dynamotor	5

4. *Storage batteries.*—Twelve 4-volt storage batteries, type BB-28, are furnished with each set. These are 90-ampere-hour batteries of the lead acid type. Six batteries are in use at one time to furnish power. These are arranged in two groups in parallel, there being three batteries in series in each group. This arrangement provides a 12-volt, 180-ampere-hour source of power. Type BB-28 storage batteries have a nonspill plug. A compartment is provided in the cover of each battery for spare parts of this plug. For further information concerning storage batteries, see Signal Corps Training Pamphlet No. 8, entitled "Storage Batteries."

5. *Dynamotor.*—A dynamotor is provided for converting the 12-volt direct current furnished by the storage batteries to a 750-800-volt direct current. The motor takes 27 amperes at 12 volts; the output of the generator is approximately 0.2 of an ampere. The generator windings and terminals are well insulated, and all terminals are appropriately marked. The motor terminals are marked "+12 volts—"; the generator terminals are marked "+750 volts—." Lubrication is accomplished through dust-proof oil holes placed at

each end of the shaft. A 2-microfarad condenser, which is shunted across the generator terminals, is located in the base of the dynamotor.

SECTION IV.

DESCRIPTION OF ANTENNA EQUIPMENT.

	Paragraph.
The V antenna (used in the SCR-109-A set)	6
The umbrella antenna (used in the SCR-159 set)	7

6. *The V antenna (used in the SCR-109-A set).*—This antenna is a V-shaped antenna supported on three masts, each 20 feet high. The length of each leg is 175 feet. There is a lead-in wire 25 feet long. Each mast is made of three spruce sections, which are fitted with a spike at one end and a steel tube at the other to join with the next section. Six hundred feet of heavily insulated counterpoise wire is provided, which should be made in a V-shaped counterpoise with a third leg bisecting the V. The auxiliary antenna equipment comprises spare parts and such carrying rolls, reels, guy ropes, etc., as are needed to support or pack away the antenna. Ground mats, which may be used in place of the counterpoise under favorable conditions, are also a part of the antenna equipment.

7. *The umbrella antenna (used in the SCR-159 set).*—The umbrella antenna consists of six antenna wires each 50 feet long spread radially from the top of a 40-foot mast. At the end of each antenna wire there is attached a properly insulated guy rope, 95 feet long, by which the antenna wires are kept stretched out from the mast. The mast is composed of 10 spruce sections, each having a coupling tube to engage the next section. These sections are all alike except the top and bottom sections; the top section is fitted to receive the mast cap, the bottom section carries a heavy insulator on which it rests. The counterpoise system consists of six heavily insulated wires, each 90 feet long, radiating out from a central connecting block. Necessary spare parts and accessories are provided as a part of the antenna equipment.

SECTION V.

DESCRIPTION OF THE RADIO TRANSMITTER, TYPE BC-86-A.

(Used in both sets.)

	Paragraph.
Exterior	8
Interior	9

8. *Exterior.*—The transmitting apparatus proper is all contained in a wooden box, the front of which is a bakelite panel upon which the various switches, controls, meters, and binding posts are

mounted. Figure 1 shows a view of this panel. At the upper left-hand corner is a milliammeter reading from 0 to 500 milliamperes which measures the plate current of the vacuum tubes used in the transmitter. To the right of this meter is a thermoammeter, reading from 0 to 2.5 amperes, which indicates the antenna current. In the upper right-hand corner is a 28-point dial switch controlling the number of turns of inductance included in the antenna circuit and hence controlling the transmitting wave length. Below this dial switch is a large four-pole double-throw switch marked "Transmit-

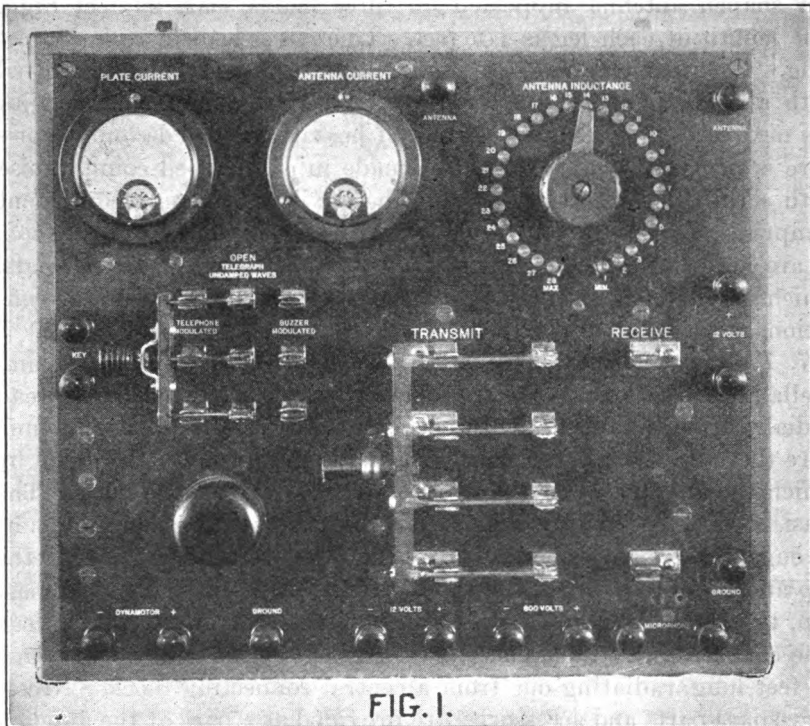


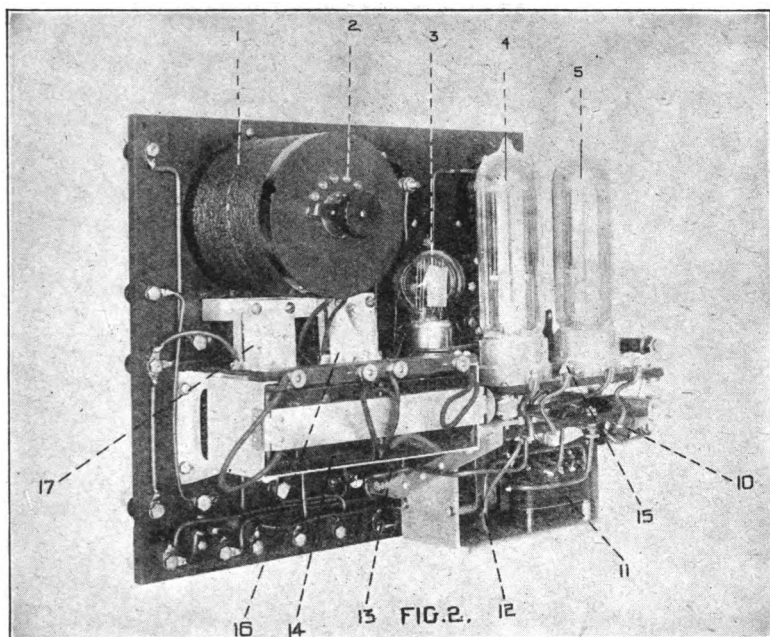
FIG. 1.

Receive." When thrown to "Transmit" the upper blade connects the antenna to the transmitting apparatus; the second blade closes the 800-volt plate circuit; the third blade closes the circuit of the 12-volt supply of the dynamotor, thus causing it to start up; the bottom blade closes the filament circuit of the transmitting tubes. When thrown to "Receive," the upper blade connects the antenna to the receiving apparatus (in a separate box) and the lower blade closes the filament circuit of the receiver vacuum tubes.

Beneath the two ammeters is a small three-pole double-throw switch which must be considered as having three positions—closed to the left, closed to the right, and open. This switch is thrown to the left when it is desired to use radio telephony, to the right to use

buzzer-modulated telegraphy, and left open for undamped wave telegraphy. Each position of the switch is appropriately marked. The upper blade of the switch connects either the buzzer or the microphone; the middle blade, in either position, closes the filament circuit of the modulator and the speech amplifier vacuum tube; the lower blade when thrown to the "Telephone Modulated" side short-circuits the key. The buzzer used in buzzer-modulated telegraphy is mounted just below the three-pole switch.

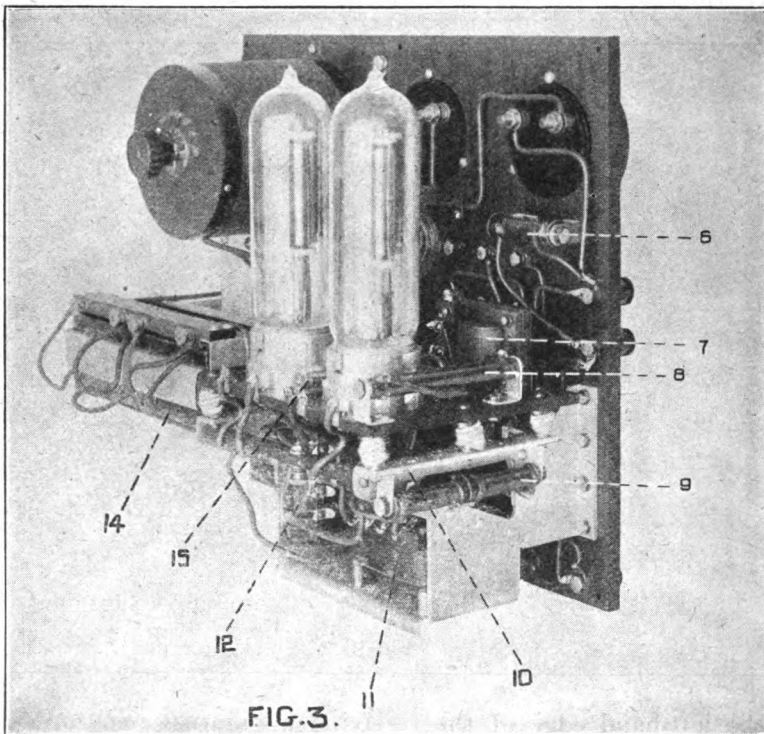
There are four binding posts along the right-hand edge of the panel which are to be connected to similarly marked binding posts



on the left-hand edge of the receiving apparatus. No cords are provided for these connections. The annunciator wire provided with the set should be used. On the left-hand edge of the panel is a pair of binding posts marked "Key," to which the key is connected by means of the proper cord. (Cord type CD-49.) The lower edge of the panel bears nine binding posts. The left-hand pair marked "-Dynamotor+" are to be connected to the motor (12-volt) side of the dynamotor; the next post marked "Ground" is to be connected to the counterpoise or ground; the next pair marked "-12 volts+" are to be connected to the storage batteries; the next pair marked "-800 volts+" are to be connected to the generator side of the dynamotor. The right-hand pair, marked "Microphone" are to have the microphone transmitter connected to them if it is not pro-

vided with the two-terminal plug to fit the jacks mounted directly above the binding posts. A cording diagram is shown in Figure 6.

9. *Interior.*—Access to the interior of the box is gained by removing a part of the back, sides, and top, which are joined together to form a cover and which are fastened to the box by clasps. The equipment inside the box is either directly attached to the rear of the panel or is mounted on brackets attached to the panel. By removing six machine screws, one located at each corner and one at the center of the top and bottom of the panel, the entire apparatus can be re-



moved as a unit from the wood box. Interior views of the box are shown in Figures 2 and 3. The method of mounting of the various parts is clearly shown in the illustration. It is to be noted that the shelf carrying vacuum tubes is mounted on coiled wire spring shock absorbers. The plate-coupling control handle is placed on the inside of the box as shown at 2, Figure 2. In Figures 2 and 3 the numbers show apparatus as follows:

1. Oscillating circuit—inductance coil.
2. Variable inductance switch for plate coupling.
3. VT-2 speech amplifier tube.
4. VT-4 oscillator tube.
5. VT-4 modulator tube.

6. 5,000-ohm resistance across key.
7. Transformer (type C-51), secondary in grid circuit VT-2 speech amplifier, primary in microphone circuit.
8. 10,000-ohm resistance in series with plate circuit of VT-2 speech amplifier.
9. 10,000-ohm resistance, leak resistance for grid circuit of VT-4 oscillator tube.
10. Radio-frequency choke coil (type C-25) in series with leak resistance of grid circuit of VT-4 oscillator tube.
11. Transformer (type C-50) coupling plate circuit of VT-2 speech amplifier with grid circuit of VT-4 modulator tube.
12. Transformer (type C-50) coupling plate circuit of VT-4 modulator tube with plate circuit of VT-4 oscillator tube.
13. Radio-frequency choke coil (type C-25) in series with circuit supplying plate current to VT-4 oscillator tube.
14. BA-2 batteries used to supply negative grid biasing potential for VT-2 speech amplifier and VT-4 modulator tubes.
15. 0.2-megohm resistance (type RS-48) across secondary of transformers in grid circuit of VT-2 speech amplifier.
16. 1,500-mmf. condenser (type CA-93) used to block the high-voltage direct current on the plate of the VT-4 oscillator tube from reaching the grid.
17. 1,775-mmf. condenser (type CA-81) oscillating current condenser connected between the grid and the filament of the VT-4 oscillating tube.

SECTION VI.

DESCRIPTION OF THE RADIO RECEIVER, TYPE BC-98-A.

(Used in both sets.)

	Paragraph.
Exterior.....	10
Interior.....	11

10. *Exterior.*—The receiving apparatus, consisting of a detector tube followed by two stages of audio-frequency amplification, is mounted in a wooden box having a bakelite panel for a front. This bakelite panel carries control handles and binding posts. A view of the front of the box is shown in Figure 4. Along the left-hand edge are four binding posts which are to be connected by annunciator or other suitable wire to similarly marked binding posts on the radio transmitter. Two binding posts on the upper right edge marked “+volts Aux. Plate Battery—” are provided in case it is necessary to use an external plate battery instead of the one that fits in the compartment provided in the interior. There are two binding posts marked “Aux. Tel.” to which telephones may be attached if they are not provided with a plug to fit the jack located above the binding post. There are two such jacks, one for each headset provided with the set.

Control handles for the coupling between primary and secondary and for the tickler coil are located in the upper left hand part of the panel. The tickler control handle is in front of and concentric with the coupling control handle. Each has its properly marked

scale. The tickler, secondary, and primary inductance coils are mounted one within the other in the order named. Changing the coupling between the primary and secondary coils does not change the coupling between the secondary and the tickler coil.

Below the coupling control handle is mounted a three-point switch that controls the number of turns of the primary inductance coil in circuit. Below this is the control handle for the primary variable air condenser.

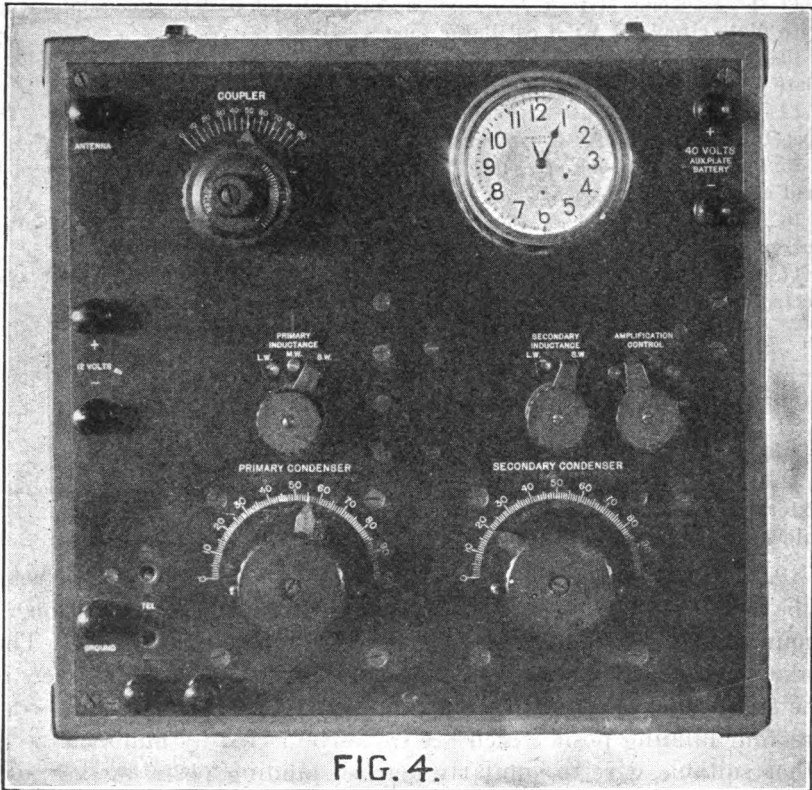


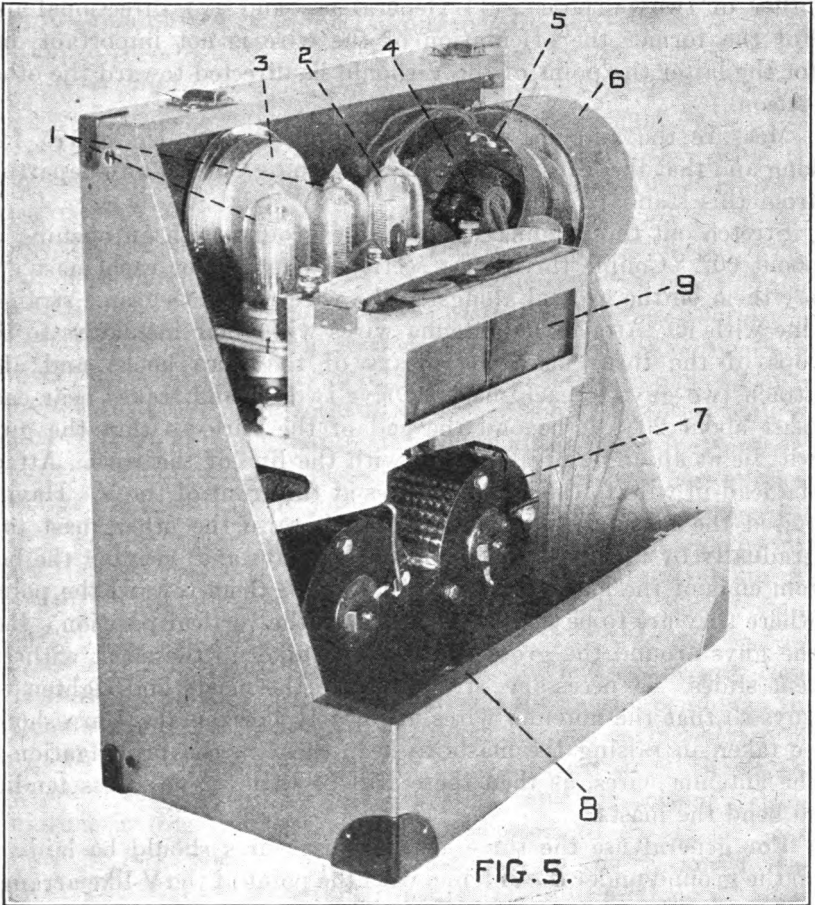
FIG. 4.

An eight-day clock of the automobile type is located in the upper right hand part of the panel. Below this are two switches; the one to the left, a two-point switch, controls the number of turns of the secondary inductance in circuit; the one to the right, a six-point switch, controls the amount of amplification. Below these switches is the control handle of the secondary variable air condenser.

11. *Interior.*—Access to the interior of the box is gained by removing part of the top, back, and sides which are joined to make a cover. This is fastened to the rest of the box by clasps. The method of mounting the equipment is very similar to that used in the radio

transmitter. A view of the interior is shown in Figure 5. The tubes are mounted upon a shelf which is supported by shock-absorbing springs. The two air condensers are shielded to avoid outside objects affecting their capacity. A spare grid leak resistance is fastened by spring clips to the inside of the cover. The reference numbers in the illustration refer to apparatus as follows:

1. Amplifying tubes (type VT-1).
2. Detector tube (type VT-1).



3. Eight-day automobile clock.
4. Tickler coil, coupled with secondary inductance.
5. Secondary inductance, coupled with primary inductance and with tickler coil.
6. Primary inductance, coupled with secondary inductance.
7. Primary variable air condenser (20 to 750 mmf.).
8. Secondary variable air condenser (20 to 750 mmf.).
9. Plate batteries (two type BA-2).

SECTION VII.

INSTALLING THE SETS.

	Paragraph.
Erecting the antenna and ground system of the SCR-109-A set.....	12
Erecting the antenna and ground system of the SCR-159 set.....	13
Installing the radio transmitting and receiving apparatus.....	14

12. *Erecting the antenna and ground system of the SCR-109-A set.*—The V antenna is used. This antenna can be installed for either of two purposes: (1) General use and (2) directional use. For the former the orientation of the wire is not important, but for the latter the point of the V should be directed toward the other station.

Measure the antenna wires to insure that each leg is 175 feet long and that the lead-in wire is 25 feet long. Correct any departure from this standard length.

Stretch out the antenna wires on the ground with an opening of about 60°. Couple three mast sections together for each mast and lay them on the ground alongside the wire and in the same straight line with it. Attach the antenna wires with their insulators to the tops of the three masts by means of the snap hooks and also attach two guys to each mast. Drive two ground stakes near each mast about 20 feet beyond the end of the wire, so that the guys will lie at an angle of about 45° with the line of the wire. Attach the lead-in wire to the antenna wires at the front of the V. Having raised the mast at the point of the V, raise the other mast tops gradually by using a light strain on the guys and, keeping the bottom ends of the masts on the ground, move them toward the points where they are to be when the mast is in the vertical position. Pass the guys around the ground stakes and take up the slack with the tent slides. If necessary, straighten up the masts and tighten the guys so that the antenna wires are nearly horizontal. Care should be taken in raising the masts to keep them in the prolongation of the antenna wires, as then there will be little or no stress tending to bend the masts.

For general use the three counterpoise wires should be laid out on the ground under the antenna with the point of the V-like arrangement near the radio transmitter. The counterpoise wires, each of which should be made 175 feet long, are arranged in a V with the third wire bisecting the angle made by the two legs of the V. For directional use the three wires should be laid out in the V-like arrangement with the point near the radio transmitter as before and with the free ends opening out toward the other station. The legs of the counterpoise are connected together electrically at the point of the V. Wherever possible the counterpoise wires should be sup-

ported on wood stakes about 1 foot high. This will give greater distance of transmission as well as better telephone communication.

Although ground mats are provided as a part of the antenna equipment, they are seldom used, for it is only under exceptional conditions that they will give as good results as the counterpoise. When used they should be buried under a few inches of earth, which should be well packed down on them. For general use the ground mats may be buried under the antenna wires. For directional use they should extend away from the radio transmitter toward the receiving station.

13. *Erecting the antenna and ground system of the SCR-159 set.*—At least five men are needed to erect the antenna. Three men are at the end of the antenna wires and guy ropes, two men raising the mast and adding the sections. The following directions should be observed:

Select clear space in which the antenna is to be erected. This clear space should be at least 200 feet in diameter. Place the mast and antenna equipment in the center of the space where the mast is to be erected. Take the top section (the one which has no iron pipe projecting from either end) and place the mast cap in one end of it. (The mast cap has eight sockets, which will hold the metal balls on the end of the antenna wires. It should have the 50-foot antenna lead-in wire permanently fastened to it.) Attach the six antenna wires to the mast cap by means of the ball and sockets provided. Unreel and lay out on the ground the six antenna wires and the guy ropes fastened to them. They should extend out radially from the mast, dividing the circle in equal parts—that is, they should make angles of 60° with each other:

Place a man at every other guy rope at the end of the guy rope. It is the duty of these three men to keep the mast upright as the sections are added. They do this by keeping the correct strain on the guy ropes, walking toward the mast as necessary. Select the eight other sections to be added (all alike) and the bottom section. (This has an insulator screwed on the bottom of it. If it is not screwed on, this should be done before adding the sections to the mast.) The mast will contain, when erected, 10 sections in all, 8 besides the top and bottom sections.

Add the sections, one man raising the mast directly upward and the other man adding the sections. Keep the mast upright, giving any directions that may be necessary to the men at the end of the guy ropes to do this. Having added all the sections, including the bottom one, allow the mast to rest on the ground. The two men at the mast then go out to the end of a guy rope and drive a stake in

the ground and by means of the metal tent slide tighten the guy to the proper tension. This is done for each of the six guy ropes. Be careful that the mast is upright and that it is not bent. Make any changes in the strain on the guys necessary to insure this.

It is to be noted that on each guy rope there is an insulator between it and the antenna wire to which it is fastened. The rope is also divided by insulators. It is absolutely necessary that the antenna wires be well insulated. The antenna wires must not touch an object such as a tree, building, etc. The lead-in wire hangs down beside the mast.

Having erected the antenna, place the counterpoise connecting block on the ground near the mast. (This is fitted with holes in which the ends of the counterpoise wire are plugged.) A short wire leading to the set box is attached to it. Reel out the six counterpoise

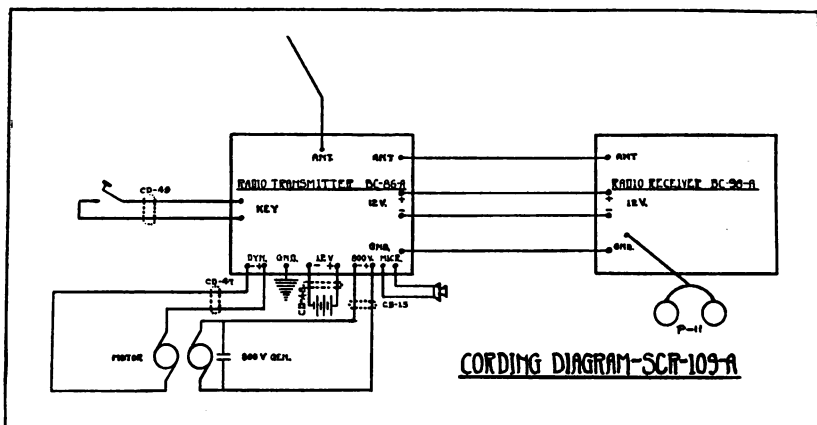


FIG. 6.

wires to their full extent, 90 feet. Each rests directly under an antenna wire. The counterpoise connecting block should be raised off the ground to properly insulate it. Wherever possible the counterpoise wires should be supported on wood stakes about 1 foot high. This will give greater distance of transmission as well as better telephone transmission.

14. *Installing the radio transmitting and receiving apparatus.*—A cording diagram is shown in Figure 6. The following directions should be observed:

a. Pull open the "Transmit-Receive" switch on the radio transmitter.

b. Remove the cover of the radio transmitter and place in the holder two BA-2 dry batteries. Connect the batteries to the terminals provided, being sure to observe the correct polarity as marked. Make all connections tight and clean. Fasten the batteries in place by the hinged clamp.

c. In a similar manner place two BA-2 dry batteries in the radio receiver. If no BA-2 batteries are available, an external 40-volt battery may be used. This should be connected with the proper polarity to the pair of binding posts on the radio receiver marked "+40 volt Aux. Plate Battery—."

d. Place in the radio transmitter a VT-4 vacuum tube in each of the two sockets, and a VT-2 tube in its socket. Leave off the cover of the radio transmitter, unless it is rainy or very damp.

e. Place in the radio receiver a VT-1 vacuum tube in each of the three sockets. Put on the cover of the radio receiver.

f. Connect in series three of the four-volt storage batteries, using the cords type CD-38. Similarly connect the other three four-volt storage batteries in series. Now connect these two sets of batteries in parallel. This is done by connecting the free *positive* terminal of the end battery in the first set to the free *positive* terminal of the corresponding battery in the second set; and by connecting the free *negative* terminal of the other end battery in the first set to the free *negative* terminal of the corresponding battery in the second set.

g. Using cord type CD-48, connect the storage batteries to the binding posts on the radio transmitter, marked "12 volts+." Observe the proper polarity. At the storage battery the positive end of the cord is attached to either of the two positive terminals that are connected together, and the negative end is attached to either of the two negative terminals that are connected together.

h. Connect by suitable lengths of annunciator wire (type W-7) the binding posts along the right-hand edge of the radio transmitter to the correspondingly marked binding posts along the left-hand edge of the radio receiver.

i. Connect the antenna lead-in wire to the binding post marked "Antenna" in the middle of the upper edge of the panel of the radio transmitter.

j. Connect the third binding post from the left at the bottom edge of the panel, marked "Ground," to the counterpoise block by means of the cord provided, if using the umbrella antenna. If using the V antenna, the binding post is connected by a piece of the counterpoise wire to the point of the V of the counterpoise.

k. Using cord type CD-47, connect binding posts on the radio transmitter marked "—dynamotor+" to the motor (12-volt) side of the dynamotor. Observe the proper polarity.

l. Using cord type CD-15, connect the binding posts on the radio transmitter marked "—800 volts+" to the generator (high voltage) side of the dynamotor. Observe the proper polarity.

m. Using cord type CD-49, connect the key to the binding posts marked "Key" on the radio transmitter.

n. Plug the microphone in the jacks provided in the radio transmitter. If no plugs are provided with the microphone, connect them to the binding posts beneath the jacks.

o. Plug the telephone receiver in one of the two jacks provided in the radio receiver. If a plug is not provided, connect the receiver to the binding post placed below the jacks. There is a right and wrong polarity for this connection to the binding post. To test for this connection, remove the cap of the telephone receiver and, using the diaphragm, test the strength of the permanent magnet of the receiver. Throw the "Transmit-Receive" switch to "Receive," thus causing the receiving vacuum tube to light up. If the strength of the magnet is increased, the telephones are connected with the right polarity.

SECTION VIII.

OPERATION AND CARE OF SETS.

	Paragraph.
To transmit	15
To receive	16
Calibration of transmitter	17
Calibration of receiver	18
Notes on operation	19
Care of sets	20

15. *To transmit.*—Pull open the small three-pole double-throw switch on the radio transmitter. Throw the "Transmit-Receive" switch to the "Transmit" position, being sure to make good contacts by pushing it firmly into this position. The dynamotor should start and the oscillator tubes should light up. Turn the "antenna inductance" switch to that stud which will give the wave length desired. Close the key of the transmitter and adjust the plate current of the oscillator tube by means of the eight-point plate coupling control switch located at the rear of the inductance coil. Continue this adjustment until the plate current ammeter shows a reading of 125 milliamperes or the value nearest this that can be obtained. With this adjustment the antenna current should be approximately 1.5 amperes. If it is not known what stud is to be used to produce the wave length desired, and if the set has not been calibrated (see par. 17), it will be necessary to determine the setting of the antenna inductance by the aid of a wavemeter. (See Radio Communication Pamphlet No. 28.) In using a wavemeter, it is well to remember that the transmitter should always be adjusted so that its plate current is approximately 125 milliamperes before the reading is taken.

No matter what kinds of signals are to be transmitted, the above adjustment should always be made. The three-pole double-throw switch controls the circuits for the various kinds of signals.

To send undamped wave telegraph signals, leave the three-pole switch open and operate the key. Only the oscillator tube is lighted.

To send buzzer modulated telegraph signals, throw the three-pole switch to the "Buzzer Modulated" position. All three tubes should light up and the buzzer should give a clear note. Operate the key to transmit signals.

To transmit speech, throw the three-pole switch to the "Telephone Modulated" position. All three tubes should light up. Speak distinctly in the microphone, holding it in an upright position close to the mouth.

Under some conditions the plate current of the oscillator tube can be made more than 125 milliamperes. This should not be done except where the extra power is absolutely necessary in order to reach the distant station. The adjustment of the plate coupling control should be determined by the reading of the plate current ammeter and not by the reading of the antenna ammeter. If with proper plate current the antenna current is too low, the fault lies in the antenna system.

16. *To receive.*—The primary and secondary circuits must be tuned to each other in the usual way. When picking up damped wave, buzzer modulated, or radio telephone signals, the tickler coil should have zero coupling and the coupling between primary and secondary should be at maximum. The amplification control should be on the maximum position. When the signals are picked up the coupling between primary and secondary should be loosened and the tickler coupling increased. Continue this adjustment until clear signals are obtained without interference. The tickler coupling should be adjusted so that the detector tube is just at the point of oscillating. If it should oscillate—indicated by the character of the signal changing—the tickler coupling should be reduced gradually until the clear signal appears. Adjusting the coupling will to some extent throw the primary and secondary circuits out of resonance and hence these should be readjusted with every change in the coupling adjustment. After these adjustments have been made the amplification control may be changed to the stud that gives the best readable result. This control will oftentimes reduce interfering noises that can not be tuned out, including static, so that the desired signal may be read through the interference.

When receiving undamped wave telegraphy, all adjustments are much more critical than when receiving damped waves. *The setting of the tickler control coupling and secondary condenser is particularly critical.* For picking up undamped wave signals the tickler coupling should be placed near the maximum position. Make sure that the receiver is oscillating. Test by placing a wet finger

in the antenna lead-in. A distinct sound will be heard if the set is oscillating. As soon as the desired signal is picked up final adjustments must be made. The heterodyne note heard is changed in pitch by adjusting either the tickler, coupling, or secondary variables. These should be adjusted to give the best results as regards selectivity and pitch.

After an operator becomes familiar with the set he will learn to pick up buzzer modulated and telephone signals with his tickler set at a point just below that which will cause the set to oscillate, and to pick up undamped wave signals with the tickler set just above that point which will cause the set to oscillate.

It is very difficult to pick up signals unless the radio receiver has been calibrated. If not calibrated and a signal of a definite wave length must be received, it will be found much easier to pick up this signal if the receiving set is tuned to that wave length by the use of a wavemeter.

17. *Calibration of transmitter.*—As soon as possible after receiving the radio set it should be calibrated. A table should be made out as follows:

Wave length.	Primary inductance tap.	Plate coupling tap.	Plate current.	Antenna current.
.....	1.....	.....	.....	.....
.....	2.....	.....	.....	.....
.....	3.....	.....	.....	.....
.....	Etc.....	.....	.....	.....

In making the table, the *standard antenna* should be used, great care being taken to have the correct length of the lead-in wire as well as each antenna wire. Any change in the antenna will invalidate the table, so that thereafter no change should be made in the antenna when it is erected. When completed the table should be labeled as to the height of antenna, length of each antenna leg, length of lead-in wire, and kind of ground used. It should then be firmly attached to the inside of the cover of the transmitter box.

The best method of procedure to get data for the table is, having erected the antenna, to place the antenna inductance dial on tap 1 and then vary the plate coupling control until the plate current is 125 milliamperes. The plate coupling tap, the plate current, and the antenna current are to be noted in their proper columns. The wave length is then to be measured and noted in its column. This is repeated for each tap of the antenna inductance switch. It is advisable to get the average of three readings before making the permanent table.

In using the table, the first three columns are to be directly used, the fourth and fifth columns being a check upon the condition of the transmitting apparatus. The whole table should be frequently checked so that it will always be known to be correct.

18. *Calibration of receiver.*—Picking up signals is made much easier if the approximate setting of the control handles for any wave length is known. These settings should be determined by the use of a wavemeter and noted in a table as follows:

Wave length.	Primary inductance.	Primary condenser.	Secondary inductance.	Secondary condenser.	Coupler U. W. Tgh.	Tickler U. W. Tgh.	Coupler telephony.	Tickler telephony.
.....
.....
.....

As in making the transmitter table, the standard antenna should be used and thereafter always erected without change. The completed table should be appropriately labeled and fastened to the inside of the receiver cover.

The first five columns can be filled in by the use of a wavemeter. Set the wavemeter oscillating at 300 meters and tune the primary and secondary circuits to resonance. Tune accurately and sharply, using a loose coupling. Note in the proper column the settings of the control handles. Repeat for 325 meters, 350 meters, etc., until the limit of wave length reception has been reached. The lower limit should also be determined and noted. It is advisable to get the average of three readings before making the permanent table.

The remaining four columns should be filled in as determined by settings when actually receiving signals from a distant station. It will be found that they can not be given a single accurate value. The limits of the value should be put in the column. For instance, it may be found for one wave length that the tickler coupling may vary from 4 to 7. This should be entered in the column thus: 4-7.

In using the table it must be remembered that the *settings are not final*. As soon as the signals are picked up, fine adjustment should be made. As previously noted, certain adjustments call for particular care.

19. *Notes on operation.*—For efficient operation, the SCR-109-A and SCR-159 sets require experienced operators who are familiar with the sets. If the operators are not familiar with the sets, it may be expected that at first only poor results will be obtained. The sets should be studied and their adjustments and peculiarities learned. The sets are capable of excellent transmission and reception. If a

set fails to operate satisfactorily the following points should be noted:

Carefully go over all connections made when installing the set. Check up as to correct connections, including correct polarity, and as to clean and tight connections.

Test the voltage of all batteries, both storage and dry.

See that the dynamotor is running properly and easily. See that it is properly oiled. The end covers of the dynamotor may be removed for ventilation if conditions are such that dirt, etc., will not get into the dynamotor.

Note that all switches make good contact. Press the double-throw switches firmly in their positions. *Clean their contacts frequently.*

Inspect the antenna. Check it as to correct length of legs and lead-in wire. See that the antenna wires are properly insulated. Improve the ground system if it admits of improvement.

When using the microphone, speak distinctly and directly into the transmitter. It is well to tap the transmitter smartly with the heel of the hand to make sure that its microphone element is not stuck.

Do not overlook the fact that the tickler adjustment is very critical, especially in receiving undamped wave radio telegraphy.

If the receiving set howls or sings try the same remedies you would on an amplifier. (See Radio Communication Pamphlet No. 9.)

In transmitting, if any of the three tubes fails to light, it may be due to a bad connection in the socket or a dirty contact pin. Clean the contact pin and replace the tube properly in the socket. If this does not remedy the defect, try a new tube. *In exchanging tubes always pull the "Transmit-Receive" switch so that it makes no contact.*

In receiving, all three of the tubes will light or none of them will, because their filaments are connected in series. Examine and clean the tube contact pins.

Sometimes a tube is defective. Find the defective one by trial of other tubes known to be in good condition.

Interchange the receiving tube until you have found the combination that works the best. Some tubes are better detectors than others. One of the receiving sockets is connected so that its tube is a detector.

In transmitting in an area where there is much traffic or under other conditions requiring an exact predetermined wave length, if your control settings have been made from the calibration curve, always check them by the aid of a wavemeter.

Be careful not to touch any of the metal parts of the transmitter when transmitting, as a shock will result. This applies particularly to the ammeters, the double-throw switches, and the various

inductance taps. Even when not transmitting, if the dynamotor is running, a shock is likely to be received. Thus it is well to *open the "Transmit-Receive" switch if it is necessary to make any adjustments other than by the control handles.*

In transmitting, unless it is rainy or very damp, the cover of the transmitter should be left off to allow plenty of ventilation for the VT-4 tubes.

In transmitting radio telephony, the plate current should continually vary. If it does not, the set is not working properly.

During a thunderstorm or other severe electrical disturbance, disconnect the antenna and ground wires from their binding posts and connect them directly to each other. This should always be done if the set is left installed without an operator being present.

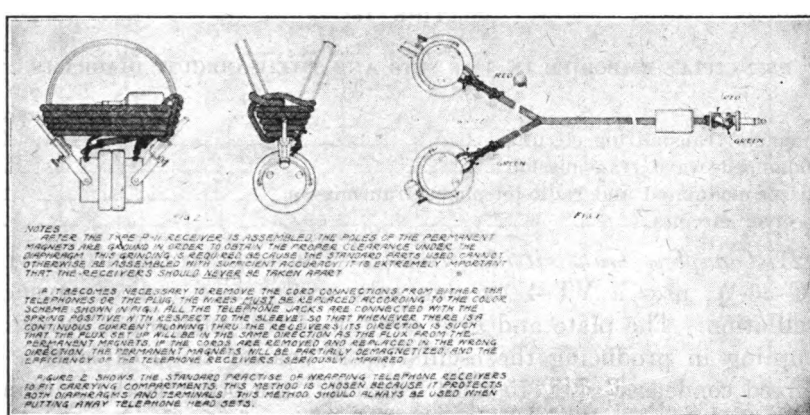


FIG. 7.

20. Care of sets.—The radio equipment must be handled with great care. The various parts are of delicate construction and rough handling will make the set inoperative. The transmitter and receiver boxes contain many parts closely packed together and with a great many connections. These are liable to become dislodged and the connection broken. The set should not be stored in a damp place nor unnecessarily exposed to rain. If the set becomes wet it should be carefully dried out but never exposed to intense heat.

The storage batteries must receive proper attention and care. (See Training Pamphlet No. 8.) The dynamotor panel should be kept clean and the dynamotor properly oiled. Use a good grade of oil and apply one or two drops after two hours' operation. It is important that not too much oil be used. It is much better to oil frequently with a small amount than to oil less frequently using a larger amount of oil.

The clock needs no attention other than winding and setting. It is wound by a key fastened at the top of the clock, access to which

is gained by turning the rim counterclockwise about 45° and pulling outward. The clock is set in the usual manner by pulling the key up until a click is heard.

Great accuracy has been observed in assembling the telephones and the microphone. There is a right and wrong polarity in connecting the cords of the telephones. If the cords are removed for any reason this must be taken into account in replacing them. Figure 7 shows the scheme of connection. The colors referred to in the figure are small, colored tracer threads running through the insulator. Figure 7 shows the standard practice of wrapping the telephones for storage. This method should always be followed. The microphone must be carefully handled and packed. It should need no other attention.

SECTION IX.

PRINCIPLES EMBODIED IN THE SETS AND THEIR CIRCUIT DIAGRAMS.

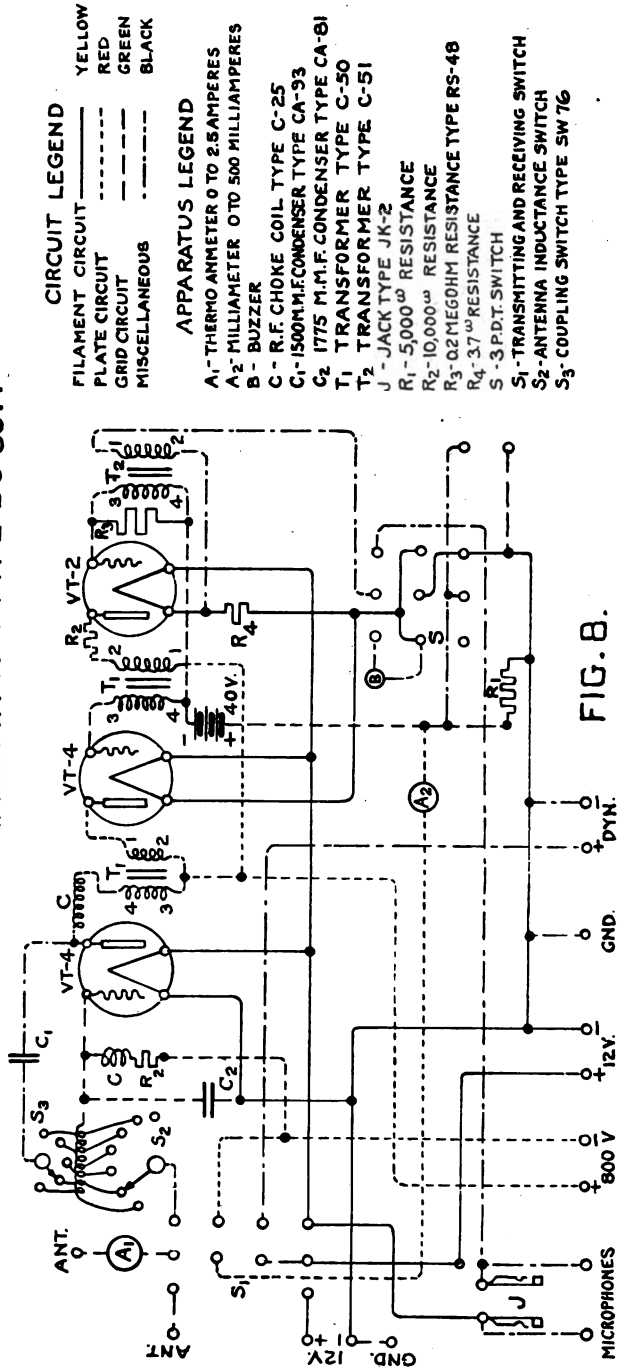
	Paragraph.
Complete transmitting circuits.....	21
Undamped wave transmission.....	22
Buzzer-modulated and radio-telephone transmission.....	23
Receiver circuits.....	24

21. *Complete transmitting circuits.*—The radio transmitter, type BC-86-A, uses a VT-4 vacuum tube to produce radio-frequency oscillation. The plate and grid circuits of this tube use a capacity coupling in producing the oscillations. One of these capacities is a fixed condenser of 1,775 mmf. capacity; the other is the antenna used with the set. The antenna, therefore, is a factor in determining the wave length of the set, and its electrical constants should not differ from those of the standard antenna. A complete circuit diagram of the transmitter is shown in Figure 8. The circuits are best studied by simplified circuits of each kind of transmission.

22. *Undamped wave transmission.*—Figure 9 shows the simplified circuit for undamped wave transmission. The VT-4 tube generates radio frequency, there being a capacity coupling. The inductance is controlled by two dial switches, a 28-point switch connected to the antenna and used for changing the wave length, and an 8-point switch determining within certain limits the coupling of the oscillatory circuit to the plate. The latter adjustment enables a fairly constant output to be obtained over the working range of wave length and with some variation in the antenna characteristics.

Radio-frequency choke coils limit the radio-frequency current to the proper circuits. The plate current is supplied from an 800-volt generator in series with a telegraph sending key having a 5,000-ohm resistance in parallel with it. The grid of the tube is connected

CIRCUIT DIAGRAM
RADIO TRANSMITTER TYPE BC-86A



CIRCUIT LEGEND

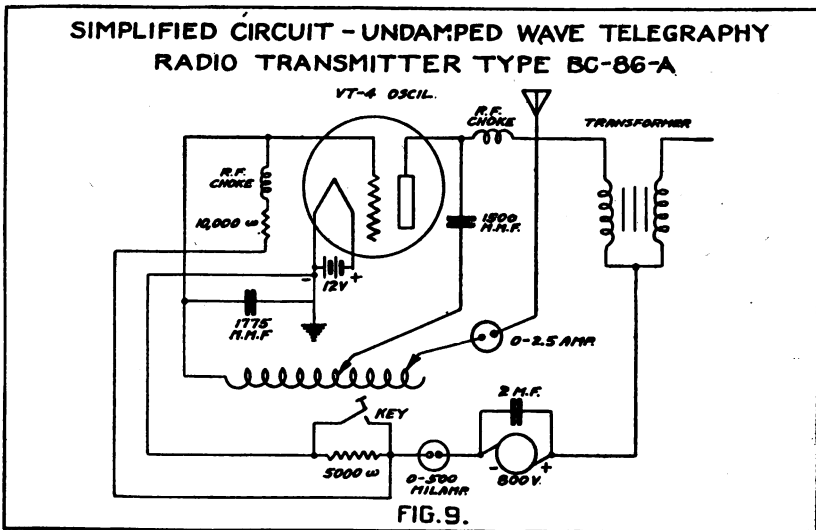
- FILAMENT CIRCUIT ———— YELLOW
- PLATE CIRCUIT - - - - - RED
- GRID CIRCUIT - - - - - GREEN
- MISCELLANEOUS - - - - - BLACK

APPARATUS LEGEND

- A1 - THERMO ANMETER 0 TO 2.5 AMPERES
- A2 - MILLIAMETER 0 TO 500 MILLIAMPERES
- B - BUZZER
- C - R.F. CHOKE COIL TYPE C-25
- C1 - 1500 M.M.F. CONDENSER TYPE CA-93
- C2 - 1775 M.M.F. CONDENSER TYPE CA-81
- T1 - TRANSFORMER TYPE C-50
- T2 - TRANSFORMER TYPE C-51
- J - JACK TYPE JK-2
- R1 - 5,000Ω RESISTANCE
- R2 - 10,000Ω RESISTANCE
- R3 - 0.2 MEGOHM RESISTANCE TYPE RS-48
- R4 - 37Ω RESISTANCE
- S - 3-P.D.T. SWITCH
- S1 - TRANSMITTING AND RECEIVING SWITCH
- S2 - ANTENNA INDUCTANCE SWITCH
- S3 - COUPLING SWITCH TYPE SW 76

FIG. 8.

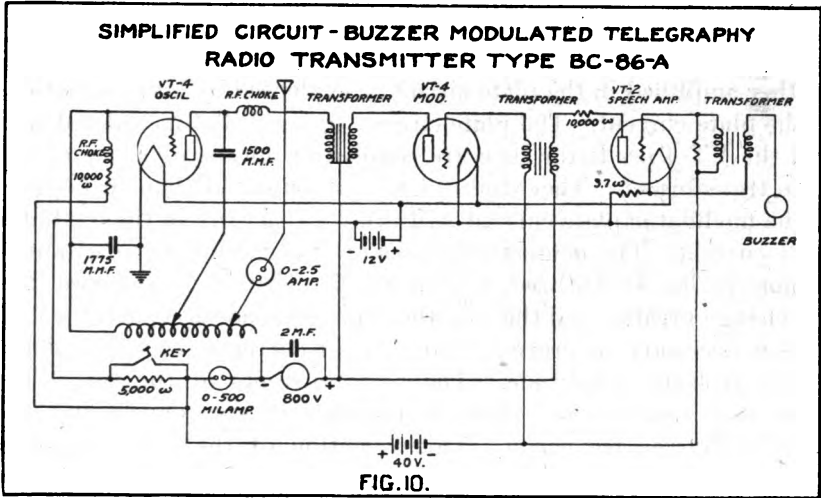
through a 10,000-ohm resistance to one side of the 5,000-ohm key resistance so that this key resistance is also in series in the direct current circuit between the grid and the filament. When the key is closed, the 5,000-ohm resistance is short-circuited and the grid potential is very nearly that of the negative side of the filament. Strong oscillations are then built up in the oscillatory circuit. When the key is opened the plate current has to pass through the 5,000-ohm resistance, causing a difference of potential to be established across the resistance so that a strong negative potential is placed on the grid, stopping the oscillations. The circuit therefore oscillates when the key is closed and stops oscillating when the key is opened. It will be noted that a 2 mf. condenser is placed across the 800-volt generator. This is contained in the base of the dynamotor.



23. *Buzzer-modulated and radio-telephone transmission.*—Figure 10 shows the schematic circuit and apparatus when buzzer-modulated telegraph signals are transmitted. It will be noted that the VT-4 oscillator circuit, including the telegraph sending key, is the same as used for U. W. telegraph, but the VT-4 modulator tube and the VT-2 speech amplifier are now in use. The buzzer is operated steadily by utilizing the drop in potential across the 3.7-ohm resistance in series with the filament of the VT-2 tube. The telegraph sending key operates the same as for U. W. telegraph signals—by stopping oscillations when the key is opened, by reason of the large negative potential then impressed on the grid of the oscillator tube.

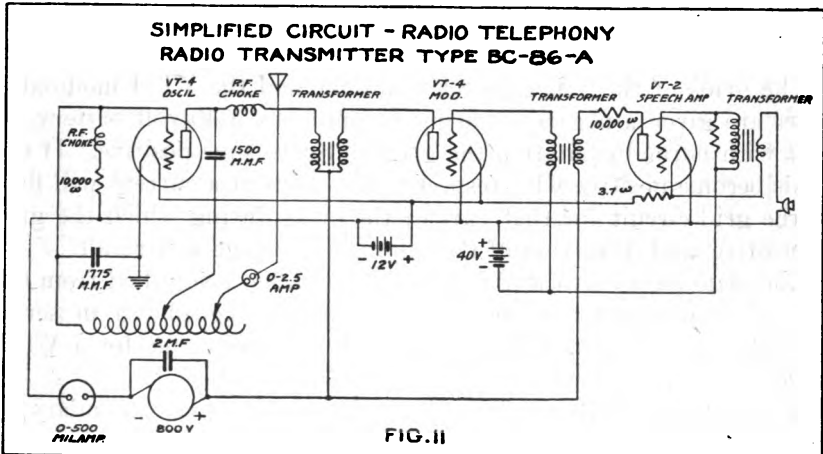
Figure 11 shows the schematic circuit and apparatus when telephone modulated signals are transmitted. The circuit of the VT-4

oscillator tube is still the same as for the other two conditions, except that the telegraph sending key is now short-circuited, and hence is not shown in the figure. The VT-4 oscillator is therefore producing oscillations continuously. A microphone transmitter is supplied



power by utilizing the voltage drop across the filament of the VT-2 tube.

The operation of the speech amplifier and modulator circuits is as follows, it being understood that the description applies to both



the telephone-modulated and the buzzer-modulated telegraph conditions: Buzzer or voice frequency currents are set up in the primary circuits of the first transformer. The voltage set up across the primary is stepped up to a larger value by the secondary winding, and

this voltage is impressed upon the grid of the VT-2 speech amplifier. This tube operates as an amplifier, so the alternating current voltages on the grid appear in the plate circuit in amplified form but undistorted. The alternating current voltage in the plate circuit of the VT-2 tube is then transferred to the grid of the VT-4 modulator tube by means of a one to one ratio transformer. The audio-frequency voltage on the grid of the VT-4 modulator tube then appears further amplified in the plate circuit as evidenced by large variations in the plate current. The plate circuits of the VT-4 modulated tube and the VT-4 oscillator tube are coupled by means of a one to one ratio transformer. The windings are so connected that an *increase* in the modulator plate current will cause an *increase* in the oscillator plate current. The magnetic flux set up by current in the windings is more or less neutralized, so that the flux density in the core does not change greatly, and the core therefore does not become saturated. This is necessary to prevent distortion of currents set up by sound waves of large amplitude. The plate currents of the two VT-4 tubes then increase and decrease together in accordance with the voice or buzzer frequency. This variation of the oscillator plate current causes the radio-frequency oscillations generated by the tube to increase and decrease in amplitude so that the wave sent out from the antenna undergoes the voice or buzzer frequency modulation.

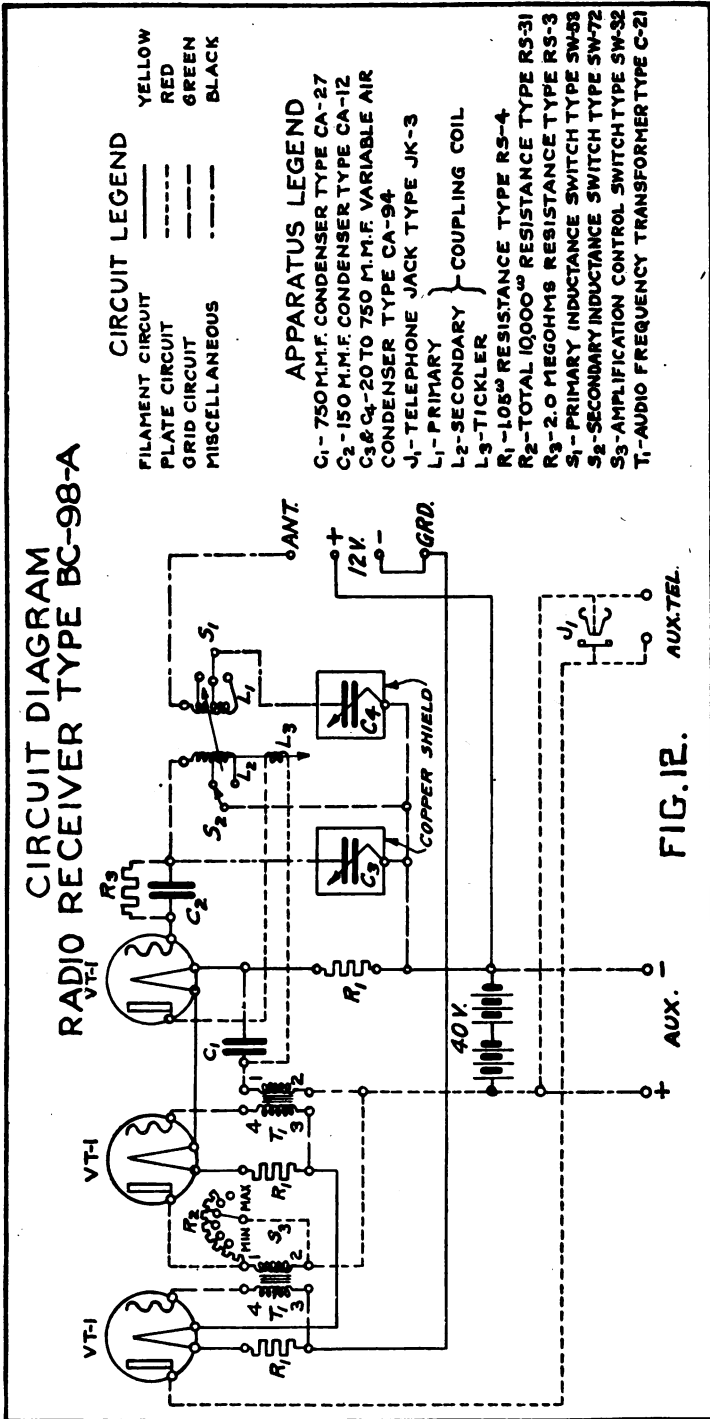
The current delivered by the 800-volt generator varies between wide limits, so the generator must be bridged by a condenser of at least 2 mf. capacity in order to prevent the inductance of the generator retarding the rapid change of plate current, and to prevent the self-induction of the generator causing the production of voltages across the generator sufficient to cause its breakdown.

The grids of the VT-2 speech amplifier and the VT-4 modulator tubes are given a negative biasing potential by a 40-volt battery, so that with normal excitation the grids never become positive. If the grids become positive with respect to the filament a current will flow in the grid circuit for that part of the cycle during which the grid is positive, and distortion of the impressed voltage will result.

The plate circuit of the VT-2 speech amplifier is supplied from the 800-volt generator, a 10,000-ohm resistance being placed in series with the circuit to limit the current to the proper value for a VT-2 tube.

A 0.2 megohm leak resistance is connected across the secondary of the transformer in the grid circuit of the speech amplifier tube in order to definitely limit the otherwise high impedance of the winding and thereby prevent tube blocking.

24. *Receiver circuits.*—The wiring diagram of the radio receiver is shown in Figure 12. The antenna circuit consists of a variable air



condenser and an inductance having three taps connected in series. This inductance is inductively coupled to a secondary circuit, consisting of an inductance having two taps and a variable air condenser. The grid circuit of the detector tube contains a grid leak resistance and a condenser. The proper positive grid biasing voltage is obtained by using the drop across the resistance in the filament circuits. The detector tube is followed by two stages of audio-frequency amplification coupled by audio-frequency iron core transformers. The plate circuit of the detector tube contains a tickler coil. By careful adjustment of the coupling between the tickler coil and the secondary inductance the detector circuit will be made regenerative, increasing the strength of spark and telephone signals. By increasing the tickler coupling still more the detector circuit will oscillate, permitting heterodyne reception of undamped wave telegraph signals. A switch on the front of the set box panel provides control of the amplification. This is accomplished by placing a variable shunt across the primary side of the audio-frequency transformer coupling the two amplifier tubes. A type P-11 head set is to be plugged into the jack in the plate circuit of the second amplifier tube. The plate current for all three tubes is supplied from a 40-volt battery consisting of two type BA-2 batteries connected in series, or may be supplied by an external 40-volt battery connected to the auxiliary binding posts provided. The filaments of the three type VT-1 tubes are connected in series and are supplied through the "Transmit-Receive" switch on the transmitting set box panel.

SECTION X.

SPECIAL WIRING FOR LONG-DISTANCE TRANSMISSION.

	Paragraph.
Purpose of special wiring.....	25
Authority required to make the change.....	26
Detailed instructions for making the change.....	27
Precautions necessary in using the modified set.....	28
Marking the modified set.....	29
Parts of modified set not in use.....	30

25. *Purpose of special wiring.*—It is possible to change the wiring of the radio transmitter so that the modulator tube is connected in parallel with the oscillator tube. This practically doubles the output of the set and hence greatly increases the distance of reliable undamped wave telegraph transmission. When the wiring of the set is changed for this purpose, it can not be used for buzzer-modulated telegraphy nor for radio telephony.

26. *Authority required to make the change.*—The change in the wiring should not be made unless absolutely necessary to obtain the

extra power for the distance over which communication must be maintained. Special authority of the signal officer of the unit must be obtained before the change is made. The work should be done by a competent radio electrician. The set should never be turned back to the depot without it being changed back to the standard wiring.

27. *Detailed instructions for making the change.*—The following directions should be strictly observed: The wiring diagram after changes have been made is shown in Figure 13. This should be compared with Figure 8. In Figure 13 the drawing items have the same labels and number as Figure 8, but with an exponent added to more clearly identify them. A study of the other illustrations of this pamphlet, as well as Figures 8 and 13, will aid in the identification. *Make only the specific changes listed.* These have been found to give the best results possible while permitting the set to be changed back to its standard wiring at any time.

(VT-4)¹ refers to VT-4 tube at left of diagram.

(VT-4)² refers to VT-4 tube at right of diagram.

R₁¹ refers to R₂ connected through choke coil C¹ to grid of (VT-4)¹. (This is the lower resistance tube at extreme right of set looking at the back of set.)

R₂² refers to R₂ connected to plate of VT-2 tube. (This resistance is just above resistance R₁¹ at extreme right of set looking at the back of set.)

C¹ refers to choke coil connected to grid of (VT-4)¹.

C² refers to choke coil connected to plate of (VT-4)¹.

T₁¹ refers to transformer T₁ connected to choke coil C² and plate of (VT-4)¹. (This transformer is left-hand one of the two large ones looking at the back of set.)

T₁² refers to transformer T₁ connected to grid of (VT-4)² through R₂² to plate of VT-2 tube. (This transformer is same size as the above and is at the right looking at back of the set.)

Using the above symbols, the following changes in connections should be made:

a. Remove connection from terminal 1 of transformer T₁¹ going to plate of (VT-4)².

b. Connect plate of (VT-4)² to plate of (VT-4)¹.

c. Connect together terminals 3 and 4 of transformer T₁¹. This will produce same results as if +800-volt lead was connected direct to choke coil C².

d. Remove connections from grid of (VT-4)² going to terminal 3 of transformer T₁².

e. Connect grid of (VT-4)² direct to grid of (VT-4)¹.

f. Remove +800-volt connection from terminal 1 of transformer T₁².

g. Disconnect R_2^2 from plate of VT-2 and terminal 2 of transformer T_1^2 .

h. Connect R_2^2 in parallel with R_2^1 . This will make the resistance of the two in parallel 5,000 ohms. These two resistances are placed one directly over the other in the set as stated above.

i. Remove left filament lead of $(VT-4)^2$ going to three-pole double-throw switch at right.

j. Connect left filament terminal of $(VT-4)^2$ to left filament terminal of $(VT-4)^1$. That is, the filaments of $(VT-4)^1$ and $(VT-4)^2$ will be in parallel.

k. Remove back of antenna inductance. Disconnect all eight leads going from switch S_3 on back disk of antenna coil. Reconnect the eight leads of coupling switch S_3 to coil taps connected to following numbers on front panel: 4, 5, 6, 8, 10, 12, 14, and 16.

l. The switch contacts on front of the set are numbered; those on coupling switch at back of set are not numbered. Looking at the unnumbered contacts on the back of the set, the left-hand contact after the above change would be connected to the lead inside of the coil going to contact No. 4 on the front of the set. The next to the left contact on the back of the set will connect to the lead connected to contact No. 5 on front of set, etc., as enumerated in *k*.

m. For use with some antennae, the condenser at C_1 should have double its present capacity; that is, 3,000 mmf. New condensers of 3,000 mmf. should be installed if available after removing the condenser originally supplied in the set.

28. *Precautions necessary in using the modified set.*—In using the set after the changes outlined above have been made, care must be taken to overload as little as possible the output of the high-voltage side of the dynamotor. The current from the dynamotor is shown on the plate ammeter. Two hundred milliamperes is the normal output. With the two tubes in parallel the plate current will probably be between 250 and 400 milliamperes. The plate current can be kept at a minimum by taking care to adjust the coupling switch on the back of the antenna coil for minimum plate current and yet keep the antenna current at the desired value. If the plate current used for transmission is over 200 milliamperes, care should be taken that the key is kept closed no longer than necessary. It is believed a plate current of 300 to 350 milliamperes or over can be used safely for transmitting (measured when key is closed), as the average current during sending will not exceed one-half to two-thirds of the current with the key closed.

29. *Marking the modified set.*—Any sets modified described above should be tagged in some manner to show that they have been modified and can not be used for telephony or modulated telegraphy.

30. *Parts of modified set not in use.*—As indicated in Figure 13, certain parts of the set are not in use after it is modified. As these include the VT-2 tube and the 40-volt dry battery, they should be removed from the set.

SECTION XI.

PARTS LISTS OF SETS.

	Paragraph.
Equipments in the SCR-100-A set.....	31
Equipments in the SCR-159 set.....	32
Parts lists of above equipment.....	33

31. *Equipments in the SCR-109-A set.*—The SCR-109-A set comprises the following equipments:

- One power equipment, type PE-36.
- One radio equipment, type RE-19-A.
- One antenna equipment, type A-9-B.

32. *Equipments in the SCR-159 set.*—The SCR-159 set comprises the following equipments:

- One power equipment, type PE-36.
- One radio equipment, type RE-19-A.
- One antenna equipment, type A-14.

33. *Parts lists of above equipment.*—These equipments are made up of parts as noted below:

Power equipment, type PE-36:

- Battery, type BB-28; 12, 6 in use, 6 spare.
- Dynamotor, type DM-13; 1.

Radio equipment, type RE-19-A:

- Battery, type BA-2; 8, 4 in use, 4 spare.
- Chest, carrying, type BE-49; 1, for radio transmitter and receiver.
- Chest, carrying, type BE-50; 1, for spare parts and accessories including dynamotor.
- Cord, type CD-15; 1, transmitter to high voltage side of dynamotor.
- Cord, type CD-38; 8, for storage battery connections.
- Cord, type CD-47; 1, transmitter to low voltage side of dynamotor.
- Cord, type CD-48; 1, transmitter to storage batteries.
- Cord, type CD-49; 1, transmitter to key.
- Head sets, type P-11; 2.
- Key, type J-12 or J-2; 1, telegraph sending.
- Pliers, side cutting, 6-inch; 1 pair.
- Radio receiver, type BC-98-A; 1.
- Radio transmitter, type BC-86-A; 1.
- Screw driver, electricians, 3-inch blade; 1.
- Tape, friction, $\frac{3}{4}$ -inch; 1 pound.
- Transmitter, type T-3; 1, microphone.
- Tube, type VT-1; 6, 3 in use, 3 spare.
- Tube, type VT-2; 2, 1 in use, 1 spare.
- Tube, type VT-4; 4, 2 in use, 2 spare.
- Wire, type W-7; 2 pounds.

Antenna equipment, type A-9-B (V antenna) :

- Antenna, type AN-8-A ; 2, on 2 reels, 1 in use, 1 spare.
- Bag, type BG-12 ; 2, carrying.
- Cord, type RP-3 ; sash No. 5, olive drab, 300 feet.
- Guy, type GY-4 ; 8, complete on 4 reels, 6 in use, 2 spare.
- Hammer, 2-pound crosspein ; 1.
- Insulator, type IN-10 ; 4 spare.
- Mast section, type MS-14 ; 12, 9 in use, 3 spare.
- Mat, type M-5 ; 3, ground.
- Pliers, combination, 6-inch ; 1 pair.
- Reel, type RL-3 ; 10 hand, 4 for counterpoise, 4 for guys, 2 for antennas.
- Roll, type M-15 ; 1, carrying.
- Stake, type GP-8 ; 12 ground, 6 in use, 6 spare.
- Tape, friction ; 1 roll.
- Wire, type W-4 ; 50 feet, lead-in.
- Wire, type W-24 ; 750 feet on a spool, antenna.
- Wire, type W-30 ; 600 feet, on 4 reels, counterpoise.

Antenna equipment, type A-14, 40-foot umbrella :

- Antenna, type AN-12 ; 1, six 50-foot wires with insulators and cords attached.
- Bag, type BG-6 ; 2, carrying.
- Bag, type BG-7 ; 1, carrying.
- Connector, type M-6 ; 2 spares for antenna wires.
- Cord, type CD-94 ; 1, to counterpoise. Insulator block BL-2 on one end.
- Counterpoise, type CP-3 ; 1, six 90-foot wires.
- Hammer, 2-pound crosspein ; 2.
- Insulator, type IN-4 ; 1, for bottom of mast.
- Mast cap, type MP-4 ; 1, with 50 feet lead-in wire.
- Mast section, type MS-1 ; 1, top.
- Mast section, type MS-2 ; 8, intermediate.
- Mast section, type MS-3 ; 1, bottom.
- Reels, type RL-3 ; 13, 6 for antenna, 6 for counterpoise, 1 for lead-in.
- Stakes, type GP-2 ; 6, ground.
- Straps, type ST-5 ; 6, for bundling mast sections.

SIGNAL CORPS PAMPHLETS.

(Corrected to June 1, 1922.)

RADIO COMMUNICATION PAMPHLETS.

(Formerly designated Radio Pamphlets.)

No.

1. Elementary Principles of Radio Telegraphy and Telephony (edition of 4-28-21). (W. D. D. 1064.)
2. Antenna Systems.
3. Radio Receiving Sets (SCR-54 and SCR-54-A) and Vacuum Tube Detector Equipment (Type DT-3-A).
5. Airplane Radio Telegraph Transmitting Sets (Types SCR-65 and 65-A).
9. Amplifiers and Heterodynes. (W. D. D. 1092.)
11. Radio Telegraph Transmitting Sets (SCR-74 ; SCR-74-A).
13. Airplane Radio Telegraph Transmitting Set (Type SCR 73).
14. Radio Telegraph Transmitting Set (Type SCR-69).

17. Sets, U. W. Radio Telegraph (Types SCR-79-A and SCR-99). (W. D. D. 1084.)
20. Airplane Radio Telephone Sets (Types SCR-68; SCR-68-A; SCR-114; SCR-116; SCR-59; SCR-59-A; SCR-75; SCR-115).
22. Ground Radio Telephone Sets (Types SCR-67; SCR-67-A). (W. D. D. 1091.)
23. U. W. Airplane Radio Telegraph Set (Type SCR-80).
24. Tank Radio Telegraph Set (Type SCR-78-A).
25. Set, Radio Telegraph, Type SCR-105 (W. D. D. 1077).
26. Sets, U. W. Radio Telegraph, Types SCR-127 and SCR-130. (W. D. D. 1056.)
27. Sets, Radio Telephone and Telegraph, Type SCR-109-A and SCR-159. (W. D. D. 1111.)
28. Wavemeters and Decremeters. (W. D. D. 1094.)
30. The Radio Mechanic and the Airplane.
40. The Principles Underlying Radio Communication (edition of May, 1921). (W. D. D. 1069.)

WIRE COMMUNICATION PAMPHLETS.

(Formerly designated Electrical Engineering Pamphlets.)

1. The Buzzerphone (Type EE-1).
2. Monocord Switchboards of Units Type EE-2 and Type EE-2-A and Monocord Switchboard Operator's Set Type EE-64. (W. D. D. 1081.)
3. Field Telephones (Types EE-3; EE-4; EE-5).
4. Laying Cable in the Forward Area (formerly designated Training Pamphlet No. 3).
6. Trench Line Construction (formerly designated Training Pamphlet No. 6-a).
7. Signal Corps Universal Test Set, Type EE-65. (W. D. D. 1020.) (2d edition.)
10. Wire Axis Installation and Maintenance Within the Division. (W. D. D. 1068.)
11. Elements of the Automatic Telephone System. (W. D. D. 1096.)

TRAINING PAMPHLETS.

1. Elementary Electricity (edition of 1-1-21). (W. D. D. 1055.)
2. Instructions for Using the Cipher Device, Type M-94. (W. D. D. 1097.)
For official use only.
4. Visual Signaling.
7. Primary Batteries (edition of 6-9-22). (W. W. D. 1112.)
8. Storage Batteries (formerly designated Radio Pamphlet No. 8).

FIELD PAMPHLETS.

1. Directions for Using the 24-cm. Signal Lamp (Type EE-7).
2. Directions for Using the 14-cm. Signal Lamp (Type EE-6).

TRAINING REGULATIONS.

(Signal Corps subjects.)

450-190—Elements of Cryptanalysis.



